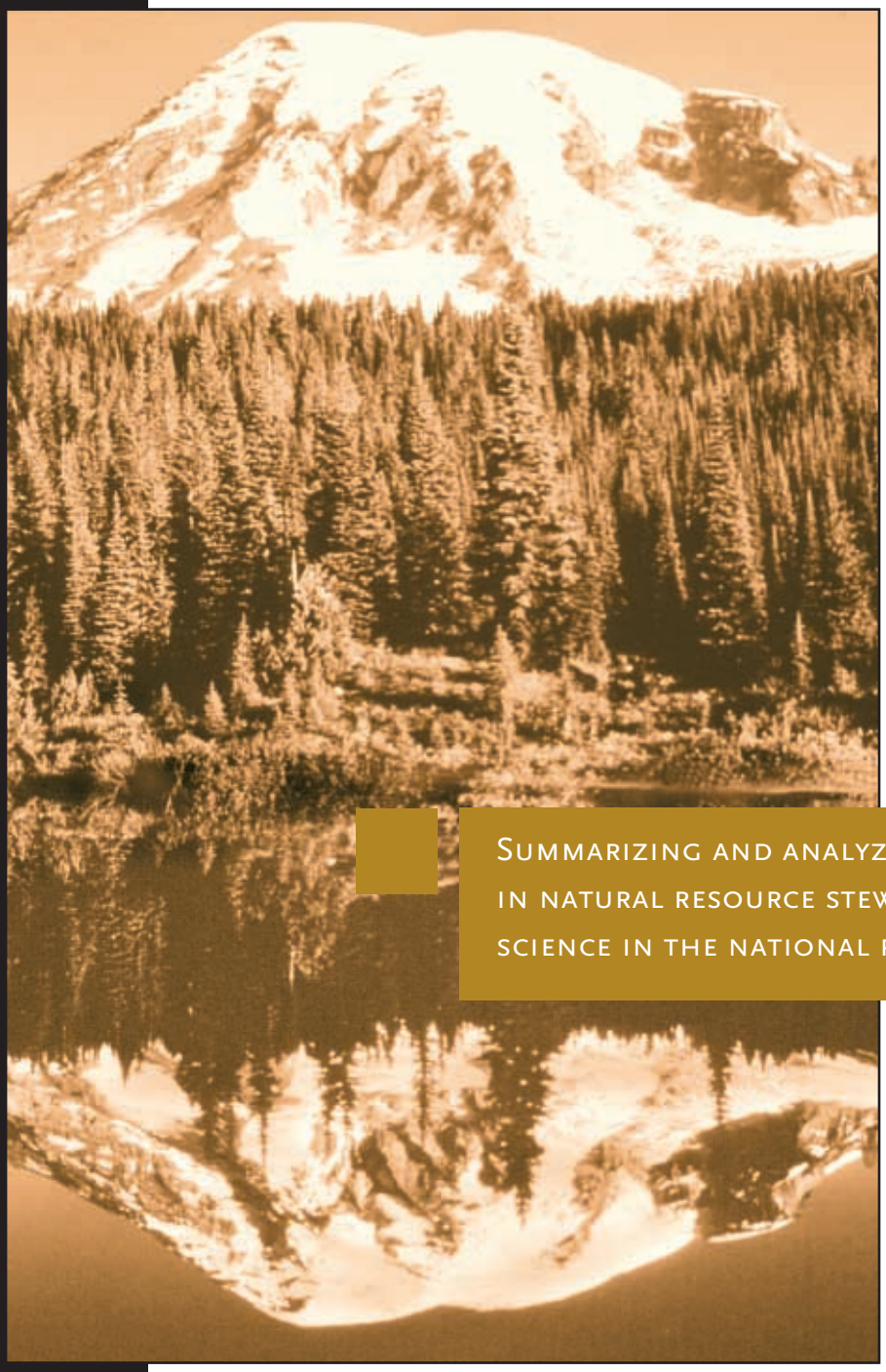
Natural Resource Year in Review—1999

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



Summarizing and analyzing the year in natural resource stewardship and science in the National Park System

Natural Resource Year in Review—1999

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Hopes ran high for the Natural Resource Challenge during 1999, *a transition year from planning to implementation of the all-important initiative. In August, NPS Director Stanton launched the Challenge in a speech at Mount Rainier, Washington, on the occasion of the park's centennial celebration.*

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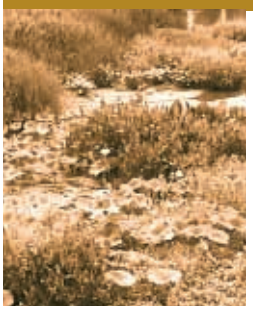

Science Outreach

Looking Ahead

Year at a Glance–1999

January

The White-tailed Deer Management Program of Gettysburg National Military Park is reinstated by a federal district court in Pennsylvania following a lawsuit brought by groups opposing the program.

A federal district court in Montana blocks the National Park Service from issuing a finding of no significant impact, which stops NPS plans for the removal of rare trees in order to build a parking lot in Glacier National Park.

The National Park Service participates in the Panel on the Ecological Integrity of Canada's National Parks, noting similarities in problems affecting Canadian and U.S. national parks.

February

Forty-six African oryx are removed from White Sands National Monument, New Mexico, in the first of several planned operations to rid the park of this nonnative antelope species that degrades park soils and vegetation.

March

The steering committee for the Natural Resource Initiative reviews a draft of 12 consolidated action plans that will later become the Natural Resource Challenge and the associated requests for budget increases.

April

The first island foxes on San Miguel Island at Channel Islands National Park, California, are captured as part of a captive-breeding program established to bolster the species' declining numbers.

The EPA promulgates new regulations requiring state governments to improve visibility in 48 units of the national park system through overall reductions in regional haze, rather than focusing solely on pollution from individual sources as in the past.

A congressionally mandated partnership is formed between the National Park Service and the Foundation for Shackleford Horses, Inc., for the joint management of feral horses at Cape Lookout National Seashore, North Carolina.

May

Regulations pertaining to the National Natural Landmarks Program are published in the *Federal Register,* ending a 10-year moratorium on the designation of new sites and granting landmark owners a 90-day period to withdraw their property from landmark status.

A coordinated, interagency water quality–monitoring program begins at St. Croix National Scenic Riverway, Minnesota and Wisconsin, to provide data for modeling the impacts of increased nutrient enrichment, particularly phosphorus.

A technical literature review conducted by the NPS Water Resources Division links two-stroke engines used in personal watercraft to water pollution and answers questions about risks to water quality in parks.

June

The National Park Service reviews its draft management policies, which contain language that would require managers to err on the side of resource protection when making decisions that pit visitor enjoyment against resource preservation.

The "Island Explorer" bus system operates for the first time at Acadia National Park, Maine, reducing traffic and natural resource–related impacts.

July

Underwater spires consisting of siliceous remains of diatoms and filamentous bacteria and containing trace amounts of heavy metals commonly associated with hydrothermal vents are discovered on the floor of Yellowstone Lake.

Following years of study and planning, the lighthouse at Cape Hatteras National Seashore, North Carolina, is moved to a new location, safe for now from the natural process of shoreline erosion.

August

At Mount Rainier National Park, Washington, Director Stanton announces the Natural Resource Challenge, the National Park Service's action plan for preserving natural resources.

Secretary of the Interior Bruce Babbitt appoints a new National Park System Advisory Board, which includes three members with natural resource science credentials.

High school students document a new species of damselfly for Great Smoky Mountains National Park, Tennessee, as part of a hands-on science education program that contributes data to the All Taxa Biodiversity Inventory.

Eight Ph.D. students are named recipients of the Canon National Parks Science Scholars Program awards, which focus dissertation research on the national park system.

September

The Natural Resources Protection Law and Policy Course for Superintendents is presented for the second time in 1999, bringing the total to nearly 50 superintendents who attended the 32-hour training course during the year.

The Director's Awards for Natural Resource Stewardship are presented to five recipients for their contributions in leadership, research excellence, resource management, preservation of resources at a small park, and promoting sustainable park operations.

The federal government announces plans to enhance the protection of bison in Yellowstone National Park by acquiring land from the Royal Teton Ranch, Montana, which will augment the species' winter habitat north of the park.

The associate director for natural resource stewardship and science announces that AQUIMS, the Air Quality Information Management System, will be enhanced to incorporate more parks and more natural resource data systems, improving its utility as a standard interface for accessing resource information.

Grand Canyon National Park, Arizona, deploys portable air particulate samplers in conjunction with a managed fire to provide real-time information to decision makers in regard to smoke management.

October

Wet scrubbers commence operation at the Navajo Generating Station near Page, Arizona, and are expected to reduce sulfur dioxide emissions by 90% and improve visibility during the winter at Grand Canyon National Park.

Owners of the Mohave Power Plant in Laughlin, Nevada, agree to install $300 million worth of air pollution control equipment designed to significantly reduce sulfur dioxide emissions and improve visibility on the Colorado Plateau.

Earthmoving begins along Glorieta Creek at Pecos National Memorial, New Mexico, and involves removing dams and levees and reshaping the site to rehabilitate a native riparian-wetland system.

November

Congress appropriates $14.329 million in FY 2000 funds for implementation of natural resource inventories and other items, the first budget increases to be realized through the Natural Resource Challenge.

With assistance from several partners, including the U.S. Geological Survey, the National Park Service prepares to monitor mosquito populations at several units in the northeastern United States for the presence of West Nile virus, a mosquito-borne disease that kills free-ranging birds and can cause encephalitis in people.

December

Director Stanton implements Resources Careers, the first action of the Natural Resource Challenge, to help the National Park Service fairly and effectively manage its natural and cultural resources personnel.

Cooperative Ecosystem Studies Units (CESUs) for the Rocky Mountains and Colorado Plateau are staffed by the National Park Service, and begin to give managers access to the research, technical assistance, and educational tools available through the CESU network.

Avalanche lily *(Erythronium montanum); Mount Rainier National Park, Washington.*

The Year 1999 in Review

by Michael Soukup

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From the natural resource perspective, 1999 was a great success, filled with even greater promise. Amid many signs of natural phenomena bending to the press of human activity, there was a growing sense in the National Park Service of the importance and likelihood that the organization was capable of positioning itself for the challenges of the new millennium.

The focus of 1999 for those of us in natural resources was planning and then beginning to implement the Natural Resource Challenge. We barely had time to fret about Y2K. Finally, in October, natural resource management in parks received significant new increases from Congress for the first year of its five-year Challenge budget. The words in the House of Representatives appropriations bill state the rationale for these funds best:

> The Committee has provided significant increases for the Service's natural resource initiative, including inventory and monitoring, natural resource preservation, native and exotic species management and for geologic expertise. The Committee applauds the Service for recognizing that the preservation of the diverse natural elements and the great scenic beauty of America's national parks and other units should be as high a priority in the Service as providing visitor services.
>
> A major part of protecting those resources is knowing what they are, where they are, how they interact with their environment and what condition they are in. This involves a serious commitment from the leadership of the National Park Service to insist that the superintendents carry out a systematic, consistent, professional inventory and monitoring program, along with other scientific activities, that is regularly updated to ensure that the Service makes sound resource decisions based on sound scientific data.

We agree. Jon Jarvis, superintendent of Mount Rainier National Park, wrote, "This is the first time natural resource management has had a significant contribution since George Wright used his own fortune to get wildlife management started in [the national park system in the 1930s]."

Congress also indicated that it would watch very closely how we fared in making progress toward our goals.

Along with apprehension about Y2K, there were some dark clouds in 1999. Major setbacks suggested that our commitment to environmental compliance and the National Environmental Policy Act (NEPA) was less than total. The reverberations from the Glacier National Park campgrounds lawsuit *(Coalition for Canyon Preservation v. Babbit et al.*—see article on page 12), the Canyonlands off-road vehicle plan lawsuit *(Southern Utah Wilderness Alliance v. Dabney et al.),* and others highlighted unresolved conflicts over resource impacts in the administrative records underpinning our decisions and a lack of willingness to fully protect significant natural resources in the face of pressure for visitor uses. The Canyonlands decision should end any confusion as to whether the National Park Service can assume it should balance resource preservation with visitor accommodations; the judge reasoned that if resources are destroyed, visitor services probably will not be required in the long run. Happily, the NPS Management Policies had been scheduled to be revised in 1999, and new language was added to the draft before the public comment period began in December. The new language distinguishes between acceptable temporary impacts that may result from park management for visitor services and unacceptable long-term impairments (see article on page 5). This may finally bury the long-argued paradox of equal balance between resource protection and visitor accommodation. Director Stanton also formed a work group to make recommendations for making stellar NEPA compliance second nature to the National Park Service.

There were many other notable events in 1999, including the addition of Drs. Sylvia A. Earle, Shirley M. Malcolm, and Gary Paul Nabhan as the natural science members of a very supportive National Park System Advisory Board (see "Scientist Profiles" of these board members on page 18). Dr. Earle closes this issue with her review of the state of the oceans and the year's progress in response to the President's Executive Order on Coral Reef Protection (see page 61).

A very exciting, most promising year!

Associate Director
Mike Soukup

National Park Service Director Robert Stanton *launched the Natural Resource Challenge in a speech at Mount Rainier on the occasion of the national park's centennial in Washington state.*

In previous issues of the Year in Review, *"New Horizons" has often referred to the development and intelligent use of technological, administrative, and legal tools for the protection of park natural resources. It still does. This year, however, and perhaps for several years to come, it also means the promise of greater fiscal and human resources to meet the many challenges ahead. This is because of the Natural Resource Challenge, a five-year budget initiative and NPS commitment to increase the use of science in park management. Launched in August 1999, the Challenge comes at a time when concerns about ecosystem integrity are high and resource preservation issues complex. In its first year (FY 2000), the Challenge is enabling quicker acquisition of park natural resource inventories, improved management of biological and geological resources, and targeted efforts to eradicate exotic species. Many other program enhancements are planned over the next four years. If fully implemented over this time, the Challenge will provide a good foundation for the professional care of park natural resources. It is a source of optimism and will help the National Park Service progress toward new horizons in resource management.*

Future of Natural Resource Stewardship

Natural Resource Challenge addresses natural resource protection needs

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On 12 August 1999, NPS Director Robert Stanton made a major announcement on the occasion of Mount Rainier National Park's 100th birthday. From the majestic mountain at Paradise, he proclaimed the National Park Service's strong new commitment to improving its preservation of the national park system's natural heritage through a five-year action plan called the "Natural Resource Challenge."

The efforts leading up to the August announcement have been termed an "internal conversation," and reflect the involvement of many participants. From the outset, there has been little difficulty in naming the natural resource preservation issues and outcomes desired. The difficulty was how best to achieve the outcomes.

The endeavor had its genesis in the ideas presented in Richard Sellars' 1997 book, *Preserving Nature in the National Parks: A History* (Yale University Press). Sellars observed that, throughout its history, the National Park Service has focused on visitor accommodation to the detriment of natural resources. His carefully researched and documented case became a catalyst for action. In addition, many other evaluations, including Starker Leopold's 1963 report and National Research Council reports in 1963 and 1992, chaired respectively by William Robbins and Paul Risser, confirm that park resources are being compromised in ways both understood and still unknown. The Director and the NPS National Leadership Council seized the moment and made a substantial response.

> "The Challenge is a set of goals that ... assert improved management of national parks through a greater reliance on scientific knowledge and expanded sharing of knowledge."

Developing an action plan has taken some time. Beginning in January 1998, a task force appointed by the regional directors developed the first report, outlining a wide range of issues, problems, and possible solutions. After much discussion, the report was revised and a plan assembled to develop the report's themes into actions that could be implemented. Twelve work groups led by superintendents and specialists developed draft action plans. The results were consolidated into the Natural Resource Challenge, a single action plan that combines related and overlapping actions and, of necessity, omits some to meet a budget target deemed

Among the many officials *attending the Mount Rainier centennial celebration were (from left) Congressman Norman Dicks (member of the House Appropriations Subcommittee on Interior) and NPS Director Robert Stanton, who announced the Natural Resource Challenge.*

reasonable to request. The additional budget for the five-year action plan totals about $100 million above the FY 1999 natural resource budget of $107 million—a doubling of budget capability. The Challenge, as it is called, is posted on the Web at www.nature.nps.gov/challengedoc.

The FY 2000 budget was formulated partway through the evolution of the Challenge. As a result, the FY 2000 request included actions about which there was broad agreement and little question about implementation. First, the FY 2000 request proposed funding to complete all of the Park Service–funded basic natural resource inventories. Another major request provided for a national biological resource management program, including a substantial commitment to field-based teams to combat exotic species. Smaller requests were made for increased project funding for natural resource management, broader expertise in geologic resource disciplines other than minerals management, California desert restoration, and Resource Protection Act implementation capability. All except the last two were successful—they were funded at 88% of the requested level—bringing the total funding for the Challenge to $14.329 million in FY 2000.

Although all participants in the process sent a clear message about the need for additional fiscal and personnel resources, the action plan was carefully constructed to be more than a budget initiative and therefore not entirely budget-dependent. The Challenge is a set of goals that collectively assert improved management of national parks through a greater reliance on scientific knowledge and expanded sharing of knowledge. Sustaining the early success of the FY 2000 budget, however, depends also on energy and commitment in the day-to-day work of the parks. Toward that end, the director has appointed a council of park superintendents to lead the way.

To fully implement the Challenge requires a different image of NPS employees—by themselves and by others. It requires that superintendents be viewed by their partners, congressional delegation, and others as much for their advocacy of resources as they are for seeking funding to repair or build new infrastructure. For interpretive rangers and others who serve visitors, it means persuasive and constructive information relayed to visitors about threats to resource values and what can be done to address them. It means park law enforcement programs that emphasize resource preservation and that are based on an understanding of which resources are threatened and effective means to address such threats. Likewise, it means facilities that are developed and maintained in a manner that is gentle to park resources. Finally, it means a full commitment to environmental leadership.

Thrusts of the Natural Resource Challenge

- Protecting and restoring native and endangered species and their habitats
- Controlling nonnative species
- Abiding by environmental laws and applying high environmental standards to park operations
- Expanding efforts to monitor and understand air quality in parks
- Monitoring and protecting park waters, watersheds, and aquatic life
- Accelerating acquisition of basic inventories of park natural resources
- Monitoring changes in the condition of park natural resources
- Collaborating to acquire, apply, and disseminate scientific knowledge in pursuit of natural resource goals
- Basing all NPS planning on a thorough understanding of resources
- Facilitating broad scientific inquiry for the betterment of both parks and society
- Expanding and improving opportunities for the public to enjoy and learn about park natural resources and their preservation
- Developing professional and technically proficient park staffs (see following article on Resources Careers)

Managing Natural Resource Personnel

Resources Careers implemented

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The first action of the Natural Resource Challenge, Resources Careers, was implemented by Director Stanton on 17 December 1999 to help the Park Service fairly and effectively manage and develop its natural and cultural resources personnel. The National Park Service realizes that if park resources are to be managed effectively, superintendents must have easy access to advice from resource professionals, and the resource management tools available to them must be increased. The Natural Resource Challenge stresses that the NPS workforce must have the appropriate professional, technical, and leadership skills to identify resource issues; obtain, interpret, and apply scientific information; and solve highly technical and complex policy problems. It also states that development programs for field staffs must be strengthened so that they can contribute effectively to the resource preservation mission, and that they must have opportunities to advance and achieve upper-level management positions. Resources Careers, which was begun in 1994 by the Careers Council of the Vail Agenda, provides the personnel management tools to carry out the Natural Resource Challenge.

The most important feature that Resources Careers establishes is a career ladder of GS-5/7/9/11 for 24 professional resource management positions, which will be the norm throughout the National Park Service. Following extensive field reviews, human resource advisors found that GS-11 was the minimum full performance level for professional resource management positions. The career ladder offers an entry level with the opportunity for professional development and career growth.

> "Resources Careers ... provides the personnel tools to carry out the Natural Resource Challenge."

A total of 81 benchmark position descriptions (PDs) for professional (GS-5/7/9/11; GS-12) and technician (GS-5, GS-6, and GS-7) jobs were written precisely for the specialized resource expertise needed by the National Park Service. Collectively, the PDs, which cover the academic disciplines for work done in the National Park Service, allow managers to create effective position management plans for existing and future resource management divisions. Supervisors can avoid the generalized lumping that created the "GS-401 natural resources specialist" occupation and acknowledge that the Park Service needs botanists, biologists, fisheries biologists, hydrologists, physical scientists, and other applied specialists in addition to resource program managers. The Resources Careers Committee looked to the cultural resources disciplines as a model for using applied specialists, such as archeologists, curators, historians, archivists, and librarians.

Resources Careers is designed to be flexible by adding or editing position descriptions in the future. It is the foundation that describes the type of work done by the National Park Service and sets the grade value of that work. When the initiative started six years ago, chief of resource management positions were filled at the GS-7/9 level. Now they are typically GS-9/11 or above in recognition of their complexity. Supervisors are reappraising current positions as being either program managers or applied specialists and using the correct series for the expertise needed. Technician position descriptions have pointed out inappropriately assigned work, beyond an employee's grade level, and incumbents have been upgraded to be compensated for the demands of the job. These examples demonstrate the positive impact Resources Careers has already had on improving the development and management of professional staff to meet the needs of complex resource management issues in the parks.

Extensive position management guidance, including all of the PDs and the career ladders, is featured on the NPS Natural Resources Intranet website at www1.nrintra.nps.gov/careers/. Additionally, each park will receive a manual that explains the new personnel management tools.

Strengthening Natural Resource Leadership

Natural resources law and policy course revived for superintendents

by Carol McCoy, Bob Karotko, and Sharon Kliwinski

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Calendar year 1999 marked the reintroduction of the Natural Resources Protection Law and Policy Course for Superintendents, one of several natural resources courses funded by the Horace M. Albright Training Center. The center, working closely with staff at the Natural Resource Program Center, organized and conducted this dynamic and rigorous course for park superintendents in Salt Lake City in May 1999, and then again in Washington, D.C., in September. Nearly 50 superintendents enrolled in the course. Assessments of the course in the two locales included: "Relevant and an intellectual challenge directly related to our work." "Excellent course!" "Presenters were knowledgeable and passionate about the subject matter." And, "I'll be far more conscientious when applying NPS Management Policies."

Several NPS litigation losses pointed to the need to reestablish the course to better equip park managers to make sound, defensible decisions. The course also responds, in part, to congressional direction contained in the National Parks Omnibus Management Act of 1998, calling for park managers to always enhance their competencies.

The 32-hour course provides park managers with a fundamental understanding of their overarching legal and policy mandates to advance park protection and of the ABCs of litigation. Special emphasis is placed on the statutory provisions of the NPS Organic Act and the body of case law pertaining to park management action. Class participants also explore other resource protection tools through a combination of presentations, case studies, and small group discussions.

The pivotal role that park managers play in litigation is a recurring theme in the course. The course covers the importance of the administrative record in the outcome of litigation and provides insight into the strategic thinking involved in the federal government's response to a lawsuit. Class participants come away with an understanding of why not all lawsuits end up in court trials. This insight extends beyond the natural resource protection arena to operations, cultural resources protection, maintenance, and planning. Participants learned that the legal field is permeated with policy choices, and that it is not only critical to have the administrative record in order but also advantageous to seek out legal counsel early and often.

"The course covers the importance of the administrative record in the outcome of litigation."

Instructors in 1999 included Dave Watts, then deputy associate solicitor for parks and wildlife in the Department of the Interior Office of the Solicitor in Washington, D.C., and now assistant to the solicitor for Everglades and special projects; Pete Raynor, then assistant solicitor for fish and wildlife and now deputy associate solicitor for parks and wildlife; K. C. Becker, an attorney with the Solicitor's Office; Bill Lockhart, a distinguished law professor at the University of Utah and a proven park protection advocate; Tom Kiernan, executive director of the National Parks and Conservation Association (NPCA); Don Barger, NPCA southeast regional director; and managers and staff from the NPS Natural Resources Program Center.

The quality of instruction and the relevant course material led one superintendent to remark, "This course should be mandatory for every superintendent!" The Albright Training Center now offers the course annually.

Emphasizing Resource Protection

SUWA case has ramifications for NPS management policies

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In 1998, the Southeast Utah Wilderness Alliance (SUWA) prevailed in federal district court in Utah, vacating an NPS decision to keep open a popular four-wheel-drive road in Canyonlands National Park (see the related story on page 13 of the *Natural Resource Year in Review—1998).* Not initially a big case, this issue has had significant consequences for the Park Service as a whole, and has influenced the revision of NPS management policies for the protection of natural and cultural resources.

In early 1999 the draft management policies were under internal review. The draft included wording that would require managers to err on the side of resource protection when making decisions that pit visitor enjoyment against resource preservation. This refuted the "balancing test" that many NPS managers believe applies to their decision-making process. The notion of a balancing test stems from the 1916 NPS Organic Act, which states that the fundamental purpose of the parks is "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

Variations in the interpretation of this clause have led to inconsistency across the national park system in the way decisions have been made. Some managers view this clause as requiring them to give equal weight to resource conservation and public enjoyment. Others believe it gives them discretionary authority to favor either conservation or public enjoyment. The draft policy language was intended to bring more consistency to NPS decision making by adopting a single interpretation that the dual objectives of resource protection and public enjoyment do not carry equal weight, because public enjoyment cannot be sustained if park resources are unacceptably damaged or compromised.

However, neither the balancing test nor the draft language adequately took into account one of the most important phrases in the Organic Act: "unimpaired for the enjoyment of future generations." The importance of this phrase was driven home when the court ruled the National Park Service has no authority to allow activities that permanently impair park resources. Internal deliberations over a possible appeal forced the Park Service to more thoughtfully examine its position. Ultimately, the Park Service did not appeal the court's basic finding that, when the law says "unimpaired," it means unimpaired. Instead, the finding was accepted as a valid—albeit alternative—basis to conclude that, when there is a conflict between conservation and enjoyment, conservation is predominant.

> "When there is a conflict between conservation and enjoyment, conservation is predominant."

The new policies acknowledge that providing opportunities for public enjoyment is a fundamental part of the NPS mission. But they emphasize that recreational and other activities, including NPS management activities, may be allowed only when they will not cause impairment or derogation of a park's resources, values, or purposes. The sole exception is when an activity that would cause impairment or derogation is directly and specifically mandated by Congress.

The most difficult challenge for NPS managers will be to determine when an otherwise allowable adverse impact crosses the threshold to become an impairment. This determination must be made as part of an environmental analysis, using insights provided by science.

The four-wheel-drive road *along Salt Creek in Canyonlands National Park (Utah) has become a symbol of the emphasis placed on resource preservation in the 1999 draft NPS Management Policies. The road was closed in 1998 after federal district court in Utah ruled the National Park Service has no authority to allow activities that permanently impair park resources.*

Sustaining Park Operations

NPS establishes environmental leadership program

by Shawn Norton and Dan Kimball

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For national park visitors, the promise of the parks is to reconnect their lives to the natural and cultural resources around them. Expectations also include the protection of the environment through sound management practices. Thus the activities of the National Park Service and its concessionaires must be sensitive to the park environment, in addition to the larger environment we all influence. To ensure this, the National Park Service must perform its operations in a sustainable manner. *Sustainability* has been defined as meeting the needs of the present without compromising the ability of future generations to meet their needs. This definition complements the language used by the founders of the National Park Service, with which they outlined a mission that conserves wildlife, scenery, and natural and historical objects, leaving them unimpaired for the enjoyment of future generations.

During 1999 the National Park Service was busy developing a comprehensive plan to realize this vision of sustainability through a new program called Environmental Leadership (for more information see www.nps.gov/renew/). Through this effort, the Park Service will educate its visitors by showcasing sustainability in building design and construction, energy and water usage, transportation, natural and cultural resource management, waste management, procurement, contracting, and concessions management. Tools are being developed to assist parks in meeting new sustainability goals, including reissuing the landmark NPS publication *Guiding Principles of Sustainable Design* (1995, second edition, D-902). Environmental compliance for the National Park Service and concession facilities and activities will also be stressed. To achieve this objective, the Park Service is implementing an environmental auditing program that will measure and track environmental performance at every park. This effort will result in enhanced natural resource protection and, as such, complement the Natural Resource Challenge.

The massive viewing platform *at Old Faithful Geyser in Yellowstone is constructed of recycled-content plastic, demonstrating to thousands of tourists daily the practicality of this tough and sensible wood alternative. Unilever Home and Personal Care–USA, in conjunction with a cost-share agreement with the park, obtained the plastic lumber, valued at over $300,000, which was produced from the equivalent of more than 4 million plastic milk jugs.*

The National Park Service has many existing park programs and projects that demonstrate environmental leadership. For example, the "Greening of Yellowstone" is an ongoing project designed to investigate all business practices taking place in the park for opportunities to practice sustainability. A cleaning-products substitution program has eliminated an inventory of 130 cleaning products, many of which are highly toxic, to just 20 environmentally preferable ones. A boardwalk restoration project at Old Faithful uses recycled-content plastic lumber that withstands environmental extremes better than wood. These efforts have also led to profound changes outside the park. For example, a creative recycling program has brought together nine counties and two states to more cost effectively reuse crushed glass. In another project, five counties have joined the Park Service to build a municipal waste-composting facility on U.S. Forest Service land that is managed by a private firm.

"*Sustainability* has been defined as meeting the needs of the present without compromising the ability of future generations to meet their needs."

Implementing the Environmental Leadership Program in the National Park Service will require a careful evaluation of every program and an effort by every NPS staff. From the cleaning of restrooms to the management of vehicle fleets, from conserving energy to ensuring environmental compliance, opportunities to practice sustainability and environmental leadership are everywhere. The leaders of the future will need to recognize these opportunities and the deeper connection between NPS actions and park resources. As a result, the NPS mission will become more recognizable to the public and make the National Park Service better stewards of the land.

Fueled by biodiesel *or rapeseed (canola) ethyl ester, this pickup truck has traveled more than 115,000 miles in and around Yellowstone since 1995, averaging 17 miles per gallon. Engine and fuel system modifications were not needed, and emissions of smoke, hydrocarbons, nitrogen oxide, and carbon monoxide were reduced compared to regular diesel.*

"Island Explorer" bus transportation on-line at Acadia

Acadia National Park inaugurated a new regional transit system in June 1999 that links neighboring communities to destinations throughout the park. Eight buses, operating on six routes, allow visitors to leave their cars at their hotels and campgrounds and visit the park aboard clean-burning propane buses. Called the Island Explorer, the free transit system is expected to reduce traffic congestion, overflow parking along roadways, and vehicle emissions on the island, while increasing visitor enjoyment of the area. Elsewhere in 1999, Zion National Park continued construction of its visitor transit facilities with plans to begin propane bus service in spring 2000. Also during the year, Yosemite became a partner in a demonstration bus system planned to start in May 2000; the Yosemite system will target both visitors and park employees to reduce traffic congestion and related problems. In early 2000, Grand Canyon selected business teams qualified to bid on the contract to develop the park's planned bus and light rail transit system.

Award-Winner Profile

Kathy Davis honored for contributions to Resources Careers

Kathy M. Davis, chief of resource management with the Southern Arizona Office (Phoenix), is the recipient of the Director's Award for Natural Resource Management. Given in September 1999, the award recognizes her leadership in the development and implementation of the NPS Resources Careers initiative. Under Kathy's leadership, the Resources Careers task force conceived, developed, and completed professional, career-ladder position descriptions and classification evaluation statements in natural and cultural resource series and interdisciplinary series. Her efforts affect every resource manager in the National Park Service by creating a framework for professionalization and success. Additionally, Kathy serves as an effective resource manager for 10 small parks in southern Arizona.

Kathy was humbled by the award and the realization that it marked the completion of a long, difficult, and crucial project. Asked to chair Resources Careers in 1994, Kathy did not "fully comprehend the size of the task ahead. From the start," she says, "there were delays and uncertainty with money and support. What kept us going were the hopes and expectations of resources staff for career improvements, a growing recognition of professional expertise needed in the National Park Service, and the dedication of committee members. While the award was given to me as chairperson, many clever, hard-working people were involved." Kathy hopes that Resources Careers "becomes institutionalized as the foundation for career paths to management or expertise in a resources field," but regrets that it was implemented without funding. "We need more high-level managers and specialists with academic expertise and credentials in resources and science to carry out the mission of the National Park Service."

Kathy's work as resource manager with the Southern Arizona Office has also been satisfying. Since 1985 she has seen resource management staff for southern Arizona parks increase from three to more than 25. "It has been rewarding to watch the natural and cultural resources program grow and become more professional over the years," Kathy says. She considers Bill Halvorson (see page 31) of the USGS Sonoran Desert Field Station a tireless and caring colleague who has enhanced this professionalism and helped improve regional science and management in the national parks.

Collaborative Decision Making

From local to regional: A new focus for air resources protection

by Bruce Polkowsky

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On 1 July 1999, the Environmental Protection Agency (EPA) promulgated new regulations that will require state governments to improve visibility in 48 parks that are designated Class I under the Clean Air Act. These new regulations bring a sweeping change to the process of visibility protection, which until now focused only on resolving visibility impairment that could be traced to specific sources and new source-permitting reviews.

The thrust of the new regulations is a 60-year planning path to return visibility conditions to "natural." The states must implement, in 10-year steps, emission-control actions that decrease regional haze to the point that it represents no human-caused impairment. The states may take into account the costs of emission controls as well as the availability of techniques to reduce visibility impacts in developing their control plans. In addition, they must determine the appropriate control levels for certain older major stationary sources of emissions and implement those controls within the first 10-year plan period.

Although this sounds simple enough, the key is that visibility impairment is caused, for the most part, by very fine particles. Some particles form in the atmosphere from "invisible" gaseous pollutants such as sulfur dioxide and nitrogen oxides. These fine particles can also travel hundreds of kilometers, well beyond state borders. Herein lies the new regulatory challenge: having the individual state plans under the Clean Air Act address a regional problem.

Enhanced protection for Yellowstone bison and thermal features

The federal government announced plans in 1999 to increase the protection of Yellowstone's bison, geysers, and hot springs when it agreed to acquire title to, and conservation easements on, 9,300 acres of the Royal Teton Ranch north of Yellowstone National Park. In addition, the government will acquire geothermal water rights to the entire 12,000-acre ranch. The land will be managed by the Gallatin National Forest and will provide important winter range for bison. Bison often leave the park in winter when food is difficult to reach and face unnecessary killing by the State of Montana to prevent any possibility of the spread of brucellosis from bison to domestic cattle even though there have never been any documented cases of such transmissions in the wild. The move will also prevent development of geothermal resources on the ranch that could have a deleterious effect on park thermal features. The government agreed to pay $13 million for the deal, which was still being prepared at year's end.

In this composite view of Shenandoah National Park (Virginia), *the right portion is a photograph that represents the 20% most impaired visibility days according to current monitoring data. The majority of haze seen in this photo is caused by sulfate particles resulting from combustion of coal. The left portion is a photograph of monitored conditions representing the estimated 60-year goal for improving the most impaired days under the new regional haze rules.*

New Horizons

The EPA has encouraged states to coordinate planning through five "regional planning" bodies covering all of the contiguous 48 states. States that do not contain Class I areas and have never addressed the issue will now need to implement regulatory plans to address impacts at parks and other Class I areas in distant states. In the eastern United States, where there is severe visibility impairment, the scope of emissions changes needed to attain natural conditions is daunting. However, there are other programs, including the EPA's new health standards, which are also expected to require major emissions reductions.

"Issues such as defining 'natural conditions,' including the role of fire, will require that new analytical techniques be developed."

The new regulations bring to light new questions for NPS management, too. How will the National Park Service coordinate with these five planning bodies? On the technical side, issues such as defining "natural conditions," including the role of fire, will require that new analytical techniques be developed. What are the roles of the Air Resources Division, regional offices, and individual parks in helping the states develop regulatory plans? The National Park Service will need to answer these questions before the first 10-year plans are due.

The Air Resources Division has already expended considerable resources in working on a plan for western states through the Grand Canyon Visibility Transport Commission and its successor, the Western Regional Air Partnership. Whether that effort will be the model for other regional efforts will depend on resources and the types of regulatory plans the states pursue. In any case, the technical and policy work will need to be addressed soon. The first 10-year plans must be in place between 2003 and 2008, depending on the region of the country and certain planning options open to the states. These plans will be the first step in a process that promises dramatic visibility improvement in many parks.

Award-Winner Profile

Joe Dunstan recognized with sustainability award

Joseph Dunstan is the sustainability coordinator for the Pacific West Region and recipient of the 1998 Director's Award for Excellence in Natural Resource Stewardship Through Maintenance, given in 1999. Joe is a leader in promoting sustainable practices and opportunity planning (SPOP) in parks. Through the SPOP process, he has been able to increase the role of sustainability in two parks, Fort Vancouver National Historic Site and Joshua Tree National Park, by conducting team evaluations of such park operations as maintenance, concessions and visitor services, handling of waste, and energy uses. The team of NPS staff, mechanical engineers, and sustainable design consultants identified resources flowing into the parks, described how the activities of staff and visitors altered those resources, and explored ways that parks can incorporate additional sustainable practices into their daily routines.

Joe is pleased that recognition of the SPOP process has resulted in better partnership between maintenance staff, resource managers, rangers, and interpreters. "Sustainability is not just the responsibility of maintenance," he says. "It involves purchasing, office practices, reducing solid waste in landfills, innovative research to better understand human interaction with ecological systems, and visitor education." He adds, "I sense a great deal of enthusiasm for implementing sustainable practices in the field. Managers need to unleash this spirit, recognize and reward innovative work, and support employees who take risks. The most important task," he says, "is fostering and building a workforce that is willing to try new products and implement new practices to achieve sustainability."

Cleaner air for Grand Canyon and the West

In 1999 the Navajo Generating Station, in Page, Arizona, completed construction of three scrubbing units based on a negotiated agreement witnessed by President Bush at Grand Canyon National Park in 1991. These scrubbers will reduce sulfur dioxide emissions by approximately 55,000 tons per year. Also in 1999, agreement was reached to reduce sulfur dioxide emissions from the Mohave Generating Station, in Laughlin, Nevada, by approximately 40,000 tons per year by 2007. Both of these actions, while specifically aimed at improving visibility at Grand Canyon, lay the foundation for future plans to address regional haze in the West.

Feral horses at Cape Lookout National Seashore *are managed under a congressionally legislated partnership between the National Park Service and the Foundation for Shackleford Horses, Inc. Begun in 1999, the partnership is working well and has the goal of maintaining the herd size in the range of 100–110 animals.*

With about 270 units in the national park system featuring significant natural resources, the National Park Service faces an awesome, complex, and critical stewardship task. Preserving these resources and their associated values requires many things: knowledge of the resources and understanding of the natural functions that are crucial to preservation; setting priorities for action; applying technical expertise to solve problems; and basing management decisions on scientific information. However, just as discrete biological and geophysical resources interact with one another in park ecosystems, the Park Service does not act in isolation to protect them. As the following stories remind us, natural resource protection is a public responsibility and process. The Park Service is accountable for planning, environmental evaluation, and public involvement required by environmental protection legislation, and must improve in this area. It must also be prepared, when necessary, to meet legal challenges with persuasive and scientifically defensible arguments in court. When circumstances for desired outcomes are not in its control, the Park Service must be principled, assertive, influential, sometimes persistent, sometimes patient. Additionally, it needs to continually improve its collaboration with partners for the benefit of resource preservation. The following articles illustrate some of these challenging areas of natural resource protection.

Legislated Resolution of a Resource Management Issue

Feral horses at Cape Lookout National Seashore

by Sue Stuska, Ed.D.

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Partnerships with citizen groups to manage park natural resources are nothing new. Such public partnerships are extremely beneficial in that they pool resources and enable more progress than either the National Park Service or an independent organization could achieve on its own. In 1999, however, Congress mandated a partnership for the management of feral horses on Shackleford Banks at Cape Lookout National Seashore, North Carolina (P.L. 105-202 and 105-229). Legislated resolution to management issues is uncommon, and it is perhaps not the preferred method of coming to agreement on a partnership. The Cape Lookout legislation came about when the public felt the park was not addressing their concerns and input regarding management of the horses. Perhaps an agreement could have been reached without legislation, perhaps not. What is important is that now a partnership is in place, and it is working well to everyone's advantage.

The legislation specified a partnership with "the Foundation for Shackleford Horses, Inc., … or another qualified nonprofit entity." This foundation, a private, local, nonprofit organization, is Cape Lookout's partner in management of the horses. A memorandum of understanding (MOU), a common and valuable document for partnerships, is now in place, and a jointly drafted Horse Management Plan has been implemented. The legislation, the MOU, the Horse Management Plan, and the partnership now structure the day-to-day and long-term management of the horses.

> "Legislated management can create other challenges by restricting the ability to adapt … to future unknowns."

One difficulty with legislated partnerships is that the battle surrounding the creation of legislation can engender negativity between the parties. This complicates management issues, and negative feelings can persist even after the legislation is in place. Strained community relations can occur when one group is chosen as a partner to the exclusion of others, and science can even be overridden during decision making. Additionally, legislated management can create other challenges by restricting the ability to adapt management to future unknowns.

For example, the Shackleford Banks legislation specifies a minimum of 100 horses with a target population range of 100–110 animals. This range provides a clear and appropriate

goal to work toward at this time. The legislation also specifies that the natural resources on Shackleford Banks must not be adversely impacted by the horses. Presently, the 9-mile-long, 1/2- to 1-mile-wide barrier island supports a herd of this size on existing vegetation. However, the dynamic nature of barrier islands is likely to result in changes in the availability of vegetation in the future, suggesting the need to adapt the target size of the herd.

Although this partnership is working remarkably well at Cape Lookout, parks faced with similar issues might reflect on the processes that brought it about. The following steps will help provide a solid basis for making management decisions. Parks should: (1) identify early those issues that are likely to create intense interest by the public; (2) obtain timely scientific information from peer-reviewed literature and incorporate it into park planning and National Environmental Policy Act documents; (3) include expert opinion and available information from works in progress, particularly when rapid changes to resources are likely; (4) seek review (possibly including independent peer review) to validate the interpretation and application of the scientific information; (5) strive to reach agreement and consider using a third-party mediator if needed; and (6) work proactively with the public to involve them and include their input. The goal is to benefit the resource, which ultimately benefits everyone.

Parks exceed ozone standard in 1999

Five parks comprise the list of worst ozone-polluted units in the national park system in 1999, according to data from the NPS Air Resources Division. During the year, Sequoia–Kings Canyon National Park (California) logged 64 days on which it exceeded the level of the National Ambient Air Quality Standard for ozone. Next was Great Smoky Mountains National Park (North Carolina and Tennessee), followed by Joshua Tree National Park (California). Mammoth Cave (Kentucky) and Shenandoah National Parks (Virginia) were fourth and fifth on the list, respectively. To exceed the national standard, a park must log an eight-hour period in which the average ozone concentrations exceed 85 parts per billion. In the case of Sequoia, the fourth-highest daily maximum eight-hour average for ozone (the statistical benchmark for determining compliance with the standard) was 108 parts per billion in 1999. Ozone is a secondary air pollutant that results from chemical reactions of emissions of nitrogen oxides and volatile organic compounds in sunlight. It can cause human health problems and damage park vegetation.

Environmental Compliance

Lessons from NEPA lawsuits

by Jake Hoogland

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The National Park Service was the defendant in several lawsuits in 1999 stemming from violations of the National Environmental Policy Act. Known as NEPA, the act directs federal agencies to follow a systematic and scientific approach to assessing environmental impacts when proposing actions that may adversely affect the environment.

In the case of *Sierra Club v. Slater et al.,* the National Park Service proposed to construct new lodging in Yosemite National Park, California. A 1997 flood had damaged lodging near the Merced River in Yosemite Valley, and the park proposed to remove the damaged structures and replace them with new construction outside of the 100-year floodplain. The park issued an environmental assessment (EA) that dismissed the possibility of relocating the facilities outside the park because the project would not conform to park planning documents that had already been adopted. Later, the park released a finding of no significant impact (FONSI) regarding the proposed construction. The federal court ruled that earlier environmental impact statements (EIS) did not "relieve the NPS of its obligation to conduct an EIS…, because the cumulative environmental concerns raised by the lodge plan … [were] not … previously addressed…. The Park Service failed to acknowledge that … damage caused by the 1997 flood gave rise to new circumstances not contemplated by the prior planning documents." From this experience the Park Service learned that generalized planning documents may not provide the specific and detailed environmental analysis needed for many proposed actions. Additionally, cumulative effects arising from multiple planning projects need to be addressed comprehensively. Finally, conditions that have changed since earlier planning documents were written may require a fresh look at alternatives.

A second case revolved around the proposal to construct a parking lot on the Going-to-the-Sun Road in Glacier National Park, Montana *(Coalition for Canyon Preservation v. Babbitt et al.)*. Proposed to reduce pedestrian traffic across the road, construction of the parking lot would require removing a portion of a rare and vulnerable forest. The park prepared an EA and later issued a FONSI, although the FONSI implied the need for an EIS to consider the project's impact on an extremely significant resource: the cedar–devil's club forest. In this case, decision makers ignored repeated warnings in the administrative record that tree removal and other impacts were significant. This reinforces for the National Park Service that if an environmental assessment indicates that impacts may be significant, then an EIS must be prepared. In addition, decisions must be based on reasonable information, well documented, and fully disclosed. As the court noted, "In ignoring the repeated references in the administrative record about the significance of the proposal's impacts, the National Park Service's decision not to perform an EIS is arbitrary and capricious." Finally, proposed mitigation measures must not be speculative, but rather must be based on scientific and technical analysis and present a realistic opportunity for success in the foreseeable future.

These judgments serve as reminders of the importance of environmental compliance and the use of scientific information in arriving at preferred alternatives for management decisions.

Achieving Results in an Out-of-Control Arena

What can the National Park Service do about air quality problems?

by Christine Shaver

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The National Park Service has been monitoring air quality in many parks for more than a decade. Under the Government Performance and Results Act, the Park Service measures the effectiveness of its air quality program based on results. It holds itself publicly accountable for preventing air quality deterioration in parks, even though it has no direct control over sources of pollution located outside park boundaries. Why? Because the public expects the Park Service to protect these special places, not just keep tabs on their condition.

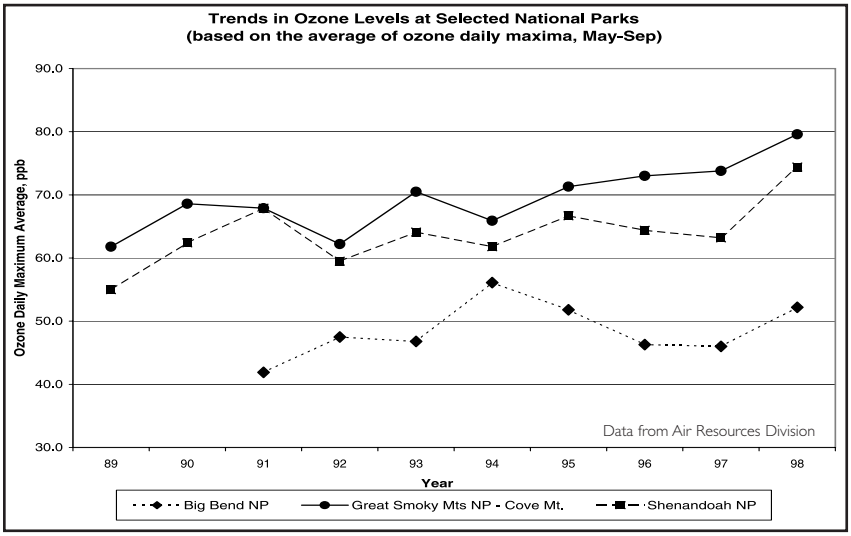
Although resource managers have used a variety of methods to detect changes in air quality, preparation of the first annual performance report in 1999 required development of a systematic, consistent, and comprehensive approach for assessing air quality trends. As a result of this detailed data analysis, park and program managers were alerted to deteriorating air quality trends in several national parks, including Shenandoah, Great Smoky Mountains, and Big Bend. When confronted with data documenting deteriorating air quality, managers are using a variety of strategies to exercise influence over air pollution sources the National Park Service cannot control. This suite of strategies includes communication, constituency building, collaboration, and, when necessary, a more direct approach.

One of the simplest, and perhaps most effective, strategies is to communicate air quality–related information to the public. Shenandoah, Great Smoky Mountains, and Big Bend have all embraced this strategy. Through a combination of wayside and visitor center exhibits, information pamphlets or site bulletins, articles in park newspapers, websites (including real-time access to air quality data being collected at Great Smoky Mountains), press releases, and other methods, these parks reach out to the public and local and national media. For example, Great Smoky Mountains has been issuing advisories to visitors and employees on days when air pollution levels are unhealthy. Shenandoah is developing a similar program.

Communication also builds constituencies that may use the information to echo and advance the objectives of the National Park Service for resource protection. The approach used in each of these parks is to find common ground and interests with local community organizations, including traditional, nongovernmental friends groups; economic and business interests; state and local government officials; schools and universities; congressional delegations; other federal land managers; and the scientific community. Effective constituency building by Great Smoky Mountains and Shenandoah led the National Parks and Conservation Association and the Izaak Walton League of America to publish reports highlighting park air quality issues and advocating for more aggressive pollution-reduction programs.

Collaboration is critical to achieving air quality-improvement objectives. At Big Bend the National Park Service worked with federal, state, private, and international officials to design and conduct an intensive monitoring program encompassing a multistate area, including the region bordering Mexico. The study was aimed at identifying sources contributing to air pollution problems at Big Bend and will provide a foundation for seeking pollution reductions needed to restore good air quality at the park. Great Smoky Mountains and Shenandoah have been participating in the Southern Appalachian Mountain Initiative, a stakeholder-based air quality planning effort in the Southeast. Following several years of data analysis, the partnership is now beginning to build consensus on what additional pollution control strategies will be needed.

When all of these strategies fail to produce results, however, the National Park Service needs to be willing to challenge actions and confront inaction head-on. Face-to-face meetings involving the NPS Director, superintendents, and state environmental directors have been convened to signal the importance of the issue. In Shenandoah's case, where a state was not responsive, appeals have been lodged with the Environmental Protection Agency (EPA). The next step is to ensure that the EPA carries out its oversight responsibility.



The graph shows a rising trend *in ozone levels at Big Bend, Great Smoky Mountains, and Shenandoah National Parks from 1989 to 1998. When confronted with data documenting deteriorating air quality, NPS managers are using a variety of strategies to exercise influence over air pollution sources the National Park Service cannot control.*

Bison management planning moves forward

In December 1999 the National Park Service, the U.S. Forest Service, and the Animal and Plant Health Inspection Service announced that discussions with the State of Montana had reached an impasse regarding a preferred alternative in the final environmental impact statement for managing bison in greater Yellowstone. The federal agencies intend to move forward with a final plan to protect Yellowstone's free-ranging bison population while maintaining Montana's brucellosis class-free status and minimizing the need for lethal control of bison. Efforts to produce a long-range plan have been under way since 1990, and a final decision is expected in fall 2000.

Bioprospecting Challenge

National Park Service prevails in court; environmental impact statement on schedule

by John D. Varley with Ann Deutch

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Bioprospecting is the search for valuable organic compounds in nature. Once discovered, these compounds are normally taken to a public or private laboratory where staff develop techniques to synthesize or produce a promising compound in larger quantities. Such discoveries are made by focused bioprospectors but are also a serendipitous result of basic research. At least 10 national parks have received proposals for scientific research projects that might lead to tangibly valuable scientific discoveries in many fields, including medicine, agriculture, energy production, and bioremediation technologies.

Like other parks, Yellowstone National Park has allowed scientists to collect small specimens of rocks, plants, and other organisms for research purposes. If the results of such research were tangibly valuable, neither Yellowstone nor the National Park Service ever received more than a pat on the back. In 1997 this situation began to be corrected. Yellowstone entered into a Cooperative Research and Development Agreement (CRADA) with Diversa Corporation to share benefits, including the licensing and sale of products developed from research involving microorganisms collected from Yellowstone's hot springs. Under this agreement, Yellowstone will receive a package of benefits, including a portion of Diversa's profits if any are derived from research involving the park's microbes.

> "Yellowstone will receive ... a portion of Diversa's profits if any are derived from research involving the park's microbes."

In 1999 the CRADA was the subject of a lawsuit in the District Court of Washington, D.C. The suit asserted that the National Park Service had failed to meet the requirements of a variety of laws when it entered into the CRADA with Diversa. In April 2000 the court ruled that Yellowstone's CRADA with Diversa is "proper" and "does not conflict with the conservation mandate." The court also emphasized congressional intent regarding these agreements involving national parks. Finding that the CRADA "plainly constitutes an 'equitable, efficient benefits sharing arrangement,'" the court went on to declare that "the far-reaching terms of the Parks Management Act reinforce the conclusion that the Yellowstone-Diversa CRADA is proper." Nonetheless, because of a preliminary judgment in 1999, the CRADA is currently suspended until the National Park Service completes an environmental analysis examining the implications of bioprospecting in the national parks.

Extremely inhospitable habitats, *such as hot springs in Yellowstone, support thriving microbial communities. The study of these microorganisms and how they function under extreme conditions can provide vital information to bioprospectors. The National Park Service is completing an environmental analysis of the implications of bioprospecting in national parks.*

Reinvigorating a Program

National Natural Landmarks Program: Up and running ... and raring to go

by Steve Gibbons

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After a 10-year hiatus in designating new sites, the National Natural Landmarks (NNL) Program is back on its feet, steady, and raring to go. As you may recall, the National Park Service placed a moratorium on the NNL Program in 1989, which postponed the nomination, evaluation, and designation of new sites for landmark status. Though not a welcome development at the time, in hindsight the moratorium provided the National Park Service with an opportunity to take stock of the program on a national scale and make some key improvements. During this period, the National Park Service was successful in garnering a congressional appropriation of $775,000 to bolster the national program, which provided funding for additional "full-time" NNL regional coordinators. Just as important, program officials had time to revise the NNL regulations, identify and contact all landmark owners, update both the national landmarks handbook and the database, and adopt management controls for the program.

The painstakingly slow and protracted 10-year moratorium officially came to a close on 12 May 1999, with the promulgation of the new NNL regulations in the *Federal Register*. The new regulations reflect a balance between the National Park Service and private landowners while providing clarity, direction, and meaning to the landmarks program. Specifically, the new regulations reinforce the truly voluntary and honorary nature of the program by granting a 90-day withdrawal period to all landmark owners. Withdrawal requests were still being processed at the end of 1999; however, early tallies indicate a large percentage coming from three problematic landmark sites across the country. These three sites each have more than 1,000 landowners and were negatively affected by local misinformation about the landmarks program. The intent of the National Natural Landmarks Program is to resume the designation process after all withdrawal requests have been processed and boundaries adjusted.

With the final passage of the new regulations and the lifting of the moratorium, a new day has begun for the NNL Program. However, the National Park Service cannot do it alone. To be a truly successful program an all-inclusive prescription is needed, forging cooperative partnerships and relationships at all levels. Success for the NNL Program must prescribe success for all stakeholders, involving private landowners, government employees, academia, county commissioners, state representatives, and the Congress at large. Director Stanton's Natural Resource Challenge affirmatively echoes this call. National Natural Landmark Program coordinators, too, are ready to make a go of it. The real question is, are you?

Located in the Deschutes National Forest in central Oregon, *Newberry Crater National Natural Landmark is a young volcano formed within the last million years of the Pleistocene Epoch. It is the largest Pleistocene volcano east of the Cascades Range and stands isolated and conspicuous on a broad plateau of lava.*

The recently appointed National Park System Advisory Board *consists of (left to right):* ***Charles R. Jordan*** *(director, Parks and Recreation, Portland, Oregon);* ***Sylvia A. Earle*** *(marine biologist and ocean explorer);* ***Javier M. Gonzales*** *(Santa Fe County commissioner and former mayor of Santa Fe, New Mexico);* ***Margaret L. Brown*** *(former senior vice president of Cook Inlet Region, Inc., an Alaska native lands corporation);* ***Gary Paul Nabhan*** *(museum science director and natural history author);* ***Parker Westbrook*** *(former special assistant and administrative aide for Arkansas members of Congress);* ***Marie W. Ridder*** *(environmental advocate and journalist);* ***John Hope Franklin*** *(James B. Duke Professor Emeritus of History, Duke University);* ***Robert S. Chandler*** *(retired NPS superintendent);* ***Stanley Selengut*** *(civil engineer and creator of sustainable and ecologically appropriate resorts and businesses);* ***Thomas B. Williams*** *(retired Democratic staff director for the Senate Committee on Energy and Natural Resources); and* ***Shirley M. Malcolm*** *(science educator, ecologist, and administrator with the American Association for the Advancement of Science).*

Scientific management of natural resources has long been a precept of park resource managers. The National Park Service strengthened its commitment to this principle in 1999 when three prominent scientists were named to the National Park System Advisory Board. Their ability to link science to several key questions about the long-term direction of the National Park Service is sure to bring valuable insights. Other exciting news was the budget increase for the Inventory and Monitoring Program late in the year. This development will speed up acquisition of natural resource baseline inventories, giving parks a foundation for planning long-term ecological monitoring to detect changes in resource condition. In other areas, scientific data management is advancing through the development of computer interfaces and other tools or systems to afford park resource managers access to centralized databases of natural resource information. These and other developments reported here represent substantial progress for the year with respect to the scientific role of the National Park Service in managing park natural resources.

Leadership in Science

NPS Advisory Board features strong science presence

by the editor

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Secretary of the Interior Bruce Babbitt appointed a new National Park System Advisory Board in 1999 in response to a recent reauthorization of the board by the Congress. As in the past, the board's mission is to further the purposes of the national parks and the National Park Service. Its 12 members are a group of scholars, businesspeople, public servants, and philanthropists, each with credentials and a strong interest in the conservation of park resources and the role of the National Park Service in American life.

"The advisory board features a strong natural resource science presence in the persons of Sylvia A. Earle, Gary Paul Nabhan, and Shirley M. Malcolm."

John Hope Franklin, renowned historian, legal scholar, and cultural resource scientist, chairs the reinvigorated board. A culturally diverse and professionally balanced group, the advisory board features a strong natural resource science presence in the persons of Sylvia A. Earle, Gary Paul Nabhan, and Shirley M. Malcolm (see profiles of these board members on the following page).

After announcing the board in August, Director Stanton spelled out his charge in a December memorandum, asking the group to tackle several difficult and wide-ranging questions about the future of the parks and the National Park Service. How should the National Park Service reconcile resource protection with visitor enjoyment, and how should it protect park resources in changing landscapes? How should it respond to a changing population, and what is its role in education? How should the national park system grow? And how can the National Park Service strengthen its identity? In addition, Director Stanton emphasized that scientific inquiry, including preparation of papers by leading academicians and scholars, should be part of the process in addressing these tough issues.

A final report of the findings and recommendations of the board is anticipated in spring 2001. The report is expected to be visionary and to describe the future legacy of the national parks and the role of the National Park Service in conserving the nation's natural and cultural heritage.

The National Park Service is excited about the anticipated insights and guidance of the board. It is also hopeful that the board's development of the report will stimulate a new level of public interest in the role of the national parks and the National Park Service in the life of the nation.

Sylvia A. Earle—Marine Biologist and Ocean Explorer

In addition to her work as a marine biologist, Sylvia Earle is an author, lecturer, scientific consultant, and spokesperson for SeaWeb. She is founder and chair of Deep Ocean Exploration and Research, director of Sustainable Seas Expeditions, former chief scientist of the National Oceanic and Atmospheric Administration, and the 1998–2000 explorer in residence at the National Geographic Society. She also serves on the boards of various nonprofit organizations, including the Woods Hole Oceanographic Institution, the World Resources Institute, the Center for Marine Conservation, and several others. She sits on the Visiting Committee in Ocean Engineering for the Massachusetts Institute of Technology. Holder of several diving records, Dr. Earle has led more than 50 expeditions and has authored more than 120 scientific, technical, and popular publications.

Her research concerns the ecology of marine ecosystems (see her article on the state of ocean resources on page 61) with special reference to marine plants and the development of technology for access and research in the deep sea. During more than 6,000 hours of diving, Dr. Earle has observed deterioration of ocean resources. Due to her awareness that most of the planet's oceans are unexplored, she has become an advocate of exploration, research, and protection of marine ecosystems. Her broad expertise in ecological issues concerning marine resources and science and research in general is sure to serve the National Park System Advisory Board very well.

Gary Paul Nabhan—Museum Science Director and Natural History Author

Gary Nabhan resides in Tucson, Arizona, where he is director of conservation and science at the Arizona–Sonora Desert Museum. A versatile scientist with teaching experience in economic botany at Arizona State University and in the literature of natural sciences at the University of Arizona, Dr. Nabhan is a prolific writer. He has published more than 60 technical journal articles in botany, geography, nutritional ecology, conservation biology, linguistics, anthropology, education, and regional studies literature. Additionally, he has authored more than 200 magazine articles, poems, essays, and short stories. His books include *Plants and Protected Areas* (with John Tuxill, 1998, Stanley Thornes, Ltd.); *Forgotten Pollinators* (with Stephen Bachman, 1996, Island Press); *Canyons of Color* (with Caroline Wilson, 1995, HarperCollins/West); *Saguaro* (with George Huey, 1986, Southwest Parks and Monuments Association); and *The Desert Smells Like Rain* (1982, North Point).

As director of conservation and science, Dr. Nabhan oversees a very active desert research program that includes studies in botany and ethnobotany, ecology, herpetology, invertebrate zoology and ichthyology, mammalogy and ornithology, geology, and outreach and education. In addition he serves as the principal investigator on several projects examining the relationships among native Sonoran Desert peoples, plants, and animals. One of these is a monitoring study of four migratory pollinators that move between western Mexico and the southwestern United States. This binational project incorporates local community participation in an effort to identify and develop stewardship for vulnerable habitats. His knowledge and expertise of desert ecosystems; research and its administration; outreach; and natural history education, writing, and literature are very useful scientific credentials for the work of the National Park System Advisory Board.

Shirley M. Malcolm—Ecologist and Science Educator

Shirley Malcolm is head of the Directorate for Education and Human Resources Programs, American Association for the Advancement of Science (AAAS), in Washington, D.C. In this capacity, Dr. Malcolm designs, implements, and manages a complex array of programs and projects aimed at achieving AAAS goals of advancing education in science, mathematics, and technology and expanding the talent pool for science. The directorate is the hub of a large and active network of policy makers, advocates, and practitioners working to bring science to the people, and people to science. Earlier, she worked as program manager of the Minority Institutions Science Improvement Program for the National Science Foundation.

In her leadership role with the AAAS, Dr. Malcolm has helped advance science education in the United States, especially for groups who traditionally underparticipate in education and careers based in science. To address these concerns she led the creation and development of the Black Churches Project, a network of churches designed to bring science, environment, and health education to African Americans. Likewise, Proyecto Futuro is a program to connect science learning in the school, community, and home by developing bilingual materials and showing connections between science and Latino culture. She has also guided science learning programs designed especially for children.

Dr. Malcolm serves on numerous boards, including the National Science Board and the President's Committee of Advisors on Science and Technology, both by appointment of the President, and the board of the American Museum of Natural History. Her perspectives on science education and her experience in attracting people to science careers will go far in serving the interests of the National Park Service and the National Park System Advisory Board.

Resource Inventory and Monitoring

Natural Resource Challenge benefits Inventory and Monitoring Program

by Gary Williams

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Natural resource inventory and monitoring are two of the major activities included in the National Park Service's Natural Resource Challenge ("the Challenge"). Those components of the Challenge will be carried out through the NPS Inventory and Monitoring (I&M) Program.

"The NPS I&M Program received a base increase of $7.3 million [during the first year] of the Challenge."

In fall 1999, as fiscal year 2000 got under way, the NPS I&M Program received a base increase of $7.3 million, the first in a series of budget increases planned to be requested over the five-year life of the Challenge. In FY 2000 the increase was for accelerating the completion of 11 of the 12 basic inventories initiated by the program in 1992. A portion of the increased funding will be provided to the regions to hire permanent, full-time inventory coordinators. One FTE (i.e., full-time equivalent or full-time staff) and the associated salary and support funds will be provided to each region. One million dollars of the FY 2000 increase will be used to supplement existing program funds for completing abiotic inventories (soils, geology, water resources, etc.). The remaining funds, approximately $6 million, will be used to fund inventories of vertebrates and vascular plants in parks. The Park Service has estimated that the increased funding for inventories received in FY 2000 will allow it to complete all of these basic resource inventories in about seven to eight years.

The 12th inventory component, vegetation mapping, will not be funded out of the increase received in FY 2000, since the USGS Biological Resources Division (BRD) has primary responsibility for funding vegetation mapping for all units of the national park system outside of Alaska. A funding increase is included in the FY 2001 Natural Resource Challenge budget request so that the National Park Service can share the costs of vegetation mapping with the USGS BRD and accelerate the completion of those maps over what would occur with only USGS BRD funding.

In addition to accelerating completion of basic natural resource inventories, the National Park Service designed and adopted a strategy for implementing ecological monitoring throughout the national park system as called for by the Challenge. Under this strategy, all of the natural resource parks have been assigned to one of 32 separate monitoring networks. Ecological monitoring will be implemented on a network-wide basis, with the most critical ecological variables, or indicators of ecosystem health, to be monitored in the parks of each network. Parks within a given network are expected to function as a team and share professional expertise, administrative workloads, and other burdens. The first fiscal year of funding for this monitoring strategy has been requested for FY 2001. Five of these monitoring networks, involving 55 park units, will be implemented during FY 2001, if Congress provides funding. Monitoring in the remaining 27 networks will be phased in over a period of three years if funding is appropriated. Monitoring in the 32 networks is in addition to the ecological monitoring being conducted by Prototype Long-term Ecological Monitoring (LTEM) Programs, which are already functioning. The LTEM Programs will continue to receive support for conducting the more comprehensive and intensive monitoring studies. Prototype LTEM programs will provide mentoring and other technical assistance and products to parks throughout the national park system.

Lisa Thomas, Great Plains Prairie Cluster

Staff prepare to use plastic hoops *for sampling prairie vegetation in permanent plots in Scotts Bluff National Monument, Nebraska. Long-term ecological monitoring reveals changes in the structure and species composition of plants. Such information is indispensable for evaluating grassland communities and for determining the effectiveness of restorative measures such as prescribed fire, seeding, plantings, and control of exotic plants.*

Special amphibian inventories

As part of its servicewide inventories of vertebrates, the National Park Service will contribute $940,000 during FY 2000 in support of the Amphibian Research and Monitoring Initiative (ARMI), an interagency effort on Department of the Interior lands under the leadership of the USGS Biological Resources Division. The NPS funding will be used for specialized inventories of amphibians in 12 of the 14 PRIMENet parks. PRIMENet, which stands for Park Research and Intensive Monitoring of Ecosystems Network, is a joint EPA-NPS program to assess the effects of environmental stressors on ecological systems across the country. Future amphibian inventories will be integrated into other vertebrate inventory strategies for non-PRIMENet parks.

List of fossil parks expands

Understanding of the fossil record expanded in 1999 as more than a dozen parks not formerly known to have paleontological resources joined the list of 144 parks that do. A dedicated team of paleontologists and student interns undertook exhaustive searches to uncover any occurrences of fossil plants, animals, and their traces in units of the national park system. The baseline data are being compiled to support the management, protection, and interpretation of these nonrenewable remains of past life and to better understand ancient ecosystems.

AQUIMS becomes "Synthesis"

by Bruce Nash

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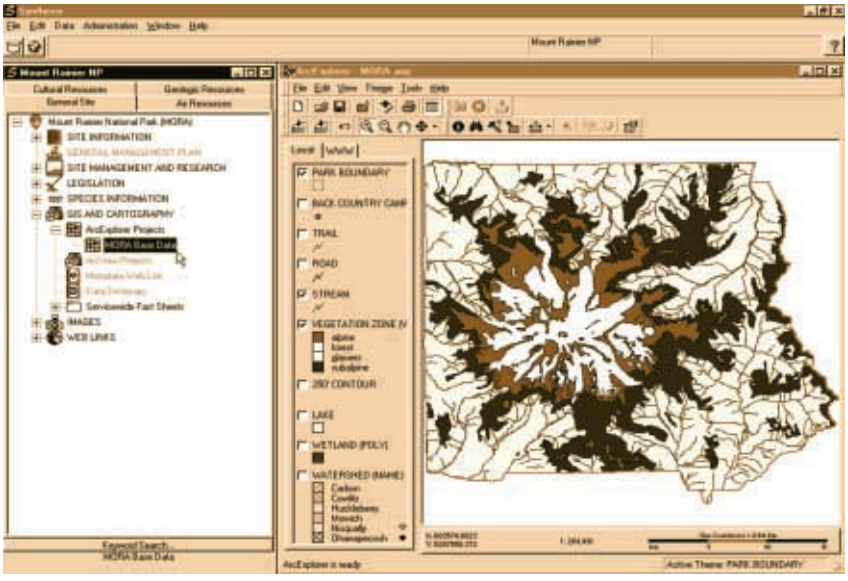
During 1999 an enhanced version of the Air Quality Information Management System (AQUIMS) software was integrated with the NPS Geographic Information System (GIS) Data Browser, creating the new information management system "Synthesis." In September, Synthesis was designated as the new standard interface for organizing and disseminating natural resource information within the Natural Resources Directorate. Synthesis represents a national information management effort involving representatives from the NPS Natural Resources Directorate, Cultural Resources Directorate, Information and Telecommunications Center, park and regional offices nationwide, and researchers at Penn State and the University of Denver. The Synthesis project is one component of an enterprise data management system planned by the Natural Resource Data and Information team who will also develop data management standards, quality assurance protocols, and tighter integration of Natural Resource Program Center databases if a related FY 2001 Natural Resource Challenge budget request is successful.

Synthesis is an information management system for efficiently locating, organizing, integrating, and disseminating data and information. It does not replace existing databases or dictate the structure or function of other databases. Rather it provides a set of pathways that link various sources of information. Synthesis presents the user with a simple, graphical user interface that functions as a gateway to information that may be stored on local computers, networks, intranets, or the Internet. From this single gateway a user may view and integrate many types of information, including text-based documents, photographic libraries, databases, spreadsheets, presentation graphics, GIS data, bibliographies, Internet-based information, and decision support systems.



Synthesis users select elements from the user interface *to reveal information and data. Mount Rainier's use of Synthesis allows for retrieval of both park–specific and park system-wide information. In this example a GIS map shows stream locations and vegetation types for application in watershed planning.*

All information, including periodic updates, will be distributed in standard NPS formats via either the Internet or CD-ROM. In addition to providing natural resource information from a standard interface, Synthesis includes a software toolbox that allows users to create a custom interface and then link information to that interface. An interface created in this manner can be designed to serve park-specific information needs. No programming expertise is needed to use the toolbox.

> "Synthesis is an information management system for efficiently locating, organizing, integrating, and disseminating data and information."

Synthesis is already functional in some parks. At Mount Rainier (Washington), Resource Manager Barbara Samora reports that Synthesis was "used in seasonal training, for developing information needed for environmental assessments, and for pulling together information requested by the USDA Forest Service for use in their watershed planning efforts." Darin Swinney, a GIS specialist at Mount Rainier, and Samora have customized the Synthesis interface to accommodate Mount Rainier–specific files, which they have added to the system. Because these files were sent to the Synthesis development team, they are now available to other parks, regions, and central offices. This is an excellent example of how Synthesis improves the dissemination of information.

At Petersburg National Battlefield (Virginia) a multidisciplinary team is working with park staff to improve all aspects of information management, including hardware and software issues, communication capability, and data management. Together this team will enter natural and cultural information into Synthesis and its integrated "sister" systems (NPS GIS Data Browser and NPS Cultural Resources MAPIT). This effort will improve information management at Petersburg and develop protocols and standards that will be used across the national park system.

Natural and Cultural Resource Protection

Preserving the Cape Hatteras lighthouse ... and the coast

by Steve Harrison

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In 1999 the Cape Hatteras Light Station was successfully relocated 2,900 feet from the spot on which it had stood since 1870. Because of the threat of shoreline erosion, a natural process, the entire light station, consisting of four historic structures, was safely moved to a new site where the buildings were placed in relation to each other, exactly as they had been at the original site. While the National Park Service has met its obligation to both historic preservation and coastal protection, the much-heralded move of the historic buildings was hotly debated and closely watched.

When constructed in 1870, the Cape Hatteras lighthouse was located a safe 1,500 feet from the ocean. Even then, however, storm-driven tides completely washed over Hatteras Island, eroding sand from the ocean side of the island and depositing it on the sound side. By 1970, this process, which has caused the gradual westward migration of the Outer Banks for at least the past 10,000 years, left the lighthouse just 120 feet from destruction.

The National Park Service has long recognized the threat to the lighthouse posed by the erosion process and began a series of measures to protect the historic structures as early as 1930. In the decades leading up to the relocation of the lighthouse, numerous interim protective actions were taken to slow the erosive power of the ocean and save the lighthouse in place. These included sand replenishment, sandbagging, and maintenance of erosion-control or groin structures. Despite these human efforts, the power of the ocean did not abate and the waves continued to break closer and closer to the lighthouse.

In 1980 the National Park Service began planning, under the National Environmental Policy Act, for long-term protection. A three-year process that included public meetings yielded several alternatives. Relocation was considered but quickly discounted as impractical. The option finally selected was a seawall revetment that would have protected the lighthouse in place but would eventually have created an island as the coastline receded to the southwest. When additional information became available about relocation versus the approved seawall, the National Park Service examined the alternative that allowed it to accommodate natural processes while still preserving the historic structures of the light station.

In 1987, to quickly resolve the issue, the National Park Service contracted for assistance from the National Research Council of the National Academy of Sciences in developing long-term options for preserving the Cape Hatteras lighthouse. The committee formed to address this question considered all options, but recognized that the National Park Service ultimately would have to make its decision in the context of NPS policy, the various public policies relating to U.S. coastlines, and scientific and engineering constraints. Both NPS policy and state law (Coastal Area Management Act) precluded additional temporary protective measures or hardening of the coast for long-term protection. In its report, *Saving Cape*

Moving the 4,800-ton lighthouse *was no small engineering feat. Contractors employed 100 jacks to keep the lighthouse level while five hydraulic rams gently nudged it along iron beams lubricated with soap to its new resting place 2,900 feet away. The operation went smoothly, taking 23 days and causing no damage to the 130-year-old treasure.*

Battered by perennial ocean storms, *the shoreline at Cape Hatteras National Seashore had become a precarious home to the famous black-and-white lighthouse and four associated historic buildings. After years of study the National Park Service opted in 1999 to move the structures and cleared a pathway to a safe haven 1,600 feet from the shoreline.*

Deer management EIS survives lawsuit

Held up for nearly two years in federal district court, the White-tailed Deer Management Program of Gettysburg National Military Park and Eisenhower National Historic Site (Pennsylvania) was reinstated by the court in January 1999. The suit was brought by three animal rights organizations and six citizens in 1997 who opposed the National Park Service deer management program. However, the court ruled that the Park Service had "considered a full range of reasonable alternatives and was within its discretion" when it chose direct reduction through shooting as the method of reducing deer numbers to the goal of 25 deer per square mile of forest. There is no public hunting. The court also ruled that the Park Service "acted consistently with the Organic Act … and that it complied with the … National Environmental Policy Act and the National Historic Preservation Act."

The Park Service conducted more than 10 years of research and completed an environmental impact statement (EIS) that examined alternatives for reducing white-tailed deer populations at the parks. The studies concluded that the parks have more deer than the natural and historic landscape can support. Intensive deer browsing is preventing tree seedlings from becoming established, and historical crops are being destroyed before they can be harvested. The 1995 EIS, which included public review, considered all feasible options for meeting park objectives, including public hunts, animal relocation, and sterilization and contraception.

Hatteras Lighthouse from the Sea: Options and Policy Implications (full text available at www.nps.gov/caha/lrp.htm), the committee evaluated 10 options for preserving the lighthouse, but recommended incremental relocation as the preferred alternative. The National Park Service also considered this the best overall solution in that it would preserve the structures and accommodate the natural shoreline processes.

Nevertheless, many people feared destruction of the brick lighthouse, the tallest in the United States. As a result, in 1996, North Carolina State University (NCSU) independently reviewed the National Academy of Sciences report, and then issued its own report, *Saving the Cape Hatteras Lighthouse from the Sea,* in January 1997. It not only supported the findings of the National Academy of Sciences report, but also recommended that "the National Park Service proceed as soon as possible with its present plans to obtain the financial resources necessary to preserve the lighthouse by moving it." Funding was appropriated by Congress beginning in FY 1998.

Management decisions of this magnitude in national parks are based on laws and regulations through a public planning process. The decision to relocate the Cape Hatteras Light Station was a sound public policy decision based on the best science and engineering available, and on 9 July 1999, the Cape Hatteras Lighthouse reached its new home. Now safely 1,600 feet from the ocean, it should not be threatened by the indomitable ocean waves for another 100 years.

Scientific Design

Reducing the hazards of open mine shafts in parks

by Philip Cloues

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As odd as it sounds, accidentally falling into an abandoned mine shaft while hiking or exploring is a possibility in approximately 140 units of the national park system. The Abandoned Mineral Lands Program of the NPS Geologic Resources Division is responsible for addressing problems, including safety concerns and environmental degradation, associated with abandoned mines in parks. Polyurethane foam (PUF) can be used to form a plug or stopper at the top of a mine shaft to prevent the accidental falls of humans and wildlife. Research sponsored by the National Park Service and completed in 1999 by a team of senior engineers at the Colorado School of Mines in partnership with the Bureau of Reclamation's Materials Engineering and Research Division developed a PUF plug design with reduced cost and other benefits. In this case, "doing more with less" is a reality through innovation.

Polyurethane foam has been used for mine shaft closures for over two decades. However, it usually requires equipment and mechanical transportation that can leave a footprint on sensitive soils and disturb other natural resources and sensitive cultural landscapes. Equipment-free, bagged PUF is transported in backpacks, mixed by hand in its plastic-bag container, and installed without a proportioning unit and portable generator. The method is a proven long-term alternative to heavy concrete caps, steel grates, fences, and total backfill. The 1:30 expansion factor from liquid to solid is an added plus in reducing material transported to the site.

During the 1999 research the Senior Engineering Design Project focused on design and material properties testing (e.g., density, compression, tension, and shear strength). The team minimized the amount of testing by first generating finite element analysis using computer modeling. Full-scale testing on the 2,500-ton hydraulic press at the Bureau of Reclamation followed bench modeling at the School of Mines engineering laboratory in Golden, Colorado. One benefit of the new design is that cardboard shipping containers are incorporated in the plug and need not be removed from the site. Other benefits are reduction in PUF volume per shaft closure, material cost savings of about $500 per closure, less installation time, and tested strength reliability. The foam left over from the tests was put to use at Fort Bowie National Historic Site in Arizona to close an abandoned mine shaft at no cost to the park.

Equipment-free PUF may provide a long-term solution in areas with limited access and sensitive natural resources and cultural landscapes. The stabilization of the shaft collar with lightweight rigid foam can prevent collapse and stop the problem from getting larger over time. Polyurethane foam transforms from a liquid to a solid in about six to eight minutes. A typical 25-square-foot PUF shaft plug is only 6–7 feet thick and can support a load of 30 tons. Additionally, although in some cases the plug is vented, it reduces the amount of water seeping into the shaft, thereby decreasing the potential for mineral contamination of groundwater. Tested during 1999, the new PUF plug design will improve park safety and reduce resource impacts from mine shaft closures in many units of the national park system.

Real-time Information

Monitoring air quality during fire at Grand Canyon

by Tonja Opperman and Kara Leonard

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With a new national wildland fire policy and a prescribed fire management program emphasizing landscape-scale ignitions, fire played a beneficial role in over 12,000 acres of Grand Canyon's forests in 1999. Although managed fires produce unique resource benefits, they also create large volumes of smoke. Because the park receives the highest level of protection under the Clean Air Act as a Class I area, this smoke creates resource management conflicts. Fire managers work with the Arizona Department of Environmental Quality (ADEQ) to ensure that smoke emissions do not violate air quality standards. For the first time, in 1999 the park combined many technologies to provide real-time information to the Department of Environmental Quality. This allowed regulators and managers to make better, science-based decisions concerning the air and forest resources under protection.

"The Arizona Department of Environmental Quality used the real-time smoke information ... to decide if the park could allow existing fires to continue burning naturally."

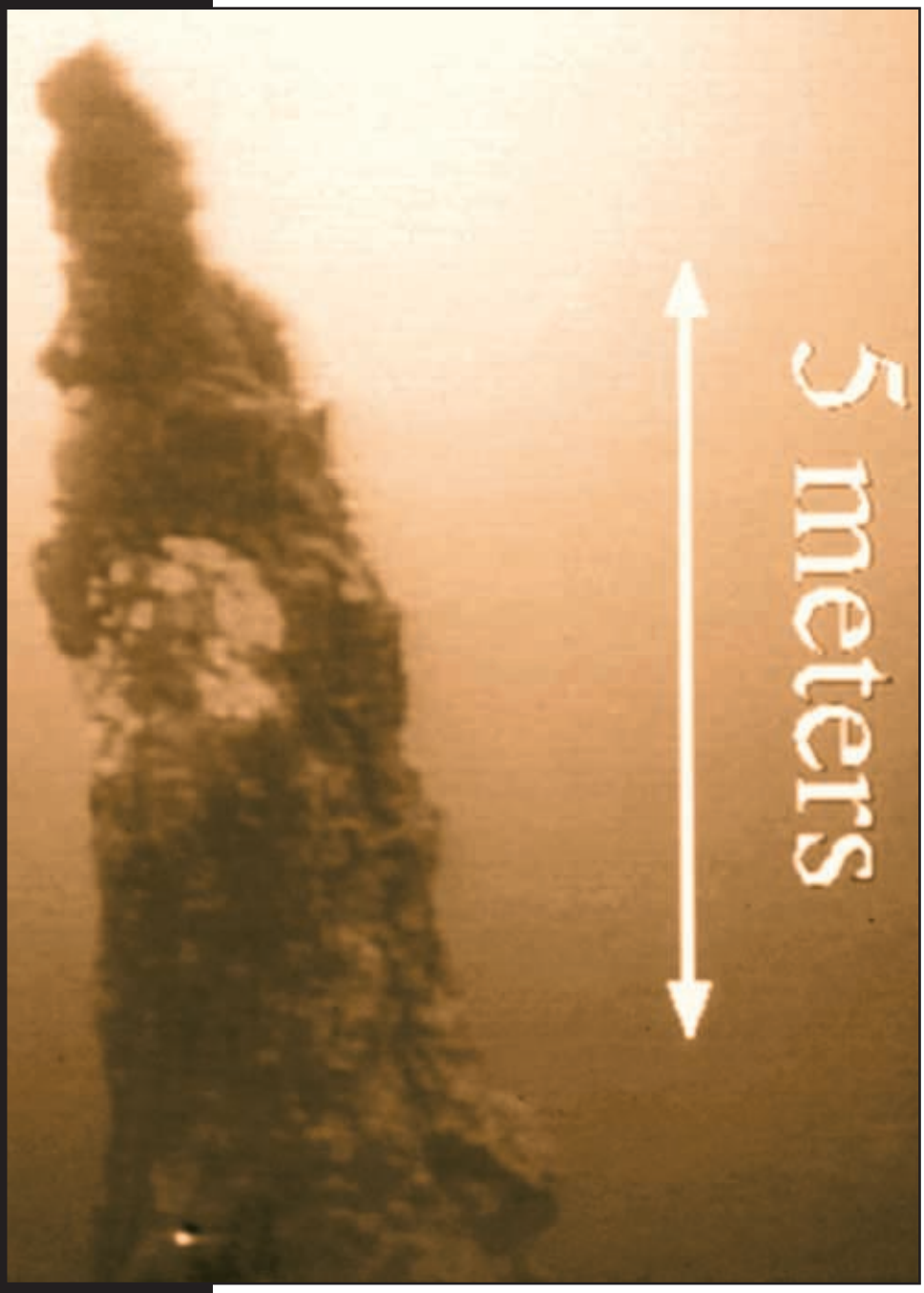
Fire monitoring personnel used DataRAM 2000 portable air-sampling machines to measure particulates in populated areas. During significant fire activity, fire monitors downloaded the data every evening and created graphs of particulate levels from the previous 24 hours. Several times each day, they took digital photographs from the same vantage points to record the presence or absence of smoke in the canyon. To accompany the photos, they wrote a description of the color, volume, location, and movement of the smoke column. Finally, the fire monitors sent all of this information to state regulators daily via e-mail.

While the fires were actively producing smoke, fire managers discussed management options each morning with ADEQ decision makers 200 miles away. The ADEQ used the real-time smoke information in combination with weather forecasts to decide if the park could allow existing fires to continue burning naturally, and even ignite additional prescribed fire acres. In the past the park collected data that could not be used in a real-time fashion; decisions were based solely on a monitor's written description. Now regulators can better understand the dynamic nature of smoke using the daily digital photos and particulate information. They know that excessive smoke levels will be recognizable almost immediately. As a result the ADEQ has increased confidence in the park's ability to manage smoke, allowing Grand Canyon National Park to take advantage of additional burning opportunities.

Managing smoke is a complex process, and even the best technologies do not predict smoke movement or weather patterns with complete accuracy. The park's science-based monitoring system allows fire managers and air quality regulators to make informed decisions based on detailed and timely information. The ADEQ is now better able to work with park fire managers to allow a burn to continue, rather than stop it entirely on the basis of air quality concerns. The improved relationship between Grand Canyon National Park and the ADEQ helps balance stringent air quality standards against the ecological need for fire. The park continues to learn from the past and to refine smoke management techniques, ensuring that air quality is protected, while fire—with its smoke—remains an integral part of the Grand Canyon landscape.

Prescribed fire poses a dilemma *for the National Park Service: how to conduct burns without violating air quality health standards. In 1999, fire managers at Grand Canyon National Park began to deploy air particulate samplers in areas of the park where people stay overnight. While this technology does not measure air pollutants such as volatile organic compounds or ozone, it does provide real-time information on particulates associated with fire, which are a concern for human health and visibility.*

Placement of the air particulate sampler, *the DataRAM 2000, is determined a few weeks before the burn. Samplers are located where human populations are greatest near the prescribed burn. The units are placed in standard fire weather stations before the fire is ignited and left in place until after the fire is out, which allows staff to monitor background particulates before smoke is in the air. Although it is not an EPA-referenced method for particulate sampling, the DataRAM 2000 has the advantage of providing real-time information, which staff download daily for use in making fire management decisions. The park currently uses three DataRAM units.*



At more than 5 meters in height, *this spire is one of hundreds discovered in 1999 on the floor of Yellowstone Lake by researchers conducting surveys of the lake bottom. The spires occur singly or in clusters and may be up to 35 meters high.*

Relatively intact ecosystems, many of which are found in the national park system, can provide excellent locations for natural resource-related research. In places where human influences are minimal, research can focus on such natural systems and their functions in ways that might be impossible in highly disturbed sites. Moreover, with their diverse resources, national parks are very desireable places for researchers. Additionaly, they provide opportunites to study the relationship of people to parks. Whether the goal of scientific inquiry is to illuminate new information to increase academic understanding or to apply it to societal needs, including the preservation of park resources, parks are labratories that contain untold numbers of facinating interactions and valuable applications. As the articles in this Year in Review *demonstrate, the National Park Service relies on scientific information developed by research partners and baseline data collected by its own staff for application in the management of park natural resources and the evaluation of resource management programs. For all these reasons, the Park Service will continue to make parks friendlier places for scientific inquiry.*

New Discoveries

The underwater spires of Yellowstone Lake

by Sue Consolo Murphy with Lisa Morgan

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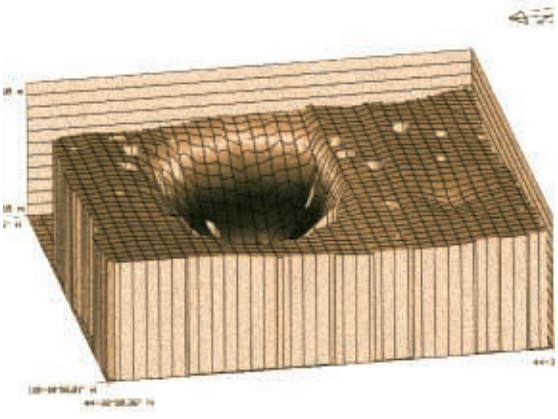
For more than a decade, researchers have been exploring the underwater environment of Yellowstone Lake. While visitors to Yellowstone may be more enamored of its fish population or the eagles and ospreys flying overhead, scientists have been eager to map and explore the thermal influences apparent even at several hundred–foot depths of this cold, high-mountain lake. An underwater roving vehicle had photographed thermal vents, and in 1997 an intriguing set of pinnacle-like "spires" was discovered in a section of the lake's floor that lies entirely within the 630,000-year-old Yellowstone caldera.

In July 1999, scientists from the U.S. Geological Survey, the Great Lakes WATER Institute at the University of Wisconsin at Milwaukee, and Eastern Oceanics returned to help the National Park Service begin conducting high-resolution bathymetric, seismic reflection, and magnetic mapping surveys of the lake. Although they were able to intensively map only the northern quarter of Yellowstone Lake, they discovered an array of interesting features, including dozens of circular, steep-walled depressions from 5 to 500 meters across (16–1,640 feet), and hundreds of pinnacles and spires. Some spires may be up to 35 meters tall (115 feet) and some are 50 meters (164 feet) in diameter; they occur singly or in clusters.

Under the direction of the researchers, members of the park dive team found and collected small spire samples near the mouth of Bridge Bay. The scientists waiting on the water's surface greeted the specimens with great delight and awe. Scientists took the spire samples, which had a light-



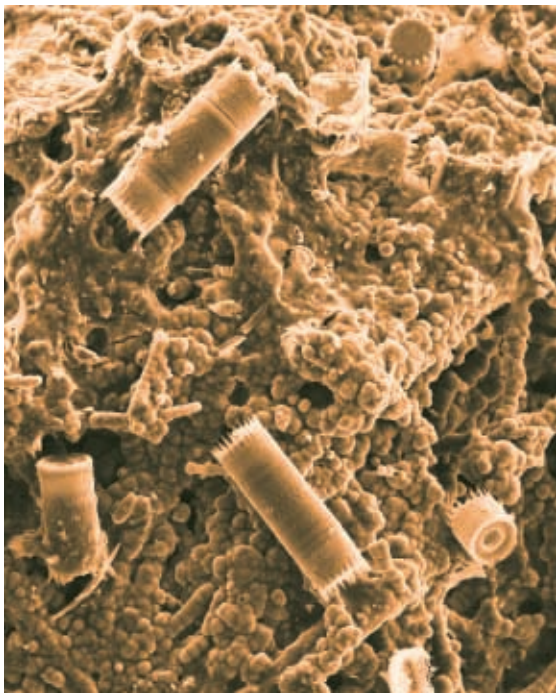
A computer-generated map *shows an intriguing array of steep-walled depressions on the floor of Yellowstone Lake. Also observed were pinnacles, spires, faults, and submerged former shorelines of the cold, high-mountain lake.*

Volcanic vent discovered at El Malpais

While exploring the Bandera lava flow in El Malpais National Monument (New Mexico) in 1999, the management assistant and the park archeologist discovered what is apparently a volcanic vent. Tentatively named "RK Crater," the vent is obscured from aerial view by a dense stand of mature ponderosa pine. It is about 60 feet in diameter and about 30 feet deep; an associated spatter cone is about 100 feet in height. The vent and cone are important pieces of the park's geologic puzzle. Once they had mapped the new discoveries, the two employees were able to interpret evidence of the vent on a topographic map, but still could not make out any evidence of its existence in aerial photos. The find underscores that new geologic discoveries are possible even in areas that have been previously studied.

colored, porous interior mantled with a coating of iron oxide, for laboratory analysis. Results indicate the spires are composed of amorphous silica; images from a scanning electron microscope reveal that samples contain remains from a broad variety of diatoms and botryoidal and filamentous bacteria. The spires also have trace amounts of heavy metals commonly associated with hydrothermal vents. Formation of both spires and circular depressions is related to deep fluid circulation that occurred over the past 12,000 years and left visible vents on the lake bottom. Other features seen during the survey are recent faults and submerged former shorelines. Though researchers hypothesized that the vent field in Bridge Bay is now inactive, the sheer number of features now known on the Yellowstone Lake bottom suggests very active vent sites, some of which may still be creating spires and other formations.

Later in 1999, one of the ranger-divers reported finding an outcrop of spirelike material in Lewis Lake, inside the southern boundary of the Yellowstone caldera. Researchers intend to return in 2000 to photograph features already discovered and to sample more spires, vent waters, and material from the lake bottom. They hope to map the entire floor of Yellowstone Lake—and possibly beyond—in future years. The study aims to understand the geologic processes that shape the lake and how they affect present-day aquatic populations.



A scanning electronic micrograph *of a small spire sample reveals siliceous remains of diatoms (cylindrical objects) and bacteria (objects shaped like bunches of grapes) as the primary constituents of the spire. Trace amounts of heavy metals commonly associated with hydrothermal vents are also present.*

Gathering Baseline Data

Sockeye salmon population status and local adaptation inventoried at Aniakchak

by Troy Hamon

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Fishery Biologist, Katmai National Park and Preserve, Aniakchak National Monument and Preserve, and Alagnak Wild River, Alaska

Small population sizes and often extreme weather conditions (even for Alaska) have led to poor documentation of the sockeye salmon populations in the Aniakchak River drainage, a designated wild river. However, a history of subsistence use, observations by recreational visitors and researchers, and aerial surveys by the State of Alaska establish the presence of sockeye salmon within the drainage. Considering the significance of fisheries to the area and the increasing pressures on federal managers to obtain adequate information to respond to subsistence issues, park resource management personnel began a project in 1999 with the purpose of identifying spawning locations and the overall number of spawning populations in the drainage. An ancillary goal was to obtain genetic samples and measurements of habitat and body dimensions for comparison with other populations of earlier origins.

Sockeye salmon populations in Aniakchak Caldera and the Aniakchak Wild River drainage were established recently relative to other sockeye salmon populations in southwestern Alaska. Most lake systems supporting sockeye in the region are of glacial origin and have been accessible to anadromous species (those that reproduce in freshwater but go to sea to feed and grow) for 20,000 years. Most of those lakes are also within 200 feet of sea level in elevation. By contrast, Aniakchak Caldera, in Aniakchak National Monument and Preserve, was formed by a massive volcanic eruption 3,400 years ago. It subsequently filled with water, housing a large lake similar to Crater Lake in Oregon. The hydraulic pressure on the caldera wall was eventually too great and a weak spot in the wall gave way between 1,800 and 3,400 years ago,

resulting in a tremendous flood. The flood established a connecting river between the lake, still present in one corner of the caldera though much smaller, and the Gulf of Alaska basin of the north Pacific Ocean, and allowed access by anadromous species. The lake, now known as Surprise Lake, is 32 river miles from the ocean, but lies at over 1,000 feet in elevation. Sockeye salmon accessed Surprise Lake at some time since the flood and established spawning populations there, persisting despite an eruption in 1931, which dumped six feet of volcanic material into the lake.

In this first year of inventory, the project successfully identified and sampled three spawning populations. Two of the spawning populations are in the caldera and one is downstream at Albert Johnson Creek, a major tributary to the river. Initial results from body size and shape measurements suggest limited mixing among the two populations sampled within the caldera. Genetic analysis is pending. In addition to sockeye salmon populations, the project obtained the first documentation of chinook salmon in the Aniakchak River drainage. Future study plans include completing characterization of the identified populations and their habitats, and additional efforts to identify more spawning populations at sites in the caldera and in Aniakchak River itself.

"This baseline information is especially critical because these populations are subject to commercial harvest outside and subsistence harvests inside the unit boundaries."

This project is supported and carried out by the National Park Service. It will provide a foundation of population information to ensure protection of sockeye salmon populations in Aniakchak National Monument and Preserve. This baseline information is especially critical because these populations are subject to commercial harvest outside and subsistence harvests inside the unit boundaries.

National Park Service resource managers *display anesthetized male and female sockeye salmon at the beach spawning area in Surprise Lake where the population status is being assessed. The wall of Aniakchak crater and the "Gates," where the lake flows out through the caldera wall to the Pacific Ocean, are visible in the background.*

New species discovered at Great Smokies

The first pilot year of the All Taxa Biodiversity Inventory (ATBI) in Great Smoky Mountains National Park was completed in 1999, with reports of 29 new species discoveries and 244 new park records. However, only a small portion of samples had been processed as the year came to a close. Ranges for some species have been quite extensive. For example, two species of slime molds were found in the park that were not previously known in the New World. Many more discoveries await as the second pilot year begins in 2000.

Partners in Science

Canon scholarship program expands in its third year

by Jean French

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The Canon National Parks Science Scholars Program awarded scholarships to eight doctoral students in 1999, twice the number of annual awards available in previous years. Each awardee receives $75,000, $25,000 per year for up to three years, to conduct dissertation research in the national park system.

The Canon National Parks Science Scholars Program is underwritten and supported by Canon U.S.A., Inc. Other collaborating organizations are the National Park Service, the National Park Foundation (NPF), and the American Association for the Advancement of Science (AAAS). The program was established in 1997 to encourage the best and brightest graduate students in all relevant scientific disciplines to conduct innovative park-related research and to encourage the use of national parks as laboratories for science.

Each year, the National Park Service develops specific research questions in four broad disciplines: the biological, physical, social, and cultural sciences. Graduate students from universities across the United States submit research proposals addressing one of the questions. During the first two years of the program, one student in each of the four categories was eligible to win a scholarship. In 1999 the program was significantly expanded, awarding scholarships to two students in each of the four categories. In addition, four honorable mention awards of $2,000 each are now available, one in each category.

This program is a unique public- and private-sector collaboration, the benefits of which became evident once again during the annual Canon National Parks Science Scholars Symposium in November 1999. In attendance were representatives of Canon U.S.A., Inc., the National Park Service, the NPF, and the AAAS, several of whom made presentations to the students. The Second Annual Canon Lecture on science and the national parks was given by NPS Historian Dr. Richard Sellars. All Canon Scholars (14, including the 1999 class) attended the two-day event in Washington, D.C. The students presented their research projects, taking advantage of the opportunity to discuss their research interests and further interact with NPS scientists, AAAS officials, NPF representatives, and their peers.

In the third year of this program, the Canon Scholars began to make significant, valuable contributions to science and the conservation of park resources through their research activities (see accompanying profiles). Since receiving their Canon scholarships, the 1997 class has authored a total of five peer-reviewed journal articles, published in *Science, Water Resources Research, Biological Invasions, Tree,* and *Ecology.* In addition the 1997 Canon Scholars' research has been described in *Discover,* the *Los Angeles Times, National Geographic, National Wildlife,* the *New York Times, Science News,* and other notable publications.

> "In the third year ... the Canon Scholars began to make significant, valuable contributions to science and the conservation of park resources."

The first Canon Scholar to complete the program, Tom Meixner, earned his Ph.D. in 1999. The rest of the 1997 Canon Scholars expect to earn their degrees in 2000, and the 1998 Canon Scholars are all on schedule to complete their degrees the following year. The 1999 Canon Scholars are just beginning their research. The 2000 competition is under way (visit www.nps.gov/socialscience for further information) and the 2000 Canon Scholars will be selected by 7 August 2000. Through the Canon National Parks Science Scholars Program these extraordinary scientists are able to learn, discover, invent, and create solutions to help preserve the nation's collective heritage in the 21st century.

Scientist Profiles

Tom Meixner, a 1997 Canon Scholar, is the first to complete the program. He earned his Ph.D. in 1999 from the University of Arizona. His dissertation is entitled "Alpine Biogeochemical Modeling: Case Studies, Improvements, and Parameter Estimation." In his research at Sequoia–Kings Canyon and Rocky Mountain National Parks, he developed modeling techniques to help in his study of alpine wilderness. In 1998 he authored a peer-reviewed journal article in *Water Resources Research.* Dr. Meixner is currently an assistant professor of hydrology at the University of California–Riverside.

Karen Short is studying the effects of frequent low-severity fires on bird populations in southwestern ponderosa pine forests. Karen is a 1998 Canon Scholar who is attending the University of Montana. She is collecting her data from Saguaro National Park, Walnut Canyon National Monument, and Grand Canyon National Park.

Andrew Suarez, a 1997 Canon Scholar at the University of California–San Diego, is measuring the impact of exotic species on natural systems. Andy has studied Argentine ant invasion, one of the most problematic biological invasions in southern California. Much of his research has been in Cabrillo National Monument. He has authored or coauthored four peer-reviewed journal articles since 1998 in *Science, Ecology, Tree,* and *Biological Invasions*. In addition, Andy's research has been described in many notable publications, including *Discover,* the *Los Angeles Times, National Geographic, National Wildlife,* the *New York Times,* and *Science News*.

Alice Wondrak is a 1999 Canon Scholar and a student at the University of Colorado–Boulder. She is exploring the environmental history of the "Yellowstone bear," from tourism icon to ecological indicator. Alice will conduct a broad examination of texts and artifacts, both contemporary and historical, including park literature, archival documents, and key informant interviews to identify the ways in which environmental history and cultural change have influenced park policies. Her research will identify opportunities for improved park interpretation.

CESUs Staffed in the West

As reported on page 27 of the 1998 *Natural Resource Year in Review,* four Cooperative Ecosystem Studies Units (CESUs) were selected in 1998: Rocky Mountains (hosted by the University of Montana), Colorado Plateau (hosted by Northern Arizona University), North Atlantic Coast (hosted by the University of Rhode Island), and Southern Appalachian Mountains (hosted by the University of Tennessee). In 1999 the National Park Service hired and placed research coordinators at the two CESUs in the West. Dr. Ron Hiebert, formerly the associate regional director for Natural Resources in the Midwest Region, reported to his duty station in Flagstaff, Arizona, in December; Dr. Kathy Tonnessen, previously an ecologist and the director of Biological Effects in the Air Resources Division, moved to Missoula, Montana, also at that time. The purpose of these positions is to foster communication among the many academic, governmental, and nongovernmental scientific institutions that have signed on as partners in the CESUs and to apply the wealth of research, technical assistance, and educational tools now available from the many partners to the management of parks.

Movies for managers: An advance in coral reef monitoring

by Caroline Rogers

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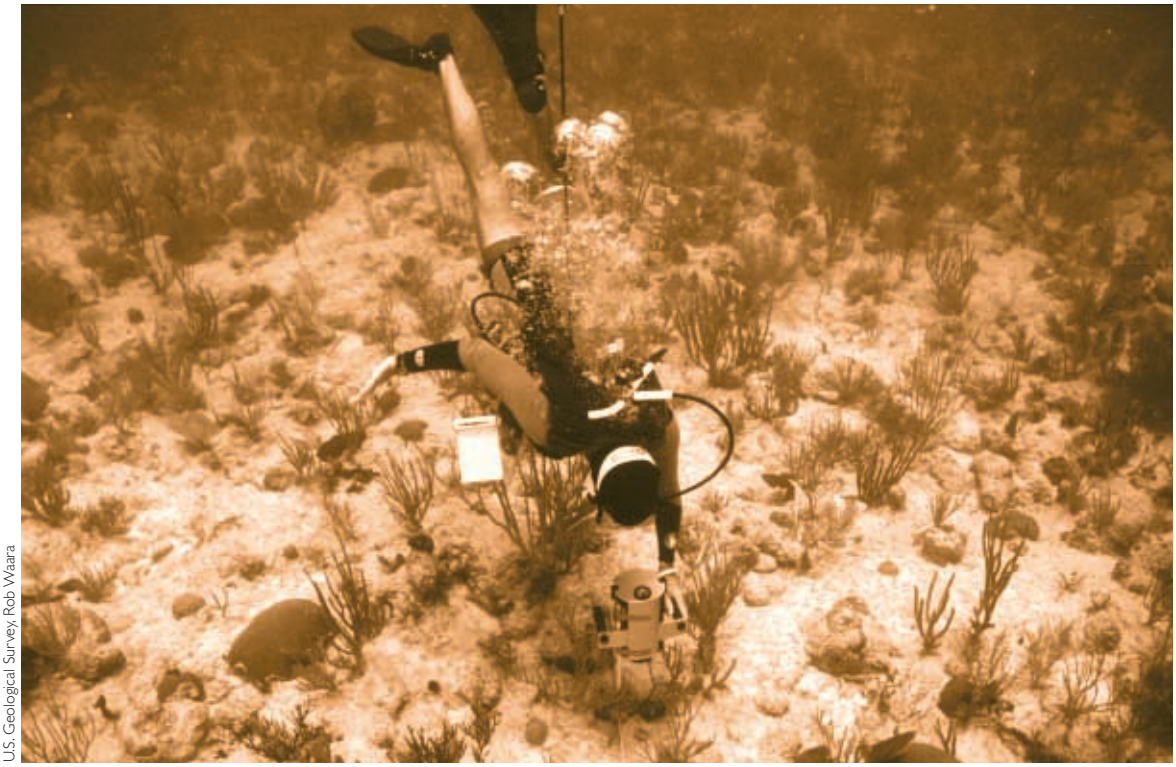
As part of the NPS-USGS Inventory and Monitoring Program, scientists with the U.S. Geological Survey (USGS) based in the U.S. Virgin Islands are working with other researchers and NPS resource managers to develop protocols to monitor coral reefs, reef fishes, sea turtles, seagrass beds, and water quality. During 1999 they developed a protocol for monitoring coral reefs using a digital video camera in an underwater housing and an innovative application of readily available computer software for processing the digital images. They have used this technique at several reefs in Virgin Islands National Park and at Buck Island Reef National Monument. Although "videography" has been employed by other scientists to monitor coral reefs, scientists at the Caribbean Field Station are the first to use it in conjunction with a sonar-based, underwater position-locating system that allows random selection of reef transects for videotaping. The selection of random, independent transects satisfies the criteria for rigorous statistical analysis and increases the likelihood that the data will be representative of the study site. The position-locating system also enables researchers to return to the same transects for future monitoring without the need for installation of permanent markers.

"The USGS biologist use videotapes to collect quantitative data on changes in abundance and condition of corals and other reef organisms."

The USGS biologists use videotapes to collect quantitative data on changes in abundance and condition of corals and other reef organisms along transects, as well as to document general, qualitative information about reefs. The tapes are immediately available for park managers and other scientists to view. Images from the tapes can also be sent electronically to other reef experts, for example, to confirm the presence of a particular coral disease. The tapes can be archived on CD-ROMs for future reference.



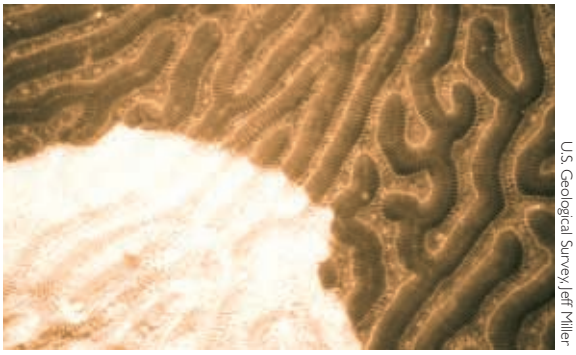
U.S. Geological Survey, Rob Waara

Using a digital video camera, *a USGS diver monitors the relative abundance of coral, sponges, algae, and other organisms, and records information on the presence of coral bleaching, diseases, and storm damage. In 1999 the USGS developed a video-monitoring protocol as a monitoring tool, which promotes standardized data collection. It is being used throughout the Caribbean and has utility in all coral reef parks.*

Videotapes are especially effective in recording the effects of a variety of stresses that cause conspicuous changes in the appearance of coral colonies—for example, breakage from hurricanes and boat anchors, and bright white patches from coral diseases and bleaching. They can also show recovery of reefs following damage.

Other, nonphotographic techniques for monitoring reefs require more time in the water and are therefore constrained by depth and time limits for scuba diving. They also depend on the diver's ability to identify a high diversity of organisms in the field. However, an experienced diver who lacks training in identification of reef species can collect data with the video method.

Jeff Miller, the biologist who has taken the lead on all aspects of this protocol, has trained NPS resource managers and people from Belize, Jamaica, and the Bahamas in the use of video cameras to collect quantitative data. More and more reef scientists are using this exciting new technology in Florida, the Caribbean, Australia, and elsewhere. It will be a very valuable tool as the National Park Service and other agencies begin to implement the National Action Plan to Conserve Coral Reefs, which was officially adopted on 2 March 2000. This plan calls for the design of a nationally coordinated, long-term program to assess and monitor U.S. coral reef ecosystems.



U.S. Geological Survey, Jeff Miller

Coral disease *(shown here in white) and coral bleaching, two threats to coral reefs, are being monitored with a digital video camera in Virgin Islands National Park. Quantitative and qualitative data can be derived from the videotapes and used by researchers and resource managers to address resource concerns in parks with coral reefs.*

Award-Winner Profile

Bill Halvorson receives top research honor

William Halvorson is the Cooperative Park Studies Unit leader at the University of Arizona–USGS Biological Resources Division. In 1999 he won the Director's Award for Natural Resource Research. Bill is a champion of research applicability in park management. His ongoing, professional support of park staffs and commitment to quality research and resource management in southern Arizona parks have enabled these units to overcome significant challenges. One of his trademarks is communication of research results through such means as a forum he helped found for the discussion and evaluation of natural and cultural resource programs. Additionally, he published *Bajada* (a research newsletter) for several years and co-edited the influential 1996 book, *Science in Ecosystem Management in the National Parks*.

Bill was particularly pleased to win the award at the same time that the Director's Award for Natural Resource Management was presented to Kathy Davis (see page 7). "Kathy … has contributed a lot to my understanding of what managers need in the way of information," he says. "I hope that I have … been helpful to her in gaining a better understanding of researchers' needs. Together we have been able to show the benefit of having two groups with fairly significant differences in needs, desires, and outlooks on life, working together to solve problems."

Bill sees the National Park Service "moving with giant strides, now that Richard Sellars' book has shaken the foundations, toward improving the scientific understanding of all resources in the parks." He says, "With added knowledge will come improved management. I look forward … to watching as … park managers gain in ability and comfort level at having so much more information at their fingertips." However, he cautions, "Having arrived at the point of moving strongly into the monitoring of resources in our parks, it will soon be necessary to beef up our capability to manage information…. Our systems for managing information are at a state that would relate … to a package delivery company that used propeller-driven airplanes, and the package pickup folks had to maintain and fly the planes as collateral duties."

Unfamiliar with aerial predators *and with few places to hide, the island fox has suffered a severe population decline since 1994 at Channel Islands National Park (California). Nonnative, feral pigs living on the islands now support a year-round population of golden eagles that also prey on the small and vulnerable canid species.*

Maintaining the health of ecosystems is a common struggle for park resource managers and represents the primary challenge for the National Park Service in the 21st century. Particularly pervasive problems are water and air pollution as well as exotic plant and animal infestations and their consequences for native species. The advent of the Natural Resource Challenge in 1999 will certainly help address these trouble spots. For example, long-term ecological monitoring will receive a boost from the initiative. A vital resource management tool, monitoring helps reveal accelerated or unhealthy changes in the condition of natural resources, giving resource managers time to intervene. As the first article in this chapter explains, monitoring was responsible for detecting the decline in the island fox population at Channel Islands National Park. Long-term monitoring and the other emphases of the Challenge will help combat the many pressures that negatively impact park natural resources, including those described in the following articles.

Wildlife

Island foxes, golden eagles, and feral pigs: When is predation not natural?

by Tim Coonan

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Island foxes *(Urocyon littoralis)* at Channel Islands National Park have indirectly fallen victim to nonnative feral pigs. The pigs support a breeding population of golden eagles *(Aquila chrysaetos),* which prey on island foxes in addition to piglets. The decline is so severe that only 15 foxes are known to exist on San Miguel Island, and the park is now taking extraordinary emergency action to prevent extinction of the species.

The island fox is one of the world's smallest and most restricted canid species. Six subspecies are distributed on the six largest of the California Channel Islands, one subspecies per island. The park began monitoring the species on San Miguel Island in 1993 as part of its long-term ecological monitoring program. Fox densities initially were high, but the San Miguel population declined from approximately 450 adults in 1994 to less than 20 in 1999. Similar declines occurred simultaneously on neighboring Santa Cruz and Santa Rosa Islands.

Research allowed the park to eliminate disease and parasites as primary mortality factors, but research on Santa Cruz Island had pointed to eagle predation as an important mortality factor for its island foxes. The park began a radiotelemetry study in fall 1998 to determine mortality causes for foxes on San Miguel Island. Within four months, four of eight foxes were killed by golden eagles, and fox survivorship over the yearlong study was approximately 10%. The eagle predation is unnatural; golden eagles were never known on the islands until the 1980s, because a prey base to support them was never present, and native bald eagles probably drove them off. A new prey base (feral pigs on Santa Cruz Island) has allowed golden eagles to roost, winter, and now breed on the northern Channel Islands. Foxes are vulnerable because they have never known aerial predators, and because vegetation changes brought about by historic livestock grazing resulted in the replacement of shrub communities by nonnative annual grasses, which offer virtually no cover from aerial predators.

> "Foxes are vulnerable because they have never known aerial predators."

Concerned about the imminent extirpation of three subspecies of island foxes, the National Park Service convened an island fox recovery team in 1999. The team recommended that (1) golden eagles be removed from the Channel Islands, (2) captive breeding be established on San Miguel and Santa Rosa Islands, (3) bald eagles be reintroduced, and (4) feral pigs be removed. The park started a captive breeding program on San Miguel Island in 1999. As the year ended, 14 foxes had been placed in the facility, and only 1 fox was known to exist in the wild. The park will

Population monitoring begun in 1993 *revealed the sharp decline in island foxes. To save the species, park managers implemented a captive-breeding program on San Miguel Island in 1999. At year's end, 14 foxes had been placed in the facility and only one was known to exist in the wild.*

establish captive breeding on Santa Rosa in 2000, and is cooperating with the Santa Cruz Predatory Bird Research Group to remove golden eagles from the northern Channel Islands.

The park has begun planning for removal of feral pigs from Santa Cruz Island, but this will be a costly endeavor. Until the pigs are removed, however, they may attract golden eagles that will prey on island foxes. Far from being a single-species management crisis, the interaction of pigs, eagles, and foxes illustrates the pervasive influence that nonnative species can have on ecosystem structure and function, especially in simplified island systems. The decline of the island fox also underscores the importance of ecological monitoring. Without such programs, parks will not be able to detect change in the condition of park resources in time to take corrective action.

Exotic Vegetation

Catoctin Mountain Park tackles invasive plants

by K. L. Kyde

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Two of the biggest threats to native plant populations are habitat destruction and nonnative species invasion. In Catoctin Mountain Park (Maryland), two shade-tolerant nonnative species, Japanese stilt grass and garlic mustard, are invading some of the park's most botanically diverse sites, forming monocultures, and seemingly crowding out native species. In a research project funded by Canon U.S.A., Inc., the park set out to quantify the extent of nonnative plant invasion, to assess its effect on rare and threatened species, and to compare the effectiveness of three control methods on the worst invaders.

During the 1999 field season a team of Hood College (Maryland) ecologists, park resource managers, summer Youth Conservation Corps members, and student volunteers surveyed 77 plots in the park. These included previously established vegetation-monitoring plots, new roadside plots, and plots set up on a grid throughout the park's undeveloped acreage. They covered all the geologically and floristically distinct habitats in the park and sites ranging from highly

Ecologists, resource managers, and volunteers *pull nonnative weeds by hand from a study plot at Catoctin Mountain Park, Maryland. The effort is part of an ongoing experiment to test the efficacy of three methods of controlling nonnative, invasive plant species in the park.*

disturbed to rarely visited. In each plot, in addition to recording data on the existing native species, researchers identified and estimated the percentage of cover of a group of especially problematic woody and herbaceous nonnative species.

"Two of the biggest threats to native plant populations are habitat destruction and nonnative species invasion."

Late in summer 1999 the team set up plots to test methods of controlling Japanese stilt grass and garlic mustard plus two shrubs, multiflora rose and Japanese barberry. All four species present significant threats to park resources. Researchers used torching, spraying with herbicide, and hand pulling to remove the exotics from the test plots. Results will be observed and evaluated during the 2000 field season. Assessment of invasive species threats to rare species will also be completed in 2000.

Project scientists are completing analysis of the data gathered so far. Initial findings indicate that Japanese stilt grass presence is significantly linked to disturbance, even when that disturbance occurred many years ago. Japanese stilt grass and garlic mustard populations are increasing and spreading farther into the park. Because deer in Catoctin Mountain Park do not browse these species, seeming to prefer native species, the team expects to find that browse leads to further increases in nonnatives. The park has already found that deer browse significantly reduces species richness and diversity among herbaceous plants.[1]

Funding for this research came from Expedition Into The Parks, a grant program funded by Canon U.S.A., Inc., in conjunction with the National Park Foundation. The program provides grants for national parks to address crucial resource management issues in partnership with university scientists and community and volunteer organizations. Canon also supplied the park with camera equipment to help document the research.

In addition to the Canon support, the park spent $10,000 in 1999 for labor and supplies to control exotic species, a large amount for a park only 5,770 acres in size. This research will provide resource managers with detailed information about the identity, size, and location of nonnative species invasions; any immediate threats to rare species from invaders; and the relative costs and efficacy of control methods for four major exotic invasive species.

[1] Boucher, D. H., and K. L. Kyde. 1999. Effects of deer exclosures on plant abundance and diversity in Catoctin Mountain Park, Maryland: 1999 results. Report to Catoctin Mountain Park.

Water Pollution

Water quality concerns related to personal watercraft usage

by Mark VanMouwerik

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Two-stroke engines used in personal watercraft (PWC) were linked to water quality concerns during 1999 as a result of a comprehensive literature review on the subject by staff of the Water Resources Division. Research included a review of current literature—journal articles, gray (or less formal) scientific literature, government documents, information from websites—and personal communications with leaders in the industry and in regulatory and scientific research fields. This review was conducted at the request of the NPS Ranger Activities Division in Washington, D.C., to provide information that might aid resource management decisions pertaining to park waters.

Commonly known as "jet skis," PWCs are found in about 34 of the 87 areas of the national park system that allow motorized boating. Most personal watercraft, and most outboard-engine motorboats, use a conventional two-stroke engine that can discharge up to one-third of its fuel directly into the water. Personal watercraft have been found to discharge more unburned fuel into water than do outboard (two-stroke) motorboats because of differences in design and operation. One study comparing these two types of watercraft found that PWCs, though representing only one-third of the watercraft observed, emitted 80% of total watercraft hydrocarbon emissions.

"Surprisingly low concentrations (parts-per-trillion range) [of PAH compounds] can cause adverse effects in both fish and zooplankton through phototoxicity."

The pollutants of greatest concern are methyl tertiary butyl ether, or MTBE (an oxygenate added to gasoline), and polycyclic aromatic hydrocarbons, or PAHs (by-products of the combustion process). Concentrations of MTBE in lakes and reservoirs with heavy PWC use have been observed to exceed federal health advisory levels, State of California human health standards, and thresholds for taste and odor. In drinking-water reservoirs, MTBE is particularly worrisome since experts are uncertain whether it can be easily removed by water treatment plants with conventional water treatment methods. Aquatic life does not appear to be threatened by observed concentrations of MTBE, but more research is needed to confirm this conclusion.

Personal watercraft, *such as these at Glen Canyon National Recreation Area (Utah and Arizona), commonly use two-stroke engines that discharge pollutants from burned and unburned fuel into park waters. In 1999 the National Park Service conducted a literature review that linked two-stroke engines to water quality concerns.*

Concentrations of PAHs in lakes and reservoirs with high motorboat activity have been found at levels dangerous to aquatic organisms. Surprisingly low concentrations (parts-per-trillion range) can cause adverse effects in both fish and zooplankton through phototoxicity—that is, greatly increased toxicity of PAHs in the presence of sunlight. Also, at observed concentrations, PAHs may pose a risk to human health in lakes and reservoirs that serve as drinking-water supplies or from which fish are caught and eaten.

Direct-injection, two-stroke engines are now becoming available for PWCs. Because this new technology allows more complete combustion, the discharge of unburned fuel—including MTBE, if used—would be greatly reduced. However, since PAHs are not present in unburned fuel but rather are by-products of combustion, it is uncertain how this technology would affect PAH inputs into the water.

In March 2000 the National Park Service published in the *Federal Register* a final rule that prohibits PWC use in most units of the national park system. The rule allows PWC use to continue in 10 national recreation areas. Eleven additional areas will have a two-year grace period from the general prohibition so that NPS staff can review PWC use and develop special regulations if continued PWC use is deemed appropriate. A park's enabling legislation, park general management plan, other uses, and resource impacts are all considered in determining the appropriateness of continued PWC use. Studies of PAH and MTBE contaminants in these areas are expected to increase given this new rule. Off-road vehicle use in parks is also being reviewed—and in the case of snowmobiles, severely restricted—to make certain that park resources remain unimpaired. The PWC regulation is available on the Internet by selecting "Personal Watercraft Use …" from the NPS Web page www.nps.gov/refdesk/hotdocs.htm.

Award-Winner Profile

Rick Potts given Trish Patterson–SCA Award

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

Rick Potts discusses *Kalaupapa's coral reef and ocean resources with Molokai High School students.*

Rick is quick to point out the importance of involving local students in the protection of the park's natural resources. "With the constant bombardment of new threats to Molokai's ecosystem," he says, "I believe the only chance we have to preserve what's left lies in their willingness to … take an active interest. Theirs may very well be the last generation that still has the option of saving this ecosystem." He continues, "Anyone with a trained eye who has been here awhile can certainly see the fabric of ecosystem stability unraveling. [These students] are our last hope, and it is deeply fulfilling and encouraging for me to have the opportunity to interact with them."

Rick is proud to have won the award, but prefers to remember its namesake, Trish Patterson, an NPS resource manager with the Southeast Region who was known for her efforts to assist small parks in her region. She was killed in a car accident in 1995. "Incredibly vibrant and so full of life, she continues to assist field staff through this award," Rick says of Patterson. "[The award] hangs on my wall not as recognition for past accomplishments, but rather as a challenge to try to live up to all it stands for."

Water Quality Monitoring

Cooperative monitoring program examines nutrient management issues at Saint Croix National Scenic Riverway

by Randy Ferrin

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Agencies responsible for the management and protection of the Saint Croix National Scenic Riverway (NSR—Minnesota and Wisconsin) and its watershed took steps in 1999 to address threats to water quality from increased nutrient loading, primarily phosphorus. The interagency Saint Croix Basin Water Resources Planning Team (Basin Team) developed and implemented a multiagency water quality–monitoring program. The program's objectives were to validate the concern over nutrients and to provide the data needed for modeling the impacts of phosphorus and setting phosphorus standards. The effort built upon the preliminary results of the USGS National Water Quality Assessment (NAWQA) Program, NPS Water Resources Division–funded studies, and the riverway's Water Resources Management Plan.

The Saint Croix NSR is one of the original components of the national wild and scenic rivers system. In addition to its scenic qualities, the river was designated for its outstanding biological diversity, related largely to its good water quality. With an expanding population in the Twin Cities metropolitan area and corresponding land use conversions, water quality in the Saint Croix River is under constant threat from the hundreds of tributaries

Saint Croix National Scenic Riverway, Marianna Young

Outstanding scenery, *biological diversity, and good water quality played a role in the designation of Saint Croix National Scenic Riverway as an initial component of the national wild and scenic rivers system in 1968. In 1999 the National Park Service and several partners implemented a water quality–monitoring program to protect the riverway and its watershed from the threat of increased nutrient loading, particularly phosphorus.*

Saint Croix National Scenic Riverway, Marianna Young

The monitoring program *entails semimonthly water sampling at 27 sites on the river and its tributaries. Twenty specific parameters are measured, using both field and lab techniques, to provide data for modeling the impacts of phosphorus and setting phosphorus standards.*

draining its 7,650-square-mile (19,814-square-kilometer) watershed. Realizing this threat, the riverway staff and cooperators formed the Basin Team in 1994, involving more than 10 agencies and organizations. The Basin Team identified nutrient enrichment as one of the primary threats to water quality and set a goal in 1998 of no net increase in phosphorus loading to surface water within the basin.

"The concern ... is ... algal blooms that would cause eutrophic conditions, lowering dissolved oxygen levels."

Phosphorus is an essential element for most life-forms, but in excess concentrations in lakes or rivers it can create significant problems. The concern for the Saint Croix River is the potential for algal blooms that would cause eutrophic conditions, lowering dissolved oxygen levels and triggering numerous related problems, such as changes in the structure of aquatic communities. Though other nutrients, such as nitrogen, are necessary for algal blooms, phosphorus is the limiting nutrient in the Saint Croix.

The 35-page monitoring plan took over a year to develop and implement. Hurdles included synchronizing fiscal year budgets that differed among participating agencies; selecting sampling sites, parameters, and methods; and ensuring quality control. Sampling was done at 27 sites on the riverway and representative tributaries every two weeks from May to October 1999. Riverway staff were responsible for three sites. More than 20 specific parameters were measured using both field and lab techniques. Three separate labs were used by the 10 agencies conducting the monitoring. A quality assurance program ensured the integrity of the data. In addition to surface water sampling, all major dischargers in the river basin monitored the nitrogen and phosphorus levels in their effluent. Six sites monitored by volunteers were also established to inform and involve the public and to gauge the public's perception of water quality conditions.

The data will be collated for analyses and modeling in spring 2000. The Basin Team will develop a nutrient management plan based on the results of the modeling. This may include recommendations for policy changes, best management practices, or new water quality standards.

West Nile virus

West Nile virus (WNV) was found in the Western Hemisphere for the first time in 1999. This mosquito-transmitted virus caused about 60 human disease cases in New York City during the year, resulting in seven deaths. The virus has also caused mortality in several wild bird species (crows appear to be especially vulnerable) and in horses. Gateway National Recreation Area, Fire Island National Seashore, and Sagamore Hill National Historic Site are within the area where viral activity was demonstrated. With the assistance of Howard Ginsberg of the USGS Patuxent Wildlife Research Center, these parks and others in the Northeast are developing surveillance and management protocols to monitor mosquito populations and viral activity in the next active season and to respond appropriately in the event of disease risk.

San Francisco–area park units compensated for oil spill damage

More than $3.4 million was deposited in the Department of the Interior's Natural Resource Damage Assessment and Restoration Fund in late 1998 on behalf of the National Park Service and other natural resource trustees. The settlement payment is the result of the S.S. Cape Mohican *oil spill in San Francisco Bay in October 1996. Four units of the national park system were affected by the spill: Fort Point National Historic Site, San Francisco Maritime National Historical Park, Point Reyes National Seashore, and parts of Golden Gate National Recreation Area. The spill damaged natural resources at several of the sites and deprived the public of use of the sites, allowing the National Park Service, through its Environmental Quality Division, to seek damages under the authority of several laws, including 16 U.S.C. §19jj et seq., commonly called the Park System Resource Protection Act. The settlement is being used to fund related natural resource restoration projects at the various park units. These include rehabilitating wetlands, sandy beaches, and rocky intertidal and dune habitats, and enhancing public areas and services that were affected by the spill.*

Water quality study addresses pollution questions at Chattahoochee River National Recreation Area

by Adrienne Funk

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Visitors to Chattahoochee River National Recreation Area (NRA) often ask, "Is the water polluted?" Responding to this question is a problem confronting the staff of this 16-unit park located on the Chattahoochee River, which runs through metropolitan Atlanta. Although the park provides vital green space and river recreation for 3.5 million annual visitors, unprecedented recent growth in Atlanta has resulted in pervasive contamination of the river and its tributaries. Giving a precise answer to the pollution question is difficult because water quality in the river changes on a daily basis. Even when information is available, the National Park Service has not been able to distribute it in a timely way to park visitors.

Answers are beginning to emerge, however. In FY 1999, Chattahoochee River NRA and the U.S. Geologic Survey (USGS) began a two-year, microbial water quality–monitoring project to identify the severity and extent of microbial contamination in the river and eight tributaries within the national recreation area. Fecal coliform, *E. coli,* and enterococci, indicators of bacterial pathogens in the water, are particular problems at Chattahoochee. They come from animal waste, leaking and overburdened sewers, wastewater treatment facilities, leachate from septic tanks, and fecal matter associated with storm-water runoff. Although their presence does not prove the presence of pathogenic bacteria, monitoring them is less expensive and easier than monitoring pathogenic bacteria and is useful for judging the relative safety of the recreational use of a water body.

Animal waste and overburdened sewers *are two sources of water pollution affecting the Chattahoochee River National Recreation Area in metropolitan Atlanta. In 1999 the National Park Service and the U.S. Geological Survey began a water quality–monitoring project to identify the severity and extent of microbial contamination in the river and eight tributaries in the national recreation area.*

This project used new methods to address water quality issues that are problems for parks nationally. Samples were analyzed for microbial indicators such as coliphages and *Clostridium perfringens,* and organic "wastewater tracers" such as caffeine, detergent metabolites, plasticizers, and fire retardants. These indicators and tracers had never before been measured in the Chattahoochee River. The goal is to relate them to land use, point and nonpoint sources, and hydrologic conditions such as river-flow levels and turbidity.

"Samples were analyzed for ... organic 'wastewater tracers' such as caffeine, detergent metabolites, plasticizers, and fire retardants."

The Chattahoochee National Recreation Area and the USGS are also funded to track the sources of microbial contamination. Ribosomal RNA typing or "ribotyping" of *E. coli* is being used to determine the relative importance of various hosts (for example, humans, dogs, and Canada geese) in contributing microbial contamination to the watershed. Ribotyping is a genetic analytical technique analogous to criminal forensics. Ribotypes of *E. coli* from water samples are compared to ribotypes of *E. coli* isolated from different hosts. The percentage of matches among water samples and source fecal samples provide information on the extent and distribution of each host's contribution to fecal contamination of water resources among various tributaries within the study area.

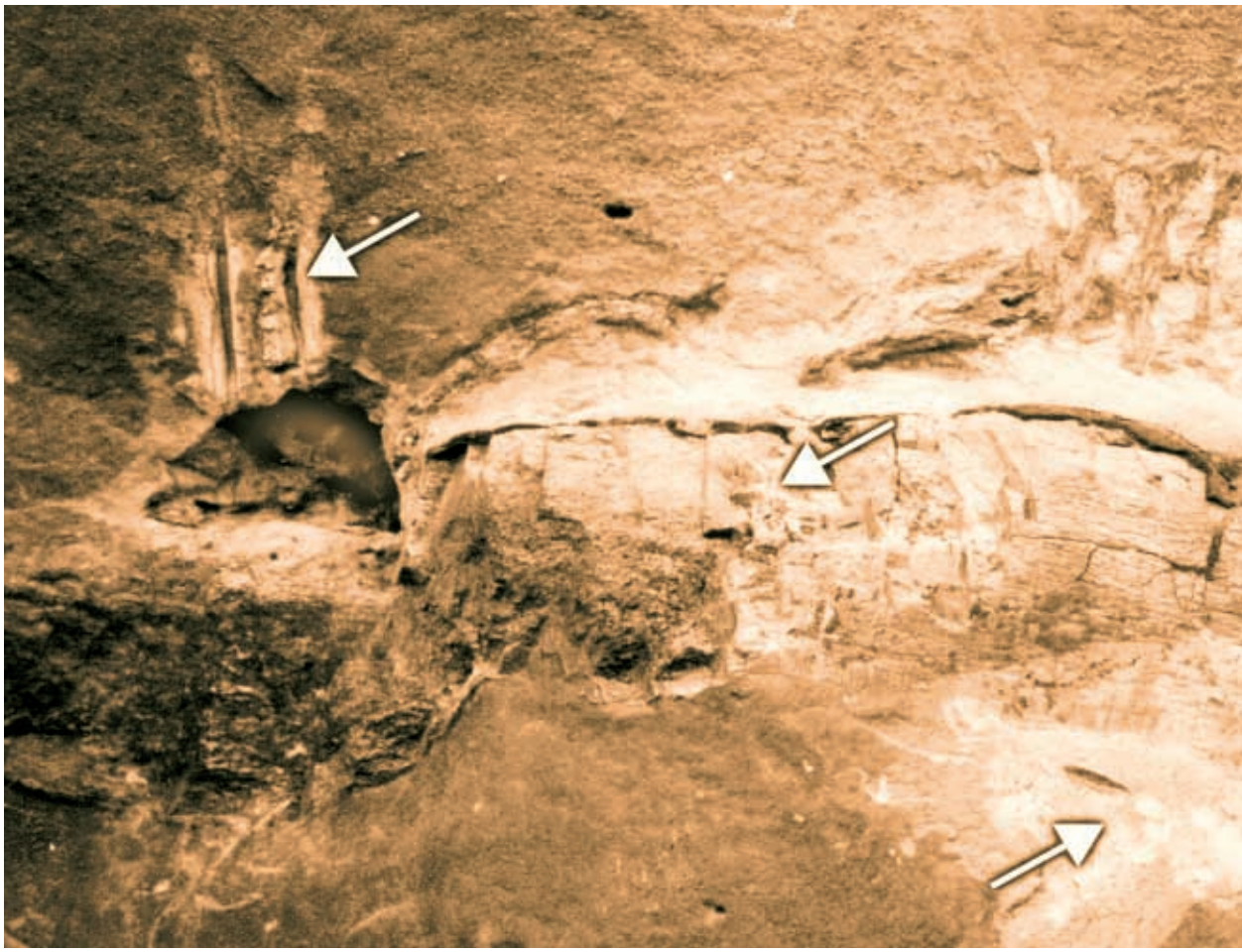
Although it is ongoing, the water quality study has already made a significant contribution to answering the question about pollution in the Chattahoochee River. Microbial contamination is chronic with widespread exceedances of both Georgia and U.S. standards for drinking water, recreation, and fishing. During summer recreation seasons, standards are exceeded in most tributary streams during wet weather. Some highly urbanized streams exhibit their highest fecal coliform concentrations during base flow conditions, indicating point sources for the contaminants. Preliminary *C. perfringens* and organic sewage tracer data indicate widespread contamination of tributary and Chattahoochee River water from both point and nonpoint sources of sewage and fecal material. The project website (http://ga.water.usgs.gov/projects/chatm) provides useful scientific information to both national recreation area staff and the public on the safety of park waters with regard to microbial pollution and includes project publications. During the one year of data collection, the website was updated every five days during the summer recreation season (May-October) and every eight days during the winter months.

Future study findings may help staff restore better water quality in the national recreation area by providing compelling scientific data in the debate over extent, timing, and sources of microbial contamination. Additionally, results from the study may help the National Park Service design and establish a needed, long-term water quality–monitoring program after the two-year study is complete.

Documented cases of illegal fossil collecting increase at Badlands

The high-profile fossil theft investigation in the early 1990s involving the *Tyrannosaurus rex* specimen named Sue had direct links to illegal fossil-collecting activities at Badlands National Park. The nearly complete fossil skeleton was discovered on the Cheyenne River Indian Reservation in South Dakota in 1990. A court awarded fossil ownership to a Cheyenne River Sioux, who sold the prize specimen in 1997 for $8.4 million to the Field Museum of Natural History of Chicago, where it went on display in spring 2000.

Intensive illegal collecting of fossils from Badlands National Park had been occurring for at least a decade before the "Sue" case. Beginning with the seizure of the famous dinosaur specimen in 1992, there was a significant drop in the number of documented incidents of fossil loss in the park (park records indicate only two incidents from 1995 to 1997). The reduction in reported incidents is supported by researchers' claims of fewer encounters with fossil poachers and little evidence of poaching in the park during that period. In spring 1999 the park reported 20 paleontological resource incidents after paleontological resource protection training was provided to staff (see story on page 42), indicating that awareness training is a key factor in recognizing and preventing illegal fossil collecting.



Chisel and other tool marks *surround this sauropod dinosaur humerus (upper arm bone) and are clear signs of attempted theft and vandalism. Training of rangers and other park staff in paleontological resource protection since 1997 is coincidental with, and may be directly related to, an increase in the documented cases of illegal fossil hunting activity over this period.*

Battling Vandalism

Geologic resource protection training increases park vigilance

by Vince Santucci

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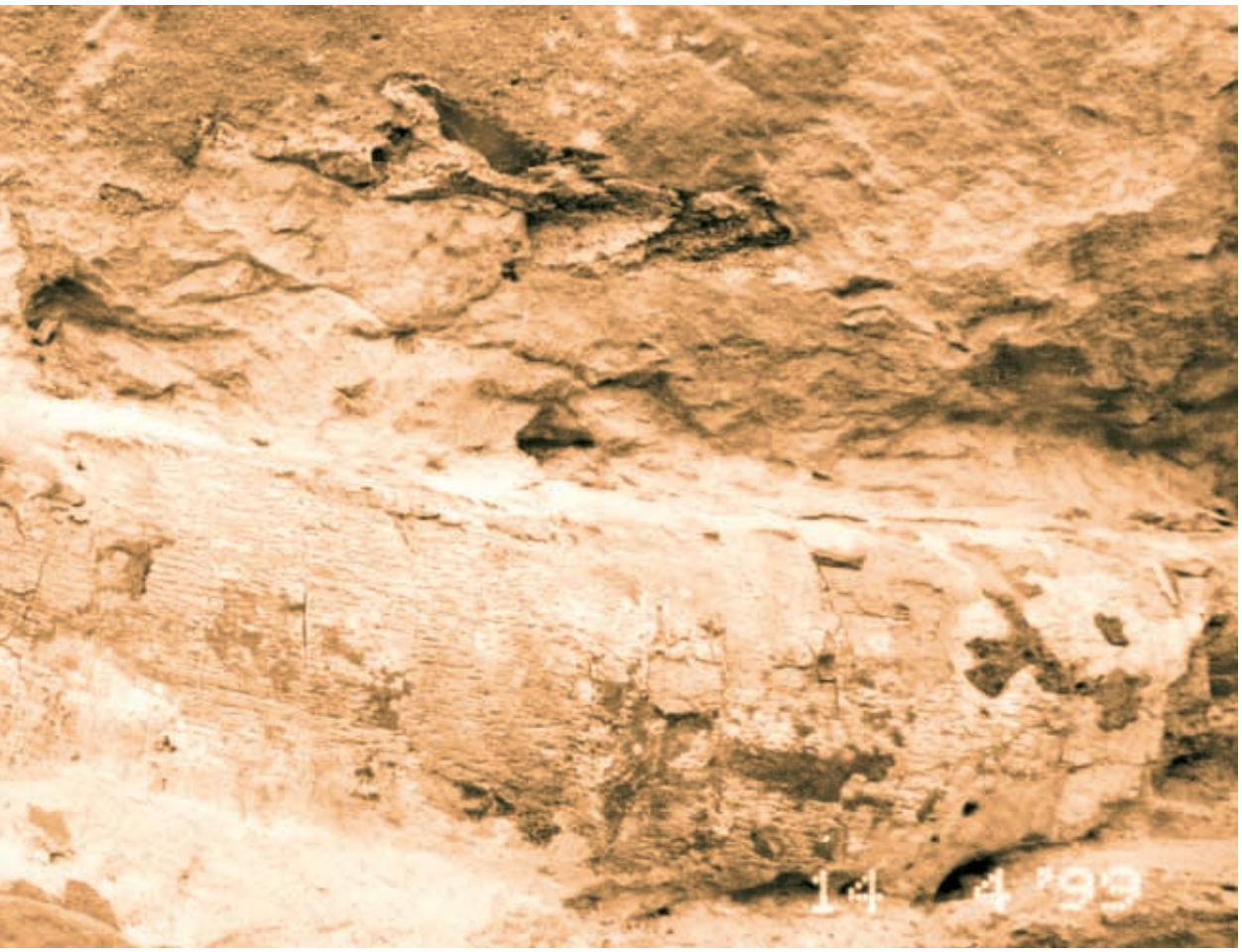
Park surveys conducted initially in 1992 and again in 1999 reveal some interesting trends in the recording of law enforcement incidents, citations, and arrests associated with the loss of paleontological resources from units of the national park system. During this time, the National Park Service increased its efforts to provide paleontological resource protection training to park staff. The data available from the two surveys show an apparent correlation between training and the increase in documented incidents of fossil theft or vandalism.

In 1999 the associate directors for natural resources and park operations jointly asked parks to participate in the survey, which also gathered information on the loss of cave and other geologic resources. However, because the 1992 survey included only paleontological resources, long-term data for caves and other geologic resources are not available.

> "The two surveys show an apparent correlation between training and the increase in documented incidents of fossil theft or vandalism."

Data from the 1992 survey were used to determine which geographic areas were most heavily impacted by fossil loss and where increased training may be valuable. These data showed that the highest incidence of paleontological resource loss was reported from parks in what is now the



Intermountain Region. Based upon the results of the 1992 survey, more than 250 NPS protection rangers, stationed in parks on the Colorado Plateau, Great Plains, and Mojave Desert, have participated in paleontological resource protection training over the past few years.

During the three years assessed in the initial survey (1989–1991), 16 parks reported incidents of paleontological resource loss, with a total of 154 issued citations totaling $5,920 in fines. During the three years assessed in the more recent survey (1995–1997), 16 parks reported incidents, with a total of 388 issued citations totaling $95,075 in fines. The survey data show a greater than 150% increase in the number of citations issued between the two periods assessed. The numbers of arrests reported in each of the surveys were not significantly different, with five reported during the initial survey and six in the more recent survey.

The data compiled in the surveys indicate a substantial increase in the number of documented cases of paleontological resource loss; however, whether this increase represents actual changes in visitor behavior or elevated awareness by park rangers leading to better documentation is unclear (see related story on fossil theft at Badlands National Park, page 41). The trend observed in national parks seems to parallel the escalation of the commercial market for fossils nationwide.

The continued monitoring of paleontological resource theft and vandalism in national parks, along with training of additional rangers (particularly in the Alaska Region), will enable a greater understanding of the variables influencing the loss of park fossils. The protection of these nonrenewable remains of past life is clearly part of the NPS mission.

Increasingly rare along the Anacostia River since the late 1800s *the American lotus (lower left and middle of photo) is making a comeback at Anacostia Park near Benning Bridge in Washington, D.C. National Capital Parks–East, in partnership with the Potomac Electric Power Company, restored the wetland habitat and transplanted native lotus tubers, which flourished in 1999.*

For park ecosystems to be fully functional, the National Park Service must at times act as natural resource physician. First, a sick patient requires a diagnosis. What is the source or cause of the dysfunction? Are the underlying processes still retained, or can they be repaired so that with some treatment the patient can be healed? Then, based upon the latest and most complete scientific information, a team of technical specialists is assembled to plan and carry out the necessary restoration or rehabilitation. If all the pieces have been preserved, as Aldo Leopold warned is critical, then it may be possible to restore the natural function to an ailing ecosystem. But this will not happen without considerable expense, effort, and time. Nevertheless, as this Year in Review *illustrates, ecological restoration is a fundamental role of the National Park Service and NPS efforts are responsible for correcting a variety of problems and returning natural resources to proper function. The many benefits bestowed on parks by these activities live on for all to contemplate, learn from, and enjoy.*

Wetlands

Restoring the American lotus to the nation's capital

by Susan Rudy

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In Washington, D.C., much of the tidal Anacostia River is managed by National Capital Parks–East as the 1,375-acre Anacostia Park. The Anacostia has been severely changed by the combined effects of agriculture and urban growth over 300 years. Early in the 20th century this slow-moving river silted in and then was walled and channeled. Today it has lost almost all its historic wetland habitat. One of the consequences of this loss was the disappearance of the spectacular American lotus, *Nelumbo lutea.*

American lotus is one of a few native species to grow in the low marsh vegetation zone of the freshwater tidal system, stabilizing sediments and extending wetland edges. Growing from banana-like rhizomes or tubers, the lotus has stiff, 5-foot stems supporting leaves that resemble inverted umbrellas, and large, yellow, fragrant flowers appearing in summer months. Once established, the species forms large colonies. A favored food of early American Indians throughout its range, the lotus also provides food and shelter for wildlife.

The American lotus had been absent from the Anacostia for such a long time that it was overlooked in recent wetland restoration projects along the river. But a review of early photographs and botanical lists revealed that the plant had been abundant before its habitat was destroyed. Based on this information, National Capital Parks–East decided to restore the plant to the wetlands in Anacostia Park. A recently created wetland in the park, located at Benning Bridge, provided the low marsh mudflat habitat required by the lotus. The site also had the advantage of being highly visible to the public as they drove, walked, or rode past on the METRO train. Interpretive signs on the history of the Anacostia River, the importance of wetland ecosystems, and wetland vegetation including American lotus were produced as part of this project and erected on-site.

> "The American lotus had been absent ... for such a long time that it was overlooked in recent wetland restoration projects along the river."

To begin restoration, National Capital Parks–East needed to find an accessible native population of the lotus near the planting site. A search of the botanical voucher collections at the Smithsonian Institution's Natural History Museum indicated that several local sites had historically supported lotus populations. Discussing these records with local botanists and biologists familiar with contemporary lotus populations on the Potomac River and with staffs of the State Heritage Programs of Maryland and Virginia, resource managers at National Capital Parks–East identified a native stand 40 miles away at the U.S. Marine Corps Base in Quantico, Virginia.

Transplanting lotus rhizomes is grubby work. *Resource managers first collect the plants from a donor site by lying facedown in the mud, carefully feeling for the delicate tubers, which grow at an arm's length below the soil surface. Protection from air and quick transplanting proved to be important factors for success.*

Digging lotus tubers is grubby work. The tubers are extremely delicate and must be dug bare-handed just as the shoots emerge from the mud in April. They grow an arm's length from the soil surface and are collected by feel, digging carefully and slowly so as not to damage the tender shoot. Collecting these plants entails lying facedown on the mud during low tide! With the permission of the U.S. Marine Corps, resource managers collected the plant for three consecutive years; each spring required a new crop of volunteer diggers, as nobody wanted the experience more than once.

Resource managers found that lotus tubers did best when protected from air and transplanted quickly to their intended habitat. Early transplanting attempts were scuttled by incorrect handling and animal predation in the holding ponds. In spring 1998, 26 tubers were dug and packed in mud. Half were taken to the USDA Plant Materials Center in Maryland for propagation as future planting stock. The rest were potted and held in outdoor ponds at the historic Kenilworth Aquatic Gardens, a unit of the national park system, then transplanted to the restoration site. By August the plants had spread, sending shoots beyond their protective cages (necessary to prevent wildlife predation). In their second summer, in 1999, the plants grew at a spectacular rate, densely filling the wetland mudflat previously devoid of vegetation. The lotus produced vigorous vegetative growth as well as flowers and viable seeds.

In spring 2000 a major, 42-acre wetland restoration at Kinsman Lake will include American lotus collected and grown during this project. After more than 60 years, this beautiful plant will continue its return to the banks of the Anacostia River in the nation's capital.

Rehabilitating a wetland-riparian ecosystem at Pecos National Historical Park

by Joel Wagner and Marten Schmitz

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In addition to preserving 10,000 years of human history, Pecos National Historical Park (New Mexico) is responsible for managing riparian and wetland habitats along Glorieta Creek and the Pecos River. One such area, a half-mile stretch of floodplain and terraces along lower Glorieta Creek, was mined for sand and gravel before becoming part of the park. Once mining ended in the mid-1980s, ranchers bulldozed the remaining material into a series of levees and dams, creating two reservoirs on 5.6 acres. These reservoirs soon became a threat to the ecology of Glorieta Creek. Floodwaters periodically swept thousands of fish from the creek into the reservoirs, where they were trapped and later died as the ponds dried. Flooding also caused breaches in the progressively weakening reservoir walls, washing sediment into the creek. Although ranching and 1850s-era Hispanic farming are primary cultural themes of the park, the National Park Service determined that removal of the reservoirs would not diminish these themes. Therefore, park managers sought technical assistance and funding to create a more stable, functional wetland-riparian ecosystem in this highly disturbed landscape.

> "The ecosystem was designed to be self-perpetuating, with revegetation largely from natural seed sources and processes."

Rehabilitation of the site was a cooperative effort among the park, the NPS Water Resources Division, Colorado State University, the Tierra y Montes Soil and Water Conservation District, and the NPS Intermountain Region. In the early planning phases the design team monitored surface and groundwater levels, created existing-condition topographic and water-table maps, completed biological inventories, and began environmental and cultural compliance. In summer 1999 the environmental assessment for the project was approved and the design team prepared the final grading plan, which called for removing the levees

Most earthmoving contractors *are experienced in creating smooth surfaces needed for roads or parking lots, but may not know how to interpret the degree of undulation or "roughness" called for in wetland projects. For the Glorieta Creek rehabilitation project, a member of the design team was on-site at all times during the earthmoving phase, interpreting these details for the contractor and checking elevations with a laser level.*

and dams and reshaping the site to create a native wetland-riparian system. Although portions of the site would be planted with native species to stabilize soils and promote rapid revegetation, the ecosystem would be designed to be self-perpetuating, with revegetation largely from natural seed sources and processes.

The final grading plan was based on thorough knowledge of site hydrology obtained through a network of 21 wells and surface water gauges, and on an understanding of plant community–soil–hydrology relationships in nearby reference communities. The design called for a number of depressions and mound features, and specified a rough, undulating surface that would allow a diversity of wetland plants to establish where conditions are favorable. The result would be a complex of ponds, wet meadows, willow thickets, and cottonwood galleries modeled after nearby undisturbed habitats.

With funding and assistance from the NPS Water Resources Division, the NPS Geologic Resources Division, the Tierra y Montes Soil and Water Conservation District, and the park, earthmoving began in October 1999. A critical step was stationing a member of the design team on-site to supervise the earthmoving. Most contractors are experienced in creating smooth surfaces needed for roads or parking lots, but may not know how to interpret the degree of undulation or "roughness" called for in this wetland rehabilitation project design. The on-site supervisor interpreted these details for the contractors, checked elevations, and identified issues to be addressed by the full design team during its weekly site visits. By mid-November the contractors had completed this phase, moving over 30,000 cubic yards of material in the process. In early December, upland areas were seeded with native grasses and biodegradable erosion-control blankets were installed where necessary.

In spring 2000, park staff, project cooperators, and volunteers planted more than 1,000 rooted willow and cottonwood cuttings collected from the surrounding area. Additionally, thousands of native sedges, rushes, bulrushes, and other wetland species grown from local seed sources were planted. Park staff have begun a program of weed and exotic plant control, and follow-up monitoring of water levels and plant establishment and survival is planned for the 2000 growing season. Over the longer term the park envisions a trail on the edge of the project area for public enjoyment and interpretation of the cultural landscape; the wetland rehabilitation process; and the waterfowl, songbirds, muskrats, deer, and other wildlife that are expected to thrive there.

The Pueblo Colorado Wash demonstration project

by Pamela Benjamin and Nancy Stone

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Hubbell Trading Post National Historic Site (Arizona) is partnering with Navajo Nation agencies and the Arizona Water Protection Fund through a three-year grant (1998–2000) to restore a 1.5-mile section of the Pueblo Colorado Wash. The Pueblo Colorado Wash is the most significant natural resource at Hubbell Trading Post and is by far the most important element responsible for the presence of the cultural resources for which the national historic site was established. As a result of historic and modern disturbances (including stream channeling by the National Park Service), the wash had become severely degraded. These disturbances led to the establishment of dense stands of nonnative vegetation (primarily tamarisk and Russian olive), eliminating the view of the stream channel and de-emphasizing the cultural connection of the waterway for visitors.

In 1998, the Arizona Water Protection Fund awarded the Pueblo Colorado Wash restoration project a three-year grant to promote the use of low-cost, low-tech approaches to stream enhancement and to focus attention on the project as a successful demonstration for other waterway enhancements within the Navajo Nation. Project activities have resulted in removal of livestock and exotic plant species from three-fourths of the 1.5-mile section of the wash. Additionally, a fence has been established to eliminate livestock trespass. Natural materials have been used to build in-stream structures to add sinuosity and floodplain to the channel through induced stream meandering and sediment deposition. Finally, the wash has been revegetated with native plant materials.

Monitoring activities in 1999 have revealed natural recruitment of native in-stream vegetation in addition to natural regeneration of native cottonwoods and willows. Groundwater levels and the quantity of water maintained in the stream have increased as a result of nonnative plant removal. In summer 1999 the increased channel capacity and sinuosity greatly reduced bank erosion during an ex-

tremely high-water monsoon event (9,000 cubic feet per second). From its humble beginnings as a volunteer initiative, the project has grown into a multijurisdictional, multi-interest conservation partnership to enhance and conserve this significant waterway. Additional partners, including the U.S. Environmental Protection Agency (EPA), Public Land Corps grants, the Student Conservation Association, and numerous volunteers, have also been critical in the success of the restoration project. In 1999 the project was awarded an additional grant, the EPA "Five Star Restoration Partnership" grant, and the park was presented with a plaque as the first EPA "Five Star Restoration Site." For all its erosion control and native plant revegetation achievements, perhaps the greatest success is that the Pueblo Colorado Wash is again visible to the public, reconnecting the cultural resources at Hubbell Trading Post with their appropriate natural setting.

"The Pueblo Colorado Wash is ... the most important element responsible for the presence of the [site's] cultural resources."

Volunteers construct small water-diversion structures *within Pueblo Colorado Wash to encourage the formation of stream meanders. The work is part of a three-year demonstration restoration project at Hubbell Trading Post National Historic Site.*

— 1999

Integrating Natural and Cultural Resource Management

Greening earthworks: Managing historic structures with native plants

by Michele Webber

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Stones River National Battlefield has taken on the challenge to preserve a portion of the largest earthen fortification built during the Civil War. The Union Army constructed the 200-acre fort in Murfreesboro, Tennessee, after winning the Battle of Stones River in early 1863. The National Park Service acquired 25 acres of the fort in 1993 that were so overgrown with invasive exotic plant species that few people even knew the fort existed.

Opening the area for interpretation presented a preservation challenge: How could the National Park Service remove the dense growth of invasive exotic plants without exposing the soil to erosion? In response to 1987 legislation that directed the Secretary of the Interior to preserve the earthworks, the NPS Southeast Region developed the *Preservation and Management Plan, Environmental Assessment: Remnants of Fortress Rosecrans* in 1991. Following the recommendations of the *Earthworks Landscape Management Manual,* (1989, prepared under contract by Andropogon Associates, Ltd., of Philadelphia), the park decided to open the canopy, clear the understory, and establish native grasses as a low-maintenance ground cover.

"Native grasses stabilize the earthen walls and allow the structures to be legible."

Native grasses stabilize the earthen walls and allow the structures to be legible. When interpreted through wayside exhibits, the earthen components of the fortress can be seen and understood by visitors. Thus, in 1993, NPS crews cleared the understory of the invasive exotics Chinese privet, bush honeysuckle, Japanese honeysuckle, periwinkle, and kudzu. They selectively removed trees, leaving some to provide shade for the trail to be constructed. Of the species removed, some, like sassafras and black locust, form large colonies by sprouting aggressively from their roots. Since the park did not initially treat the exotics or trees with herbicide after cutting them, many resprouted, showing tremendous growth in just one season. Project staff seeded the area with warm-season native grasses, but this posed the challenge of continuing to clear the area of invasive exotics while encouraging the barely established grasses.

The park chose warm-season native grasses as a ground cover to preserve the earthworks for several reasons. First, warm-season grasses are a major component of the regional flora. Although slower to establish, grasses such as broomsedge, side-oats grama grass, and little bluestem are self-seeding and require little maintenance once established, offering a labor- and cost-reducing alternative to fescue, the typical lawn and turf grass in the area. Moreover, the Tennessee Exotic Pest Plant Council lists fescue as an invasive exotic ranked as a significant threat to natural areas and native plant communities.

The park manages nonnative evergreen species with herbicide during the dormant season. Nonnative species that are not evergreen are treated mechanically, either by hand pulling or by cutting before seed is set, and by using a broadleaf herbicide to avoid damaging the grasses.

Since the initial clear-cutting and seeding, the park has been managed for exotic and weedy species year-round. Many of the exotics are persistent, and management requires long-term commitment. Additionally, the park has documented an increase in the numbers and abundance of a variety of native species including forbs and grasses returning on their own.

During 1999, the earthworks crew continued to manage for native grasses. Large expanses of sapling black locust and sassafras were sprayed with a broadleaf herbicide, opening areas for further seeding. Aggressive annual weeds such as ragweed, horseweed, and fireweed were identified and cut before setting seed. In November 1999 the park contracted to treat the entire site for evergreen exotics, effectively opening areas for native grasses that were once dense with periwinkle and Japanese honeysuckle. However, success has been limited on the steepest walls of the earthworks where seed is likely to wash away before it can take hold. To remedy this problem, the park planted more than 7,000 rootstocks of mature native grasses in spring 2000.

Educating coworkers, adjacent property owners, and community members on the identification of exotics and their impact on the environment is crucial to habitat restoration projects. By adopting an integrated approach to managing cultural and natural resources, Stones River National Battlefield is working to achieve maintenance objectives that not only preserve historic resources, but also achieve the goal of replacing exotic species with native plants.

The ambitious restoration project at *Stones River National Battlefield, Tennessee, entails the meticulous management of native plant species for the preservation and interpretation of a cultural resource: the largest earthen fortress built during the Civil War. Follow-up vegetation monitoring, shown here, has documented an increase in numbers and abundance of several native grasses and forbs.*

African oryx expelled from White Sands

White Sands National Monument, New Mexico, is on its way to being oryx-free. The large African antelope *(Oryx gazella)* is seriously degrading native plants and soils at the monument. The New Mexico Department of Game and Fish released approximately 100 oryx adjacent to the monument in the 1960s and early 1970s with plans to establish a population of large game for public hunting. However, by the late 1990s the population had increased to more than 3,000 animals despite public hunting outside the monument. In 1996 a boundary fence was constructed around the 145,000-acre monument to exclude the semisolitary, wandering species, but a 1999 survey estimated the population within the monument to be about 140 animals. In a planned three-year operation involving numerous partners, the National Park Service drove 46 oryx out of the monument in 1999 using helicopter hazing methods. In February 2000 an additional 31 animals were tranquilized and relocated by helicopter to the adjacent U.S. Army–White Sands Missile Range. Further actions will be taken in 2000 and 2001 to remove additional oryx from the park using nonlethal methods.

A biology student from Page High School *samples water for* E. coli *at a Lake Powell swimming beach in Glen Canyon National Recreation Area. Students and park staff are working together on aquatic and rangeland resource management projects as a way to generate enthusiasm for science and teach lessons about land stewardship.*

Outreach through scientific endeavors related to the national parks is an important role for the National Park Service. Domestic environmental education and international technical assistance exchange are two areas that are bearing fruit for the Park Service, its neighbors, and international colleagues, as the following articles indicate. As deep reservoirs of natural and cultural resource values, national parks have many lessons to teach about this nation's natural and cultural legacy. Scientific outreach is an effective way of making meaningful connections with park neighbors and international partners. For example, students participating in curriculum-based science education programs with parks are developing an interest in science and its role in park management, and are also forming important personal bonds with these places. This sense of ownership bodes well for the future stewardship of the national parks. Likewise, international assistance brings governments together to solve complex natural resource management problems collectively and to share in the benefits of increased international conservation. Both nurture goodwill and further the application of science in the management of national parks.

Student Involvement

Glen Canyon benefits from local science education program

by Joele B. Doty

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"Kids learn first-hand about the threats to their local environment. They have shared this enthusiasm with their parents, and that, in turn, has generated unprecedented community support for preservation of the very resource that is the economic lifeblood of the region."

—Jerry Spangler, *Deseret News,* 10 March 1999

High school biology students are working hand in hand with park scientists on aquatic and rangeland resource management projects at Glen Canyon National Recreation Area (Utah and Arizona). This multifaceted partnership between the Page School District in Arizona and Glen Canyon provides public education on Glen Canyon's fragile resources. The program reaches a high percentage of Navajo and female students who will help cultivate a diverse workforce including resource managers.

The curriculum-based research and science program, in cooperation with the Utah Division of Wildlife Resources and the U.S. Fish and Wildlife Service, provides student-acquired data for maintaining local golf course ponds as a viable grow-out facility for fish augmentation. Razorback suckers, endangered fish endemic to the Colorado River Basin, are being reared in the ponds to maintain a backup brood stock and to grow large enough so they are not vulnerable to predation when stocked in the wild. Students routinely monitor water quality, fish growth, and health, and harvest fish for stocking. In 1999, 7 out of 153 of the stocked fish from the golf course ponds were recaptured in Lake Powell and the San Juan River, a high recapture rate for razorback suckers.

> "Students provide a necessary link between the local community and federal land managers."

Students also contributed to the collection of razorback sucker larvae in Lake Mohave, at the southern end of Lake Mead National Recreation Area, to help the Native Fish Work Group reach their projected capture rate for 1999. They also assisted with pit-tagging bonytail chub, an endangered species, for stocking.

Students are currently working on two other projects: bacteria monitoring at Glen Canyon National Recreation Area and a new rangeland ecology study. They learn the scientific basis for water quality and rangeland management decisions, both highly political and economic issues in the park. Through these courses they are given an opportunity to be involved in an internship with Utah State University,

Glen Canyon National Recreation Area, and the Bureau of Land Management. A Navajo student completing a rangeland ecology study for the park was told by Navajo elders that "when the wind blew, the land looked like a yellow ocean" because of the swaying knee- and waist-high vegetation. Her goal is to help restore the vegetation and "make this land a yellow ocean once again." She is a recipient of the American Museum of Natural History's Young Naturalist Award 2000 for her telling paper about her rangeland study being completed at Glen Canyon.

These students provide a necessary link between the local community and federal land managers. Students create original presentations on their project work, which they give to park managers, community members, and younger students. More than 1,600 students have attended these presentations. These programs generate enthusiasm and provide outreach education, teaching lessons of stewardship along the way. With a firm foundation in the role of science in land management decisions, the youth of this community will move forward and make strong, environmentally sound decisions that affect not only this park but also other public lands in years to come.

This partnership is dependent on funding from the Arizona Community Foundation, National Park Foundation "Parks as Classrooms," NPS "Parks as Classrooms," and the National Park Foundation–Exxon Corporation "P.A.R.K.S." program. The education program recently received national recognition when it won first place in the Sea World–Busch Gardens Environmental Excellence Awards, Wildlife Partners category, providing further funding for the expansion of this outstanding program. A new "Lake Level Transition Zone Study" project targeted for seventh graders will be made possible in year 2000 by a Toyota TAPESTRY Grant for Teachers allowing a new audience of students to conduct science in Glen Canyon National Recreation Area.

Students of the curriculum-based research and science program *tend to the welfare of the razorback sucker, an endangered fish species. Data collected by the students are used to maintain healthy living conditions in a golf course pond, where the fish are reared for restoration of the species and maintained as a backup brood stock.*

Students help meet the research needs of the present and future

by Paul E. Super

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On 3 August 1999, Hanley helped to catch a specimen of the damselfly *Enallagma civile,* which proved to be a species previously unknown in Great Smoky Mountains National Park (Tennessee and North Carolina). Two weeks later, Amanda and Teddi discovered an adult *Desmognathus santeetlah* in their salamander-monitoring transect, a species more commonly found 1,000 feet higher up in the mountains. In late September, Jessie sorted through 50 moths caught the previous night, examining one with puzzling characteristics that proved to be a new park record: *Agriphila ruricolella.* These four researchers, ages 13 to 17, and five other student research interns are part of a new program begun in 1999 to make science real to students, grades 8–12, by helping them collect data for use by park managers and scientists. This multiyear project has the goal of attracting and exciting students who will be the next generation of scientists, resource managers, and taxonomists to work in the park.

These student researchers are trained and supervised by the science education specialist at the environmental education center inside the park (Great Smoky Mountains Institute at Tremont). This education specialist identifies and implements opportunities for local students to learn

about scientific research in the park through hands-on participation, integrating science and education. Park management identified this education specialist position as its highest priority for funding from the Natural History Association donation account in FY 1999. Supervisors from both the park Resource Management and Science and Resource Education Divisions join the director of the institute to oversee this education specialist to facilitate exchange of skills, ideas, and knowledge among the partners.

"This ... project has the goal of attracting ... students who will be the next generation of scientists, resource managers, and taxonomists to work in the park."

In 1999 nine student research interns underwent training and took part in studies of moths, salamanders, pond invertebrates, rhododendrons, and the ecological effects of nonnative plants. One result is that 57 new species of moths have been added to the park All Taxa Biodiversity Inventory (ATBI [see brief article on page 28]). More students will be added to this team in 2000.

The park and its partners are working to expand the program to reach even more students. A Parks as Classrooms eighth grade unit on biodiversity, a summer high school field science course, and a high school field science camp are all being developed for 2000. Student research interns will be demonstrating their projects to visiting school groups. For students younger than grade 8, hands-on projects that mimic the real data-collecting research are being implemented to teach them the techniques and spark their interest.

This science-education integration addresses the park themes of biological diversity and abundance and the scientific opportunities presented by relatively undisturbed ecological communities. It also addresses the needs of the present and future. Results of the ATBI will support management decisions by future generations of park managers. In order for ambitious projects like these to succeed, the park needs many technicians to collect data now and many new scientists and taxonomic specialists to interpret the data collected.

A student research intern *searches for crayfish as part of an initiative at Great Smoky Mountains National Park to integrate science and education. The program makes science come alive for students in grades 8–12 and is also a source of data for the All Taxa Biodiversity Inventory.*

Community Collaboration

Bear-proofing garbage cans near Great Smoky Mountains National Park

by Kim Delozier

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Black bear population density at Great Smoky Mountains National Park (Tennessee and North Carolina) is one of the highest in the eastern United States, and visitation to the park exceeds 10 million people annually. This situation increases the likelihood of bear-human conflicts. Reducing a bear's access to human food and garbage is a priority for park resource managers. In recent years the park has made several improvements in bear management. These include incorporating animal-proof dumpsters, modification of work schedules for maintenance personnel, earlier closures of picnic areas, installation of food-storage cables in backcountry campsites, development of educational materials, and increased monitoring of bear activity in developed areas.

During 1999, park staff worked with Gatlinburg city officials, state biologists, and private individuals to develop an ordinance for mandatory animal-resistant garbage containers in areas of Gatlinburg that are adjacent to the park. Bears were becoming "garbage-conditioned" when they crossed the park boundary and were creating problems in both the city and the park. Bears in the city of Gatlinburg are not new; a bear task force was established for Gatlinburg in 1988 to address this issue. City officials, however, repeatedly voted down the proposed ordinance, but were finally convinced of its need by local response to the numerous bears killed (i.e., shot, poisoned, hit by vehicles) in backyards, parking lots, and trash receptacles in the city.

> "The ordinance requires residents ... to 'bear-proof' their trash receptacles...."

The ordinance requires residents of designated zones and managers of food-producing businesses throughout Gatlinburg to "bear-proof" their trash receptacles by 1 June 2000. The ordinance will ultimately save the lives of many park bears in addition to other wildlife. The park plans to work with the Tennessee Wildlife Resources Agency to aggressively manage or relocate any garbage-conditioned bears that show up in Gatlinburg in spring in hopes of breaking the garbage dependency cycle passed down from females to their cubs. The next step is to work with this state agency to address the intentional feeding of bears, which is currently legal in Tennessee.

David and Linda Morris

Animal-resistant garbage containers *are becoming a common sight in Gatlinburg, Tennessee. In 1999 the city adopted an ordinance requiring residents of designated zones near Great Smoky Mountains National Park and managers of food-producing businesses to "bear-proof" their trash receptacles. To promote the change, the city set up this demonstration site where residents can see and purchase various designs.*

International Outreach

Parallels in ecological preservation challenges in U.S. and Canadian national parks

by John G. Dennis

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In late 1998, Parks Canada invited the U.S. National Park Service to participate in a Panel on the Ecological Integrity of Canada's National Parks. The Minister of Canadian Heritage called for the panel because of a growing awareness that Canada's parks are under stress. As in the United States, Canadian parks are meant by law to be maintained unimpaired for the enjoyment of future generations. However, almost all of Canada's 39 national parks are being stressed by habitat loss and fragmentation, loss of large carnivores, air pollution, pesticides, exotic species, or overuse. The panel was to assess the strengths and weaknesses of Parks Canada's approach to maintaining ecological integrity in Canadian parks and to recommend improvements in these methods. The 11-member panel, which conducted its first field visit in January 1999, comprised a biologist from the Mohawk Council of the Akwesasne, several academics and consultants, a member of a nongovernmental organization, and a Parks Canada scientist. It also included two advisors, one of whom was the author, to represent the international community broadly and the United States specifically.

Over the past several years the U.S. National Park Service has increased its technical involvement with other governments regarding the management of park natural resources. While these exchanges may respond to specific requests for help, they also build collaborative relationships and provide opportunities for the Park Service to learn from managers of parks in other parts of the world. Canada's request for an NPS participant on the panel gave this bureau a chance to exchange ideas with a sister park service and to consider the striking parallels between ecological integrity problems and their potential solutions in Canadian parks and those in the United States.

The panel found that park ecological integrity is being impaired and that a majority of Canadian national parks have significant threats to their natural resources. These threats originate from both inside and outside park boundaries. Solutions are not simple and will require a broad range of initiatives. Participation by citizens, commerce, conservation organizations, and governments will be needed to protect Canada's national treasures.

The findings and recommendations of the panel, published by Parks Canada,[1] are similar to those of the NPS 1999 Natural Resource Challenge and 1980 report on threats to U.S. national parks. This commonality suggests several key points. Worldwide, park natural resources are at risk because of human population growth. Park management must change if parks are to accomplish their statutory mission to protect natural resources unimpaired for future generations. Everyone, not just a few park resource managers, is a contributor to the long-term protection of park natural resources.

The development of the panel's report and the Natural Resource Challenge are serendipitously coincidental. Each identifies a common challenge and offers comparable solutions. Each stresses the need for investment in inventory, monitoring, research, and adaptive management. By sharing knowledge and effort through partnership with Parks Canada, the National Park Service can improve its own field methods, data management techniques, and assessment processes more rapidly and effectively. The two countries also have natural resources in common—migratory animals, ecosystems that extend to both sides of the border, and gene pools of wide-ranging species. By working together, each nation's park service can contribute to the well-being of continental biota. Finally, both the panel's report and the Natural Resource Challenge encourage environmental leadership, especially in action. In striving to be environmental leaders, there is room for partnership. There is also room for healthy competition of ideas and action—competition that can benefit not only both countries but also national parks throughout the world!

"Both the panel's report and the Natural Resource Challenge encourage environmental leadership."

[1]Parks Canada Agency. 2000. Unimpaired for future generations? Protecting ecological integrity with Canada's national parks. Volume I—A call to action. Volume II—Setting a new direction for Canada's national parks. Report of the Panel on the Ecological Integrity of Canada's National Parks. http://parkscanada.pch.gc.ca/EI-IE/index_e.htm. Ottawa, Ontario.

Growing and greening the economy of Vietnam: A role for the National Park Service?

by Mike Soukup

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Both the beauty and squalor of Ha Long Bay proclaim that much is at stake presently in the environmental history of Vietnam. But can the U.S. National Park Service make a difference? At the invitation of The World Bank, special assistant to the director Brooke Shearer and the author attended a conference in Ha Long Bay in April 1999. The Bank believes that the National Park Service's long experience in protecting, managing, and regulating U.S. natural resources makes it well suited to help developing nations like Vietnam get control of their own resources before they are lost.

The Park Service invited Costa Rican economist and former environment minister Rene Castro Salazar to be a member of the team. His assignment: to speak to the Vietnamese as one small, developing country to another. Under his leadership, Costa Rica's economy had prospered from investing in green infrastructure—biodiversity protection and research, park development, and ecotourism.

"The spectacular limestone island caves and quaint coastal villages are fast deteriorating, becoming crowded, tacky, and polluted."

Ha Long Bay became a world heritage site in 1994. However, with no special staff for site management and little control of visitors or activities along its borders, the spectacular limestone island caves and quaint coastal villages are fast deteriorating, becoming crowded, tacky, and polluted. Additionally, from an environmental point of view, Ha Long Bay has always been a high-impact area. The most serious problem has been coal mining and the storage and transport of coal in coastal waters.

As part of the conference, the team toured Ha Long Bay and witnessed untreated sewage from the town being released directly through a large pipe onto the shore. (The team was told later that over 90% of domestic waste in Vietnam is untreated.) Also, mangroves, a key feature of the bay's special character and habitat, had apparently been sacrificed to build the hotel and sandy beach. The need for environmental standards was obvious. So too was the need to demonstrate that tourism does not have to lead to haphazard development—a lesson that already has been learned in many other places.

Now enter the Japanese. Since the early 1990s, they have become major donors to Vietnam. At Ha Long Bay they are financing a big port and bridge-building project, located at the edge of the world heritage site. Once the new port project is complete, one large ship will go through the area every 15–20 minutes, according to economic forecasters. Indeed, The World Bank planned its Ha Long Bay conference to take advantage of the economic slowdown in Japan and the region, hoping the crisis might encourage Vietnam to reexamine its long-term interests.

As part of the visit, the team also drove north of Hanoi to see Cuc Phong, one of Vietnam's oldest national parks. The park staff is as dedicated as any, but poachers are capturing the resident primate fauna for export. Conservation groups from abroad, such as the Primate Rescue Center, are rescuing animals at the border, and there are small captive breeding programs under way. But visitor education and interpretation at the park are inadequate; the park's roadway promises future harm to the forest wildlife; and little attention has been devoted to involving nearby villages in park protection and programs.

American Ambassador Pete Peterson, himself a Vietnam War veteran, has appealed to the National Park Service to partner with parks in Vietnam. The Department of State also strongly encourages the Park Service to pursue cooperation with Vietnam—before it is too late. The team's participation in the conference marks a beginning in this process.

Program to preserve Neotropical migrants takes flight

by Scott Hall and Gary Johnston

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In 1999 the National Park Service began to implement a new initiative to assist Central American nations in the conservation of shared species of Neotropical migratory birds. Called the Park Flight Program, the initiative is a partnership among the National Park Service, American Airlines, and the National Park Foundation. The program will support Central American park managers through technical assistance and training, enabling them to better protect important habitat for shared migratory species. The long-term goal of the Park Flight Program is to create a framework for the "co-management" of shared migratory species facing a precarious future. This goal will be carried out through the formation of sister park relationships and other forms of NPS technical support.

The Park Flight Program has its origin in a series of 1997 and 1998 contacts between Michael Soukup, associate director for Natural Resource Stewardship and Science, and several Central American environmental and conservation officials, who developed the concept for a joint cooperative program to protect shared migratory species and their habitats through technical exchange and cooperation. To accomplish this goal, the program needed a small quantity of project start-up funds and a few airline tickets. The tickets would be used for travel by either NPS or Central American park personnel for training, technical assistance activities, or the exchange of information on shared migratory species. American Airlines has stepped forward to provide more than $330,000 in program funds and 45 round-trip airline tickets, facilitated through the efforts of the National Park Foundation.

In December 1999 the National Park Service sent a five-person team to Central America to define the scope of the Park Flight Program and to assess the interests and needs of Central American park managers and wildlife biologists. The NPS team's trip report identifies both short-term and long-term program activities; a copy is available from the authors. The National Park Service hopes to select the migratory species and U.S. and Central American parks that will be the focus of technical assistance and support efforts and to start funding exchange projects in 2000.

Park biologist Ingrid Arias *guides NPS resource managers through Cerro San Gil Reserve in Guatemala. The small NPS contingent visited parks in Central America in late 1999 and began coordinating the Park Flight Program, an international training and technical support initiative for the conservation of shared migratory species and their habitats.*

Award-Winner Profile

Karen Wade honored for advancing resource preservation

Karen Wade is winner of the 1998 Director's Award for Superintendent of the Year for Natural Resource Stewardship, presented in 1999. As superintendent of Great Smoky Mountains National Park, North Carolina and Tennessee, Karen encouraged her staff to initiate the All Taxa Biodiversity Inventory, an ambitious effort to identify all species living in the park. Under her direction the park developed a strategy to complete the inventory without significant federal funding.

Karen is widely regarded as a creative thinker and believes strongly that partnerships among a broad cross-section of constituents are key to solving problems related to park issues. "Common values are the glue that holds society together," she says. "Not surprisingly, for many communities located adjacent to national parks, the resources embodied within park boundaries are reminders (and sometimes remainders) of those values." What can the National Park Service do to enhance understanding of these connections? Karen views educational efforts as vital. She says, "We can excite public interest further by delivering the mysteries of new scientific discoveries to their doorsteps. And it makes sense that the more we involve in our work those neighbors with the most obvious common interests, the stronger our attachments will become and the more relevant our parks will become." In 1999 Karen became intermountain regional director of the National Park Service.

Submerged Resources Center, John Brooks

National park coral resources, *including these at Dry Tortugas National Park, Florida, received a conservation boost from Executive Order 13089, which calls for greater understanding of coral reefs through mapping, inventories, and research. It also mandates greater reef protection. As a result, the National Park Service requested and received $1.6 million in FY 2000, which it distributed among nine coral reef parks to add personnel in inventory and monitoring, mapping, and protection positions.*

Oceans, coastlines, coral reefs, and national parks

by Dr. Sylvia A. Earle

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I am very pleased to contribute to this year's *Natural Resource Year in Review* both because of my recent appointment to the National Park System Advisory Board and because of the increased level of attention our nation's marine resources are now receiving. Nineteen ninety-nine was a landmark year concerning public understanding and acknowledgment of the need to better protect and manage our marine resources and the need for more and better protected marine parks and reserves.

Growing out of the National Oceans Conference held in Monterey, California, in June 1998, a coordinated, disciplined, long-term federal oceans policy was completed in 1999 that will guide federal efforts in addressing the many challenges we face in ensuring that all ocean resources are protected and sustained. The U.S. Coral Reef Task Force, created by Executive Order 13089, also made much progress toward reviewing and organizing future federal actions addressing our understanding and protection of coral reefs. The President's executive order calls for greater understanding of coral reefs through mapping, inventories, and research; it also calls for greater protection. This must mean, among other things, closure of reefs to fishing—both recreational and commercial. The loss of long-lived predators from reefs has great implications for the long-term preservation of coral reefs. The task force completed a *National Action Plan to Conserve Coral Reefs* that calls for the protection of at least 20% of all coral reefs and their associated habitat types in "no-take" ecological reserves by 2010. However, we will only be able to protect our marine environments if we understand them. If decisions are made to close areas to fishing, we must reach them using a well-developed research and monitoring framework so that the effects of closures can be clearly understood and constantly evaluated.

As the premier federal agency for natural and cultural resource protection and preservation, the National Park Service should take a leading role in the establishment and management of marine protected areas. Many of our nation's most significant marine and coastal resources have been placed under the stewardship of the National Park Service, and these resources need to receive the same level of attention, nurturing, care, and protection as do their terrestrial counterparts. Our natural and cultural marine resource heritage should be viewed as no less important.

What will our oceans, coastlines, coral reefs, and national marine parks be like in 2020? What do we want them to be? What must we do now to make sure we get there? What kind of national park system will best represent the nation's wonderful natural heritage and meet the needs of its citizens? Should we not make sure that the hydrosphere is better represented?

"The National Park Service should take a leading role in the establishment and management of marine protected areas."

Will there be a day when the deep ocean is accessible to national park visitors? Do some of our early, experimental underwater laboratories deserve recognition as important cultural or historic sites worthy of preservation, visitation, and interpretation? What about better representation of the diversity of coral reefs in our national park system? And is it not time for better protection of the reefs already in our care?

I am very pleased to have the opportunity to serve on the National Park System Advisory Board so that I can ask these very questions. I am excited and optimistic about a greater representation of important marine habitats as future units of national parks and seashores. I am equally certain that there must be a greater emphasis in the National Park Service on its role in preserving marine areas in the future. History will record that Executive Order 13089 recognized these needs and will judge us on how well we responded.