

## A CLOSE LOOK AT THE ROCK ART OF AMISTAD NATIONAL RECREATION AREA, TEXAS

Pictograph Paint and Accretion Analysis Techniques Improve Understanding of Rock Art Deterioration and Preservation Processes

By WARNA KALUARACHCHI, JOSEPH H. LABADIE, AND JON RUSS

**M**OST NATIONAL PARK SYSTEM UNITS IN THE WESTERN United States have a variety of Native American cultural sites. Many parks have prehistoric or historic sacred paintings, known to archeologists as pictographs (fig. 1); petroglyphs are made by incising or scratching designs into rock surfaces. Although pictographs represent an important component of many early societies, the scientific study of these artifacts has been fraught with frustration due primarily to the inability to affiliate the art with the cultures that produced it. This will soon change with the recent developments in techniques for analyzing prehistoric paints. Samples of paint so small as to not compromise the artifact can now be collected and analyzed to determine the age and chemical composition. A completely new source of archeological information is now at hand that will begin to allow these important artifacts to be integrated into cultural reconstructions.

In most cases rock surfaces that contain prehistoric paints are not static; instead they are active biogeochemical systems. The result of this activity is the formation of rock accretions. These natural accretions often cover the prehistoric paints, sometimes protecting them, but

also causing them to appear faded. Because the processes that form the accretion may affect the paint materials, accurate and reliable analyses of the paints require that we understand the relationship between the paint components and the natural rock substrate-accretion system. This information is also particularly



Figure 1. Large, multicolored, Pecos River style pictographs such as this shaman scene number in the thousands at Amistad National Recreation Area and are a testament to a period of highest cultural activity 3,000-4,200 years ago. Scientists are now using new radiocarbon paint dating and accretion analysis techniques to date the art and assess the processes of deterioration.

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National Park Service  
Natural Resource Information Division  
Room 215  
P.O. Box 25287  
Denver, CO 80225-0287  
Phone (303) 969-2147

E-mail: "jeff\_selleck@nps.gov" & NPS cc:Mail  
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## IN THE NEXT ISSUE. . .

*Several contributors will report the results of conferences around the country. We'll hear about hot water organism research and the debate over commercial development of publicly owned, financially valuable, research specimens at Yellowstone; the Greater Yellowstone Ecosystem conference; the Partners in Flight gathering in New Jersey; and the Wildlife Society conclave in Portland. Also look for articles on retrieving biological information over the Internet for park cc:Mail users, landslide assessment at Hagerman Fossil Beds, and a look back at the first class of natural resource management trainees from 1984.*

## GAUGING PROGRESS

FIFTEEN YEARS AGO THIS FALL, PACIFIC PARK SCIENCE, THE precursor to this publication, made its debut with the goal of exploring, amplifying, and relating the links between research and resource management. This focus has been the hallmark of the publication since its inception, and the articles have traced our development in bringing science to bear on the resource management activities in the parks. This issue, we pay homage to our roots by looking back on two stories carried in that premier issue in a new department called, "Fifteen Years Ago in Park Science."

Appearing from time to time, this section will revisit natural resource and science issues that commanded our attention 15 years ago. These brief follow-up articles will point out how far we've come since then, whether we've changed much in our application of science, which resource management techniques have proven to be especially useful, and in which areas we've progressed or lost ground. At their best, they will provoke thought on where we're headed, based on where we've been. Most of the time, however, they will simply be fun and interesting to read.

In some cases, as with computer technology (the subject of a special *Park Science* issue in 1984), we are sure to chuckle as we remember the venerable and frustratingly slow 8088 processor machines that were state of the art then. On the other hand, issues like bear management (the main follow-up story this issue) illustrate a more substantive point. An unfolding story 15 years ago about Sierra Nevada bear management reads very differently from the version told today, due to improvements in both resource management techniques and the information available to managers from further research. Resource management tools and the science that supports them only develop given time, and this new department will allow us to tell the rest of the story.

Following up on early articles, is no more important, certainly, than reporting new research and resource management work as it occurs. This is our bread and butter, our focus, and I want to encourage everyone to continue contributing to *Park Science*. As always, we need your input on feature articles, case studies, brief highlights of park happenings, and bits that apply broadly to the park system. Also of interest are research and resource management travel opportunities, reviews of books and other articles that you would like to share with others.

This publication is about sharing. We share what we know, what we don't know, what we would like to know, how we go about getting the answers, and what we do with them once we've got them. The question we begin to investigate today, like the resource management technique we begin to employ, is an investment that pays dividends as we learn more and perfect our use of these tools. Looking back is one way to gauge our progress.



## NEWS & VIEWS

### Errata

Last issue, a News & Views story on resource management plan and Investigators Annual Report software updates on page 5 incorrectly credited Tim Goddard with software development. Walter Sydoriak, now with the NPS Boise Interagency Fire Center, is the author of the software.

• • •

Tom Zimmerman, also at the Idaho fire center, points out that the definitions for prescribed natural fire and prescribed fire presented last issue in the table 1 glossary of selected fire terms on page 22 were reversed.

### Park Science Text Files Available

Articles comprising this and subsequent issues of *Park Science* are available as ASCII text files and can be obtained by contacting the editor over cc:Mail or Internet e-mail. Text files have many uses, one of which is to allow sight-disabled readers to enjoy the publication by way of a text file reader.

### President Addresses Fisheries Management

On June 8, the President signed the Recreational Fisheries Stewardship Executive Order, requiring federal agencies to develop a comprehensive recreational fishery resources conservation plan within the next 12 months. The order further directs federal agencies to:

1. Develop and encourage partnerships,
2. Identify fisheries limited by poor water quality,
3. Foster aquatic conservation and restoration,
4. Provide access to and promote awareness of recreational fishing opportunities,
5. Support outreach programs to stimulate angler participation in conservation and restoration of aquatic systems,
6. Establish cost-share programs for conservation projects, and,
7. Assist private landowners with conservation plans.

In addition, the U.S. Fish and Wildlife Service and National Marine Fisheries Service are directed to establish a joint policy for administering the Endangered Species Act in a way that identifies and minimizes conflicts between recreational fisheries and the act.

### I & M Video in Competition

A just-completed NPS video entitled "Vital Signs" has been submitted to the 9th International Festival of Documentary Films on Parks to be held in Sondrio, Italy, October 9-14, 1995. This renowned forum presents a great opportunity to share NPS views on the importance of the resource Inventory and Monitoring Program in preserving parklands while increasing conservation awareness around the globe. Produced by Larry Pointer of the National Natural Resource Program Center in Fort Collins, Colorado, with help from Kristen Ramsey of Yosemite

*Continued on page 5*

## JULY NATIONAL COMMITTEE MEETING REPORT

**T**HE UNITED STATES Man and the Biosphere Committee met at Camp Hoover in Shenandoah National Park, Virginia, on July 25-26. Approximately a dozen member agencies attended, including, for the first time, the Bureau of Land Management. The principal agenda items focused on the United States Man and the Biosphere Program (USMAB) response to the final report of a blue ribbon commission, convened by Man and the Biosphere Program (MAB) Chairman Dean Bibles earlier this year to review MAB and recommend future directions, and to allocate remaining fiscal year 1995 funds.

The commission report made numerous recommendations aimed at increasing MAB visibility, financial and institutional support from government and the private sector, and contributions to ecosystem sustainability. In accepting the commission's report, the committee...

1. Adopted the proposed mission and goal statement for USMAB,
2. Requested the chairman to immediately convene special task forces to assess and rec-

ommend ways to better integrate components of MAB (i.e., interdisciplinary ecosystem-based research, regional partnerships, biosphere reserves, and international networks) and substantially increase MAB financial and institutional support from government and the private sector,

3. Increased its support of the USMAB secretariat by hiring a new clerical position and placing a fellowship recipient to coordinate the EcoNet America Program. The chair will continue efforts to arrange a detail from a member agency to coordinate the U.S. biosphere reserve program (possibly in lieu of direct annual contributions).
4. Asked each federal agency to recommend ways for USMAB to strengthen its support for MAB, for example, through briefings of

The 1995 MAB budget of \$1.1 million includes contributions from 11 federal agencies and bureaus. The committee allocated the remaining \$506,000 of unobligated funds based on proposals from MAB directorates and several nonsolicited proposals (from the secretariat and Human Biology Association).

The committee increased its support of the Biosphere Reserve Directorate for developing the U.S. Biosphere Reserve Program in accord with the strategic plan approved last year. The committee funded the following projects:

1. Network review, including preliminary gap analysis and functional evaluation,
2. Second U.S. Biosphere Reserve Managers' Workshop (October 30-November 1),

4. Brochure and slide presentation media development,
5. Biosphere Reserve Integrated Monitoring Program support for U.S. biosphere reserve electronic directory, MABFlora and MABFauna databases, and network connectivity strengthening,
6. United States-Russia cooperative watershed and ecosystem research,
7. International "targets of opportunity."

The High Latitude Ecosystems Directorate received support for a series of workshops to present the results of comparative interdisciplinary research on caribou comanagement systems in the United States and Canada. To be held in Alaska, the presentations will be directed to federal

*"The mission of the U.S. Man and the Biosphere Program is to and encourage harmonious relationships between people on the network of biosphere reserves and [conducting] inter-*

senior management on MAB accomplishments and new directions.

3. Catalytic small grants to support development of U.S. biosphere reserve partnerships and activities,

agencies, advisory councils, and native wildlife management organizations.

The Marine and Coastal Ecosystems Directorate received continued support for



the second year of a three-year interdisciplinary study of access management strategies and marine biodiversity.

The Temperate Ecosystems Directorate received support for cooperation with MAB Germany on techniques for integrating social and biological information in assessing ecosystem change in biosphere reserves.

The committee also approved several new directorate members: a BLM representative will serve on the Biosphere Reserve Directorate; six new members, including Gary Davis from the NBS Channel Islands Field Station, will serve on the Coastal-Marine Directorate. The committee also agreed to continue supporting the national committee, the six MAB directorates, and U.S. participation in biosphere reserve networks (EcoNet America and EuroMAB) and the Northern Science Network.

New MAB publications, available from the MAB Secretariat, OES/ETC/MAB, SA-44C, Department of State, Washington, D.C. 20522-4401; (202) 776-8318; FAX (202) 776-8367, include:

- Biosphere Reserves in Action (12 U.S. case studies)
- La Selva Maya

Unpublished reports include a status report on Human Dominated Ecosystems Research on Ecological Sustainability of South Florida, MAB Fauna—a Handbook for Users of the MAB Biological Inventory System (includes software), University of California, Davis, and the Constable Commission—Final Report.

*Bill Gregg, who contributed this report, is International Affairs Officer for the National Biological Service and can be reached at (202) 208-1502, fax (202) 208-7275, or by Internet, "william\_gregg@nbs.gov".*

## Continued

National Park, California, the video explains the importance of inventory and monitoring work to park managers. For more information on the video, contact Larry Pointer at (970) 225-3541.

## Integrated Pest Management Findings

The Department of the Navy recently evaluated its pest control programs through its environmental compliance section and found many shortcomings. A quick review of some of the common findings listed below may help parks improve their IPM programs.

- Unlabeled pesticide containers
- Canceled products on shelves
- Improperly stored containers
- Pesticide spills on floors and shelves
- Flammable pesticides not stored in fire resistant locker
- Respirator and cartridges stored in mixing areas
- Spill and evacuation plans not in pest control shop
- Pest management records not on file
- Copy of contractor business certificate missing or expired
- Depredation permit not on file
- Pest management plan not approved or professionally reviewed annually
- Carpet and wood used in storage room
- Improper disposal of pesticides
- Reuse of empty pesticide containers

- Food presence in mixing and storage areas
- Staff smoking in storage and mixing areas.

## National Research Needs Prioritized

The National Park Service recently prioritized its needs for National Biological Service research for the preservation of national park system natural resources and other attributes. The areas needing greatest attention are listed in descending priority order:

- Amphibian decline
- Survey and ranking of nonindigenous plants for management and control
- Effects of regional air pollutants on park resources
- Fish management impacts to natural aquatic systems in national parks
- Population trends and habitats of neotropical migratory birds in the parks
- Effects of native animal species overpopulation in parks
- Development of protocols for aquatic inventories, assessments, and monitoring
- Status of invertebrate biodiversity and establishment of monitoring methods in national parks
- Risk assessment of zebra mussel establishment in national parks
- Efficacy of replenishment zones in restoring harvested marine ecosystems.

explore, demonstrate, promote, and their environments [by] building interdisciplinary research."

- Biosphere Reserve Strategic Plan
- Brochures on USMAB and the Biosphere Reserve Integrated Monitoring Program

## NBS Databases Accessible Over Internet

Several bird-related databases are available over the Internet through the home page of the NBS Patuxent Environmental Science Center on the World Wide Web. Users can access the information by using the URL (uniform resource locator) address "http://www.im.nbs.gov/bbs/bbs.html". Once on the home page, various pointers will direct users to the following databases:

- North American breeding bird survey
- Breeding bird census
- Christmas bird count
- Bird banding

## NBS Releases First Technical I&M Report

"Our Living Resources" is the first report released by the National Biological Service (NBS) Inventory and Monitoring Activity. Written in nontechnical language suitable for the lay person, this compendium of nearly 200 peer-reviewed articles and overviews is authored by researchers from the NBS and other federal and state agencies, academia, and the private sector. Tabular and graphical data also make the report valuable to resource managers, environmental scientists, planners, policy makers, and conservation organizations. An open request throughout the scientific community resulted in these articles that share current information on the abundance, distribution, health, and trends of national biological resources.

The 530-page, full-color report is organized by chapters that address taxonomic groups (birds, mammals, fish, reptiles and amphibians, plants, and invertebrates); geographic areas (Alaska, Hawaii, Great Plains, and interior west); ecosystem types (aquatic, riparian, terrestrial, and coastal marine), and impact assessments (global climate change, human influences, nonnative species, and habitat assessments). A glossary and index are provided.

Hard copies of the report can be purchased for \$44.00 (including postage) from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. In late 1995, the report should be available through the NBS home page on the Internet and on CD-ROM. For further information, contact Michael J. Mac, National Biological Service, Inventory and Monitoring, Mailstop 3660 MIB, 1849 C Street NW, Washington, D.C. 20240; phone (202) 482-2929; fax (202) 273-0825; e-mail "michael\_mac@nbs.gov".

## New Journal Available Through E-Mail

*Conservation Ecology* is a new peer-reviewed journal of the Ecological Society of America. With article preparation, submission, review, and publication to be entirely electronic, *Conservation Ecology* is intended to supplement, rather than supplant, similar extant periodicals. Papers will range from theoretical to applied and will focus on, (1) the ecological bases for the conservation of ecosystems, landscapes, species, popula-

tions, and genetic diversity, (2) habitat restoration, and (3) resource management.

On-line access and subscriptions are offered without charge. Access to the journal will be via the World Wide Web, Gopher, and e-mail over the Internet. Those intrigued will be able to find *Conservation Ecology* by browsing the web and searching under "Electronic Journals" or by connecting directly to URL "http://journal.biology.carleton.ca/Journal/Overview.html".

Once it is up and running, the publication will also be available by connecting to Gopher at "journal.biology.carleton.ca" for text-only access. Internet users can subscribe by sending an e-mail message to "subscribe@journal.biology.carleton.ca" that contains the following message: subscribe conservation-ecology <reader's full e-mail address>. The first issue will be available in early 1996.

## Turf Grass Research Reported in Monthly Newsletter

The July issue of *TurfGrass Trends* (ISSN 1076-7207), a monthly periodical devoted to turfgrass (rolled sod) research, reported on the art and science (and complexity) of diagnosing turfgrass diseases. Commonly used as groundcover at historical parks and sites, monuments, and memorials, turf often poses perplexing pest problems for the manager. While weed and insect infestations are readily identifiable by eye, turf disease pathogens are microscopic, and their activities can be seen only indirectly, by noting the responses of the infected plants.

Diagnosis requires 10 logical steps, as described in the issue, from affected plant identification to pathogen management strategy, and the issue takes the reader through each step with easy to understand explanations of the processes. The author cites examples of various diseases and the species they affect, explaining the symptoms that accompany the disease. Also important in the discovery process is examination of the entire affected area, looking for abiotic causes for what may otherwise appear to be manifestations of disease. Thorough field examination for pathogen structures, environmental conditions, and the history of irrigation, fertilization, etc., of the affected area also provide much needed information for follow-up laboratory clinical diagnosis, the last stage before addressing management strategy. Finally, correct diagnosis allows the manager to choose from various control options that are appropriate for the site.

As in this article, *TurfGrass Trends* translates science into practical tools for the turf manager. The monthly is available through subscription (\$120 per year) by contacting publication staff at 1775 T Street NW, Washington, D.C. 20009-7124, phone (202) 483-TURF, Fax (202) 483-5797, and e-mail "765172451@compuserve.com". Upcoming issues will cover fertility and soil chemistry, biocontrols, integrated pest management, weeds, diseases, new grass varieties, nontarget effects, insects and chemical and products studies.

## Plants Return to Oil Slick Perimeter

Scientists reported in the July 27 issue of *Nature* (as summarized in *Science News* [volume 148, no. 6]) that wildflowers (*Compositae*) have begun to recolonize the perimeters of oily lakes created by the destruction of oil pipelines and wells from the 1991 Gulf War in the Persian Gulf region. Biologists analyzing this surprising phenomenon see a potential connection between oil spill recovery and plant cultivation.

The microbiologists uprooted plants growing amidst the oil-soaked soils and found that their roots were healthy and oil-free. Hypothesizing that the roots recruited commonplace oil-degrading microbes to aid in the clean up, the scientists cultured bacteria and fungi residing in the petroleum-laced sand. They discovered that, indeed, the plant root zone was rich in the well-known oil-metabolizing organisms. Ninety-five percent of the microbes were a bacterium, *Anthrobacter*, that resided nearest the plant, but a different community of fungi and other bacteria occurred about 1 cm (0.4 in) further away from the wildflower roots.

The group repeated the experiment in controlled conditions, planting other species to see what would happen. Most of the species grew into normal looking plants, although most were 25%-40% smaller than those reared in clean sand. The sugars, amino acids, oxygen, and vitamins associated with plant root zones, evidently, create an environment that attracts the oil-loving microorganisms. The investigators conclude that part of the answer to cleaning

up the extensive desert pollution is densely cultivating suitable plants known for this phenomenon. They add that this "solar-powered" bioremediation approach may also prove useful elsewhere in the world and with contaminants other than oil.

## Mitigation of Radiological Hazards in Parks Explained

During compilation of the NPS inventory of abandoned mineral lands, Colorado Plateau park managers raised concern over the issue of radiation at abandoned uranium mine and mill sites. Geologist John Burghardt, with the NPS Geologic Resources Division in Denver, has recently written the paper, "Effective Understanding and Management of Radiological Hazards at Abandoned Uranium Mine and Mill Sites," in response to these concerns.

The paper describes that the Colorado Plateau was heavily mined for uranium from the late 1940s through the 1950s, and that uranium mining has continued on a small scale through the present. These sites, and others that were mined for different commodities that contained radioactive elements in their ore, are hazardous due to potentially elevated radioactive emissions. While guidelines are available for land management agencies to establish their own regulations and policies, no federal regulations presently address management of the hazardous sites. Burghardt describes effective and safe management of these sites beginning with the fundamental concepts of radioactivity, environmental characterization

methods, pathways of exposure, and data interpretation. Further discussion links site management and cleanup to the planned uses of the sites, their levels of radioactivity, and typical duration of public exposure anticipated.

Contact the author, John Burghardt, at National Park Service, Geologic Resources Division, P.O. Box 25287, Denver, CO 80225-0287; phone (303) 969-2099; fax (303) 969-2822; e-mail "john\_burghardt@nos.gov", to receive a copy of the paper.

## Murrelet Report Available

A 420-page tome, "Ecology and Conservation of the Marbled Murrelet," Pacific Southwest Research Station, General Technical Report PSW-GTR-152, February 1995, is available free by calling (510) 559-6300. Edited by C. John Ralph, George L. Hunt, Jr., Martin G. Raphael, and John F. Piatt, this document was compiled by the interagency marbled murrelet conservation assessment core team. The 37 chapters cover both original studies and literature reviews of the species' biology, ecology, and conservation needs. It includes new information on forest habitat, marine distribution, and demographic analyses; and describes past and potential effects of humans on the species' habitats. Future research needs and possible management strategies for both marine and forest habitats are suggested.

## Climate Change Book Just Out

David L. Peterson and Darryl R. Johnson of the University of Washington Cooperative Park Studies Unit have just edited the book, "Human Ecology and Climate Change: People and Resources in the Far North." Published by Taylor and Francis, Washington, D.C., 1995, the book is the first of its kind, exploring how global change might affect the ecosystems and cultures of the far north during the next century. The work brings together biologists, anthropologists, sociologists, and resource managers to contribute their diverse knowledge and insight in an interdisciplinary approach to this important topic. The book takes an objective look into the future and offers suggestions for further research. It is meant to be a positive step toward sound future managerial policy in the region. Some of the topics covered include: demography and socioeconomics, wildlife biology, ethnography and archeology, global warming, meteorology and climatic modeling, environmental values, resource use and management. With additional funding from the National Biological Service, the U.S. Forest Service, and the George Wright Society, the book concept was developed at a workshop sponsored by the National Park Service.

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## GREAT PLAIN

### Ferrets Sighted for Littering

Biologists and resource managers reported on the involved restoration last summer and fall of black-footed ferrets to three areas of Badlands National Park, South Dakota, in the spring (volume 15, number 2) issue of *Park Science*. They now add that park spotlighting crews have located five black-footed ferret kits in two litters and their female parents in the park wilderness area release site during surveys conducted in July and August. The nighttime researchers also located a third female in the core release prairie dog colonies (separate from the wilderness release site) where biologists released 36 captive-reared animals last fall. Two of the three adult female ferrets had been exposed to live prairie dogs and their burrow systems within miniature prairie dog towns contained in outdoor pens at ferret breeding locales before release; one female ferret was *naïve*, having had no previous contact with the prairie dog environment before being given its freedom. Two of the females detected this summer had not been seen during intense postrelease spotlight surveys during December 1994, opening the possibility that more of the animals have survived, but remain undetected. The park considers reproduction a landmark achievement that validates the restoration methods being used.

The goal of the National Park Service, U.S. Fish and Wildlife Service, U.S. Forest Service, and South Dakota Department of Game, Fish, and Parks is to establish a self-sustaining population of ferrets within the Conata Basin/Badlands prairie dog

complex located within Badlands National Park and the adjoining Buffalo Gap National Grassland. The ferret reintroduction plan calls for annual releases in South Dakota over the next 5 years. These ferrets, being raised in seven breeding facilities, are scheduled for release in South Dakota and Montana this fall.

Reintroduction sites in Wyoming and Montana also have recorded successful breeding and survival of young this year. This gives hope that the black-footed ferret, North America's most endangered mammal and once believed to have been extinct in the wild, may yet be part of the prairie community.

## ROCKY MOUNTAIN

### Three-way Weed Control Program

In its 40-year struggle to control the nonnative, noxious weed leafy spurge (*Euphorbia esula*), Devils Tower National Monument, Wyoming, recently completed its most successful and productive year to date. The park is phasing out its traditional heavy use of the broadleaf herbicide Tordon (Picloram) in favor of herbivorous insects of the genus *Aphthona* that eat the invasive plant exclusively.

Introduced from grain seed stocks brought to the area by eastern European homesteaders, leafy spurge has infested the flood plain of the Belle Fourche River valley in northeastern Wyoming for 50 years. Unfortunately, the natural control predator, the *Aphthona* flea beetle, did not come with the invasion. Instead, the U.S. Department of Agriculture, through its APHIS-PPQ pro-

gram, imported the beetle from Canada in 1990, where the insect had already been introduced. The University of Wyoming, Crook County Weed and Pest District, and the USDA set up a cooperative *insectary* called the "Ike ranch site" in Crook County in 1990 that would in the future produce millions of insects for collection and redistribution around the county and state.

Park field crews collected and distributed 35,000 biological control insects from the insectary in 1994 and 188,000 in 1995. In addition to these, crews gathered and redistributed 41,000 of the flea beetles from insectaries established at Devils Tower in 1991 and 1992 with the help of the same partners. Altogether, field crews have collected some 250,000 biological control insects and released them at 160 sites within the monument.

While the spurge eradication program has shifted its focus to the ecologically sound, long-term, biological control method, herbicide use continues (to a lesser degree), and other herbivores augment the work of the beetle. This year, crews spot treated about 100 acres of spurge using herbicide. At the same time, a flock of 400 Angora goats chewed through an additional 200 acres of thick spurge along the river flood plain.

Only in its second summer, this integrated, tripartite, leafy spurge control program has become a model for neighboring cattle ranchers. Initially skeptical, local ranchers now have started using goats and sheep to consume spurge on their lands. To further aid park neighbors, and in the spirit of ecosystem management, the

monument has facilitated two insect collection days and instructed the five participating area landowners in how to manage the insects for the purposes of spurge reduction. Altogether, park neighbors collected 26,000 biological control insects in the two-day activity. Park neighbors and Devils Tower National Monument alike plan to expand the use of goats and insects next year both within and outside the monument.

## SOUTHWEST

### "Adopt-A-Bat" Donations Fund Research

Deep in Carlsbad Caverns, almost 1,000 feet below the surface, lives a small colony of fringed myotis bats (*Myotis thysanodes*). Numbering around 100 individuals, this maternity colony lives just above Lake of the Clouds. With knowledge that the bats roosted deep in the cave, over a mile from any known opening, researchers wanted to learn the route used by the bats in reaching the desert world above ground. They also were interested in other basic information, such as the time of emergence, the duration of the exit flight, and destination springs used by the bats for drinking, that might aid in conserving the species. In mid-July, researchers Ken Geluso and Troy Best outfitted 13 of these bats (comprised of males and females) with transmitters. Weighing about one-eighth of an ounce, only slightly thicker than a dime, and placed on the tiny mammals with a glue that deteriorates in about ten days, these transmitters enabled the scientists to follow the bats as

they exited the cave, fed, and returned during the 8 following days.

On most evenings, the bats left along with the outflight of the abundant Mexican free-tailed bat (*Tadarida brasiliensis*). The fringed myotis principally exited via the *larger* natural entrance, although a few departed through the *smaller* natural entrance. Curiously, lights that were left on during 2 days of the study in the below-ground cave lunchroom, due to uncharacteristic emergency maintenance, delayed the emergence of the fringed myotis by 2 hours. The lights also seemed to have altered their flight path on these days sending some of the bats to a narrower, vertical cave passageway (not used by people). Located some 200 yards from the main bat exit point, this opening had been surrounded by a fence on the surface to keep people out. Initially, some bats flew into the fence and got caught. Following this discovery, staff repositioned the fence farther from the opening to allow the bats to gain more elevation before heading off to desert feeding and drinking locales.

Although it is not listed as threatened or endangered, the fringed myotis is a category 2 species and is protected under the Endangered Species Act. Category 2 species are those for which inadequate scientific information is available to determine if listing is warranted. The project was funded with \$5,300 from the park "adopt-a-bat" fund, a nonprofit fund derived from park visitor donations in support of research and education.

## GULF COAST

### Chinch Bugs at Biscayne

A menace to turf grasses, chinch bugs infested sod adjacent to the Biscayne National Park, Florida, visitor center in 1993. Chinch bugs love St. Augustine grass, and the Biscayne visitor center was planted with it right up to the shoreline. The troublesome Hemipterans suck fluids from the grass blades, causing yellowing, dieback, and eventually death of the turf. In 1995, resource managers began replacing an area of turf grass along the shore with a strip of perennial native plants. The mix included sea daisy, *Gaillardia*, blue porter weed, yellowtop, and beach sunflower. These native plants tolerate the climate and remain healthy with no pest problems. Integration of other management actions will ensure long-term sustainable management, and may spell the end for the chinch bug.

For the future, park staff are working with the Denver Service Center to suggest the best design for new visitor center landscaping. The native grass *Distichlis*, well suited to the coastal climate, has been suggested. Selecting native plants that are well suited to the site will create low maintenance areas and healthy plants—the very best defense against pests.

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### Least Terns Nest in Biscayne

During a Biscayne National Park sea turtle nesting survey, resource managers observed terns flying in isolated rocky areas on Soldiers Key. With the help of the Florida Game and Freshwater Fish Commission, staff identified the birds as least terns (*Sterna antillarum*), a species listed as threatened by the

state of Florida. The resource managers surveyed the island and identified two nests with two eggs in each nest. On a return trip to the island they observed three fledglings.

Park managers responded to the information by closing the nesting keys through the end of the nesting season (April-August). The park will continue to monitor these birds and their future nesting activities.

Park staff had presumed that least terns nested here, but had not confirmed this until the recent sightings. Now, the Florida Game and Freshwater Fish Commission has added Soldiers Key and Ragged Key #1 in Biscayne National Park to their database of active nesting sites. Least tern nesting habitat has been greatly reduced and these park islands represent some of the few known nesting sites in South Florida.

## COLUMBIA-CASCADES

### Fort Vancouver Develops Pest Plan

Park staff at Fort Vancouver, Washington, recently convened an integrated pest management (IPM) scoping session at the fort to begin writing a plan for the management of biological threats there. The participants, which included park natural and cultural resource staff, maintenance personnel, and system support office and Washington Office staff, outlined the new plan by dividing the park into two zones, each of which was further divided into subzones, as follows:

Landscapes  
turf  
trees and ornamental  
beds  
agricultural  
garden  
orchard  
revegetation  
Structures  
exterior  
modern  
historic  
interior  
modern exhibits, museum collections, historic furnished areas  
office, shop, work areas

Once the group defined the zones, they identified the expertise needed to develop objectives for each zone. After experts gather to complete the objectives, a contractor will complete the plan with extensive help from the park. This format for IPM plans is being developed as a model that has the potential to be used service-wide with park-specific modifications.

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### USGS Help Sought

Looking for opportunities to apply their research efforts to federal lands, the U.S. Geological Survey recently entered into a memorandum of understanding with the National Park Service and requested project proposals in support of park research, resource management, and interpretation. Columbia Cascades Cluster parks have been busy preparing eight proposals that take advantage of USGS mapping and other expertise.

Research and resource management applications range from assessing the stability of

*Continued on page 10*



*Continued*

Mount Rainier, Washington, and investigating the relationship of its geology to volcanic hazards, producing a suite of resource maps for City of Rocks National Reserve, Idaho, to detailed facies mapping at Hagermann Fossil Beds National Monument, Idaho, and landform and soil mapping at North Cascades National Park, Washington. Interpretation related projects include producing videos on Crater Lake and Mount Mazama, Oregon, geology and research, a geologic handbook of scientific investigations at Hagermann Fossil Beds, and a guidebook of the geology of the North Cascades and San Juan Islands, Washington.

## CHESAPEAKE

### Flood Assessment in Shenandoah

"It was as if someone were pouring water out of a glass." That is how one resource specialist described the relentless rainstorm that caused extensive flooding in central Virginia and Shenandoah National Park late last June. After 5 days of soaking rain, the storm delivered 12 inches more that fell on already-saturated ground in a period of a few hours. Outside the park, the storm killed eight people, displaced 800 residents, and damaged 2,000 area homes. Within the park, numerous landslides rerouted and reshaped entire drainages (see photo). The barrage of water carried massive boulders down streams and even cut channels 15-20 feet down to bedrock in some areas. Tree-covered, bubbling mountain stream channels

once 15-30 feet wide were "blown out" and are now 150-200 feet wide, treeless, and filled with rocks and large debris dams of debarked trees. The concentrated erosion and landslides altered some administrative roads beyond repair, but only affected 37 miles of the over 500 miles of park trails.

Although devastating to people and property, the flood was a natural, albeit rare, event. Floods of this magnitude occur at an estimated interval of approximately 100-1,000 years. The opportunity to understand geologic processes and ecological recovery from catastrophic disturbance is rare and Shenandoah intends to make the most of it.

Park managers asked that resources and facilities be assessed for safety hazards, management options, and short- and long-term resource monitoring. The park set up an incident com-

Shenandoah National Park, Assateague Island National Seashore, University of Virginia, U.S. Geological Survey, NPS Water Resources Division, NPS Geologic Resources Division, Virginia Tech, and Virginia Department of Game and Inland Fisheries. The team examined existing and potential geohazards, slope stability, hydrology, fisheries, aquatic ecology, and vegetation affected by the flooding. Shenandoah and Assateague staff recorded the information collected by members of the team on the park Geographic Information System using global positioning system units.

The team observed impacts that were caused by both large volumes of water (flood) and the mass movement of rocks, sediments, and woody debris in a slurry with water (debris flow, debris torrent). They recommended that the park restrict or

The team strongly recommended against stabilization of debris slopes. Trail or road rebuilding, if done at all, should wait until after next winter to allow some settling, continued slumping, and rockfall to occur. Some trail rerouting to more stable slopes was also recommended.

As part of the NPS prototype Inventory and Monitoring Program, Shenandoah had detailed information from many park watersheds on water chemistry, geology, fisheries, amphibians, and aquatic insects before the storm. In fact, the watershed with the greatest flood impacts was also, fortuitously, the one with the most preflood data. Gathered over a period of several years, the information will greatly help the park assess ecosystem changes with respect to the severe storm. When compared with postflood surveys of the same areas, the data already show a marked change in watershed fish. Just one week before the storm over 800 fish of 15 species along 100 meters of stream were counted. A week after the flood, the same area had only 6 fish of 4 species. Biological recovery of these streams to support trout populations will require perhaps as little as 3 years to 30 years or more and will vary from one watershed to the next.

More biological resource assessment information will follow in the report to be written by the scientific assessment team. Also expected in this report are assessments of the park infrastructure and a strategy for interpreting the flood and its effects to park visitors.

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*Days of relentless rainfall caused landslides in Shenandoah National Park, Virginia, including these 2-5 acre (0.8-2.0 hectare) slides in the Moormans River drainage. While flood impacts were considerable throughout the park and region, the rare natural event provides scientists the opportunity to study geologic processes and ecological recovery.*

mand team to deal with assessment planning and coordination. The scientific assessment team consisted of experts from

discourage use of former trails or roads with undercut banks and "toe" areas at the base of the most unstable debris flows.

*Continued, right column, page 13*

# THESE AMERICAN LANDS: PARKS, WILDERNESS, AND THE PUBLIC LANDS

Dyan Zaslow and T.H. Watkins

A REVIEW BY WILLIAM TWEED

FOR AS LONG AS OUR REPUBLIC HAS existed, critics have remarked upon its lack of a sense of history. Nowhere is this more true today than in the management of our public lands. The current intense political debate over the fate of these lands seldom pays much attention to history. Political discussions about issues like the ancient forests, spotted owls, public lands grazing, or Alaskan North Slope oil almost never dwell at any length on the historic origins of these controversies. Generally, we are much more interested in where we are going than in where we have been.

In *These American Lands* authors Dyan Zaslow and T.H. Watkins address this issue by presenting a history of federal public land management in the United States. This is not a simple story, and to make it more approachable, Zaslow and Watkins have abandoned the historian's traditional strategy of integrated chronology for a more topical approach. Rather than attempt a broad synthesized history of federal public land management, the authors provide separate histories for each of the major federal land management programs. Separate chapters summarize the histories of the national park system, national forest system, national resource lands (Bureau of Land Management), national refuge system, national wilderness preservation system, national wild and scenic rivers and national trails systems, and the national interest lands of Alaska. Appendixes document critical legislation and list the units of each system.

In pursuing this approach the authors have both provided a major resource to anyone interested in public lands and produced a flawed book.

The value of the book is that it provides quick and relatively simple access to the basic events that have shaped our public lands policy and the institutions that carry it out. The book's flaws, which are not fatal, result from how it approaches the discipline of history.

An essential starting point for understanding *These American Lands* is that the book is an advocacy document not a neutral analysis. Counselor to the Wilderness Society Gaylord Nelson's foreword details how the conservation organization came to publish its vision of federal land management history. The theme is further reinforced by the fact that each chapter ends with Wilderness Society recommendations for the future management of the resources in question.

Because the book represents an advocacy organization's view of public land history, it offers not so much analysis as carefully honed interpretation. The story has clear heroes and villains. It also has a strong sense of historical direction that verges on inevitability. In attempting the admittedly difficult task of condensing these complex stories into simple narratives, the social context of American thought and behavior has been largely left behind in favor of a story line in which aware people slowly wear down and outwit wasteful, destructive opponents.

This sense of the inevitability of the right thing eventually happening shows especially in Nelson's foreword, written in April 1994, that suggests that with the

election of Bill Clinton, "a new age of responsibility and stewardship clearly has begun." As the past year has clearly demonstrated, American history is far too complex and unpredictable to fit well into

any simple deterministic pattern. We are a large and complicated people, and we have a long way yet to go before we resolve the question of how we are to balance the goals of individual freedom and collective good.

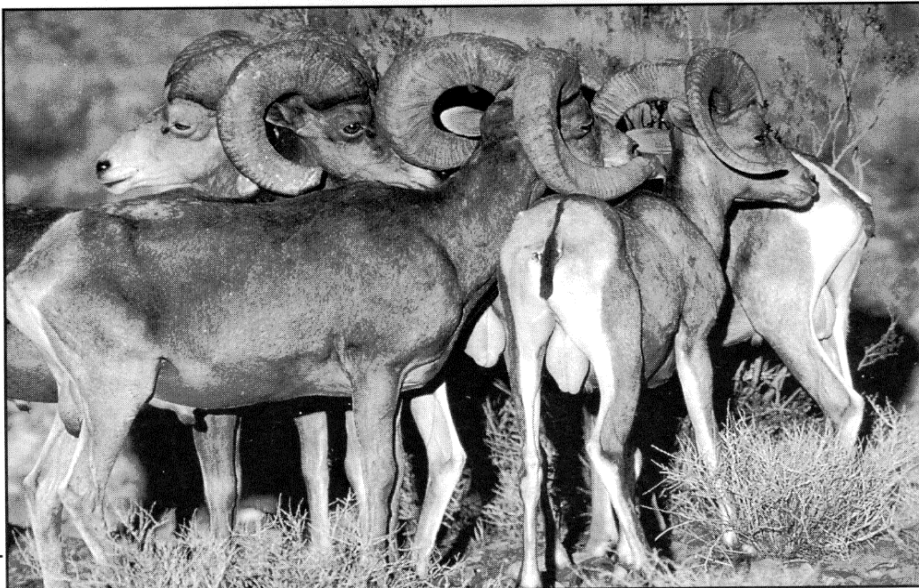
Read with caution, *These American Lands* is a useful introduction to how preservationists view the evolution of public lands management. It is not, however, the same sort of high quality analytical history that coauthor Watkins has produced on other

occasions, most notably in *Righteous Pilgrim*, his superb biography of Harold Ickes.

Revised and  
expanded  
edition,  
published by  
Island Press  
for the  
Wilderness  
Society,  
1994.

William Tweed is Management Assistant at Sequoia and Kings Canyons National Parks, California. His phone number is (209) 565-3102.

*Not since the 1970s has Joshua Tree National Park taken census of its desert bighorn sheep, a species that frequents springs. The Canon funds will enable staff to test a noninvasive inventorying technique where researchers identify sheep from unique natural markings, such as scars and horn characteristics. Also funded are projects to convert spring location data into GIS-compatible format and remove tamarisk (a nonnative tree that transpires water and impedes sheep access to the springs) from the water sources.*



## INVENTORY AND MONITORING PROJECTS GET \$1,200,000 BOOST

By LISSA FOX

**A**N UNEXPECTED \$1,200,000 corporate grant from Canon USA will put 35 inventory, monitoring, and restoration projects on the ground over the next 2 years. In the first year, volunteers will help 20 parks inventory and monitor their biological resources. These projects will provide resource managers with information vitally needed to make scientifically based management decisions. In the second year, the grant will send volunteers into 15 of the original 20 parks to work on habitat restoration. Canon will also donate equipment such as laptop computers, cameras, and binoculars to the parks.

The biological inventory and monitoring projects supported by the Canon grant will bring the National Park Service closer to its goal of completing baseline inventories of biological and geophysical resources in the approximately 250 parks with significant natural resources. Grants such as this allow the National Park Service to accomplish projects that would not otherwise be possible in this time of shrinking budgets and fewer federal employees.

This grant opportunity came up fast and with an extremely short turnaround time. The National Park Foundation, which raises money to support NPS

programs, managed to pique Canon's interest in the four-year-old program called Expedition Into America. This program was designed to stretch park biological inventory and monitoring budgets by providing volunteer labor and funding. All projects considered for the Canon program, now called "Expedition Into the Parks: Preserving America's National Treasures," had to be biological inventory or monitoring projects and needed to include volunteers.

The responsibility for pulling together this program fell to Larry May, then NPS Wildlife and Vegetation Division Chief, and Lissa Fox, the author of this article and Expedition Into America program manager. For Larry, this opportunity was a harbinger of things to come. Under the new NPS organization of Natural Resources Stewardship and Science, the need for someone to develop these kinds of relationships had already been identified. Now serving as Partnerships Program Manager, Larry will be directly responsible for developing similar partnerships with other agencies and funding sources to support natural resource projects and programs. These partnerships will be designed to complement and supplement NPS programs that support NPS natural resource management policies and goals.

To produce a list of projects for Canon to review, division staff selected proposals submitted for other grants and relied heavily on the resource management plan (RMP) database. Tim Goddard, the RMP database manager, searched RMP project statements for the key words "inventory" or "monitoring" and "volunteers" to find projects that met program criteria. Parks contacted responded quickly to short-notice demands for additional information, and Canon received a list of 30 projects in 1 week!

According to the National Park Foundation, grants to support natural resources work are hard to come by—most foundations or corporations do not have a basic understanding of the importance of natural resource management. However, Canon has supported other environmental causes prior to this donation. Their five-year-old Clean Earth Campaign has resulted in over 6,000,000 recycled copier and facsimile cartridges and substantial donations to the Nature Conservancy and the National Wildlife Federation.

While concerns remain about "selling" the NPS to the highest bidder, every precaution is being taken by the National Park Service and National Park Foundation to ensure the continued integrity of the NPS image. Guidelines

## Expedition Into the Parks Projects:

1. Big Bend National Park: inventory and preserve two candidate plant species, tall paintbrush and Guadalupe fescue
2. Buffalo National River: plant inventory of selected springs and seeps within the park
3. Crater Lake National Park: inventory and monitor rare plant, Mount Mazama collomia
4. Fire Island National Seashore: inventory and monitor effects of sand compaction or burial on soft-bodied beach insects, including threatened northeastern beach tiger beetle
5. Gateway NRA—Breezy Point and Jamaica Bay units: conduct limnological monitoring of east and west ponds
6. Golden Gate National Recreation Area: determine wildlife habitat relationships and monitor ecology
7. Grand Canyon National Park: monitor brown-headed cowbird impact on nesting neotropical migrant birds
8. Great Smoky Mountains National Park: inventory brook trout distribution and implement restoration efforts
9. Gulf Islands National Seashore: monitor populations and restore habitat for the recovery of the endangered Perdido Key beach mouse
10. Hawaii Volcanoes National Park: inventory and monitor populations of rare lowland plants
11. Joshua Tree National Park: inventory bighorn sheep at Stubbe Springs (see photo)
12. Mammoth Cave National Park: inventory cultural and paleontological resources in Mammoth Cave
13. Olympic National Park: monitor visitor impacts on wilderness resources and rehabilitate targeted areas
14. Padre Island National Seashore: inventory and monitor threatened and endangered sea turtles
15. Rocky Mountain National Park: Determine productivity and survivorship of songbirds in elk winter habitat
16. Santa Monica Mountains National Recreation Area: determine status and distribution of large carnivores
17. Shenandoah National Park: study impacts of white-tailed deer on forest communities in the eastern United States
18. Yosemite National Park: inventory nonnative fish in alpine lakes
19. Yellowstone National Park: survey for *Agrostis rossiae* and *Abronia ammophila*
20. Cape Cod National Seashore: restore kettle pond habitats

delineating NPS behavior direct all activities. Among the rules are that NPS employees cannot endorse a product and that no NPS uniforms can appear in corporate advertising. All promotional activities and materials are reviewed by technical and policy experts. In order to direct the focus of the promotional materials produced by Canon, the NPS provided the company with realistic, technically accurate descriptions of each project, potential products, and general ideas they could emphasize, such as the threats to natural resources, the importance of information gathering, and the connection between a single species and its habitat. To date, Canon has been coopera-

tive and quite willing to help us spread the story of our threatened natural resources to the public.



*Lissa Fox is a Writer-editor with the new NPS Natural Resources Information Division. Her office is in Harpers Ferry, West Virginia, and she can be reached at (304) 535-6283.*

*Highlights continued*

## COLORADO PLATEAU

### Senior Scientist Joins Grand Canyon Staff

After years of effort, a new position of Grand Canyon Senior Scientist has become a reality. Dr. Robert Winfree will join the newly organized Grand Canyon National Park Science Center this fall. A past U.S. Fish and Wildlife Service scientist, Bob comes from the National Biological Service Leetown Science Center in West Virginia. His background is primarily fisheries, but he is also certified as a wildlife biologist and has a keen interest in cave resources. Grand Canyon Science Center Director Dave Haskell is thrilled to have Bob in this position to provide leadership for the park research program and to be engaged in the many park-related interagency science programs.

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### Support for Peregrine Delisting

Based on sound scientific evidence provided by an extensive monitoring program, NPS officials are able to support delisting the peregrine falcon in Arizona from endangered to threatened. The number of Arizona breeding pairs far exceeds the recovery goals for this species. The estimated 90 pairs of falcons breeding within the park represent a significant portion of the state's viable population and a majority of the population located within a totally protected area, which graphically points out the value of national parks as refugia for species at risk. This support, however, is based on continued U.S. Fish and Wildlife Service funding of the long-term species monitoring in the park.







# CLUSTERING MAKES SENSE FOR COLORADO PLATEAU PARKS CONCERNED WITH WATER RESOURCES

Photo by Jeff Seltzer  
The Glen Canyon Dam

By SUSAN DODSON

CENTRALLY LOCATED ON THE COLORADO Plateau on the Utah-Arizona border, Glen Canyon National Recreation Area sports premier water resources and aquatic systems that include spectacular Lake Powell, and portions of the Colorado, San Juan, Escalante, Dirty Devil, and Paria Rivers. Adjacent upstream along the Colorado River lies Canyonlands National Park, Utah, another wonderland of Colorado Plateau and related water resources. Downstream along the Colorado River lies the Grand Canyon, Arizona, associated very closely with the national recreation area and the Glen Canyon Dam (photo) that controls river flow through the park.

The operation of the Glen Canyon Dam is the topic of an environmental impact statement (EIS) that is currently awaiting a record of decision by the Secretary of the Interior. Issues related to the Grand Canyon Protection Act and Endangered Species Act are considerations of the EIS. These issues are politically and environmentally complex; the new cluster park concept makes good sense for resource managers along the Colorado River corridor to work together to assess and manage the river resources and processes as one system. Aquatic ecology study at Glen Canyon is just one area that offers opportunities for cluster park cooperation and collective knowledge benefits that can aid many Colorado Plateau parks.

## WATER QUALITY

Over 3 million visitors come to Glen Canyon National Recreation Area each year for a total of 2.4 million visitor days. The average stay of 4 nights on the Lake Powell shoreline results in water quality

impacts from improper human waste disposal. Glen Canyon staff presently monitor water quality along

Lake Powell and Colorado River shoreline sites for fecal coliform bacteria, the indicator organism for human waste. State and federal water quality standards for contact recreation include fecal coliform not to exceed 200 colony forming units per 100 milliliters of water (200cfu/100ml).

Lake Powell is so vast that the park operates two 1994 Utah-Department-of-Health-certified environmental laboratories, one at Bullfrog and one at Wahweap, in order to meet analysis holding times. During peak season, Memorial Day to Labor Day, the park samples 54 sites on Lake Powell every other Monday, and seven sites once a month along the river below Glen Canyon Dam to Lees Ferry. During winter months staff discontinue river sampling and scale back lake sampling to fewer sites once a month.

This year, above average precipitation caused Lake Powell to rise over 50 feet to within 5 feet of full! As rising lake waters inundated popular camping beaches, bacterial levels at 11 sites exceeded standards. To protect public health and safety, Superintendent Joe Alston closed those beaches to swimming until bacterial levels became acceptable. Most of the closed sites are vehicle-accessible and experience heavy use; additionally, most closed sites have restroom facilities. Fluctuating lake levels dictate that bathrooms be located above high water, which can pose an inconveniently long walk to visitors when the lake is low. Misplaced *catholes*, RV dumping, and pets are other potential bacteria sources when water levels rise above recently contaminated beaches.

Media coverage and public concern prompted over 100 phone calls a day during beach closures. Overwhelming community and visitor support was channeled

into a volunteer outreach program to educate visitors to the problem and proper human waste disposal practices.

In a water resources study of a different nature, park staff and USGS scientists sampled park springs for physical, chemical, and biological characteristics in 1994-95 in an interagency seep and spring monitoring program. The USGS will submit a final report to include a long-term monitoring strategy for seeps and springs within the unit.

## FISH

Glen Canyon also has outstanding recreational fishing opportunities and complex management concerns due to the demise of native fishes. The native fish community in the Colorado River system has declined since the creation of Glen Canyon Dam. Most notable in their decline are the four endemic "big river" fish, which include the federally endangered Colorado squawfish (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), bonytail chub (*Gila elegans*), and razorback sucker (*Xyrauchen texanus*). Some of these species still occupy habitats within the park.

One entity that focuses on the plight of the native fish is the Lake Powell Native Fish Group. Initiated in 1993, the group includes members from the National Biological Service, U.S. Fish and Wildlife Service, Bureau of Reclamation, National Park Service, state game and fish departments, academia, and private environmental consulting firms. It acts as an ad hoc group of biologists who partner for the conservation and management of native fishes in Lake Powell and the recreation area. Using information pooled from the native fish group, the National Park Service, Arizona, and Utah are developing an interagency fish management plan for Glen Canyon National Recreation Area. This plan provides a forum

*Continued, left column, page 27*



# WOLF RECOVERY IN UPPER MICHIGAN

Regional Partnerships Key to Natural Wolf Recovery at Pictured Rocks National Lakeshore and Beyond



PHOTO BY ALAN AND SANDY CAREY

By BRIAN KENNER

**I**N RECENT YEARS, AS SEEMINGLY ENDLESS controversy has been swirling around wolf reintroduction in Yellowstone, something has been happening elsewhere in the lower 48 states perhaps at least as significant for the wolf in North America. Without benefit of an environmental impact statement, congressional or public hearings, national media attention, or direct human intervention, wolves have returned to the Michigan Upper Peninsula (see map, page 27). In early 1995, Michigan Department of Natural Resources winter surveys confirmed a population of 80 wolves, with a minimum of twelve packs (each consisting of at least a breeding pair). This is a significant increase from 57 wolves in 1994, 30 in 1993, and 21 in 1992. The habitat is believed to be capable of supporting a population of 300-500 animals, indicating that continued significant population increases are likely.

Wolves were essentially extirpated from Michigan via direct persecution by 1960 (except for the isolated Isle Royale population). Fortunately, travel corridors from remaining populations in northern Min-

nesota and Canada endured, as did large tracts of sparsely populated north woods habitat with abundant prey (deer, beaver, and small game). Occasional reports of individual wolves persisted to 1989, when a pair of wolves was found in the western Upper Peninsula. That pair produced pups in 1991 and 1992, thus becoming the first known pack in Michigan since the 1950s. Other packs soon established territories in the western Upper Peninsula—the result of dispersion from populations in northern Minnesota and northern Wisconsin. Wolves have also been found in the eastern Upper Peninsula, most likely Canadian dispersers crossing the ice of the Saint Marys River, which joins Lake Superior with Lake Huron.

To what can this dramatic recovery be attributed? While undoubtedly many reasons exist, the results of a 1990 survey of Michigan's human population provided one answer. The study found surprisingly high support for wolf recovery, particularly among hunters and trappers. Not surprising was the less enthusiastic response from farmers, but a majority of all respondents supported wolf recovery as long as it came about naturally without expenditure of large amounts of tax dol-

lars and did not cause undue public lands use restrictions. Public attitudes have changed significantly in 20 years—the people of the Upper Peninsula now seem willing to live with the wolf.

How do the National Park Service and Pictured Rocks National Lakeshore fit into the wolf equation? Pictured Rocks (35,000 federal acres, 35,000 nonfederal) is part of an expanse of largely protected habitat stretching across the central Upper Peninsula from Lake Superior to Lake Michigan and including a national forest, a national wildlife refuge, commercial timber lands, and state forest lands (see map, page 27). The last known pack and verified pup production in Michigan prior to 1991 was in 1956 within what is now the park (established in 1966). Observations and other evidence

(scat and tracks) are now fairly common within and near the lakeshore, and in October 1994 a local resident reported seeing an adult wolf with two pups within the lakeshore boundary.

The NPS is cooperating with the Michigan Department of Natural Resources and other agencies to monitor wolf activity. Thus far, most effort has been directed toward the western Upper Peninsula, but the recent increase in sightings and evidence of pack establishment in the central and eastern parts of the peninsula demand more effort in those areas. In 1995, the National Park Service, through a challenge-cost share grant, purchased radio collars for the natural resources department trapping team to collar wolves near the park to determine pack size, movements, home range and reproduction in the north central Upper Peninsula. Unfortunately, trappers have not yet been able to capture any wolves in the park area, but more effort will be focused there in 1996. Habitat assessments of historic deer yards (areas of winter congregation) are needed, as are studies of seasonal deer movements. To

*Continued, middle column, page 27*

important for developing informed conservation strategies.

This paper presents recent research on the prehistoric rock paints and the natural accretion from sites in and adjacent to the Amistad National Recreation area in southwest Texas. The aim of this study is to characterize the accretion, determine how it formed, and establish the relationship between the ancient paints and the natural rock crust.

#### THE AMISTAD NRA PICTOGRAPHS

Located in southwest Texas and northern Coahuila, Mexico, Amistad International Reservoir was created in 1969 by damming the Pecos, Devils, and Rio Grande rivers. The region surrounding the intersection of these three major rivers, the Lower Pecos region, contains one of the longest continuous records of human occupation in North America (Turpin 1982). Over 9,000 years ago, hunter-gatherers began inhabiting the numerous rock shelters along the steep limestone cliffs that dominate the region. Archeological research prior to the construction of the Amistad Dam firmly established the existence of literally thousands of prehistoric pictograph and archeological sites.

Archeologists have defined four major prehistoric rock art styles, each with temporal and cultural implications. The oldest and most common style, the Pecos River style, generally features large (up to 4 m or 13.1 ft), multicolored, anthropomorphic figures in multiple panels, which can cover more than 30 m (98.4 ft) of rockshelter wall (fig. 1, page 1). The first New World pictograph to be directly dated was a Pecos River style pictograph located in Seminole Canyon Historical State Park (Russ et al. 1990). Using a new technique, researchers extracted and radiocarbon dated organic carbon incorporated in the ancient paint. Three Pecos River style pictographs have now been dated with the results ranging from 3,000 to 4,200 years B.P. (Russ et al. 1992). These ages correspond to a period when cultural activity in the area was at a maximum (Turpin 1991).

A NPS rock art deterioration study (Labadie 1990) established that many national recreation area pictographs are deteriorating, due primarily to natural

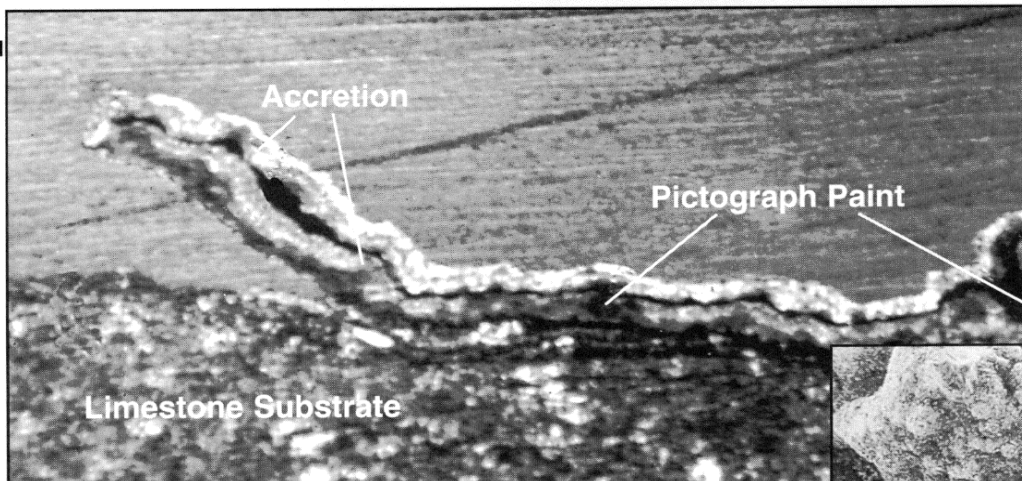


Figure 2 (above). The pictograph study technique involves examining paint encapsulated within a rare mineral accretion that serves both to protect and obscure the art. An optical photomicrograph of a thin-sectioned paint sample reveals the ancient paint, just 0.1 mm thick, encapsulated within a thicker layer of natural accretion.

Figure 3 (right). Scanning electron microscope image shows the surface of the rock accretion. Features indicate past lichen activity as the likely source of the whewellite-rich accretion. Although a nuisance to viewing the pictographs, the accretions pose less of a threat to the panels than freeze-thaw cycles or vandalism.



causes. However, vandals have intentionally destroyed some sites by carving, scratching, pecking, spray painting, and using the paintings for target practice. Early photographers in the region often used water or kerosene to enhance the contrasts in the pictographs, not knowing the long-term effect of repeated dousing with liquids. Still others have been damaged by modern campfires or are submerged under the waters of Amistad International Reservoir.

#### THE NATURAL ROCK ACCRETION

To the naked eye, most of the pictographic paints appear to be on the surface of the limestone rock. In actuality, the paints are covered with a thin veneer of natural accretion. In many of the samples that we have studied the accretion occurs both above and below the paint layer, thus encapsulating the ancient paints (fig. 2). The primary substance in this accretion is *whewellite* (Russ et al. 1994), a calcium oxalate mineral (human urinary tract stones are also composed of calcium oxalate). Although whewellite is generally regarded as rare in geological environments, it has recently been discov-

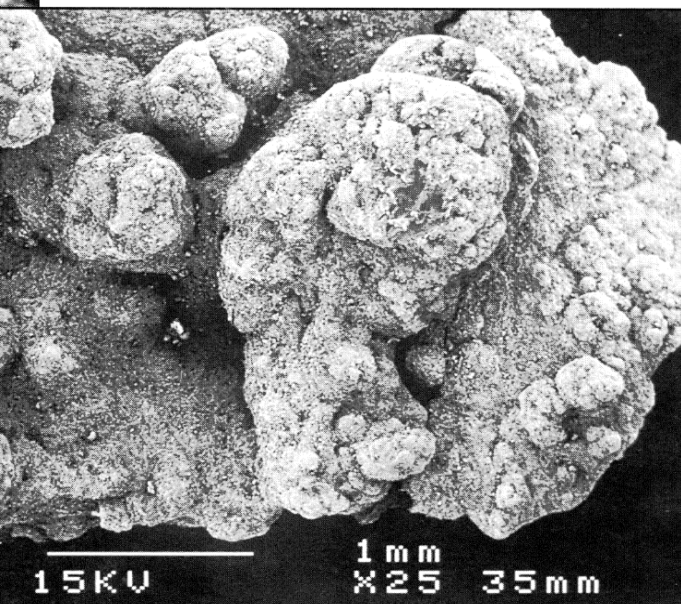
ered in rock accretions in Australia, Italy, California, and now Texas. The origin of whewellite in rock accretions is not fully understood.

The limestone walls inside the rock shelters in and adjacent to the park are completely covered with the whewellite-rich rock crust. This accretion is typically less than 0.5 mm thick and imparts a yellow to brown color to the limestone. Gypsum, quartz, and clays are the other principal components in the accretion. The whewellite, gypsum, and quartz are sufficiently translucent that the pictographs are clearly seen. However, accretions with high concentrations of clays tend to obscure the pictographs, causing them to appear faded or to be completely blocked from view.

#### A MICROSCOPIC VIEW OF THE PAINTS AND ACCRETION

Using scanning electron microscopy (SEM), we analyzed samples of prehistoric paints and accretion from Amistad (fig. 3). The SEM allows us to image and analyze individual particles that are 0.5  $\mu$  (micron–1,000  $\mu$  = 1 mm). Presented here are some of the results of this study.

Lichen living on or near the surface of the limestone produced the whewellite. We observe whewellite structures that are strikingly similar to lichen (and fungi) features at the surface and within the accretion. High magnification of the accretion surface reveals structures that resemble



microcolonial fungi and lichen; below the surface the morphology of the whewellite is similar to lichen thalli. In essence, we are observing the fossilized remains of the lichen that produced the calcium oxalate (some lichen are known to produce this compound). Finally, radiocarbon dating of the whewellite confirms a biological origin and indicates that the mineral was produced periodically over the last 5,500 years (Russ et al. 1995).

The source of the gypsum is the limestone substrate. Water moving through pores in the limestone carries dissolved sulfate and calcium ions to the rock surface. Gypsum (calcium sulfate) precipitates as the ions reach the surface by a process known as efflorescence.

The clay and quartz are primarily from eolian (airborne) matter adhering to the rockshelter wall. These materials adhere to the shelter wall usually when they are moist from high humidity. The silicate materials are then incorporated within the accretion as it continues to form.

Some of the accretions have multiple lamellae, suggesting that they were produced by different mechanisms at different times. We are currently investigating

relationships between accretion processes and major shifts in the regional climate over the last 6,000 years.

The prehistoric paints are generally 30-100  $\mu$  (0.3-0.1 mm) below the surface of the accretion and are about 100  $\mu$  (0.1 mm) thick. Zolensky (1982) identified the principal pigments in the prehistoric paints as iron oxide minerals for red paints and manganese oxides for black paints. We not only observe a high incidence of iron and manganese in the paints, but also a significant clay component. Thus, the paints are composed mainly of a mixture of clay and oxide minerals.

### CONCLUSIONS

The primary source of the accretion covering the park pictographs was lichen activity on the surface of the limestone inside the rock shelters.

Very little evidence of oxalate-producing lichen exists currently in the shelters. The primary growth of the accretion at this time is the gypsum efflorescence, indicating that water is moving through the substrate, paints, and accretion. The water should have little effect on the paint materials since paints are composed of highly insoluble clays and oxide minerals.

The current deterioration of the pictographs is not due to surface decay. In fact, the accretion may be the most important factor in how the pictographs have remained intact on the shelter walls over the last four millennia. Preserved within these natural materials, they are protected from attack by chemical and physical weathering agents. At this time, the crust is only a nuisance by causing the paintings to appear faded. Removing the accretion simply to make the paintings appear brighter will be unproductive since it may accelerate biological growth and dissolution processes on the exposed surfaces.

The major force in the deterioration of the pictographs is related to frost action within the limestone substrate (see Winkler 1975). The reality is that the rock

art will not last forever. Forces beyond our control will eventually erase this phase of human prehistory. The new methods for analyzing the ancient paints will revolutionize the study of prehistoric art, and increase our understanding of these enigmatic artifacts. With these studies our ability to preserve them will also improve.



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*Wama Kaluarachchi recently completed her master of science degree at Sam Houston State University. Joseph H. Labadie is the Park Archeologist at Amistad National Recreation Area and his phone number is (512) 775-7491. Jon Russ recently moved to Newberry College, South Carolina, from Sam Houston State University, Texas; he is an Assistant Professor of Chemistry. His address is Department of Biology and Chemistry, Newberry College, 2100 College Street, Newberry, South Carolina 29108; phone (803) 321-5262. The authors thank Research Corporation, the National Park Challenge Grant Program, and Sam Houston State Faculty Enhancement for research support.*





Figure 1. Successful establishment of the planted native species, represented by horse-weed (*Mornarda punctata*) and black-eyed Susan (*Rudbeckia serotina*), in a herbicide plot (Plate A) and a sod removal plot (Plate B) where exotic grasses were eradicated. Plates C and D show a fire plot and a control plot, respectively, where exotic grasses, represented by blue grass (*Poa pratensis*) and quackgrass (*Agropyron repens*), still dominate.

## RESTORING NATIVE VEGETATION ON INDIANA DUNES RAZED RESIDENTIAL SITES

By YOUNG D. CHOI, Ph.D. AND NOEL B. PAVLOVIC, Ph.D.

**Editor's note:** See the reference Choi and Pavlovic 1994 for a more thorough write-up of exotics control.

SAND DUNES OF THE LAKE MICHIGAN shoreline within Indiana Dunes National Lakeshore are home to over 1,000 native plant species and more than 100 Indiana endangered and threatened plant taxa (Wilhelm 1990). This 40 km (25 mi) long dune and swale complex is also home to unusual plant combinations, like prickly pear cactus (*Opuntia humifusa*) and arctic bearberry (*Arctostaphylos uva-ursi coactilis*), that led early botanist Henry Cowles (1899) to develop important principles of local plant succession. Unfortunately, human activities have disturbed much of this flora (Hiebert 1990a). Bowles et al. (1990) noted that these activities, including home construction and subsequent abandonment, disturbed 35 of 81 Indiana endangered and threatened plants studied.

Park resource managers have prioritized that native vegetation be restored to more than 800 abandoned residential sites located within the park. However, extensive exotic plant infestation is a major obstacle that must be overcome in accomplishing the restoration goals (Hiebert 1990b). To find the best feasible ways of eradicating exotic species and restoring native species, we compared the effects of fire, herbicide, and sod removal on native vegetation restoration in xeric (dry) razed residential sites (fig. 1).

### METHODS

In May 1993, we established 24 experimental plots with four treatment groups (control, herbicide application, sod removal and prescribed burning) in three razed residential sites within the park. We then used a rotary seed broadcaster in each plot to sow a mixture of seeds (627 g) consisting of nine native species (table 1).

In September 1994, two growing seasons after site preparation and seeding, we collected vegetation data. We grouped all identified plant species into three categories: (1) planted native-native species

seeded in 1993, (2) voluntary native-native species occurring voluntarily (i.e., without being planted in 1993), and (3) exotic-(table 1). Using a point contact frame we also estimated vegetative covers and, using the paired t-test, compared these data with pretreatment data from August 1992 (table 2).

### RESULTS AND DISCUSSION—FIRE

Although prescribed fire has been widely used elsewhere to control exotic species (Olson 1975, Apfelbaum and Rouffa 1983, Cole 1991), we found that fire did not successfully eradicate exotic species (e.g., blue grass—*Poa pratensis* and quackgrass—*Agropyron repens*). Voluntary native species coverage (e.g., hairy lens grass—*Paspalum stramineum* and umbrella sedges—*Cyperus* spp.) did not change significantly. Conversely, planted native species, represented by little blue stem (*Andropogon scoparius*), increased significantly from 2.7% to 16.0%. This increase, however, was not much different from the

**TABLE 1. THREE CATEGORIES OF PLANT SPECIES SAMPLED IN EXPERIMENTAL RESTORATION PLOTS IN THREE RAZED RESIDENTIAL SITES WITHIN INDIANA DUNES NATIONAL LAKESHORE.**

Category	Genus & Species	Common Name
<b>Planted Native</b>		
	<i>Andropogon scoparius</i>	little blue stem
	<i>Elymus canadensis</i>	Canada rye grass
	<i>Koeleria cristata</i>	junegrass
	<i>Oenothera biennis</i>	evening primrose
	<i>Panicum virgatum</i>	switch grass
	<i>Monarda punctata</i>	horseweed
	<i>Rudbeckia serotina</i>	black-eyed Susan
	<i>Stipa spartea</i>	porcupine grass
	<i>Sorghastrum nutans</i>	Indian grass
<b>Voluntary Native</b>		
	<i>Aster sp.</i> <sup>1</sup>	aster
	<i>Cyperus spp.</i> <sup>2</sup>	umbrella sedges
	<i>Erigeron annuus</i>	horseweed
	<i>Eragrostis spp.</i> <sup>3</sup>	lovegrass
	<i>Paspalum stramineum</i>	hairy lens grass
	<i>Sporobolus cryptandrus</i>	sand dropseed
	<i>Solidago canadensis</i>	Canada goldenrod
	<i>Tradescantia ohiensis</i>	spiderwort
	<i>Verbascum thapsus</i>	common mullein
<b>Exotic</b>		
	<i>Agropyron repens</i>	quackgrass
	<i>Ambrosia artemisiifolia</i>	ragweed
	<i>Bromus tectorum</i>	downy chess grass
	<i>Digitaria sanguinalis</i>	crabgrass
	<i>Festuca sp.</i> <sup>4</sup>	fescue grass
	<i>Galium spp.</i> <sup>5</sup>	bedstraws
	<i>Lepidum campestre</i>	field peppergrass
	<i>Melilotus spp.</i> <sup>6</sup>	sweet clovers
	<i>Physalis heterophylla</i>	clammy groundcherry
	<i>Plantago lanceolata</i>	English plantain
	<i>Poa pratensis</i>	blue grass
	<i>Rumex acetosella</i>	field sorrel
	<i>Saponaria officinalis</i>	soapwort
	<i>Solanum carolinense</i>	horse nettle
	<i>Stellaria media</i>	common chickweed

1. This could not be identified at the species level, but is presumed to be native.
2. *Cyperus filicumbis*, *C. schewinitzii*, and *C. strigosus*
3. *Eragrostis hypnoides* and *E. spectabilis*
4. *Festuca elatior*, *F. ovina*, and *F. rubra*
5. *Galium aparine* and *G. mollugo*
6. *Melilotus alba* and *M. officinalis*

**TABLE 2. CHANGES IN COVER OF RESTORED NATIVE, NONRESTORED NATIVE, AND EXOTIC SPECIES FROM 1992 (PRETREATMENT YEAR) TO 1994 (POSTTREATMENT YEAR) IN THE EXPERIMENTAL RESTORATION PLOTS**

Category/Treatment	Cover (Mean±SE <sup>1</sup> )		p <sup>2</sup>
	1992	1994	
<b>Exotic</b>			
Control	83.0+11.8	78.8+18.4	0.85
Fire	94.5+9.0	98.8+14.7	0.93
Herbicide	81.8+14.6	24.6+7.1	0.01
Sod Removal	85.2+6.5	11.7+1.7	<0.01
<b>Voluntary Native</b>			
Control	16.2+8.4	17.3+7.6	0.92
Fire	27.0+13.8	25.5+9.7	0.93
Herbicide	28.6+13.0	35.2+7.8	0.68
Sod Removal	20.3+6.4	26.5+3.6	0.42
<b>Planted Native</b>			
Control	8.5+2.6	17.5+6.6	0.23
Fire	2.7+1.6	16.0+4.0	0.01
Herbicide	3.6+1.7	48.6+4.4	<0.01
Sod Removal	13.3+4.6	55.2+3.8	<0.01

1. Standard error of mean.

2. Probability of type I error from the paired t-test.

control plots, and it was not as significant as we found in the herbicide or sod removal plots (table 2).

These results clearly demonstrate that fire was not effective to control the fire-adaptive grasses in our study plots. In extreme cases, these exotic grasses reclaimed dominance quickly and reestablished ground cover to the prefire level within 2 weeks after the fire. Repeated fires and growing-season fires may be considered as alternatives. Further study is needed to investigate the effects of these alternatives and to determine the timing and frequencies of fires for maximum benefits.

#### HERBICIDE

We noted that the herbicide Round-up successfully controlled exotic grasses, and similar studies (e.g., Bingham et al. 1980, Marquis et al. 1984, Nuzzo 1991) support herbicide use for this purpose. Planted native species, including little blue stem, Indian grass (*Sorghastrum nutans*), horseweed (*Monarda punctata*), black-eyed Susan (*Rudbeckia serotina*), and Canada rye grass (*Elymus canadensis*), have established 49% ground cover in our herbicide plots where we removed most exotic species. Herbicide treatment did not affect voluntary native species (e.g., love grasses—*Eragrostis* spp. and umbrella sedges) as shown in table 2.

Despite its success in eradicating exotic species, herbicide application still remains questionable; some roots, seeds, and other exotic species propagules are probably viable in the topsoil implicating a potential competition with native species for resources and space. A seed bank study or a longer vegetation change monitoring study may provide useful information to answer this question.

Continued on page 20



## SOD REMOVAL

Mechanical removal of exotic sods and topsoils can benefit native species by (1) providing a sandy and relatively infertile substrate—a natural characteristic of the Lake Michigan sand dune ecosystems—and (2) avoiding potential competition with existing exotic species. This method caused a response similar to the herbicide treatment. Exotic species cover, mostly blue grass and quackgrass, decreased significantly, whereas planted native species cover (little blue stem, Indian grass, horseweed, black-eyed susan, and evening primrose (*Oenothera biennis*)) increased to 55%. Voluntary native species cover (e.g., love grasses and umbrella sedges) did not change significantly (table 2). Although the entire removal of sod may pose a potential risk of losing existing native species seed banks, it has proven to be very effective in preparing the sites for native vegetation reestablishment.

bor-intensive and expensive than the herbicide option. Using two or three crews to remove trees, shrubs, and sod for each razed residential site, this option would take approximately 800 work days (a day per site). Total cost would depend on labor costs, but can be based on a total of 12,800-19,200 crew hours. Typical NBS seasonal staff wages at Indiana Dunes are \$10 per hour, making the total cost of the sod removal option \$64,000-\$192,000. This option costs three to six times more than the herbicide option and seems prohibitively expensive. However, this cost can be reduced by using a park volunteer work force.

## RECOMMENDATIONS

Based on our 3-year study, we recommend that prescribed fire not be used to eradicate the exotic grasses in the razed residential sites. Both herbicide application and sod removal are equally effective and preferable in controlling the exotic grasses. Herbicide application is less laborious and expensive than sod removal; however, the latter option is better suited

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# Both herbicide application and sod removal are equally effective in controlling the exotic grasses.

## MANAGEMENT IMPLICATIONS

As discussed, prescribed fire did not control the exotic grasses in our study plots. Meanwhile, herbicide application and sod removal were very effective for this purpose. Herbicide treatment costs approximately \$50 per acre. Treating 800 razed residential sites (approximately 400-1,600 acres in total [162-648 ha]) using this method would cost approximately \$20,000-\$80,000 and seems to be affordable if spread over several years. Nevertheless, massive application of the herbicide Round-up, despite its relatively short half-life (about 60 days) and lower toxicity than the other commercial herbicide brands, conflicts with park policy. This is due to the potential for soil and water contamination by herbicide residue.

Sod removal is better accepted by park managers, because it is pollution-free. However, this option is much more la-

to the park policy of avoiding chemical use. Sod removal is also more feasible than herbicide application if labor costs are subsidized significantly by a volunteer work force.



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*Dr. Young D. Choi is an Assistant Professor in the Department of Biological Sciences at Purdue University Calumet in Hammond, Indiana. His phone number is (219) 989-2325; e-mail "ydchoi@calumet.purdue.edu". Dr. Noel B. Pavlovic is a Research Ecologist with the NBS Lake Michigan Ecological Station in Porter, Indiana. His phone number is (219) 926-7561, ext. 428.*

# LAND USE HISTORY OF NORTH AMERICA:

## An Emerging Project of the National Biological Service

By THOMAS D. SISK AND BARRY R. NOON

### VALUE OF A LAND USE HISTORY

**E**FFORTS TO MANAGE THE NATION'S biological resources are hampered by the lack of a historical perspective on conditions prior to European settlement and subsequent changes in the North American landscape. Much of the impact that people have had on the environment can be viewed as a series of unplanned experiments, with particular perturbations generating measurable responses, in the form of contractions in the ranges of some species and expansions in the ranges of others. Within the context of these temporal dynamics, species extinctions and the spread of nonindigenous species may be seen as the extreme cases, where biological elements are lost or introduced. These experiments have been run, and environmental scientists are beginning to assemble the data needed to assess the results. The first task is to develop a clearer understanding of the historic changes in the distributions of plants and animals and their relation to human-induced changes to the landscape. Given this understanding, land managers will be able to review the effects of past perturbations and apply this information when attempting to evaluate the likely outcomes of future land changes.

Much of the data needed to construct such a retrospective view have already been collected; information on landscape change spans the period of human habitation of North America. Impressive regional efforts have been undertaken to synthesize the available information regarding land use change and its impact on ecological systems, but these projects have generally been limited to relatively small areas and short time lines. Large quantities of valuable biological and physical information remain unexplored, warehoused in different locations, and maintained by different organizations.

Consider the abundant information on prehistoric land cover and species distributions accumulated through the creative efforts of paleoecologists. Integration of

coarse-resolution data such as these with information derived from original land surveys of the country (e.g., data archived by the Bureau of Land Management), and the U.S. Forest Service data on the fire history of North America, for example, could make the characterization of historic landscape change quite tractable. When these data are combined with aerial photography from the extensive surveys started in the 1930s, and remotely sensed data from advanced satellite imagery, it will be possible to stitch together a continuous time line, from prehistoric times to the present. Catalyzing such an effort is the intent of the National Biological Service's Land Use History of North America project (LUHNA).

### LAUNCHING THE PROJECT

This is an ambitious project, one that will require the collaboration of many different individuals and agencies, both within and outside government. In August, the National Biological Service (NBS) convened a workshop to help define the scope and intent of the LUHNA effort, and to identify a strategy for fostering the multidisciplinary collaboration that it will require. Representatives from six government agencies, six universities, and three not-for-profit organizations established a framework for building a broader LUHNA effort. The National Biological Service will serve as the organizer and initial "home base" for the project, but the agency cannot possibly carry out such a large project alone or fund all the work that will be required. Instead, the NBS will provide a forum for discussion, communication, and scoping of the project and the initiative for developing the interdisciplinary relationships that LUHNA will require. We will also approach other organizations for co-operation and funding support.

Your comments are invited. The NBS headquarters in Washington has established an electronic mail account that will be used exclusively for the LUHNA project. Currently, we have limited staff assigned to this project, so several of us will be replying to your messages as time allows. In the near

future, we will move to a bulletin board format, permitting an open exchange of ideas among all collaborators and interested parties. The e-mail address is "luhna@ibis.mib.nbs.gov".

We will assemble a directory of individuals and organizations interested in LUHNA and a bibliography of important publications related to the LUHNA concept. We would appreciate your contributions, submitted in the following formats:

### DIRECTORY:

Last name, First name MI (title)  
Organization  
Address  
City, State Zip  
Tel (xxx)xxx-xxxx; Fax (xxx)xxx-xxxx  
e-mail address

### BIBLIOGRAPHY:

Last name, First name MI, and First name MI Last name. Year. Title of article. Journal volume:pp-pp.

### FOR BOOK CHAPTERS:

Last name, First name MI, and First name MI Last name. Year. Title of chapter. Pp-pp. in First name MI Last name (editor) Book Title. Publisher, City, State, Country.

Submissions to both documents will be compiled and distributed electronically to all respondents, unless you request otherwise. If you wish to be on the mailing list but not in the directory, please indicate that on the line immediately above your name.

We look forward to your comments and our continuing interaction on this project.



*Thomas D. Sisk is an ecologist, and Barry R. Noon is Acting Chief Scientist. Both are with the National Biological Service, U.S. Department of the Interior, Washington, D.C.*

# BEHAVIORAL ECOLOGY AND MANAGEMENT OF STRIPED SKUNKS IN GREAT SMOKY MOUNTAINS NATIONAL PARK

By DANIEL R. TARDONA AND ANDREA BIXLER

ONE OF THE MANY EXCITING WILDLIFE encounters experienced by visitors to Great Smoky Mountains National Park, Tennessee, is meeting a striped skunk (*Mephitis mephitis*). Such encounters often produce wonderment, fear, and ambivalent actions by visitors. What will the skunk do? What will the visitors do? What kind of behavior will the encounter elicit from the skunk? Animal behavior in the wild and in situations where human contact is probable yields information about the biology and ecology of the animal that may influence management decisions affecting this valuable wild natural resource. Researchers at the University of Tennessee, Knoxville, are currently studying the striped skunk in Great Smoky Mountains National Park in order to better understand its behavioral ecology in the wild and to produce information that will be helpful to park natural resource managers and interpretive staff.

While many behaviors of striped skunks, such as reproductive and denning behaviors, have been studied, many facets are still not fully understood. A mustelid, the striped skunk is a solitary carnivore. It does not behave like social animals in that it does not cooperate with other members of the species to find food, defend territory, locate shelter, or select a mate. This does not mean that skunks do not interact at all with other skunks. Skunks have been observed to den in groups of up to 19 in Canada (Gunson and Bjorge, 1979). Park rangers and visitors report observing adult striped skunks (presumably mother skunks) often accompanied by 3-5 young trailing behind in the early evening hours in park campgrounds.

Researchers in the Smokies are attempting to understand the home ranges of the striped skunk. Home range is an important facet of behavior to study because it may yield information that not only helps behavioral ecologists learn

Coauthor Andrea Bixler weighs an anesthetized skunk that was probably less than 2 months old. Researchers measured each captured skunk for weight, head-body length, tail length, and upper canine length.

more about the behavior of this solitary carnivore, but also may help park personnel manage this important member of the mountain community. For example, we do not know how striped skunk relatedness affects home range overlap. If relatedness is an important component in determining home range, how do individual striped skunks communicate relatedness? Knowledge of this behavior would influence decisions regarding relocation of individual striped skunks when necessary.

Skunks are well known for their ability to spray musk when frightened or threatened. A long held belief is that this noxious spray evolved exclusively for defense against predators such as bobcats, coyotes, foxes, and owls (although it is not effective against owls as owls are unable to smell!). However, it is possible that skunks also could use this powerful and persistent odor to communicate with other skunks. Communication by odor (chemocommunication) is often observed among solitary carnivores and may be used to convey information about genetic relatedness, among other things (Gorman

and Trowbridge 1989). Individual differences in the composition of the musk sprayed by striped skunks may represent genetic differences useful in kin recognition. Striped skunks may be able to recognize kin and respond differentially to them based on scent differences. It is also possible that differences in spray composition are due to sex, age, diet, body size, or time since the skunk last sprayed.

Skunks may also space their home ranges according to relatedness. In other members of the mustelid family, while male and female ranges commonly overlap, males possess home ranges exclusive of other males, and females possess home ranges exclusive of other females (Powell 1979). However, a trap-recapture study in Cades Cove campground of Great Smoky Mountains National Park found that both male and female home ranges overlapped each other (Goldsmith 1980). Research currently in progress in the larger Cades Cove subdistrict may yield similar findings on skunk home range area and overlap.



PHOTO BY PAUL ANDREAS

From January 1993 through February 1995 researchers devoted over 260 nights to trapping and radio-tracking skunks in the Cades Cove area of the park. By February 1995 over 2,500 trap nights with a trap success of about 2.5% (56 skunks not including 14 recaptures) had been completed. Trap success has varied from month to month with most captures occurring during February. This is probably because skunks leave their winter dens and move extensively in search of food and mates during this time.

overlap females by 10% of total range. These data suggest that many more skunks may inhabit an area than is apparent from just the size of their home ranges.

Through the use of radiotelemetry, researchers are monitoring skunk movements and home ranges. Laboratory analyses of blood and genetic assays are being used to see whether and how relatedness is associated with spacing patterns in the wild. The scientists are also conducting biochemical analyses of the composition of musk to see if spacing patterns are mediated by individual odors. Analyses of collected scent samples are continuing. These careful field studies are exploring the behavioral ecology of the striped skunk and are increasing our knowledge of this animal.

In contrast to these studies, which give a more complete picture of the species, visitors often glimpse the striped skunk only in park campgrounds when the creatures make their nightly rounds in search of food. While sightings like this can be a source of enjoyment for many visitors, the experience is often artificial and not an accurate view of the natural world.

In the wild, striped skunks forage and hunt at night locating prey primarily by smell and sound. Their natural diet includes various insects and insect larvae that they acquire by clawing holes in the ground. Striped skunks eat small reptiles and amphibians such as lizards and frogs. Skunks also will eat carrion and occasionally will stalk and take smaller mammals. The skunks also range beyond campgrounds; according to Linzey and Linzey (1971), the striped skunk has been observed at elevations up to 5,200 feet in the park. Viewing these animals scavenging through picnic and campground trash may not be the lasting impression of the wild that will insure public support for the continued preservation of wildlife.

A better understanding of the behavior of these animals can help guide natural resource managers to make good decisions for the benefit of the animal, to use appropriate management techniques, and to provide visitors with the best of experiences the natural world has to of-

fer. The results of behavioral research can also provide interpreters with interesting and accurate information that can be passed on to park visitors, enhancing visitor appreciation and understanding of wildlife. The ongoing study of the behavioral ecology of striped skunks is an important step in the understanding and management of this beautiful, solitary carnivore of Great Smoky Mountains National Park.



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*Dan Tardona holds a graduate degree in psychology with research interests in animal learning and behavior. He is currently the west district supervisor in the Interpretation and Resource Management Division of the Timucuan Ecological and Historic Preserve, Jacksonville, Florida. Before moving to Florida, Dan was a Great Smoky Mountains National Park interpreter. His phone number is (904) 641-7155 and his fax number is (904) 641-3798.*

*Andrea Bixler is pursuing her Ph.D. with John Gittleman in the Ethology Program at the University of Tennessee. She has been trapping and radio-tracking striped skunks in Great Smoky Mountains National Park since February 1993, and she has been sprayed several times. You can contact her at the University of Tennessee, Department of Ecology and Evolutionary Biology, 569 Dabney Hall, Knoxville, Tennessee 37996-1610. Her phone number is (423) 974-3065 and her fax is (423) 974-3067. The research was supported by the University of Tennessee Division of Biology, the Theodore Roosevelt Memorial Grant of the American Museum of Natural History, and the Great Smoky Mountains Conservation Association.*

**TABLE 1** PRELIMINARY HOME RANGES COMPUTED FOR 9 COLLARED STRIPED SKUNKS

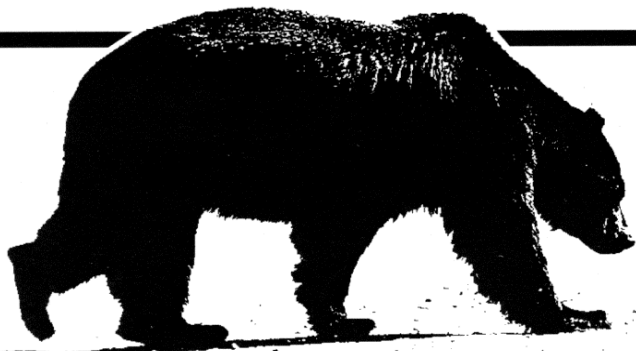
Sex	# Locations	# Nights	Home Range
F	157	84	1.35 km <sup>2</sup>
F	133	51	0.45 km <sup>2</sup>
F	96	53	0.54 km <sup>2</sup>
F	230	102	1.05 km <sup>2</sup>
F	184	125	1.27 km <sup>2</sup>
M	51	34	1.69 km <sup>2</sup>
M	62	45	0.58 km <sup>2</sup>
M	64	45	0.92 km <sup>2</sup>
M	137	90	0.90 km <sup>2</sup>

(1 km<sup>2</sup>=0.386 square miles)

Preliminary home ranges computed for nine radio-collared animals using the minimum convex polygon method from WildTrak software is presented in table 1. Only those skunks located at least 50 times are included. Since multiple locations were sometimes made on the same night, the number of nights the researchers tracked each animal is also given. The nights were not necessarily consecutive.

All skunks inhabiting home ranges within 2 km (1.2 mi) of the Cades Cove picnic area and campground make occasional forays into these areas. This has implications for skunk management, as relocation of skunks found in the picnic area and campground over a period of a few days would not eliminate all the skunks that use the area. Data collected thus far indicate that female skunk home ranges overlap extensively, up to 90% of each animal's total range. Male skunk ranges overlap as much as 85%, and males





*The restoration plan calls for relocating hibernating black bears from their dens in Great Smoky Mountains National Park, 80 miles to the east, to surrogate dens within Big South Fork. Scientists hope that the winter release will entice the bears to stay in their new home, and managers will study success of the experiment before a permanent restoration ensues.*

## STAGE SET FOR BLACK BEAR RESTORATION AT BIG SOUTH FORK

1995-96 plan calls for staff readiness, experimental winter and summer releases, and scientific follow-up

BY ARTHUR MCDADE AND ROBERT EMMOTT

RECENT MEDIA ATTENTION ON THE wolf restorations in the Great Smoky Mountains and Yellowstone National Parks has highlighted the resource management and scientific work ongoing in various national park system units. Wildlife reintroduction projects are very popular with the media and the public, and the success of the National Park Service in restoring native fauna to historic range has both scientific and public relations value. Each success story helps foster a positive scientific and public relations climate for other parks to engage in wildlife restoration projects.

An example can be found in the Big South Fork National River and Recreation Area in the mountains of eastern Tennessee and Kentucky. Park managers and biologists are studying restoring *Ursus americanus*, the black bear, to the rugged backcountry of the Big South Fork drainage (fig. 1). The park straddles the Tennessee and Kentucky borders in the Cumberland mountains (fig. 2). It is a rugged area, comprising 122,000 NPS acres (49,393 ha), bordered by approximately 80,000 additional acres (32,389 ha) of the Stearns District of the Daniel Boone National Forest.

The park is a relatively new addition to the park system, established in 1974,

but the landscape is ancient. The Big South Fork of the Cumberland River winds through deep canyons carved out of the 240 million year old Paleozoic Era sandstone. For over 10,000 years the canyons of the Big South Fork provided rock shelters and hunting grounds for the Paleo-, Archaic, and Woodland Indian peoples, who hunted the rich fauna of the area. Until about 1900, the fauna included the black bear. Overhunting, habitat destruction, and timber operations in the 20th Century took their toll on the bears. Save for an occasional lone transient, black bears have been extirpated from these mountains.

Interest in black bears in the southern mountains has always been high. Tales of early European contact with bears, and spirited bear hunts, are a standard of southern Appalachian folklore. The Great Smoky Mountains National Park, 133 kilometers (80 miles) to the east, sustains 400-600 black bears, a considerable attraction to the 8 million visitors who go there annually, many with the express desire of observing bears in the wild. Because of the great interest in this southern Appalachian symbol, several organizations in the late 1980s considered the idea of restoring black bears to the Big South Fork area.

In 1987, the Tennessee Bear and Boar Association suggested to the National Park Service and the Tennessee Wildlife

Resources Agency (TWRA) restoring bears in the Big South Fork area. A working group consisting of representatives from the NPS, TWRA, the U.S. Forest Service (USFS), the U.S. Fish and Wildlife Service, and the Kentucky Department of Fish and Wildlife Resources (KDFWR) studied the merits of the black bear proposal. The working group determined the need for a habitat suitability study to examine the feasibility of bear restoration in the area. Researchers from the University of Tennessee Department of Forestry, Wildlife, and Fisheries undertook the study.

### HABITAT SUITABILITY STUDY

The area study examined road density, human population, and the availability of food and cover. Black bears eat a variety of foods in different seasons in the southern Appalachians, consuming herbs and some insects and carrion in the spring. In the summer, an abundance of berries and fruits (soft mast) satisfy the bear's needs. In the middle and late fall, acorns, hickory nuts, and beech nuts (hard mast) dominate the bear's diet. These dietary needs would have to be available in the Big South Fork area for a successful restoration.





*Figure 1. Angel Falls of the Big South Fork of the Cumberland River, Tennessee, and other rugged park backcountry locales were once home to now extirpated black bears. If all goes as planned, bears may begin to make their reappearance in the Big South Fork National River and Recreation Area as soon as late fall, 1995.*

Completed in 1990, the habitat suitability study concluded that the Big South Fork area provided adequate summer and fall food production for bears (Van Manen). It also determined that denning cover was adequate, and that the maturing forest provided escape cover. Improved road density was determined to be low, although logging and dirt roads throughout the area are of higher density. One major element of the study was the prediction that as the second-growth forest matures in the next 5-10 years, hard mast production would improve, with optimal levels reached by the end of the century.

#### **PRELIMINARY RESEARCH PROPOSAL AND ENVIRONMENTAL ASSESSMENT**

In order to test the habitat study conclusions and to explore potential human-bear interactions, TWRA drafted a preliminary proposal for an experimental release (Wathen 1992). This proposal recommended a 2-year program in which 12 bears would be released and radio tracked in the west-central area of the park. National Park Service biologist Steve Bakaletz and Ron Cornelius, then Chief of Resource Management at the park,

began refining the proposal. Ultimately, they drafted and circulated for public comment an environmental assessment of the proposed experimental project (Emmott, 1994). The draft described the

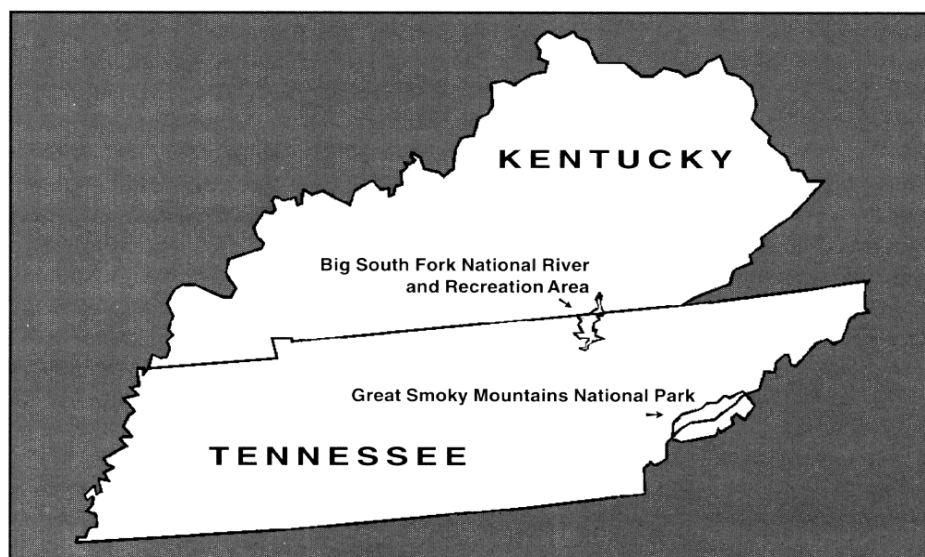
potential impacts of the experimental bear releases on the physical, biological, and human environments, and outlined steps to mitigate these impacts. The draft also outlined several project alternatives and described comments received from the public in 1993 regarding the proposed bear relocations.

#### **SPECIFIC RESEARCH PROPOSAL**

In November 1994, representatives from the cooperating agencies met and agreed that a research proposal should be completed. Dr. Joseph Clark of the National Biological Service (Southern Field Laboratory, Knoxville, Tennessee), working with NPS Resource Management Specialist Robert Emmott, completed a draft proposal consisting of a 2½-year project involving 12 released bears (Clark 1994). The proposal recommended securing the bears from the Great Smoky

Mountains National Park and gave the following objectives:

- Determine dispersal and mortality rates of reintroduced bears



*Figure 2. Located along the Tennessee-Kentucky border, the park preserves forests of the Cumberland Plateau and over 75 miles of the Big South Fork of the Cumberland River and a few of its tributaries. Now maturing, the second-growth mixed forest should produce optimal bear forage by the end of the century.*

*Continued on page 26*

- Assess bear habitat use based upon Van Manen's habitat study
- Evaluate effects of bear-human interactions and document any damage to private property
- Determine effects of age, sex, release method, or other factor on mortality and postrelease movements
- Assess feasibility and probable success of a gradual, long-term bear release to establish a permanent, viable population at Big South Fork

#### PERMANENT RESTORATION TO BE EVALUATED

At the end of the 2½-year experimental releases, park managers will be better able to determine whether a permanent restoration program should be initiated. With the results of the experimental project, managers can base this decision on scientific data regarding habitat adequacy, home range establishment, and human contact.

The park is gearing up for the potential 1995 experimental releases, and Superintendent Lee Davis is enthusiastic about the project. He shares the belief that

hold public information meetings along with home visits to park neighbors to explain the project. Backcountry hikers will receive literature about the bear reintroductions, and temporary bear ecology exhibits are planned for the two park visitor centers. Park interpreters will provide formal and informal presentations on the continuing bear project during the 2-year experimental phase.

The cooperating agencies have agreed to fund the project. At present, we anticipate a winter 1995-96 relocation of bears from the Great Smokies to the Big South Fork.

*...wild bears will be captured in their dens in the Smokies and relocated to the Big South Fork during winter where they will resume hibernation in the new location.*

Clark proposes releasing the bears in both summer and winter. For the winter releases, he will use a variation of a soft release; (a soft release involves a period of acclimation with food and shelter in an enclosure area prior to release to the wild). This includes capturing wild bears in the Smokies, relocating them to the Big South Fork, and releasing them into denning locations during the winter. To accomplish this, selected Smokies bears will be trapped and radio collared in the summer, then later tracked to their winter dens. Biologists will sedate these hibernating bears and transport them to the Big South Fork. The bears will resume hibernation in the new location, and in the spring, venture out into the new habitat acclimated to their new home range. Bears have a strong homing instinct, and we hope that the winter release will provide the acclimation needed to prevent the bears from trying to return to the Smokies.

Clark's proposal also calls for summer releases, whereby bears will be translocated from the Smokies to the Big South Fork with a short confinement period in acclimation pens. During the project, researchers from the University of Tennessee will radio track the bears until home ranges are established.

the National Park Service has a role to play in restoring native fauna to historic range, where feasible. His enthusiasm is balanced by a healthy regard for the concerns of park neighbors, however. He does not want the experimental bear releases to fail due to adverse public relations concerns, which could jeopardize a future permanent bear release. Consequently, he has been an engaged participant in the planning.

The Acting Chief of Resource Management, John Cannon, is making plans for release site protection. Rangers will closely monitor the remote release area and work jointly with cooperating agencies to establish security for the bear releases. Cannon, who came to the Big South Fork from the Great Smokies, believes that the bears will be a biological bonus for the area, restoring a native species to its historic range, and may provide an economic boost to the surrounding human communities.

The park also plans to interpret the significant project. The bear project has generated considerable interest amongst constituency groups, such as hikers, conservation organizations, and hunting and fishing clubs. Steve Seven, Chief of Interpretation, plans on using the park interpretive newspaper to highlight the ongoing experimental reintroduction project. He also plans on having site bulletins at backcountry trailheads with information on the bear project. Staff will

The intense scientific planning over 5 years at the Big South Fork is nearing fruition; the park is gearing up for an exciting and scientifically challenging research project. Between the hard science in the field and the interpretation ongoing throughout the park, the public will be able to follow the experimental release of *Ursus americanus* to a part of its former range.

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*Arthur McDade is a Park Ranger and Robert Emmott is a Resource Management Specialist; both are with the National Park Service at Big South Fork National River and Recreation Area in Tennessee and Kentucky and can be reached at (606) 376-3787.*

for cooperative, integrated fisheries management as directed in the recent presidential order on recreational fishing.

### MUSTERING THE CLUSTER

In recognizing that several parks are located along the Colorado River corridor, one must also recognize that the cluster park concept will allow aquatic ecology to expand beyond the lines on a map that we call boundaries. Clearly, the river and reservoir processes here are only a part of a larger system that affects water quality and fish movement among the several parks. This concept has been pioneered in recent years by regional fisheries biologist Ed Wick. Wick's studies of native fishes have taken him to spawning bars in Dinosaur National Monument, Colorado, and through Canyonlands National Park as he followed the newly hatched larvae drifting with the current all the way into Lake Powell at Glen Canyon National Recreation Area. Researchers have also monitored adult endangered fish migrating hundreds of miles through this corridor of parks. Broadening our scope among cluster parks will offer the ability to share resources, expertise, and management options.

Mandates of the Grand Canyon Protection Act require a long-term monitoring component to assess impacts of the operation of Glen Canyon Dam upon resources in Grand Canyon National Park and Glen Canyon National Recreation Area. An interagency monitoring group is organizing for the long-term, and NPS Colorado Plateau cluster parks are working together to identify issues and roles in this process. These mechanisms only help us to stand unified in our mission to preserve and protect our precious natural heritage, the national parks along the Colorado River on the Colorado Plateau.

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*Susan Dodson is an aquatic ecologist at Glen Canyon National Recreation Area. Her phone number is (520) 608-6266.*

facilitate integration of resource data with other agencies and regional level analyses, Pictured Rocks has been building its GIS database. Also, NPS representatives are actively involved with the Michigan Gray Wolf Recovery Team, a group that is working hard to develop a recovery plan to ensure full recovery to a sustainable population. The recovery team was established in 1992 with early evidence of packs forming, and has found itself in the awkward, yet not unpleasant, position of trying to keep planning efforts in step with a rapidly recovering population.

Education is, of course, key to the recovery. Active wolf support and education groups have sprouted up in Michigan, Minnesota, and Wisconsin to serve a vital role in keeping public attitudes positive. Their volunteer outreach programs have proven quite successful. National Park Service interpreters and rangers will be joining these groups to direct more effort to public education programs, particularly during the critical deer hunting season when hundreds of anxious hunters are roaming the woods (hunting is legal in Pictured Rocks).

While the outlook appears pretty sunny for the wolf in Upper Michigan, dark clouds also loom. Diseases such as sarcoptic mange and canine parvovirus may have significant impacts on the population; mange is believed to account for substantial mortality. Habitat loss through development and fragmentation is also a concern; a United States Coast Guard proposal to maintain shipping through the Saint Marys River in winter via icebreaker is considered to be a significant threat to movement between Canadian and Upper Peninsula populations. Perhaps the greatest threat is the possibility of a change in public attitudes. The Michigan Militia and antigovernment sentiment are strong in the Upper Peninsula; any protective action by a public agency that may be perceived as heavy-handed (particularly road closures) could cause a serious antiwolf backlash. Although farming is not a common livelihood in most of Upper Michigan, livestock depredation is also a

concern. The recovery team recognizes the need for quick assessment and effective response to depredation claims, and is seeking funding from nongovernmental organizations for a reimbursement fund.

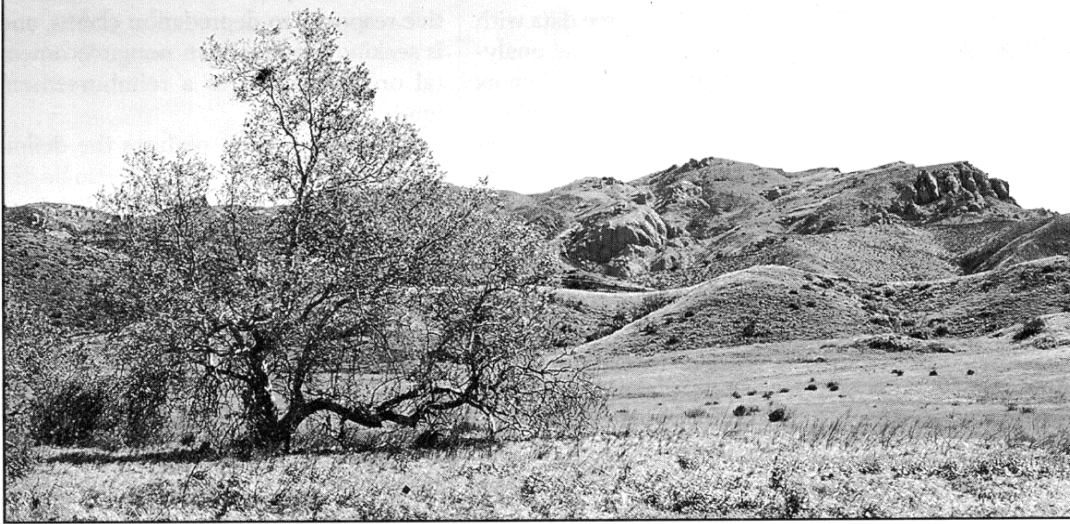
While the wolf is perhaps the definitive *charismatic megafauna* and can be dismissed as an example of politicized endangered species issues, its return to the Michigan Upper Peninsula is important for several reasons. First, it demonstrates a positive, fundamental change in attitudes



in an area where long-established antipredator sentiments die hard. This change can be built upon to broaden knowledge and gain support for other environmental issues. Second, it provides some evidence of overall ecosystem health for a large chunk of land near the country's industrial heartland (within 350 miles of both Chicago and Detroit). Third, it forces state and federal agencies to go beyond happy policy statements about "ecosystem management" and "preserving biodiversity" to actually taking positive, cooperative management actions across boundaries to benefit both human and natural environments. Pictured Rocks National Lakeshore intends to be an active partner in this endeavor.

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*Brian Kenner is a Natural Resource Management Specialist at Pictured Rocks National Lakeshore. His phone number is (906) 387-2607.*



*Figure 1. This nonnative coastal mountain grassland at Santa Monica Mountains National Recreation Area in southern California comprised the southern portion of the 32-acre site chosen for riparian vegetation restoration. The lone mature sycamore, one of a few remaining native plants, may soon be joined by other native trees, shrubs, herbs, and grasses planted by more than 250 people along the base of Boney Ridge (background) in the Potrero Creek restoration project.*

## PARTNERSHIPS IN RESOURCE MANAGEMENT: The Potrero Creek Restoration Project

By ROSE M. RUMBALL-PETRE

**P**ARK PARTNERSHIPS AND INTER-agency cooperation are essential ingredients in conducting successful projects in the Santa Monica Mountains National Recreation Area in southern California. Unlike most national parks, we will never own all, or even most, of the land within the boundary. Rather, the park demonstrates a cooperative effort itself, where the lands of private citizens and local, state, and federal governments mesh. Therefore, conducting park projects in a broad context of openness and cooperation is critical. Engendering community support for the park is essential to preserving its resources.

### BACKGROUND

Community support for the park paid big dividends last year when area cooperators helped to revegetate the Potrero Creek drainage following severe wildfires. Planning for the Potrero Creek Restoration Project began when, in the aftermath of the fall 1993 fires, Kraft General Foods, Inc., donated \$10,000 through the National Park Foundation (NPF) for revegetation. However, since the National Park

Service does not routinely revegetate after wildfires, we chose to use the grant for a high priority riparian restoration project, consistent with the development concept plan for Rancho Sierra Vista/Satwiwa (1984) and acceptable to Kraft as an alternative. This area was one of the first burned by the 1993 Greenmeadow fire, which burned over 38,000 acres (15,385 hectares) within the park.

Potrero Creek traverses a highly disturbed grassland at the base of Boney Ridge in the western end of the Santa Monica Mountains (fig. 1). Beginning around the turn of the century, well before NPS management, the restoration area was the site of a large cattle and sheep ranch; later, a citrus farm prevailed; and still later, during NPS management, the tract served as a dryland farm that partially supported a local college agricultural program through a cooperative agreement. These activities, including removal of large oaks and sycamores in support of historic ranching and farming, left Potrero Creek with little native vegetation regeneration. The development concept plan for the area and the park resource management plan both prescribed native vegetation restoration, especially in riparian

areas, as a high priority. The wildfires prompted funding, helped us rally support, and moved us to plan for this cooperative revegetation project.

### PLANNING

Initial planning and research for the project entailed publicizing the grant from the National Park Foundation and contacting a variety of individuals and agencies for information regarding similar restoration projects. We incorporated this information into a detailed restoration plan that adopted recommendations of other existing area plans to place a 400-foot (122 meter) riparian buffer along Potrero Creek through the dryland farming zone.

The Potrero Creek Restoration Plan describes the need for restoration and discusses the overall and site-related importance of riparian restoration. The document also analyzes the proposed restoration area in terms of its physical and biological site characteristics (soil, topography, hydrology, existing vegetation, succession, wildlife use). Finally, it identifies planning considerations and the goals and



objectives for the project, based on research into the successes and failures of riparian restoration projects conducted throughout the west. In addition, the restoration plan presents monitoring data

Life Wholesale Nursery provided valuable comments during the planning process; some even assisted in implementation.

dividuals and community organizations that supported the project, including TreePeople, Tree of Life Nursery, the

## Engendering community support for the park is essential to preserving its resources.

from a reference site and describes the implications of the project site characteristics on implementation.

We analyzed aerial photos and selected similar sites for use as reference areas to determine the project boundary, implementation strategy, existing plant species, planting density, and planting zonation. Finally, to develop a planting plan, we prepared a detailed site map, selected an irrigation system, and designed a monitoring program that would address the overall restoration project goals and objectives. Table 1 shows the native species we chose to plant in the restoration project.

Throughout the restoration plan literature citations of documented riparian restoration projects refer to actual implementation objectives, such as whether or not to mulch, what planting density to use with walnuts, the depth to achieve when augering holes, etc. However, little information was available on the success and failure of riparian restoration efforts. As a result, we engaged in great debates over whether or not to fertilize the plants. Lacking consensus, we decided to test the need for fertilization through this project.

The overall project area encompasses a potential of 32.2 acres (13 hectares), of which approximately 13.8 acres (5.6 hectares [1,500 x 400 ft]) have been restored. We augered holes, set up a fertilization test, and installed a drip irrigation system for 1,020 plants of seven riparian species and two coastal sage scrub affiliates. In the end, the California Department of Parks and Recreation, Topanga-Las Virgenes Resource Conservation District, City of Malibu, California Department of Fish and Game, NPS Western Regional Office, Channel Islands National Park, TreePeople, James H. Cowan and Associates, Coast Irrigation, Inc., and Tree of

### FUNDING AND DONATIONS

One of the first contacts we had with a cooperator who would help us carry out the restoration occurred even before we received the NPF grant. TreePeople, a local tree-planting activist organization, had approached us following the fall 1993 wildfires to offer assistance in planting trees in the park. Although Potrero Creek was evaluated for an initial cooperative venture, it was not selected because it lacked a restoration plan. Instead, we cooperated to revegetate Happy Hollow Campground and replaced nonnative trees, killed by the wildfires, with native trees and shrubs.

While waiting for the grant and developing the restoration plan for Potrero Creek, we also sought additional funding and support for the project through donations. Regular conversations with interested park and inter-agency staff led to over \$45,000 in donations of materials and volunteer time (calculated at \$7.50/hour, essentially a GS-3 wage), which more than quadrupled the original donation. TreePeople set aside money and contracted staff time in anticipation of the project, and when we received the NPF grant, their interest escalated.

The NPF grant was used to purchase materials and supplies to prepare for the planting date and the temporary drip irrigation system. Remaining grant funds are being used to pay for 2 years of dry-season watering. The bulk of the project, however, was implemented as the result of donations from the huge variety of in-

dividuals and community organizations that supported the project, including TreePeople, Tree of Life Nursery, the

### PLANTING AND MONITORING

The fall planting date attracted an all-time record turnout for a volunteer event in the park, gathering over 250 participants from a variety of Los Angeles and

**TABLE 1. NATIVE VEGETATION PLANTED AT THE POTRERO CREEK RESTORATION PROJECT SITE**

#### Trees

California black walnut	<i>Juglans californica</i>
Western sycamore	<i>Platanus racemosa</i>
Coast live oak	<i>Quercus agrifolia</i>
Valley oak	<i>Quercus lobata</i>

#### Shrubs & Subshrubs

California sagebrush	<i>Artemisia californica</i>
Coyote bush	<i>Baccharis pilularis</i>
Mule fat	<i>Baccharis glutinosa (salicifolia)</i>
Purple sage	<i>Salvia leucophylla</i>
Wild rose	<i>Rosa californica</i>
Mexican elderberry	<i>Sambucus mexicana</i>

#### Grasses, Sedges, Rushes

Creeping wildrye	<i>Elymus triticoides</i>
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Ventura County community organizations, such as the Roosevelt High School Ecology Club, the Los Angeles Junior Chamber of Commerce, and a number of scout groups. The largest single "group" of individuals participating in the project, however, were volunteers from the neighborhoods bordering the restoration site.

*Continued on page 30*

The first phase of monitoring is nearing completion. Plant growth and survival has been extremely variable, with elderberries (*Sambucus mexicana*) sustaining a 71% mortality rate, but with individuals attaining the greatest growth, with a range of 13.7-76.9 in (35.1-197.2 cm) and stem diameters of greater than 1.4 in (3.6 cm). Sycamores (*Platanus racemosa*) on the other hand, had an initial survival of 90% but attained virtually no additional height (range 2.3-40.6 in [5.9-104.1 cm]) due to a widespread fungus infestation that caused the trees to die back after early spring growth and then resprout from the base, with varying vigor. Wild rose (*Rosa californica* [fig. 2]) has had an 85% survival rate, and has attained heights ranging from 5.9-51.5 in (15.1-132.1 cm), with a large number, like the surviving elderberries, also producing both flowers and seeds. Live oaks (*Quercus agrifolia*) and valley oaks (*Q. lobata*) had survival rates of 78% and 62%, respectively, with height ranges of 3.3-40.6 in (8.5 cm-104.1 cm) and 5.1-55.4 in (13.1-142.1 cm), respectively.

Ongoing maintenance of the drip irrigation system will be required for at least 2 years to ensure plant establishment. Monitoring of the project will continue indefinitely, occurring at least annually, in the spring. Additional monitoring of a reference plot in the project area, weeding and alien plant removal, site maintenance, removal of cages and, possibly, follow-up planting will also occur as needed.

Visitors and park neighbors passing adjacent to the project area on Potrero Road, may still see multicolored landscaping flags denoting the wide variety of plants and ongoing efforts of park staff and volunteers to monitor the plants and to main-

tain the irrigation system. The wide, mowed field with huge truckload-sized piles of mulch is now gone and once again offers its previously disturbed appearance. However, upon closer inspection, the native vegetation has returned at irregular intervals. With continued care these plants will dominate the now nonnative landscape of the restoration area.

ing the restoration plan, augering holes, coordinating planting, maintaining the irrigation system, and monitoring. Without the thoroughly researched restoration plan, the willingness of park staff to participate in the project, and the excellent cooperative relationships established through informal connections, this project would not have been possible.

The "devastation" caused by the Greenmeadow fire was put to rights in the minds of park neighbors and volunteers by focusing on repairing the real devastation caused to a native community by years of insensitive land use. An idea, a little seed money, and numerous partnerships created the Potrero Creek restoration project, which, if all goes well, will fulfill the park enabling legislation to "enhance" the natural resources of the Santa Monica Mountains for decades to come.

PS

Rose M. Rumball-Petre is a Resource Management Specialist at Santa Monica Mountains National Recreation Area, California. She can be reached at (818) 597-1036, ext. 239 or via NPS cc:Mail.



Figure 2. One of the many shrubs planted, wild rose (*Rosa californica*) has had an 85% success rate with some individuals flowering, going to seed, and reaching 52 inches in height. A drip irrigation system will water the new plants for at least two years to help them become established.

#### CONCLUSION

The total cost for the project to date is \$63,149 of which more than 70% (\$45,552) has come from donations or volunteer time. Much of the rest can be attributed to staff time spent on develop-

**I**N AN EDITORIAL THAT DEMONSTRATES progress and still has relevance today, NPS Director Russ Dickenson ushered in the new *Pacific Park Science* with the resounding charge to strengthen the link between science and resource management in the parks. Dickenson felt that parks were being managed without use of the full complement of scientific tools available and called for parks to increase their knowledge of science and the dynamics of the resources they manage. Citing the publication as an extension of the (then) 10-year old cooperative park studies unit function "to put the highest quality science to the most intensive use" in managing park resources, Dickenson projected that this bulletin would help serve this purpose and bring the management dimension of the science and resource management mix more to the foreground. Dickenson portrayed science and management as a process that needed to be emphasized and improved, and he saw *Pacific Park Science*, then reporting just from the western United States, as a vehicle to foster the growth of this process.



Also that issue, Sequoia-Kings Canyon National Park Research Scientist Dave Graber reported on his graduate studies of black bears in Yosemite National Park. While the immense frontcountry problem of bears dining on poorly stored campground food and frequently injuring campers had been on the decline since the mid-1970s, encounters between backcountry users and bears appeared to be on the rise. Graber discovered that when bears could get high quality backcountry camper food in combination with the bulk of less nutritious herbs and grasses, they could make use of otherwise marginal habitat. The bears were clearly thriving and backcountry incidents with bears were also unacceptably high.

Since 1980, research on dozens of translocated radio-collared bears indicated that translocation did not keep a bear out of trouble or even alive. Many translocated bears wandered out of the parks and were hunted or otherwise destroyed. Based on these findings, Sequoia abandoned translocation as a management tool, concentrated its efforts on food management, and destroyed those bears that had become dangerous, habitual, campground problems. On the other hand, the combination of installing bear-proof camp boxes in frontcountry (in both

parks) and some backcountry campsites (in Sequoia only) and backpacker-carried food canisters greatly reduced bear incidents and both parks are now destroying fewer bears.

Graber still does not know if high-elevation bear populations have been reduced, due to the food management and early translocation efforts. However, follow-up research on young male bears demonstrated that by the age of 2½, most had dispersed far from natal ranges—many outside the parks where they were typically killed. In other words, the park had become a source, and the surrounding lands a sink, for bears.

From 1980-84, Graber trapped and tracked bears both in a developed portion of Sequoia and in another area with no human use. Not surprisingly, he found the wild bears to be smaller, long-lived, and less fertile than the Yosemite superbears of the 1970s. Interestingly, as food lockers and enforcement were introduced to Giant Forest and Lodgepole (Sequoia), that bear population came to look less like a habituated Yosemite population and more like its wild kin. While bear problems are still chronic and persistent in both parks today, injuries, property damage, and bear deaths are all far lower than 21 years ago when Graber started his Yosemite research.

## Meetings of Interest

### OCTOBER 25-28

Gathering near Mitchell, Indiana, at Spring Mill State Park, the twelfth national cave management symposium, "Quality Cave Management Involves Everyone," will emphasize the importance of cooperative efforts in dealing with cave management issues. Field trips will focus on local cave management practices and problems related to urbanization and road construction in karst areas. For more information, contact Keith Dunlap, Indiana Karst Conservancy, P.O. Box 2401, Indianapolis, Indiana 46206; (317) 242-2505; e-mail "kdunlap@atd.gmeds.com".

### OCTOBER 26-28

An international conference and training workshop on "Conservation and Ecology of Grassland Birds" will team up with the 1995 annual meeting of the Association of Field Ornithologists in Tulsa, Oklahoma. Areas and issues to be discussed include, landscape ecology, grazing and burning, agriculture, farmland structure, residential and commercial development, grassland management, and regional planning. Contact Dan Reinking or Ron Rohrbaugh, Sutton Avian Research Center (918) 336-7778, e-mail "gmsare@aol.com", for more information.

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# Meetings of Interest (cont'd)

## NOVEMBER 7-8

The Canadian Council on Ecological Areas is sponsoring a brief conference on protected areas in resource-based economies. Entitled, "Sustaining Biodiversity and Ecological Integrity," the miniconference will be held in Calgary, Alberta. For more information, contact Robyn Usher, Conference Registrar, 1122 4th Street SW, Suite 200, Calgary, Alberta, Canada T2N 1M1; (403) 269-9466.

## NOVEMBER 13-15

The International Association of Wildland Fire is sponsoring, "Fire Effects on Threatened and Endangered Species and Habitats," to be held in Coeur d'Alene, Idaho. The session seeks to improve our understanding of fire in habitat dynamics and has the goal of bringing together policy makers, public land managers, and conservation groups to promote dialog about the interactions of fire and imperiled species and habitats. For more information, contact the Association of Wildland Fire, P.O. Box 328, Fairfield, Washington 99012; (509) 283-2397.

## NOVEMBER 16-17

Tufts University, the American Farmland Trust, and the Henry A. Wallace Institute for Alternative Agriculture are sponsoring the "Conference on Environmental Enhancement Through Agriculture," to be held in Boston, Massachusetts. The meeting is intended to foster creative thinking about agriculture that can serve both pure agricultural and environmental interests. For more information, contact William Lockeretz, School of Nutrition, Tufts University, Medford, Massachusetts 02155; (617) 627-3223; e-mail "wlockeretz@infonet.tufts.edu".

## NOVEMBER 16-19

Reno, Nevada, will host the 27th Annual Meeting of the Desert Fishes Council. The conclave will consist of technical and agency reports, posters, and the symposium, "Translocation as a Conservation Tool for Preserving Native Fishes," which will be followed by a translocation workshop. For more information, contact E. Phil Pister, Desert Fishes Council, P.O. Box 337, Bishop, California 93515; (619) 872-8751.

## JANUARY 21-25, 1996

The Third International Conference and Workshop on Integrating GIS and Environmental Modeling will take place in Santa Fe, New Mexico. Participants will emphasize the development of environmental models and the near future improved integration of geographic information technologies, especially GIS, and modeling. For more information, contact the National Center for Geographic Information and Analysis, Phelps Hall 3510, University of California, Santa Barbara, CA 93106-4060; (805) 893-8224; fax (805) 893-8617; e-mail "sandi@ncgia.ucsb.edu".

## MAY 7-10

The 20th Tall Timbers Fire Ecology Conference will get under way next spring in Boise, Idaho. Entitled, "Fire in Ecosystem Management: Shifting the Paradigm from Suppression to Prescription," the conference aims to discuss specific prescribed fire regime alternatives in the context of modern natural resource management and policy. Many sessions will adopt a case study approach and will link the use of prescribed fire with long-term management objectives to achieve specific future forest, shrub, or grassland ecosystem conditions. Contact Leonard Brennan, Director of Research, Tall Timbers Research Station, Route 1, Box 678, Tallahassee, Florida 32312; FAX (904) 668-7781 for more information.

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