National Park Service
U.S. Department of the Interior

Natural Resource Program Center
Natural Resource Information Division

Natural Resource Year in Review–2002

A portrait of the year in natural resource stewardship and science in the National Park System

"Parks … must be viewed as special parts of human-dominated ecosystems and managed as such; there is no turning back to an earlier world, in which such areas might have been segregated and held apart from human activities."

Peter H. Raven, *Nature and Human Society*, 1999

ON THE COVER
Boulder Glacier in Glacier National Park, Montana, completely disappeared between 1932 and 1988, as documented in this photo pair. The image labeled "2002" was actually made in 1988 and is the earliest image documenting the transformation. Except for growth of low-lying tussock grasses since it was taken, the latter photograph accurately depicts the area today. Scientists at Glacier and North Cascades National Parks are studying the rapid decline in glacial mass and its consequences for park resources and visitors (see pages 24 and 32).

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Sea star, Channel Islands National Park, California. Marine protected areas have been established recently within the national park and adjacent national marine sanctuary to enhance protection of the marine ecosystem (see page 47).

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January

The new year portends progress in the scientific management of park natural resources as a result of the passage in November 2001 of the largest of three fiscal-year budgets to date in support of the Natural Resource Challenge. Added to previous annual base increases of $14.3 million in FY 2000 and $15.2 million in FY 2001, the $20 million increase in FY 2002 provides for continued gains in resource inventories and monitoring, management of native and nonnative species (including threatened and endangered), control of invasive species, water resource protection and restoration, and learning centers. The new funding also emphasizes air quality monitoring and resource restoration and protection.

The National Park Service negotiates water rights settlement agreements for Rainbow Bridge National Monument and Golden Spike National Historic Site in Utah. The agreements protect water resources, including an unnamed spring and Rainbow Bridge Creek at Rainbow Bridge and water supplies for public facilities and steam locomotive demonstrations at Golden Spike.

The Geologic Resources Division hosts a three-day workshop to develop protocols for the conduct of disturbed lands inventories and assessments in national parks. The multidisciplinary team of NPS experts attending the workshop drafts a streamlined inventory and assessment process to promote consistency while providing flexibility to meet park-specific disturbed land restoration needs.

February

The National Park Service negotiates a water rights settlement resolving issues before the Nevada State Engineer related to a groundwater permit application by the Moapa Valley Water District in southeast Nevada. The National Park Service withdrew its protest to the permit in return for a commitment and plan by the water district to monitor the effects of groundwater withdrawals on the regional aquifer system that feeds springs in nearby Lake Mead National Recreation Area and to manage their withdrawals based on analysis of the data to avoid impacts to the springs.

The Assistant Secretary for Fish and Wildlife and Parks asks the State of Kentucky not to issue a permit for the Thoroughbred Generating Station, a 1,500-megawatt, coal-fired power plant proposed for construction near Mammoth Cave National Park, Kentucky, citing the adverse impact emissions from the plant would have on visibility at the national park.

The National Park Service, Canon U.S.A., Inc., and the American Association for the Advancement of Science hold the annual Canon National Parks Science Scholars Symposium in Washington, D.C. The gathering brings together the 21 earlier recipients of the prestigious scholarship award and recognizes eight new scholars selected for 2001 to conduct graduate-level research in the National Park System.

Biologists in Yellowstone National Park document possible Canada lynx tracks in the park as part of a survey for the federally listed threatened species. Two months later, in April, hair samples collected the previous year test positive for lynx DNA.

March

Director Fran Mainella approves proposals to establish 17 additional research and learning centers across the National Park System as conceived in the Natural Resource Challenge. Although funding is not requested for these centers in FY 2003, the recommendation will serve as the basis for their future funding pending review by the Department of the Interior of an evaluation of operational learning centers.

Biologists with Grand Canyon National Park confirm two pairs of California condors nesting below the South Rim in clear view of biologists and the public. Although the nests fail, the biologists remain hopeful about the prospect of successful future reproduction of the endangered bird species in the park.

The National Wildfire Coordinating Group publishes "Burning Questions: A Social Science Research Plan for Federal Wildlife Management Agencies." The report prescribes a social science research agenda to help agency administrators and the public to better understand the human dimensions of wildland fire.

Spring

The Park Flight Migratory Bird Program receives the 2002 National Park Partnership Director's Award at the annual convention of the Association of Partners for Public Lands in Charleston, South Carolina. The program exemplifies complex partnering activities to accomplish shared goals for the protection of migratory bird species and their habitats in both U.S. and Mesoamerican national parks and protected areas.

April

After 10 years of study, the Southern Appalachian Mountains Initiative (SAMI) makes recommendations for improving air quality in the Southeast, specifically agreeing to support and promote legislation to reduce sulfur dioxide and nitrogen oxide in and outside the region, and encouraging energy efficiency and conservation. A multiagency coalition that includes the National Park Service, SAMI formed to address the adverse air quality impacts at parks and wilderness areas in the Southeast. The body discusses its recommendations in May at the Fourth Southern Governor's Summit on Air Quality and issues a final report in August.

The Geologic Resources Division holds a three-day workshop at Padre Island National Seashore, Texas, to discuss oil and gas management issues and challenges in national parks. Participants examine a variety of topics, including oil and gas exploration and production engineering, impact mitigation, compliance with the National Environmental Policy Act, soil and groundwater contamination remediation, regulatory compliance, and policy issues.

Cape Hatteras National Seashore, with assistance from the NPS Southeast Region and the Geologic Resources Division, serves as a cooperating agency on an environmental assessment prepared by the U.S. Army Corps of Engineers. The jointly prepared document will serve as the basis for the park's subsequent decision to issue a special use permit to the Army Corps for dredging the Oregon Inlet navigation channel within the park.

May

A restoration plan and environmental assessment for four national park units in the vicinity of San Francisco Bay is completed and will guide the rehabilitation of park resources damaged by a 1996 oil spill. The National Park Service will begin four restoration projects valued at $1.5 million, using funds recovered from the party responsible for the spill through the damage assessment process.

Like the water rights agreement in February, the National Park Service negotiates an agreement resolving issues before the Nevada State Engineer related to groundwater permit applications by Lincoln County and Vidler Water Company in southeast Nevada. Again, the settlement protects Lake Mead National Recreation Area and focuses on monitoring, management, and mitigation of impacts from groundwater pumping by the permittees.

June

Representatives from 13 research and learning centers gather in Estes Park, Colorado, to share accomplishments of the evolving learning center network across the National Park System. They review strategies for attracting and facilitating researchers, involving the public and partners in park science and resource management, and communicating research results for learning and application to park management.

The National Park Service and many other partners meet in Gatlinburg, Tennessee, to discuss the potential for the All Taxa Biodiversity Inventory (ATBI) in Great Smoky Mountains National Park to serve as a model to document all life in other national parks. As a result, Point Reyes National Seashore initiates the first marine ATBI.

The Water Resources Division approves research to investigate the occurrence and effects of snowmobile contaminants in Rocky Mountain and Voyageurs National Parks. Funded by the Recreational Fee Demonstration Program, the four-year, $250,000 project will be conducted by the USGS Columbia Environmental Research Center and also will provide information for staffs of all snowmobile destination parks to design appropriate monitoring programs. The study addresses two executive orders that direct the National Park Service to monitor the effects of off-road vehicles.

July

Highly pressurized oil and gas surge unexpectedly into a well being drilled adjacent to Obed Wild and Scenic River, Tennessee, causing a dangerous blowout at the surface. A large spill accumulates and cascades down steep slopes into park waters, followed by the ignition of escaping natural gas in a huge explosion and fire. National Park Service, EPA, and State of Tennessee personnel respond immediately to suppress the fire, contain and remove the spill, control the well, and assess damage.

Addressing air quality impacts of electrical generation, the Bush Administration's "Clear Skies" legislation is introduced in Congress. Through phased emissions caps the bill would reduce emissions of sulfur dioxide, nitrogen oxides, and mercury from older generators.

The Little Colorado River Adjudication Court Order confirms the binding effect of five water rights settlement agreements involving six national park units in Arizona: Grand Canyon and Petrified Forest National Parks; Walnut Canyon, Sunset Crater Volcano, and Wupatki National Monuments; and Hubble Trading Post National Historic Site.

A flood sweeps through Klondike Gold Rush National Historical Park, Alaska, threatening visitors, cultural resources, and park facilities. With technical assistance from the Geologic Resources Division, the park considers ecologically sensitive ways to stabilize the riverbank and protect park visitors and resources from future floods.

August

Resource managers and other technical science staff from five agencies gather in Denver for the second meeting of the vital signs monitoring program. The first 12 monitoring networks to be established report good progress in designing integrated resource monitoring programs in which parks in a common network share professional staff.

The Natural Resource Information Division reports to the Secretary of the Interior that the first five research and learning centers in operation are largely meeting the objectives of increasing partnerships, cooperation, and collaboration among national parks, academe, and the public. One area needing improvement is coordination among parks that host learning centers and other parks in their network.

The National Park Service announces the recipients of the Director's Awards for Natural Resource Stewardship. Michael Soukup, Associate Director for Natural Resource Stewardship and Science, presents the awards and recognizes the seven winners for their contributions to preserving the wealth of natural resources in national parks in 2001.

The Park Flight Migratory Bird Program is one of two NPS programs to be highlighted in an exhibit at the United Nations World Summit on Sustainable Development in Johannesburg, South Africa.

The other, cosponsored by the U.S. Geological Survey, explores biodiversity prospecting and benefits-sharing at Yellowstone National Park as models for sustainable use of national parks or protected areas. Nearly 15,000 world summit participants visit the exhibit hall.

Parks from around the National Park System host special events and give interpretive programs as part of the fifth annual Earth Science Week. The Geologic Resources Division works with the event sponsor, the American Geological Institute, to provide interpretive materials to the parks.

Based on revised air quality analyses, the Assistant Secretary for Fish and Wildlife and Parks withdraws the previous finding that the proposed Thoroughbred Generating Station would adversely impact visibility at Mammoth Cave National Park.

The National Park Service releases the 2001 Annual Data Summary Reports of the Gaseous Pollutant Monitoring Program, summarizing gaseous pollutant and meteorological conditions in individual parks and dry deposition of acidic compounds.

September

The Air Resources Division publishes "Air Quality in the National Parks—Second Edition." The report summarizes air quality status and trends from 1990 to 1999 for haziness, sulfate and nitrate ion concentrations, inorganic nitrogen, and ozone levels in the national parks. Trends for several of the parameters tracked in many national parks are improving.

The first 12 vital signs monitoring networks complete the first phase in a planning and design process to become fully operational, including defining objectives and synthesizing existing data. Phase 2 entails selecting monitoring indicators, and phase 3 focuses on specific methods for carrying out and reporting on resource monitoring.

Fall

Located in Point Reyes National Seashore, California, the Pacific Coast Learning Center receives the Department of the Interior's Environmental Achievement Award for 2002. The host park is credited with making its vision of a learning center—a laboratory where science and education are combined with to increase knowledge and understanding of the natural world in Pacific coast ecosystems—a reality.

October

The California Fish and Game Commission establishes a network of new marine protected areas in Channel Islands National Park and Channel Islands National Marine Sanctuary, effective April 2003. The 10 marine reserves, nine of which are in the national park, are intended to preserve marine ecosystems for exploration, inspiration, and education; to replenish depleted populations; and to sustain fisheries.

Biscayne National Park and the State of Florida sign a memorandum of understanding agreeing to develop a new comprehensive cooperative fisheries management plan to address park fishery issues, including the growing number of recreational and commercial fishers and declining fish stocks.

The Natural Sound Program becomes part of the Air Resources Division of the Natural Resource Program Center. The program combines the aircraft overflights function, which works with the Federal Aviation Administration on management planning for air-tour operators in national parks, and soundscapes management planning, which assists parks in restoring natural background levels of sound in parks. At the same time, the wilderness science function, formerly administered by the Associate Director for Operations and Education, and the Public Use Statistics Office shift to the supervision of the Associate Director for Natural Resource Stewardship and Science.

The University of Idaho's Gary Machlis steps into a new position as NPS Visiting Senior Scientist and full-time coordinator of the network of Cooperative Ecosystem Studies Units. The change creates a vacancy in the Visiting Chief Social Scientist position, now filled by Jim Gramman, professor with the Department of Recreation, Park, and Tourism Sciences at Texas A&M University.

The draft "Guidance on Assessing Impacts and Impairment to Natural Resources" is made available for field review. The information and criteria in the document are intended to assist parks in evaluating and characterizing impacts during the planning process.

November

The second phase of nonnative black rat eradication at Channel Islands National Park takes place with aerial application of a specially formulated and permitted rodenticide on West Anacapa Island. Two years of monitoring will be needed to assess the efficacy of the treatments, but after just one year all signs are positive that East Anacapa is free of black rats thanks to treatments in 2001.

Biologists from the National Park Service and interns from Latin America meet in Honduras for a workshop to improve knowledge and coordination of migratory bird monitoring programs across the Western Hemisphere. The exchange is coordinated by the NPS Office of International Affairs and supports the Park Flight Program, a partnership to conserve migratory bird species in the United States and Mesoamerican national parks and protected areas.

December

The All Taxa Biodiversity Inventory at Great Smoky Mountains National Park logs an estimated 51 moth and butterfly species new to science as a result of an intensive two-day, late-spring inventory. Altogether, the ATBI has documented 334 undescribed species and an additional 2,121 new park records over the course of its five-year history.

The Air Resources Division conducts an international peer review of the Western Airborne Contaminants Assessment Project, which will assess risk to seven western national parks (Denali, Noatak, Olympic, Mount Rainier, Rocky Mountain, Glacier, and Sequoia) from persistent organic pollutants and other airborne toxic compounds. Peer reviewers critique the research plans and implementation strategies related to snow, water, sediment, fish, vegetation, subsistence foods, and laboratory analysis.

Dr. Louise Hose joins the National Park Service as the first permanent director of the National Cave and Karst Research Institute, located in Carlsbad, New Mexico. The move signals a new phase for the start-up institute, which was created by legislation in 1998 as a federal-private partnership. The institute is developing collaborative programs to facilitate research and public education aimed at improving cave and karst resource management.

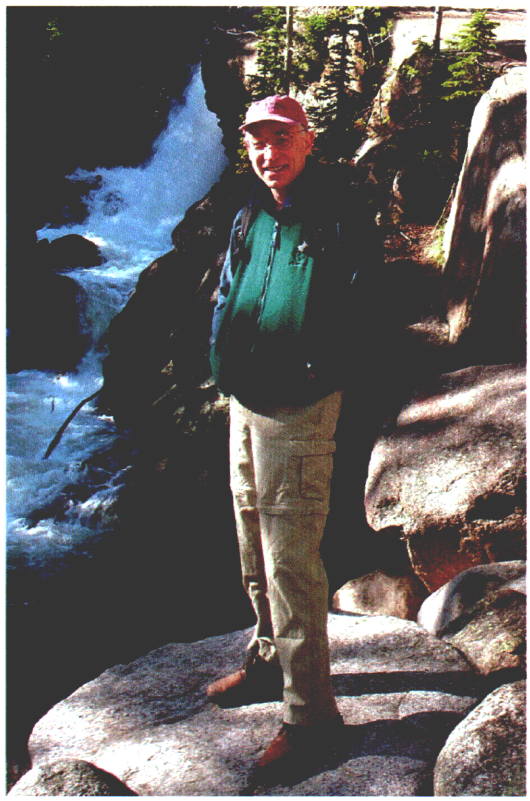
The GeoScientists-in-the-Parks program, administered by the Geologic Resources Division, places 64 geoscientists in more than 65 units of the National Park System. The program meets geologic resource management and interpretation needs in parks. The astonishing number of placements in 2002 is 10 times the number of geoscientists placed in parks since 1996, the inaugural year of the program.

Mountain lion tracks, Big Bend National Park, Texas. Noninvasive techniques, particularly DNA sampling, are being used to study mountain lions in several southwestern parks (see page 23).

"Accumulating scientific knowledge historically has not been a commitment process. It goes in fits and starts based on funding and changes in staff.... We must go beyond information collection to build institutional memory for understanding the ecology of the landscape."

Michael A. Soukup, 13 August 2002, second meeting of the inventory and monitoring networks

The Year in Review



NPS PHOTO BY CRAIG AXTELL

Associate Director Soukup at Alberta Falls, Rocky Mountain National Park, Colorado.

Reflections on 2002

by Michael Soukup

THE MISSION OF THE NATIONAL PARK SERVICE—to preserve roughly 83 million acres in more than 385 national parks unimpaired for the enjoyment of future generations—is as honorable and extraordinary as it is complex and technical. The variety, scope, and size of the units we manage and the need to keep them unimpaired require a sophisticated knowledge of how natural systems work and what does and does not harm them. This year saw continued progress under the National Park Service's program to double the level of effort and budget for natural resource management in parks. Since its inception, the Natural Resource Challenge has been a multiyear program and commitment by NPS leaders to double the base funds spent on natural resource management, from approximately $100 million of the $2.3 billion NPS budget to $200 million annually. Although keeping the Challenge on track in a period of tight budgets and other pressing priorities has proved difficult, the fourth year's budget looked promising as the year closed under a continuing resolution.

Part of one's satisfaction in helping the National Park Service fulfill its mission comes from working alongside many committed and talented people who have dedicated their lives to furthering the national parks. Regrettably, in 2002 the National Park Service lost one of its most valuable scientific assets—a person with a deep and long-term understanding of park resources—Jim Allen. We pay tribute to him on page 54. The Service also lost to cancer one of its most well-respected leaders, Boyd Evison, a friend to natural resources and to all aspects of park management. Boyd was one of the first high-level managers to understand the need for science in parks and is remembered by many current NPS employees in natural resource disciplines as their first advocate.

"We need special kinds of science advisors for ... managers."

The loss of these men, plus the retirements of many senior managers who were strong leaders of the Natural Resource Challenge, has made me think about the circumstances and processes that produce the institutional memory of the National Park Service. For example, the practice of having dedicated research scientists and park naturalists in and focused on parks, and consequently managers who have depended directly upon them and their understanding of natural phenomena, has faded.

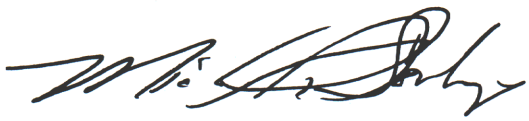
When the Natural Resource Challenge was developed, two needs stood out as especially critical. The first was the need to broaden the appreciation within the culture of the National Park Service for managing with state-of-the-art science. The second was the need for a wide range of science-based information. The Challenge is making great strides in acquiring basic inventory information. If fully funded, the Natural Resource Challenge will give the inventory and monitoring networks the infrastructure and foundation required to gather and analyze resource condition and trend data into the future. Managers will not have to guess at whether they are managing in such a way that tomorrow's park visitor will be able to experience the unspoiled natural heritage of the nation.

What remains to be done? Half of the monitoring infrastructure was unfunded at the end of FY 2002, leaving half of the parks without the capability to monitor park resource conditions and trends. And it is too early to tell what lasting impact the Challenge will have on broadening the culture of the National Park Service.

Managing park resources requires much more than good scientific information. Information must be synthesized into an understanding that can be applied in the full context of legal mandates amidst many other demands on parks and the National Park System. Managers must make long-term investments in understanding park resources and use that knowledge to make difficult decisions that protect resources while welcoming visitor enjoyment. For as natural resources become more popular in the modern landscape, the roles our national parks will play in an urbanized society will intensify, guaranteeing great interest in the rationale underlying any management decision. We need managers who can bring people together, fairly consider all sides, and make prudent decisions.

We need special kinds of science advisors for those managers. Parks need research scientists who stay in parks for much of their career, who accumulate and institutionalize a deep knowledge of park resources by synthesizing all the data developed by all scientists who can be encouraged to work in parks. They must communicate with numerous audiences and devise ways to perpetuate that understanding when they leave. The professional staffs and natural resource programs of the National Park Service today are certainly heartening. Yet it is not clear how we can develop the kind of human resources represented by people like Jim Allen or how we can retain their levels of understanding in parks over time.

The year 2002 saw continued solidification of the gains made to date through the Natural Resource Challenge, but also indicated where and how far we have to go to ensure the unspoiled natural park experience of the future. ■



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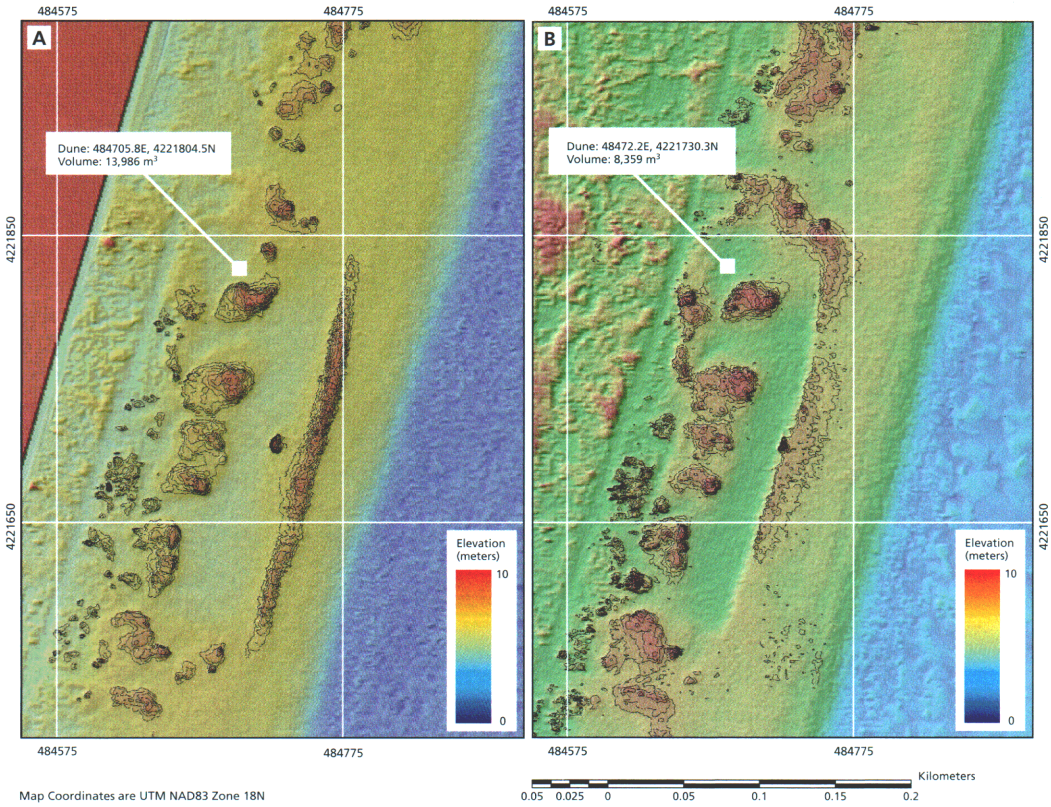
"Flooding … parks with commissioned rangers will not do the job. In the long run, we will win by showing that we have learned how these ecosystems function."

Boyd Evison, Memo to NPS Director, 1989

Building on the Challenge

A barrier island dune at Assateague Island National Seashore has moved southwest and decreased in volume, as revealed in this pair of maps developed from lidar elevation data collected on 3 April 1998 (left) and 5 September 2001 (right). The Northeast Coastal and Barrier Network is collaborating with several science partners to develop a protocol for monitoring shoreline change at many of the network parks that combines lidar and conventional mapping techniques.



In 2002 the National Park Service continued to build the capacity for effective management of the irreplaceable landscapes and living things in national parks through the Natural Resource Challenge. Now in its fourth year, the Challenge is a multiyear effort to improve resource preservation throughout the National Park System by developing a better understanding of park natural resources and implementing fundamental and innovative resource management programs. With the President's FY 2003 budget, Congress will have made available $67.5 million, or two-thirds, of the $100 million in additional annual funding needed to realize the goals established under the Natural Resource Challenge. Articles in this chapter and throughout this report examine the progress under the Challenge in 2002. In particular, inventory and monitoring networks continued their evolution, with five new networks being established in 52 parks to track key physical and biological resources. The information developed will be used to assess resource condition, a critical need in the parks. Seventeen of 32 planned networks will be operational with FY 2003 funding; the other 15 networks are identified as needs in the remaining portion of the Challenge. Altogether, the articles demonstrate the tremendous contribution of the Natural Resource Challenge to National Park Service successes in 2002.

Monitoring on the North Atlantic Coast: An example of successful collaboration

by Bryan Milstead, Sara Stevens, and Betsie Blumberg

NPS PHOTO BY BRYAN MILSTEAD

Part of the Staten Island unit of Gateway National Recreation Area, Fort Wadsworth juxtaposes cultural and natural resources with one of the world's largest metropolitan areas—New York City. Resource monitoring provides an opportunity to study urban ecology, advance conservation, and raise the awareness of park resources and values.

IN THE NORTHEAST, THREE DISTINCT ENTITIES are working together to meet the goals of the Natural Resource Challenge to monitor vital signs in national parks: the Cape Cod National Seashore Prototype Program, the Northeast Coastal and Barrier Network, and the North Atlantic Cooperative Ecosystem Studies Unit (CESU). Vital signs are specific indicators of natural processes that can be monitored over time to reveal changes in ecosystem health, providing critical information for management decisions. In addition, network monitoring protocols are being adapted for use in national wildlife refuges along the Northeast Coast.

Cape Cod National Seashore, Massachusetts, is a prototype for Atlantic and Gulf Coast parks, funded since 1996 to develop a long-term ecological monitoring program in partnership with the USGS Biological Resources Division. Guiding its monitoring is a simple but effective framework that has been adopted by the network. The framework describes representative park ecosystems and creates a conceptual model for each. The models are used to understand ecosystem responses to natural and human-related disturbance and to identify candidate variables for vital signs monitoring.

"Assateague Island National Seashore has been cooperating with NASA in using ... an airborne laser technique to derive elevation data for shoreline study."

The Northeast Coastal and Barrier Network comprises eight parks: Assateague Island, Cape Cod, and Fire Island National Seashores; Colonial National Historical Park; Gateway National Recreation Area; George Washington's Birthplace National Monument; and Sagamore Hill and Thomas Stone National Historic Sites. The network was funded in 2000 and its staff are colocated at the University of Rhode Island with the North Atlantic Cooperative Ecosystem Studies Unit, established in 1999.

The parks in this network occupy an ecosystem constantly experiencing landform changes due to natural factors such as storms, or due to human activity. As a result, monitoring shoreline change is critical. Since 1995, Assateague Island National Seashore has been cooperating with NASA in using lidar (an airborne laser technique) to derive elevation data for shoreline study. The USGS Coastal and Marine Geology Center joined the partnership in 1998, and has been developing applications for park use of these data. At the same time, Cape Cod was cooperating with the USGS Biological Resources Division to develop a shoreline change monitoring protocol.

Following the lead of Assateague and Cape Cod, the network has borrowed Assateague staff to work with network parks and with scientists from the USGS, U.S. Army Corps of Engineers, Virginia Institute of Marine Sciences, and Woods Hole Oceanographic Institute to develop a model of shoreline change and recommend procedures for long-term measurement. Beach geomorphology will be monitored twice a year by traditional mapping techniques and every other year with lidar technology.

Coastal parks play an important role in protecting wetlands along the Atlantic Coast. In collaboration with the USGS, Cape Cod has produced monitoring protocols for salt marshes. Dr. Charles Roman, who now heads the North Atlantic CESU, led the development of these protocols as a USGS scientist. The CESU and Cape Cod are now assisting the network with development of salt marsh monitoring protocols. Complementary protocols for monitoring nutrient enrichment of estuaries are being developed by the network in cooperation with the USGS and academic partners.

Some of Cape Cod's protocols are being implemented in U.S. Fish and Wildlife Service refuges along the coast. Outreach is an important part of the mission at Cape Cod and the network; achievements and insights are continually shared with parks, networks, and agencies through workshops, presentations, and the Web. This broad alliance of NPS groups is making great progress toward the realization of the goals of the Natural Resource Challenge. ■

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National Capital Region Network: A milestone in the making

by Sybil Hood

"The network has been successful in ... pooling the limited resources of its 11 parks."

THE NATIONAL PARK SERVICE'S INVENTORY and Monitoring Program is a titanic effort to develop critical information about the natural resources found within 270 parks organized into 32 monitoring networks. The National Capital Region Network is one of the first networks to receive funding to develop a comprehensive long-term monitoring plan. In 2002 the National Capital Region Network reached some key milestones and emerged as a model for how monitoring networks were envisioned to function. The network has been successful in developing partnerships with other scientific entities to undertake inventory and monitoring activities and pooling the limited resources of its 11 parks, many of which are relatively small, with limited staff and resources devoted to natural resources.

One of the year's most important accomplishments occurred in July 2002 when the National Capital Region Network hosted a three-day monitoring workshop that was designed to further engage the scientific community. The workshop attracted more than 100 participants, representing some 28 agencies and organizations, 14 national parks, and five NPS divisions and regions. Technical input was gathered on the region's most important resources, including air, water, geology, landscape, vegetation, wildlife, invertebrates, and threatened and endangered species. Participants prioritized the threats to these resources and identified potential vital signs to monitor ecosystem health. The information gathered during the workshop will feed into the planning process and the development of the network's monitoring plan. Technical committees will continue to meet and build upon the momentum created by the workshop.

NPS PHOTO BY JOHN SINCLAIR

An inventory of the fish communities within six parks of the National Capital Region Network was implemented in 2002 by the network's Inventory and Monitoring Program. Using the Chesapeake Watershed Cooperative Ecosystem Studies Unit, the National Park Service established a partnership with Dr. Richard Raesly of Frostburg State University, who surveyed habitats along the Chesapeake and Ohio Canal National Historical Park.

Biological inventories of vertebrate species and vascular plants continued in 2002. The network coordinates the field research for these surveys, which are awarded primarily to partnering agencies, universities, Cooperative Ecosystem Studies Units, and private contractors through competitive contracts. Bird inventories using volunteers are the exception to this model. Initiated by the National Capital Region Network, this highly successful volunteer effort provides valuable information to the parks at no cost, promotes park appreciation, and develops community support for the Inventory and Monitoring Program (see page 21).

Begun in 2001, the monitoring portion of the effort also posted progress in 2002 on the seven-step implementation plan recommended by the national Inventory and Monitoring Program. The National Capital Region Network began the process by summarizing existing information on important resources, resource threats, management issues, current and historical monitoring, and monitoring needs in the parks. A science advisory committee—composed of a resource manager from each park, regional NPS staff, and scientists from partnering agencies—was formed to provide technical input for the development of the network's monitoring plan. Experts affiliated with other state and federal government agencies, universities, and conservation groups were invited to many of the committee's meetings to provide additional technical expertise on an ad hoc basis.

An important part of the National Capital Region Network's 2003 agenda includes enhancing understanding of and support for the Inventory and Monitoring Program. Network staff plan to participate in meetings related to conservation in the region, create fact sheets and newsletters, and meet with park staff who have regular contact with park visitors. Work will continue on inventory efforts and the development of the monitoring plan. In 2003 the National Capital Region Network looks forward to forging new partnerships and building upon the cooperative efforts that flourished in 2002. ■

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The cornerstone of natural resource stewardship: Vital signs monitoring

by Steve Fancy

IN 2002, AS A MAJOR COMPONENT OF THE NATURAL Resource Challenge, 12 "vital signs" monitoring networks encompassing 101 parks made considerable progress with the difficult task of developing an integrated natural resource monitoring program. Another 5 networks (for 52 parks) received planning funds. Together, these 17 networks are designing a system for natural resource data collection, analysis, and reporting that is unprecedented in the history of the National Park Service.

Natural resource monitoring identifies and tracks "the most significant indicators of ecological condition and the greatest concerns of each park," known as vital signs, to provide park managers with the broad-based, scientifically sound information they need to effectively manage park resources. Monitoring focuses on the natural resources that park managers are directed to preserve "unimpaired for future generations," including water, air, geologic resources, plants and animals, and the various ecological, biological, and physical processes that created the parks and continue to act upon them.

Why is the vital signs monitoring program so important to the protection of natural resources for future generations? Simply put, monitoring provides a basis for understanding and identifying meaningful change in natural systems characterized by complexity, variability, and surprises. Knowledge and understanding result in better management decisions and allow park managers to work more successfully with the public and other agencies to protect park resources. Additionally, the credible scientific information that results from monitoring can help to resolve contentious and difficult resource issues. For example, the challenge of sustaining a natural system is even more complicated when natural areas have been so highly altered that physical and biological processes no longer operate (e.g., control of fires and floods in developed areas). In these situations, monitoring can help managers understand how to develop the most effective approach to restoration.

"Vital signs monitoring is an ongoing effort with many partners to better understand how to sustain and restore park natural systems … before irreversible loss can occur."

Hawksbill turtles at Buck Island Reef National Monument in the Caribbean Sea have benefited from the efficient and cost-effective methods developed by the Virgin Islands/South Florida prototype network for monitoring and restoring sea turtle populations. In 2002, an interagency team of scientists reviewed the network's program and commended the park staff on their success.

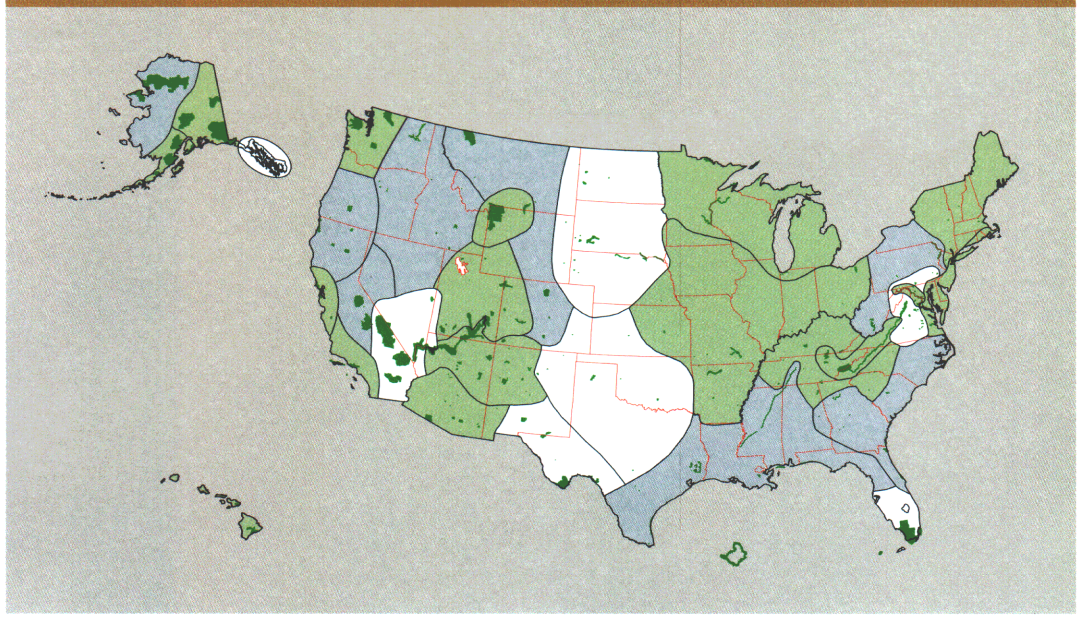
And why is the task of developing an integrated, multipark, and interagency monitoring program so challenging? Our understanding of ecological systems and the concepts of sustainability and integrity of natural systems has evolved: the classic view of the "balance of nature" has been replaced by a nonequilibrium paradigm. The new model recognizes that ecological systems are regularly subject to natural disturbances—such as droughts, floods, and fires—that alter the composition and structure of these systems and the processes that shape them. In addition, no single spatial or temporal scale is appropriate for all of the ecosystem components and processes. Depending on the resource, the appropriate scale for its understanding and effective management might be at the population, species, community, or landscape level. Not only are natural systems complex and ever changing, but parks are open systems. For example, threats such as invasive species and air and water pollution come from outside park boundaries. The scope and scale of many other threats and solutions also extend beyond park boundaries, requiring a multiagency, ecosystem approach to understand and manage these natural systems.

The overall strategy for implementing long-term ecological monitoring in approximately 270 parks with significant natural resources involves two components: 11 experimental or "prototype" monitoring programs begun in 1992, and 32 vital signs monitoring networks of parks linked by

Legend

- Monitoring networks funded in FY 2001–2003 for core park vital signs and water quality monitoring
- Monitoring neworks proposed for funding in FY 2004 for core park vital signs and water quality monitoring
- Monitoring networks that will not be funded as of FY 2005

PARK VITAL SIGNS MONITORING NETWORKS



NPS MAP BY NATURAL RESOURCE INFORMATION DIVISION

geography and shared natural resource characteristics. Parks within each of the 32 networks will work together and share funding and professional staff to plan, design, and implement an integrated, long-term monitoring program. Currently, 17 of the 32 monitoring networks are under way, and the remaining 15 networks await funding to make this important management tool available to the entire National Park System.

The complicated task of developing a network monitoring program requires an initial investment in planning and design to guarantee that monitoring meets the most critical information needs of each park and produces scientifically credible data that are readily accessible to managers and researchers. These front-end investments also ensure that monitoring will build upon existing information and understanding of park ecosystems and make maximum use of leveraging and partnerships with other agencies and academia.

At the end of FY 2002, the first 12 networks had completed Phase 1 of the three-phase planning and design process. The Phase 1 report developed by each network includes the results of summarizing existing data; defining goals and objectives; beginning the process of identifying, evaluating, and synthesizing existing data; developing draft conceptual models; and completing other background work that must be done before the initial selection of vital signs. The Phase 1 reports are peer reviewed and approved at the regional level before the network proceeds to the next phase. Phase 2 involves a series of meetings and scoping workshops to prioritize and select the indicators that will be included in the network's initial integrated monitoring program. Phase 3 entails the detailed design work needed to implement monitoring, including the development of sampling protocols, a statistical sampling design, a plan for data management and analysis, and details on the type and contents of various products of the monitoring effort, such as reports and websites.

During the past two years, park networks involved in the planning and design of monitoring programs have received assistance from numerous federal and state agencies, nongovernmental organizations such as NatureServe, private contractors, Cooperative Ecosystem Studies Units, and academic scientists from more than 100 universities. The efforts of these entities to develop an integrated, systems-based monitoring program have catalyzed the development of a number of interagency partnerships. Today, vital signs monitoring is an ongoing effort with many partners to better understand how to sustain and restore park natural systems, and it serves as an early-warning system to detect declines in ecosystem integrity and species viability before irreversible loss can occur. The vital signs monitoring networks are a central component of natural resource stewardship as the National Park Service embraces the concepts of "parks for science" and "science for parks." ■

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New aquatic resource professionals stationed in parks

by Dan B. Kimball

IN FY 2002 THE NATIONAL PARK SERVICE HIRED nine new field-based aquatic resource professionals to address a variety of critical needs. These new staff members are providing technical assistance to parks, identifying and conducting technical investigations to determine the condition of park aquatic resources, and determining if actions of the National Park Service or external parties impair or impact resources. They also are developing and implementing aquatic resource mitigation and restoration projects and interpreting and implementing NPS water resource–related policies and regulations. Of the 13 professional aquatic resource positions funded in FY 2002, 4 remain to be filled.

"These new staff members are … conducting … investigations to determine the condition of park aquatic resources and … implementing aquatic resource mitigation and restoration projects."

In deciding which aquatic resource disciplines would be required and where the new staff would be stationed, the National Park Service evaluated existing water resource–related issues and needs and the distribution of aquatic resource professionals in the parks. Based on this evaluation, the 13 newly funded positions include four fisheries biologists at Lake Clark National Park and Preserve (Alaska), Northern and Southern Colorado Plateau Networks, Chattahoochee River National Recreation Area (Georgia), and Isle Royale National Park (Michigan); four aquatic ecologists at Yukon-Charley Rivers National Preserve (Alaska), Point Reyes National Seashore (California), Saint Croix National Scenic Riverway (Wisconsin and Minnesota), and Center for Urban Ecology (National Capital Region); two hydrologists at Delaware Gap National Recreation Area (Pennsylvania and New Jersey) and Grand Teton National Park (Wyoming); a groundwater hydrologist at Sonoran Desert Network; a geomorphologist at Mount Rainier National Park (Washington); and a wetlands ecologist at Chattahoochee River.

These new staff members work on a wide range of water resource–related issues facing the parks. Some particularly significant issues to be addressed include the recovery of endangered fish (e.g., in the Colorado River), evaluating the water quality impacts of urban development (e.g., near Delaware Water Gap), assessing stream stabilization and the protection of cultural resources (e.g., Klondike Gold Rush National Historical Park, Alaska), analyzing the effects of beach replenishment projects (e.g., Fire Island National Seashore, New York), evaluating groundwater development near parks (e.g., Saguaro National Park, Arizona), and the reestablishment of anadromous fish populations in park waters (e.g., Point Reyes).

The Natural Resource Challenge calls for funding and placement of 16 new aquatic resource professionals in the parks by FY 2003. Funding for the final three positions is expected in FY 2003 and would provide two groundwater hydrologists at Chickasaw (Oklahoma) and Lake Mead National Recreation Areas (Nevada) and a marine ecologist at Fire Island.

Prior to funding provided by the Natural Resource Challenge, only 20 parks had aquatic resource professionals on staff. Founders of the Challenge recognized the need to increase professional expertise and to employ more park-based aquatic resource professionals to address water resource–related issues facing the National Park System. Consistent with the goals of the Challenge, these new positions will significantly enhance the National Park Service's capability to understand, maintain, restore, and protect aquatic resources in the national parks. ■

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NPS PHOTO

Hydrologists sample water quality in Lake Powell, Glen Canyon National Recreation Area, Utah. The Natural Resource Challenge funded a fishery biologist and water resource specialist to deal with natural resource projects and fishery issues in national parks in the Colorado River watershed.

Air quality monitoring capabilities improve thanks to Challenge

by Mark Scruggs

"The Challenge ... facilitated new monitoring ... of mercury and toxic organic pollutants and new ecological effects studies."

THE AIR RESOURCES DIVISION OPERATES a network of ambient air quality monitoring sites in many units of the National Park System. The parameters measured include ozone, dry deposition (gases and particles), wet deposition (precipitation chemistry), visibility, and particulate matter. The multiyear Natural Resource Challenge called for expanding the network to improve geographical representation, with emphasis on parks most threatened by air pollution or most vulnerable to air pollution degradation. As a result, the National Park Service began new monitoring in FY 2002 and is phasing in additional sites in FY 2003 and FY 2004. The expanded monitoring network now includes all parks classified under the Clean Air Act as Class I areas and a select number of Class II area parks.

EPA PHOTO BY DIXON LANDERS

The Natural Resource Challenge enabled the National Park Service in 2002 to begin surveying western U.S. national parks for toxic compounds in food webs. As part of the Western Airborne Contaminants Assessment Project (WACAP), NPS staff undertook a lake bathymetric assessment at Rocky Mountain National Park, Colorado.

The Challenge also facilitated new monitoring themes of mercury and toxic organic pollutants and new ecological effects studies. Ambient concentrations of mercury are usually low, but deposition of human-related sources of mercury into lakes and streams can trigger biological processes that chemically transform this element into a toxic form that can accumulate in fish and mammals. This occurrence can be harmful to the host and any organism that consumes it. The Air Resources Division initiated mercury sampling in four parks in FY 2002, with an additional site to be added in FY 2003, to determine the amount, extent, and seasonality of mercury deposition in national park ecosystems.

In 2002 the Air Resources Division initiated several projects addressing the ecological effects of air pollution in national parks. One study analyzes total deposition (cloud, fog, dry, and precipitation) patterns of pollutants such as nitrogen and sulfur, while another links ecosystems and nitrogen cycling models to estimate the threshold of nitrogen deposition when sensitive lakes become acidic. A third study examines ozone pollution damage to the growth and physiology of native trees and wildflowers. A related project correlates remote sensing of tree condition with field measurements of ozone concentration, tree condition, and soil moisture to develop large-scale predictive techniques for determining where forest stands will be at high risk for ozone injury.

The National Park Service is also concerned about risks to park food webs from airborne contaminants. Toxic airborne compounds pose serious health threats to wildlife and humans, affecting reproductive success, growth, behavior, disease, and survival. Consequently, the Air Resources Division initiated the Western Airborne Contaminants Assessment Project, a five-year program funded by the Challenge to inventory contaminants in western U.S. national parks and to develop scientific information on the exposure, accumulation, and impacts of toxic compounds in the food chain. Inventories of contaminants from snow, water, sediment, lichen, bark, and fish will be conducted in seven key parks in the West and Alaska. Contaminant concentrations in wild foods consumed by subsistence users will also be assessed in Alaska.

In addition to funding new monitoring and studies, the Natural Resource Challenge supported long-established air quality monitoring efforts in national parks and augmented data management, reporting, and interpretation. The National Park Service is now able to fill in data gaps in the existing monitoring network, expand the scope of air quality monitoring activities, and maintain sites, improving our understanding and interpretation of air pollution transport, concentrations, and effects. The Challenge funding also added to the professional expertise of the Air Resources Division to better serve local and regional resource management needs. This initiative enhances the opportunity for the National Park Service to engage fully and effectively in external arenas where decisions regarding pollution control programs are being made. ■

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Learning centers ignite interest and advance research in national parks

by Lynne Murdock

NPS PHOTO (ALL)

A joint venture between Kenai Fjords National Park and the Alaska SeaLife Center in Seward, the Ocean Alaska Science and Learning Center promotes research and educational opportunities related to the Alaskan coast and waters. As part of a learning center–sponsored conference on Alaskan ocean resources, students learned to use global positioning systems for beach mapping.

The Ocean Alaska Science and Learning Center is funding a productivity study of the black oystercatcher, a shorebird whose recovery since the 1989 *Exxon Valdez* oil spill in Kenai Fjords National Park is unknown.

IN 2002, NPS LEARNING CENTERS, A KEY COMPONENT of the Natural Resource Challenge, made tremendous progress in igniting the interest of the American public in the unsurpassed scientific and educational opportunities found in national parks. Learning centers have been designed as public-private partnerships that involve a wide spectrum of people and organizations in opportunities to better understand our natural world and to apply science in park management. The centers attract researchers not affiliated with the National Park Service to conduct research and make new information about park resources available to park managers and partners, the public, and neighboring communities. In 2002 eight new learning centers moved into various stages of development and the initial five learning centers continued to serve as field stations for collaborative research activities.

Collaboration and cooperation are the hallmarks of learning centers, serving to leverage the resources of the National Park Service and its partners. A shining example in 2002 is a joint effort between the National Park Service and the State of Maine to develop the Acadia Learning Center. The center will be sited on a 100-acre former Navy base acquired by the National Park Service on 1 July 2002. Through coordinated funding and planning, the base will be converted to suitable laboratory, classroom, office, and residential facilities.

Many of the learning centers are engaging students and volunteers in programs that provide hands-on opportunities to explore science; in most cases the efforts of students and volunteers also benefit the parks. For example, the North Coast and Cascades Learning Center, which is in its first year of operation, provided science programs for 16,400 children, teenagers, and adults in 2002. One of the center's projects helped North Cascades National Park team up with EarthCorps and Seattle Parks and Recreation to involve 200 students from inner-city Seattle in a project to control nonnative invasive plants. Through another educational partnership project, Cape Cod National Seashore's Atlantic Learning Center is partnering with NASA to develop an education program on remote sensing that involves both teachers and researchers. The program, funded by a grant from the National Park Foundation, will use existing remote sensing research to demonstrate remote sensing technology, enabling students and teachers to use these tools to interpret data collected locally.

Learning centers are well on the way to becoming leaders in education and outreach. The Pacific Coast Learning Center won awards from the National Association for Interpretation in 2002 for a curriculum guide, *Discovering the Northern Elephant Seals*, and for a redesigned website. The center also received a 2002 Department of the Interior Environmental Achievement Award for exceptional contributions in the area of education and outreach.

In 2002, learning centers also advanced groundbreaking research that benefits national parks. Researchers working in conjunction with the Appalachian Highlands Science Learning Center are addressing priority research needs at Great Smoky Mountains National Park, including the effects of ground-level ozone on native plant species; inventories of invertebrate, plant, and fungi species; and monitoring of songbird, salamander, and moth populations. Researchers and volunteers at Rocky Mountain National Park, working through the Continental Divide Research and Learning Center, also made significant contributions in 2002 (see page 14).

In addition to the 13 learning centers that are currently in operation, proposals for 17 more have been approved for establishment should funding become available in the future (see page 10). Each proposed center represents the possibility inherent in the Natural Resource Challenge to focus energy, commitment, and resources on better understanding our natural heritage. ■

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Initiated in FY 2002, the Old-growth Bottomland Forest Research and Education Center is hosted by Congaree Swamp National Monument, South Carolina. During the year the center facilitated research and educational activities, including a program to familiarize the public with fish species being investigated at the park.

Ecological integrity goals prompt expansion of Canadian national park system

by Carrie Ellen Gauthier

"Both park systems face the same threats from ecological stresses, nonnative species, fire, high levels of visitor use, habitat loss and fragmentation, ... and climate change."

IN NOVEMBER 2002 THE CANADIAN GOVERNMENT announced plans to create 10 parks and 5 new marine conservation areas over the next five years. During this time Canada also plans to accelerate actions to improve the ecological integrity of its 39 existing national parks. The increase in parkland and efforts to improve ecological integrity will implement the action plan of the panel on Ecological Integrity of Canada's National Parks.

Canada's plan focuses on inventory and monitoring, science-based decision making, developing partnerships, education, and increasing public participation, and shares many of the same fundamental goals and approaches as the National Park Service's Natural Resource Challenge. Both action plans support parks as living laboratories and identify the need to provide funding to researchers, make research at parks more accessible, and enhance opportunities for science-based education in parks.

The NPS Associate Director of Natural Resource Stewardship and Science, Dr. Michael Soukup, gave the keynote address in November 2002 at a three-day ecological integrity forum launching Canada's action plan in Halifax, Nova Scotia. Soukup focused on the increased benefits that both park systems will share with the expansion of their inventory and monitoring, improvements in science-based decision making, and implementation of better management practices to preserve natural resources. He stressed the value of gathering information about species distribution, abundance, and trends, and air and water quality for sound management, decision making, and resource problem characterization.

Both park systems face the same threats from ecological stresses, nonnative species, fire, high levels of visitor use, habitat loss and fragmentation, air and water pollution, encroachment of urban and industrial development, and climate change.

Canada's new park sites will be located in British Columbia's Gulf Islands, at Ukkusiksalik and Bathurst Island in Nunavut, in Labrador's Torngat and Mealy Mountains, in Manitoba's lowland forests, and on the East Arm of Great Slave Lake in the Northwest Territories. Canada will also add national marine conservation areas in ecologically unrepresented marine regions. Three sites have been identified: Gwaii Haanas of British Columbia's Queen Charlotte Islands, Western Lake Superior, and British Columbia's Southern Strait of Georgia. Sites for the remaining two marine conservation areas have not been announced. ■

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Pender Island is part of a proposed national park in the Gulf of Georgia, British Columbia, about 10 miles north of the U.S. San Juan Island National Historical Park.

PARKS CANADA (ALL)

Adjacent to Hudson Bay in Nunavut, Canada's third and newest territory, Wager Bay is in the heart of the proposed Ukkusiksalik National Park and represents the central tundra natural region of Canada. The proposed park area is geographically diverse and encompasses habitats that support caribou, muskox, wolf, arctic hare, peregrine falcon, gyrfalcon, polar bear, beluga, and ringed and bearded seal.

Étagaulet River Falls in the proposed Mealey Mountains National Park, Labrador.

NPS PHOTO

Dan Boughter, Jim Bromberg, and Andy Wisdom of the California EPMT cut eucalyptus trees at Cabrillo National Monument, San Diego, and apply salt (instead of herbicide) to the stumps before covering them in black plastic.

Exotic plants diminish under EPMTs

by Linda Drees

In 2002 five new Exotic Plant Management Teams (EPMTs) controlled damaging invasive plants that threaten native species conserved in the national parks. In total, nine teams served more than 95 parks, treated more than 100 species of harmful invasive plants on 85,000 infested acres, monitored more than 41,000 acres, and restored 8 acres. Six species of invasive plants have been eradicated from parks since the establishment of EPMTs.

EPMTs were first formed in 2000 with funding from the Natural Resource Challenge. As mobile strike forces consisting of plant management specialists, EPMTs assist parks with urgent invasive plant control measures. The teams have increased their technical capacity through the recent development of a Web-based data system and a corresponding Geographic Information Systems map to track progress at each project site and to illustrate the link between monitoring and management. An annually updated EPMT operations handbook provides EPMTs and other partners with a framework for developing rapid response teams. The NPS EPMTs are proving so successful that the National Wildlife Refuge Association is requesting funding for 50 of its own teams for the Wildlife Refuge System.

Seven more teams were requested in FY 2003 to serve national parks in the following areas: Colorado Plateau, Northern Rockies, Great Lakes, Mid-Atlantic, Northeast, Appalachian Highlands and Cumberland Piedmont, and Alaska. As Natural Resource Challenge support of EPMTs has grown, exotic plants have diminished and park natural resources are being protected. ■

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Learning centers meeting most objectives

With 17 learning centers proposed for future establishment, the Secretary of the Interior asked the National Park Service in 2002 to evaluate operational centers before additional funding would be considered to expand the network. The analysis focused on the initial five learning centers and found them to have great potential for increasing partnerships, cooperation, and collaboration and for giving parks the information they need but may never have the staff or internal funding to obtain.

Several accomplishments highlight the early success of the learning centers. The centers are largely meeting their research-related objectives. Most have expanded facilities for researchers, including housing, and have increased the amount and quality of the research being conducted. They are becoming excellent venues to engage "citizen scientists" in research and have programs for informing the public about what is being learned about park resources. The Internet, intranet, science conferences, and school science curriculums are all proving to be valuable avenues for information dissemination. Many strong and diverse partnerships have been formed and are furthering the goals of the learning centers. One area needing improvement is the coordination of research and informational functions between a park that hosts a learning center and the other parks in its network. Other than the Ocean Alaska Science and Learning Center, which benefits all its member parks, the initial learning centers tend to focus on the host park and are just beginning to coordinate these functions with other parks. All in all, the initial learning centers are succeeding in facilitating research in national park networks in collaboration with partners, and are serving as a catalyst to share knowledge widely.

The report was transmitted to Secretary Norton in August and recommended that the waiting list of 17 learning centers be approved for FY 2003 funding. ■

AWARD-WINNER PROFILE

A champion for the Natural Resource Challenge

NPS PHOTO

Don Neubacher

Although he serves as superintendent of Point Reyes National Seashore in California, Don Neubacher is a champion for the preservation of natural resources throughout the National Park System. "I enjoy working on something that's a legacy for the nation; it's a public service that has long-lasting value and I'm pretty inspired by that." The leadership Don has demonstrated in pursuing the Natural Resource Challenge helped to earn him the 2002 Director's Award for Superintendent of the Year for Natural Resource Stewardship.

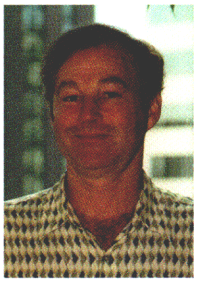
Don is a talented superintendent and has successfully managed several controversial issues during his career. He professionalized the staff of the national seashore, established lines of communication with the park's local and extended communities, and created closer ties among federal, state, and other agencies and nongovernmental organizations. His most notable achievement, however, has been five years in the making: Don helped envision and implement a major, national natural resource initiative, the Natural Resource Challenge. This program, which began in 2000, is designed to increase funding for the National Park System by $100 million annually and identifies numerous actions needed to improve the capabilities of the National Park Service to sustain park natural resources. Funding increases have already gone toward initiating nationwide natural resource inventories, establishing long-term monitoring programs, enhancing air and water quality, and creating Exotic Plant Management Teams, learning centers, and Cooperative Ecosystem Studies Units.

Don's role in pursuing this initiative has been crucial. He testified before Congress, met with the National Leadership Council and regional councils, and has educated NPS employees through presentations and literature that he and his staff developed. His energy and dedication to the Natural Resource Challenge are endless, and his leadership at Point Reyes and for this important national program is evident in the support he receives to help manage major projects. ■

AWARD-WINNER PROFILE

Changing the way the National Park Service does business

NPS PHOTO



Steve Fancy

Dr. Steven Fancy was honored in 2002 with the Professional Excellence in Natural Resources Award. He helped engineer the network concept for vital signs monitoring and was also the author of the NPS Monitoring Vision in 1999. Through his leadership and dedication, the concept of monitoring networks is becoming a reality. For Steve, it was about stepping up to the plate. "I saw a window of opportunity and I became a workaholic and did what was needed to get the program going. It took organizing, getting others involved, and establishing a vision; in the end, it got people to work together to move forward."

People did move forward and, in doing so, created a monitoring network that has essentially changed the way the National Park Service does business. It allows for data to be gathered by the parks, regions, and divisions, and makes information available to park resource managers and decision makers. The successful concept is about sharing rather than concentrating on individual projects. Steve realizes how his hard work is paying off. "The Inventory and Monitoring Program has become a unifying program. It brings people and parks together; while parks used to compete [with one another for funding and staff], now they are on the same side. It's an interdisciplinary approach to help parks work on things they have in common."

Steve has stepped into a leadership role and performed his duties with great skill. He works hard to get people to follow, and in turn, people work hard for him. ■

"If I can help document … change and thereby highlight the effects of our collective actions on the world and particularly on the invertebrate world, a world rarely noticed by humans but comprising over 90% of the species found on Earth, my retirement will be meaningful to me."

Rich Bray, Volunteer, Rocky Mountain National Park

Citizen Scientists

Intern Heather Amann prepares to untangle a bird from a mist net so that it can be identified, measured, and banded, as coauthor Paul Super looks on. Amann, interested originally in studying voice in college, served as an intern with Great Smoky Mountains Institute at Tremont and has gone on to major in biology. She says, "My volunteer experience helped me realize that I wanted to pursue a career in environmental science to become a park ranger."

The National Park System is reaping tremendous benefits from volunteers assisting park staffs with developing the scientific knowledge needed to manage natural resources in the national parks. These "citizen scientists" are often high school or college students who may become the professional park scientists of tomorrow. Others, including park neighbors, enjoy contributing to parks they love and learning about science and its role in park management. Retired professionals share their invaluable, lifelong skills with our national parks. Working with professionals who design and manage research projects, citizen scientists extend the range of park science, enabling biological inventories to cover larger areas and sampling more frequently than could be accomplished with paid staff. National parks and their partners recruit participants and provide training and coordination, often in association with one of the 13 learning centers now operating in the national parks. Articles in this chapter reflect an encouraging trend: public involvement in scientific inventories, resource monitoring, and other research and park management endeavors, often aided by Natural Resource Challenge–funded programs. National parks have profited from an engaged and committed volunteer workforce in 2002.

Citizen science a key component of Smokies resource management

by Michelle Prysby and Paul Super

"Students are part of a growing effort to involve volunteers in the real work of inventorying and monitoring the park's resources."

IT'S JULY AND THREE HIGH SCHOOL STUDENTS trek up a sunny slope in Great Smoky Mountains National Park carrying nets and vials. They lay out a strip of brightly colored bowls filled with soapy water, then spend 30 minutes catching bees as they gather nectar from summer wildflowers. By the end of the day, the pan traps will be filled with more than a dozen species of bees that the students will pin and label along with the bees caught on the wing.

These students are part of a growing effort to involve volunteers in the real work of inventorying and monitoring the park's resources. Without their involvement, most of these projects could not be attempted. In addition, the volunteers benefit from what can be a life-changing experience that could lead them into the fields of scientific research and resource protection. Citizen (or amateur) scientists are collecting data for studies on salamanders, bees, snails, beetles, daddy longlegs, archeology, and more. Many of these projects are part of the All Taxa Biodiversity Inventory (see page 20).

COPYRIGHT GREAT SMOKY MOUNTAINS INSTITUTE AT TREMONT

Aided by a summer research assistant at Great Smoky Mountains Institute at Tremont, students identify moths caught the previous night. The youths are part of Teen Science Camp, a 10-day event in which students assist with various research projects at the park. Erin Henegar (far right) is majoring in biology at college. Citizen efforts have added more than 100 new moth species to park lists.

Great Smoky Mountains Institute at Tremont, Appalachian Highlands Science Learning Center, and the nonprofit Discover Life in America work in conjunction with the park Resource Management and Science and Resource Education Divisions to involve citizens in research in a way that optimizes both the educational and scientific benefits. These citizen science efforts began in 1999, and 2002 saw the launching of several new projects and the expansion of continuing projects.

Surveying along park trails is an excellent way to gather quantitative data on species distributions that can be used for developing habitat models, but most scientists are able to visit only a small area of the park. By 2002, volunteers had collected data on the distribution of more than 40 species of ferns along one-tenth of the park trail system. Using this same model, 54 high school students collected data on Turk's-cap lily *(Lilium superbum)* in advance of reintroduced elk moving into the lily's habitat.

Based on an Australian model, the park's FungiMap project was launched in 2002. Tapping into the expertise of the Asheville Mushroom Club and other mushroom enthusiasts, volunteers are submitting observations of a set of 50 species that are easily identifiable in the field.

Gardens for monitoring the effects of ground-level ozone on native plants have been in place in the park since 2001. With the help of the scientists working on this study, these gardens were being installed in 2002 at sites in school yards, Pisgah National Forest, Blue Ridge Parkway, and Obed Wild and Scenic River to allow students to collect data on local effects while learning about air quality issues.

Using a refrigerator with an attached ultraviolet light, students and adults at the institute monitor moth diversity and abundance on a weekly basis, releasing most of the captured moths alive. A parallel project at the Appalachian Highlands Science Learning Center began in 2002. More than 100 new park species records have been added by these citizen scientists.

Not only is citizen science a useful research tool, it also is a good way to provide visitors with a real connection to park resources. Some students have chosen careers in the National Park Service or in science because of their research experiences. Teacher participants have incorporated more inquiry into their curricula. Through Parks-as-Classrooms and the institute, some teachers are even conducting comparative studies between the park and their school yards. ■

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Rocky Mountain National Park benefits from citizen scientists

by Cheri Yost

"In 2002 a legion of citizen scientists donated more than 5,600 hours to Rocky Mountain National Park research projects through the Continental Divide Research and Learning Center."

AT AN ELEVATION OF 13,160 FEET IN COLORADO sits a field of pink granite boulders that visitors scamper over on their way to the summit of Rocky Mountain National Park's highest mountain, Longs Peak. It is a stark place devoid of vegetation, scoured by strong winds, and dried by intense sun. Few visitors know that it is among the most complicated landscapes in the park. Geoscientist Jon Achuff has studied this area and believes the entire Longs Peak Boulder Field is moving on a glacier. His research is time-consuming and strenuous, requiring him to carry delicate equipment in all seasons more than 7 miles to the research site. This research effort is astonishing for another reason: Achuff is a volunteer. In 2002 a legion of citizen scientists donated more than 5,600 hours to Rocky Mountain National Park research projects through the Continental Divide Research and Learning Center.

NPS PHOTO (BOTH)

National Park Service volunteer Jim Snider explains a wilderness study to a potential participant.

Research volunteers came from diverse backgrounds and worked on a variety of research activities in 2002, ranging from a Girl Scout troop distributing cameras for a wilderness study to retirees researching the history of the park's buildings. Groups and individuals monitored vegetation recovery in a burned area, studied rare plant species, observed bighorn sheep behavior, counted elk, monitored air quality, and mapped vegetation for amphibian habitat. The learning center also recruited volunteers for cultural resource projects, enlisting them to research specific historical topics, preserve photographs and documents, and measure historic structures.

Professional scientists are also a critical part of the citizen scientist volunteer initiative at Rocky Mountain National Park. Volunteer and principal investigator Rich Bray has led the butterfly monitoring efforts for the past six years, donating a total of 6,000 hours. Not only do researchers like Bray give their own time, but they also help train others. With the help of the learning center, Bray recruited and trained volunteer field assistants. The financial value of the contribution of volunteer scientists is also substantial. For example, Achuff's glacier studies would have cost the park or its partners approximately $35,000, and volunteer efforts to measure historic buildings saved the park thousands of dollars in contract fees.

Whether they are volunteers assisting researchers with a specific project or professional scientists acting as principal investigators, research volunteers work closely with park professionals to develop and complete research projects. Volunteer researchers extend the capacity of the National Park Service to develop the science necessary to appropriately manage park resources. For example, volunteers working with a university researcher observed the behavior of bighorn sheep, helping park scientists to develop quantitative documentation of the influence of cars and people on bighorn behavior. Based on this research, managers are creating a strategy for reducing stress on the animals when they attempt to cross a popular park road to access a mineral lick.

Not only does the park benefit from citizen scientists, but also volunteers deepen their understanding of the complexities of ecosystems, learn about the quandaries of resource protection, and become active stewards of the park's natural and cultural resources. In addition to providing exceptional educational opportunities, parks are living laboratories that offer unparalleled research possibilities to professional scientists. National parks allow researchers to investigate natural systems that are relatively undisturbed, providing important opportunities to develop baseline information.

Supporting park research and providing exceptional educational experiences are the dual goals of the National Park Service's learning centers. The Continental Divide Research and Learning Center found an exciting and rewarding way to reach these goals by recruiting citizen scientists to assist with park research activities. ■

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With Longs Peak of Rocky Mountain National Park in the background, volunteer and principal investigator Jon Achuff, other volunteers, and park staff survey the Longs Peak Boulder Field for glacier movement.

The Natural Resource Challenge promotes education and stewardship in John Day Fossil Beds

by Tom Rodhouse and Lisa Garrett

IN 2002, BIOLOGISTS TOM RODHOUSE AND Alan St. John brought learning and volunteer opportunities to educators and their students in the John Day Fossil Beds National Monument, Oregon. The two were contracted by the National Park Service Northern Semi-Arid Network to conduct the Natural Resource Challenge biological inventory of birds, mammals, reptiles, and amphibians. Tom and Alan arranged for school groups, community volunteers, and NPS interpreters to meet them in the field and lend their eyes, ears, and hands to aid the project.

"Kids are great at finding stuff and they can cover a lot more ground than I can alone," according to Alan, a herpetologist, after an outing with young volunteers in a search for the elusive pygmy short-horned lizard. "Plus, it's great fun for them and they certainly are learning at the same time."

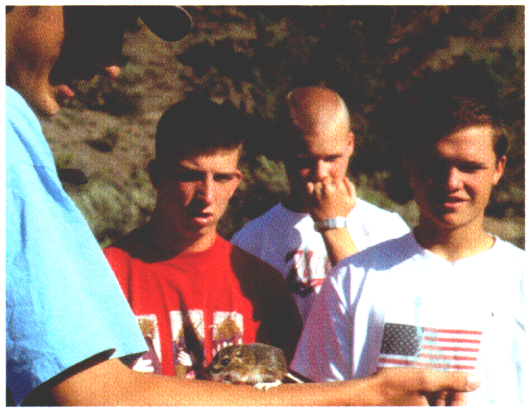
"The use of volunteers is a great introduction to citizen involvement and stewardship in national parks."

In exchange for their help, volunteers are rewarded with exciting close encounters with park animal species such as bats, pocket mice, and rattlesnakes. The use of volunteers is a great introduction to citizen involvement and stewardship in national parks. Many volunteers are surprised at the diversity of animals in the John Day Fossil Beds, and their enthusiasm is increased as they realize the importance of this first-ever comprehensive inventory to park management.

Although located in remote eastern Oregon, John Day Fossil Beds is frequently visited by school groups from across the state. Hancock Field Station, an Oregon Museum of Science and Industry environmental education camp, is located in the national monument and provides an excellent link between students and science activities at the park. Field station instructors were recruited as volunteers early in the summer season and were able to incorporate inventory activities into their school programs and summer camps.

National Park Service staff also provide educational programs to visitors. The experiences they have gained working with the biological inventory have enhanced their knowledge of natural resources in the park and enriched the content of these programs. Several staff members have even become regular after-hours assistants on bat mist-net outings for the inventory.

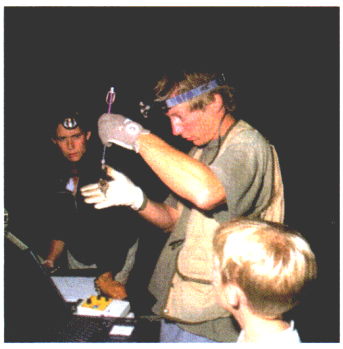
John Day Fossil Beds is an interesting site in which to conduct a biological inventory given its spectacular fossil record. For example, a group of Oregon State University biogeography students recently spent a morning working in the field with the small mammal inventory and an afternoon in the lab visiting the monument's mammal fossil collection. The group's instructor, Dr. Mary Santelmann, has brought students to the park before, but was very excited that this year students could get out in the field with scientists studying present-day fauna. "There is something about holding a small furry creature in your hand that engages the imagination. When the students looked at fossil teeth, bones, and skulls, I could see they were starting to 'see' the animal and not just the pieces."



NPS PHOTO BY TOM RODHOUSE

High school students closely examine a kangaroo rat in John Day Fossil Beds National Monument as part of the first comprehensive inventory of park mammals, birds, reptiles, and amphibians. School groups, volunteers, and NPS interpreters all played roles in the surveys, increasing their appreciation of park biological diversity, management, and science.

Volunteer involvement in the 2002 John Day Fossil Beds inventory was largely an informal and spontaneous arrangement. Tom and Alan, who have both worked as educators in the past, met with volunteers and students when schedules and activities coincided. The benefits to the National Park Service inventory and the public were clearly demonstrated in 2002. Tom and Alan both hope to see increased citizen involvement in the inventory in 2003 and will be looking for ways to formalize arrangements with educators to involve students. ■



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Biologist Tom Rodhouse weighs a Yuma myotis bat. The inventory revealed baseline species information for management and presented excellent learning opportunities for school-age students and adult volunteers alike.

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Involving the public in the search for rare plants at Point Reyes National Seashore

by Michelle Coppoletta

"The events drew a wide diversity of participants that included teachers, engineers, artists, students, and amateur and professional botanists."

POINT REYES NATIONAL SEASHORE HOSTS MORE than 900 species of flowering plants, representing approximately 16% of the plant species known to occur in California. Five plant species at Point Reyes appear on the federally endangered list, 21 are federal species of concern, and the California Native Plant Society lists an additional 24 plant species as rare. Since 1984, park staff and a devoted group of volunteers have monitored rare plant populations at Point Reyes. Before 2001, comprehensive information describing the abundance and distribution of many of these rare species did not exist. Recognizing the need for a rare plant inventory and faced with the daunting task of surveying more than 71,000 acres of potential habitat, resource managers created an event called the "Rare-Plant-A-Thon." This event involves members of the local community, agency botanists, students, and plant enthusiasts from around the San Francisco Bay Area in the search for undocumented rare plant populations within the national seashore.

In 2002, park vegetation managers hosted two Rare-Plant-A-Thons. More than 100 volunteers participated in these weekend events, traveling from as far away as Sacramento, Los Angeles, San Francisco, and Death Valley. The events drew a wide diversity of participants that included teachers, engineers, artists, students, and amateur and professional botanists. At the start of each event, volunteers received training that included a slide show of the seashore's rare plant species and a discussion of where participants might expect to encounter them. Park staff and local botanists then led small groups of volunteers to different areas within the seashore with instructions to survey and monitor rare plant species.

In addition to involving the public in the park's management activities, Rare-Plant-A-Thon events have made a large contribution to the Point Reyes inventory effort as a whole. As a result of the 2002 events, 23 previously unrecorded rare plant populations were located, documented, and mapped. One of these new occurrences was the first documented population of a very recent addition to the seashore, the federally endangered robust spineflower *(Chorizanthe robusta)*. Volunteers also monitored and mapped 18 known rare plant populations. One group helped transplant the federally endangered wetland grass Sonoma alopecurus *(Alopecurus aequalis* var. *sonomensis)* into the wild as part of a reintroduction project.

Whether participants were experienced botanists seeking opportunities to photograph endangered species or individuals who simply wanted to learn more about California's coastal wildflowers, the response was universal. Volunteers couldn't wait to come back for more. These events have generated such excitement and interest from participants that the Rare-Plant-A-Thon has now become one of the seashore's annual events. A resource management success story, the Rare-Plant-A-Thon increases local awareness and inspires enthusiasm for the abundance and diversity of rare plant species in Point Reyes. ■

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NPS PHOTO BY MICHELLE COPPOLETTA

A Rare-Plant-A-Thon volunteer climbs a hillside above Tomales Bay in Point Reyes National Seashore in search of coast rock cress *(Arabis blepharophylla)* and other rare plants. During two weekends in 2002, more than 100 volunteers surveyed the park, documenting 23 previously unrecorded rare plant populations and taking part in related restoration activities.

Hands-on science brings student researchers to Yosemite National Park

by Kathy Dimont

YOSEMITE NATIONAL PARK AND THE UNIVERSITY of California signed a memorandum of understanding that promises to fulfill goals of both entities with the creation of the Environmental Science Academy program. The university's new campus in nearby Merced focuses on science and research, and the proximity of the park offers an excellent opportunity for field studies. Additionally, the university serves the growing and culturally diverse population of California's Central Valley. The San Joaquin Valley's population expands by about 100,000 residents per year, dominated by Latinos, Asians (primarily Vietnamese and Hmong), African Americans, and other ethnic groups. The park wants to reach these audiences to help them form meaningful relationships with Yosemite National Park and to foster resource conservation.

NPS PHOTO BY JEFFREY TRUST

"Behaviors, beliefs, attitudes, and aspirations are changed by allowing students to interact directly with park resources."

Capitalizing on the combined strength of the university and park systems to reach those goals, the park, University of California–Merced, and the Merced Union High School District work together to immerse high school students in natural resource education. The USDA Forest Service also joined the partnership with the participation of their wilderness education coordinator. Students selected by their science teachers begin park classes in the summer following their freshman year. Park resource management staff and USGS scientists involve the students in projects related to air quality, water quality, geology, fire ecology, plant ecology, wildlife biology, and other studies. Students collect data throughout the watershed of the South Fork of the Merced River and participate in backpacking trips, including a six-day trip into the Clark Range, that allow them to experience the outdoors in a way they never have before. They offer their findings in presentations delivered to their families, park managers, school boards, and alumni groups. The program offers students the opportunity to return to the park each summer for advanced classes. Many of these students plan to enroll in the University of California in natural resource–related majors after completing high school.

The partnership between the university and the park allows low-income students to be the first in their families to attend college. The university provides mentors, tutors, and financial aid advice, while the park has been able to offer salaried positions in the California Welcome Center in Merced to five students each summer through a grant from the Ford Foundation. There they provide information to travelers, focusing on alternative transportation methods to help ease traffic congestion in Yosemite. Graduates of the program can serve in Ford-sponsored summer internships in the park and will also be eligible for STEP (Student Temporary Employment Program), SCEP (Student Career Experience Program), and other park employment opportunities. The program lays the foundation for a future employee pool for the National Park Service that serves a national goal of cultural diversity in hiring.

The program, begun in 1999, delivered its first graduates in 2002. It is only a beginning, but these students are reaching out exponentially to their peers, families, and communities with a conservation message, proving that the program is working. One young Hmong student tested water samples from the headwaters of the Merced River through the park and national forest, through agricultural land, and into the city of Merced. As a result of his findings, he and his family no longer eat fish caught in or near the city. One young Latina told of watching in horror as a peer threw fast-food containers into the shrubbery, then admitted that she was once guilty of thoughtless littering herself. Behaviors, beliefs, attitudes, and aspirations are changed by allowing students to interact directly with park resources. The science behind the program offers a new view of the world for these students, a place that they've learned to cherish through the Environmental Science Academy. ■

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The Environmental Science Academy combines the strengths of Yosemite National Park and the University of California, exposing high school students from various backgrounds to field-oriented science and conservation and encouraging personal growth. In stark contrast to when they were selected for the program and not planning to attend college, nearly all participants who have completed the program are now enrolled in college; most are majoring in science.

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Merced River and El Capitan,
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NPS PHOTO BY GEOLOGIC RESOURCES DIVISION

NPS PHOTO

Youth biologist Casey Salestrom is now enrolled in the Wildlife Ecology Program at Colorado State University and plans to pursue a master's degree in marine science and ecology.

Youth biologists busy at Grand Canyon

by Elaine F. Leslie

Summer 2002 marked the sixth year that NPS biologists at Grand Canyon National Park, Arizona, have demonstrated the concept that parks are powerful environments for learning. The park and Grand Canyon National Park Foundation sponsor volunteers with a keen interest in biology and the work of the National Park Service. For two to four weeks, park staff supervise the volunteers, who range in age from 10 to 17. The program has attracted young people from coast to coast.

These youths participate in ongoing wildlife inventory and monitoring projects on the North and South Rims and along the Colorado River corridor. After training, they resolve human-wildlife conflicts, present interpretive programs, collect data from DNA sampling transects as part of noninvasive carnivore studies (see page 23), and live-trap small mammals for a vertebrate inventory. In 2002 they documented a species of kangaroo rat that was not known to inhabit the south side of the Colorado River (the river was thought to have been a barrier to the species).

Park staff fully understand the importance of involving young people in science as soon as they express an interest. The young volunteers acquire useful skills in wildlife management and have an opportunity to understand the role and function of a park biologist. These youths have gone on to graduate from college and have entered into advanced studies in wildlife ecology. Although this program requires patience, the investment pays off and has proved to be an enriching experience for volunteers and park staff alike. ■

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Great Smokies species numbers continue to climb

by Becky Nichols

The All Taxa Biodiversity Inventory (ATBI), a long-term effort to document all life-forms in Great Smoky Mountains National Park, completed its fifth year in 2002 and continued to build momentum. The park has hosted several "bioquests," events designed to identify a large number of specimens over a short period of time. Many scientists are on-site during these events, in addition to volunteers and students who assist and learn from the scientists. The largest bioquest to date brought together 30 lepidopterists (moth and butterfly specialists) in the park from June 9 to 11, 2002.

During this event, special emphasis was placed on high-elevation habitats—areas that may be at great risk from air pollution and global warming. Teams of volunteers, with llamas to carry the heavy traps and batteries, visited four remote balds. At lower elevations, schoolchildren beat the bushes for caterpillars and leaf miners. Overall, collecting was heaviest the first day, with the second day devoted to producing vouchers—specimens that scientifically document species presence—and species lists.

As of December 2002, the total number of identifications for the two-day quest stood at 860 species, but more are being identified in the researchers' labs. Of this total, an estimated 51 were undescribed species and 133 other species were new records for the park. For the ATBI as a whole, by year's end 334 undescribed species had been reported and an additional 2,121 new park records had been documented. These numbers change rapidly as the project moves forward. ■

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Butterfly and moth experts sort and identify specimens caught during the 2002 lepidoptera quest.

Volunteers vital in completing National Capital Region bird inventories

by John Sinclair

In the early stages of the National Capital Region's Inventory and Monitoring Program, a data review determined that additional baseline information on bird species within six National Capital Region parks was needed. A large number of avid bird-watchers and clubs within the region provided a cost-effective means to complete the inventory. More than 30 volunteers have joined efforts with the National Park Service at Antietam National Battlefield, Catoctin Mountain Park, Harpers Ferry National Historical Park, Manassas National Battlefield Park, Prince William Forest Park, and Wolf Trap Farm Park. These skilled birders began visiting the parks in January 2001 and have collectively spent more than 2,300 hours in the field, 925 hours in 2002, and have identified 175 species, with more than 140 species identified in 2002. Many of these species have never been recorded in the parks. Furthermore, the volunteers have made special efforts to confirm nesting species, particularly those identified as species of concern by Partners in Flight, a cooperative effort among multiple agencies, nongovernmental organizations, and industry to conserve birds. The data collected will provide park managers with seasonal and breeding distributions, which can be used to identify and protect critical habitats.

Thanks to the efforts of the volunteers, the initial program goal of documenting 90% of the expected resident bird species has been reached at four of six parks. However, because the program is volunteer-based, it will continue at all parks only so long as participants are interested. ■

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Volunteers survey bird species at Manassas National Battlefield Park, Virginia.

"This is the Information Age.... Parks are created to a higher standard; the National Park Service should be held to a higher standard. The Park Service must take whatever steps are required to secure the information needed to make sound management decisions."

Dr. Robin Winks, environmental scholar and former chair, National Park System Advisory Board

Scientific Information for Management

NPS PHOTO

A mountain lion at Grand Canyon National Park triggers an infrared camera used in the noninvasive study of the large carnivore species. Self-portraits like this can often be correlated with specific tracks, hair, or feces left behind at sampling stations, adding another dimension to the study of lion kinship, food sources, and home range.

The National Park Service needs the best information science can offer to manage the national parks. In recent years—partly as a result of the National Parks Omnibus Management Act of 1998, a broadening commitment to meet this need among park managers, and increased funding from the Natural Resource Challenge—parks have made substantial progress in this area. Many small parks have hired their first natural resource manager, and increased expertise is resulting in better identification of information needs and a greater capacity to interpret and apply scientific information. Baseline inventories continue to deliver important fundamental information for management, and monitoring networks are now organizing to track long-term trends in park natural resources. Parks, too, are becoming friendlier places for researchers to do their work thanks to the developing network of research and learning centers and the streamlining of research permitting. Collaboration through partnerships and the Cooperative Ecosystem Studies Units remains critically important to scientific endeavors in parks, providing expertise, cost-sharing, and creative problem solving. The following articles give us a glimpse into this world of scientific information in 2002 that is as fascinating as it is fundamental to park management.

DNA sampling key to noninvasive study of mountain lions in southwestern parks

by Elaine F. Leslie

MOUNTAIN LION SIGHTINGS AND ATTACKS ARE commonly reported throughout the National Park System. Knowing how and when these large carnivores use park habitat, especially areas frequented by humans, is key to reducing potentially dangerous interactions with humans and facilitates this species' protection.

"The animals' DNA fingerprint and food sources can ... be determined without direct human contact."

A multiyear study is providing a framework for national parks in the Southwest to obtain information about mountain lions with minimal disruption to their natural behavior. Resource managers from Grand Canyon, Mesa Verde, Saguaro, Guadalupe Mountains, Carlsbad Caverns, and Zion National Parks and several national monuments near Flagstaff joined forces in 2002 in a multipark effort to collect DNA samples from mountain lions. Analyzed in the laboratory, the DNA identifies individuals and allows scientists to determine kinship and estimate population sizes. Before 2001 these parks had information on the presence of mountain lions, but little was known about how they used park habitat.

The parks are conducting DNA and food source studies of the reclusive species through the noninvasive collection of hair, skin, and feces. Trained staff and volunteers attach to trees small pads of carpet studded with nails and laced with scent. Attracted to these lures, mountain lions rub on the pad, leaving behind hair samples, or deposit feces, which often contain skin cells. Technicians collect the samples every two weeks and send them out for analysis. The animals' DNA fingerprint and food sources can thus be determined without direct human contact. Additional information comes from specialized cameras at some locations that catch mountain lions in the act of depositing their DNA. Investigators are therefore able to match the resulting photographs to mountain lion tracks and the DNA signatures, establish kinship, and map home ranges of the animals. The work is funded by the National Park Foundation, the Grand Canyon National Park Foundation, and the Colorado Plateau Cooperative Ecosystem Studies Unit.

Data collected since 2000 in Grand Canyon suggest that 7 adult mountain lions incorporate areas of high human activity, including the South and North Rim developed areas, into their home ranges. Another 19 mountain lions disperse or move through these areas seeking to establish home range. The majority of adult mountain lions using Guadalupe Mountains National Park disperse to nearby Carlsbad Caverns, according to early data analysis. At Mesa Verde, half of the 12 individuals identified in the first year of the study use the park as home range. (Data collection dropped off significantly following two years of intense fires and resulting habitat loss.) The Flagstaff area units of Walnut Canyon, Sunset Crater, and Wupatki National Monuments have identified one mountain lion from DNA samples.

This information has already led to changes at Grand Canyon. The park is developing a management plan that addresses visitor safety and mountain lion protection, outlining, for example, when area closures are warranted and standard procedures to follow in the event of an attack. To increase safety, park staff closely monitor or move the carcasses of animals killed by mountain lions and cached near campsites, residential areas, and trails. The park has also thinned vegetation along a path leading to a school in the park to make the area less appealing to mountain lions, and has stepped up its information campaign for visitors and residents alike.

This multipark study has added to knowledge of a large carnivore and demonstrated an effective model for increasing communication and collaboration among parks. Results will be compiled and loaded onto each park's Geographic Information Systems database. A brochure on mountain lion ecology and human safety has also been developed and is being distributed in the parks. Finally, in addition to developing management plans and standard operating procedures, the parks are planning for long-term monitoring of mountain lions beyond 2003 when the study ends. Grand Canyon National Park is also planning to evaluate the cost and efficacy of the noninvasive DNA sampling technique compared with traditional methods. To make this comparison, the park has received funding to draw blood from and radio-collar several mountain lions in 2003 and 2004 identified through the noninvasive techniques. ■

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Global environmental effects on the mountain ecosystem at Glacier National Park

by Daniel B. Fagre

"Almost all mountain glaciers are receding as global temperatures increase."

THE GLACIERS OF GLACIER NATIONAL PARK, Montana, are shrinking and may be gone within our lifetime. At the end of the Little Ice Age (ca. 1850), an estimated 150 glaciers occurred within current park boundaries. By 1968 only 37 were deemed viable or large enough to warrant being named on maps. Until recently, park promotional literature claimed "around 50" glaciers in existence. This tally included a number of smaller, unnamed glaciers. However, by 1993 the largest of park glaciers had shrunk to less than a third of the area they previously covered, and many of the smaller glaciers had disappeared or were no longer large enough to be considered glaciers. The area within park boundaries covered by ice and permanent snow was reduced from 38 square miles (99 square kilometers) to 10 square miles (26 square kilometers). Furthermore, several computer models estimated that all the park's glaciers would be gone between 2030 and 2050 at current warming rates in the northern Rocky Mountains.

The decline of glacial ice generally is linked to an increase in average summer temperature and a reduction in the winter snowpack that forms and maintains glaciers. Temperatures in the nearby city of Kalispell indicate an increase of approximately 1.4°F (0.8°C) during the past century, but climate records are less complete for high-elevation landscapes within Glacier National Park. However, a weighted average of summer temperatures from climate stations surrounding the park indicates a more dramatic rise of 2.9°F (1.6°C) for the park environment. Furthermore, the period of most rapid temperature rise roughly coincided with rapid glacier recession and increased tree establishment at tree line. The average annual maximum snowpack has significantly declined over the past 50 years; snowpacks melt about 13 days earlier in the spring than they did 50 years ago. Less snow would explain continued glacier melting, but the limited longer-term snow records (1922–present) suggest no overall decline in snowpacks, leaving temperature increases as the likely cause for most of the glacier disappearance.

Scientists with the U.S. Geological Survey (USGS) and their collaborators continue to monitor and study the park's glaciers. A comprehensive overview of glacier information was published in 2002 by Carl Key (USGS), Dan Fagre (USGS), and Richard Menicke (NPS). Recently, USGS scientists completed an effort using repeat photography (e.g., comparisons of historical and recent photographs) for 56 sites in the national park. Comparing photographs of 17 of the remaining glaciers reveals that glaciers continue to recede. Thirteen of the 17 glaciers are distinctly smaller when compared with photographs taken at various times in the 1900s. Based on a precision global positioning system survey of Grinnell Glacier, more than 35 acres (17 hectares) have been lost from a relatively small glacier since 1993. Finally, ground-penetrating radar surveys show that glacial ice has thinned by as much as 50% over the past two decades. Therefore, as Grinnell Glacier is both thinner and covers less area, it has less than 10% of the ice volume it had in 1887 when it was first described. All glaciers in the park for which there are recent measurements continue to lose ice volume. This corresponds well with the fate of glaciers elsewhere on Earth: almost all mountain glaciers are receding as global temperatures increase.

GLACIER NATIONAL PARK ARCHIVES, BY KISER

Glacier recession is evident in this comparison of Grinnell Glacier in 1910 (black and white image) and 1998 (color image). Repeat photography at Glacier National Park has shown a decrease in size among 13 of 17 park glaciers.

U.S. GEOLOGICAL SURVEY, BY KAREN HOLZER

The ecological significance of losing glaciers at Glacier National Park includes loss of stream base flow in late summer and higher water temperatures that influence the distribution and behavior of aquatic organisms. Glaciers are very popular features of the park, and a certain sparkle will be gone when the last glacier disappears. ■

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Soils inventory unearths new species at Great Smoky Mountains National Park

by Mike Jenkins and Pete Biggam

NPS PHOTO

Distinct vegetation communities of the southern Appalachian Mountains, heath balds are dominated by extremely high densities of evergreen shrubs. The shrubs produce a thick layer of highly acidic leaf litter, resulting in acidic surface soils that resist invasion by tree seedlings. The ongoing soils survey documented 21 new "species" of soils in Great Smoky Mountains National Park and spawned further studies of the heath bald soils.

STUDYING SOIL MAY SEEM AS DULL AS DIRT, BUT soil scientists are finding exciting new worlds in the earth underlying Great Smoky Mountains National Park. The Soil Resources Inventory is giving park staff and researchers valuable information on the role of soils in ecosystems. To date, approximately 65% of Great Smoky Mountains National Park has been mapped, and soil scientists have encountered 21 new "species" of soils not previously recognized. Most of them exist at elevations above 4,600 feet where climate and geologic materials interact in unique ways to form new soils. The National Park Service Inventory and Monitoring Program is working cooperatively with soil scientists from the USDA–Natural Resources Conservation Service to obtain detailed information regarding the physical, chemical, and biological properties of soils in the park. Once completed, the inventory will provide Great Smoky Mountains National Park with a powerful tool for ongoing management and research efforts.

One of the greatest limitations to the management of natural resources across a large area is poor understanding of species distributions and their relationship to the underlying physical environment. Physical and chemical properties of soils are known to be critical to the distribution of forest types and vascular plants, but these properties are also important on a smaller scale in determining the distribution of the vast number of species that comprise the flora and fauna of the park's soils. An All Taxa Biodiversity Inventory (ATBI) is being conducted to identify and determine distributions of all species of life in the park. Soil and leaf litter samples have revealed many species not only previously unknown in the park, but new to science as well. To date, 37 new species of springtails (primitive insects), 14 species of slime molds, 4 species of earthworms, and 3 species of land snails have been identified. Information from the soils inventory will allow scientists to understand the habitat needs of species identified by the ATBI and to predict their distribution and abundance throughout the park.

Although still in progress, the soils inventory has already revealed new areas for scientific study. For example, the unusual properties of the organic soils formed under heath balds have spawned a cooperative study with Western Carolina University to determine the age and paleoecology of these unique areas. Soil samples collected at various depths throughout the soil profile will be analyzed to determine the age of soil deposits and their rate of accumulation. This information may help solve the long-standing puzzle of how and when these distinctive vegetation communities were formed.

In addition to the soils inventory, efforts are being made to map the geology and vegetation communities of the park. These three layers of information will allow scientists to examine biological and physical relationships across the park at a level of detail never before possible, so that park managers may be better able to predict potential impacts of environmental threats. For example, the park receives some of the highest deposition rates of acidic sulfur and nitrogen in North America. Efforts are under way to model deposition levels across the park. Once this model is completed, resource managers will be able to understand which soil types are most vulnerable to acidification and which vegetation types and biological communities may be impacted. ■

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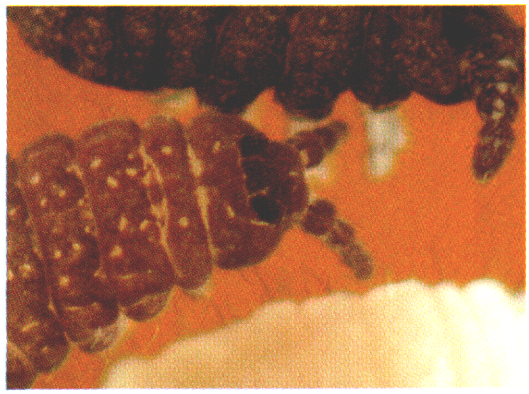

UNIVERSITY OF TENNESSEE, DR. ERNIE BERNARD

Primitive insects of the order Collembola, springtails exist in the tens of thousands per square meter of Great Smokies forest soil and leaf litter. The dark-colored specimen *(Pseudachorutes simplex)* is a common soil-dweller in the park; the pale specimen (genus *Neanura*) may be new to science.

Sound signatures may provide clues to the health of park ecosystems

by Bill Schmidt

THE NATIONAL PARK SERVICE RECENTLY completed the first round of a pioneering bioacoustic sampling of environmental sounds in selected locations in Sequoia and Kings Canyon National Parks, California. The work was performed by a team directed by Dr. Bernie Krause of Wild Sanctuary, Inc., in cooperation with Dr. Stuart Gage of the Computational Ecology and Visualization Laboratory at Michigan State University. The NPS Associate Director, Natural Resource Stewardship and Science, sponsored this study with funding from the Natural Resource Preservation Program.

The underlying thesis of this project is that interpreting an area's *biophony*—the combined sound that living organisms produce in a given habitat—is a key to understanding the health of that particular biome or ecological community. In contrast to studying the vocalization of organisms in an abstract, individualized manner as has been done historically, this study focused on recording audio samples in the context of the totality of creature sounds in a given setting. The expression of biophony is theorized to depend on location, season, weather conditions, time of day, whether the biome is wet or dry, whether the habitat is primary or secondary growth, whether it is clear-cut or unchanged, and many other factors. If the thesis that each biophony is unique and tied to the health of a particular biome is borne out, the biophonic signature of an area can provide the National Park Service with a clear record of individual place and an indicator of its fitness and age just as a thumbprint identifies individual humans.

The study sought to:

1. Digitally record audio samples from four different habitats in the two parks from October 2001 to July 2002;
2. Process bioacoustic dynamics and characteristics of each habitat;
3. Begin creating an index of acoustic dynamics within each habitat to correlate with traditional biodiversity indexes;
4. Assess habitat degradation and regeneration; and
5. Begin examining the relationship of bioacoustic dynamics to introduced noise, such as from human sources.

Dr. Bernie Krause records the "biophony," or the combined sounds made by organisms in a given habitat, on location in Sequoia National Park, California. Bioacoustic recording adds another dimension to ecosystem modeling and allows for comparisons of data among seasons, over time, and with other ecosystems.

Four teams made observations and collected audio samples. Personnel monitored per of the four sites four times per day over a period of three to five days, during fall, winter, spring, and summer, to start characterizing the natural acoustic dynamics of each site. Daily signatures of approximately 60 minutes of acoustic activity were recorded at dawn and dusk, which tend to be the most acoustically active periods, at midday, and two to three hours after sunset (representing nighttime). Park natural resource staff helped select the sites; the investigators selected seasons relative to typical weather patterns at approximate seasonal midpoints.

The results were very encouraging. The teams worked out many of the expected problems with the sampling protocols and equipment. They obtained a rich collection of biophonic information and have been working to establish preliminary correlations with traditional biodiversity indexes. In the words of Dave Graber, Senior Science Advisor for the parks, "recording a soundscape … in Sequoia represents a valuable component of a park's natural resources inventory, much like producing a vegetation map or a list of animal species.... Should concordance among various acoustic elements in a soundscape prove to be a widespread phenomenon, it … holds promise for a window into a whole new aspect of ecosystems that was heretofore undetected."

The results of the field test pointed out several areas for additional work. One is the need for analytical techniques, such as those from landscape ecology, that will allow quantification and more refined statistical analysis of the data. Even relatively short recording sessions such as these generate a tremendous amount of data that must be plotted and sorted by hand. Another need is for additional recording at these and other parks with different physical characteristics to provide multiyear data over a broad range of conditions. ■

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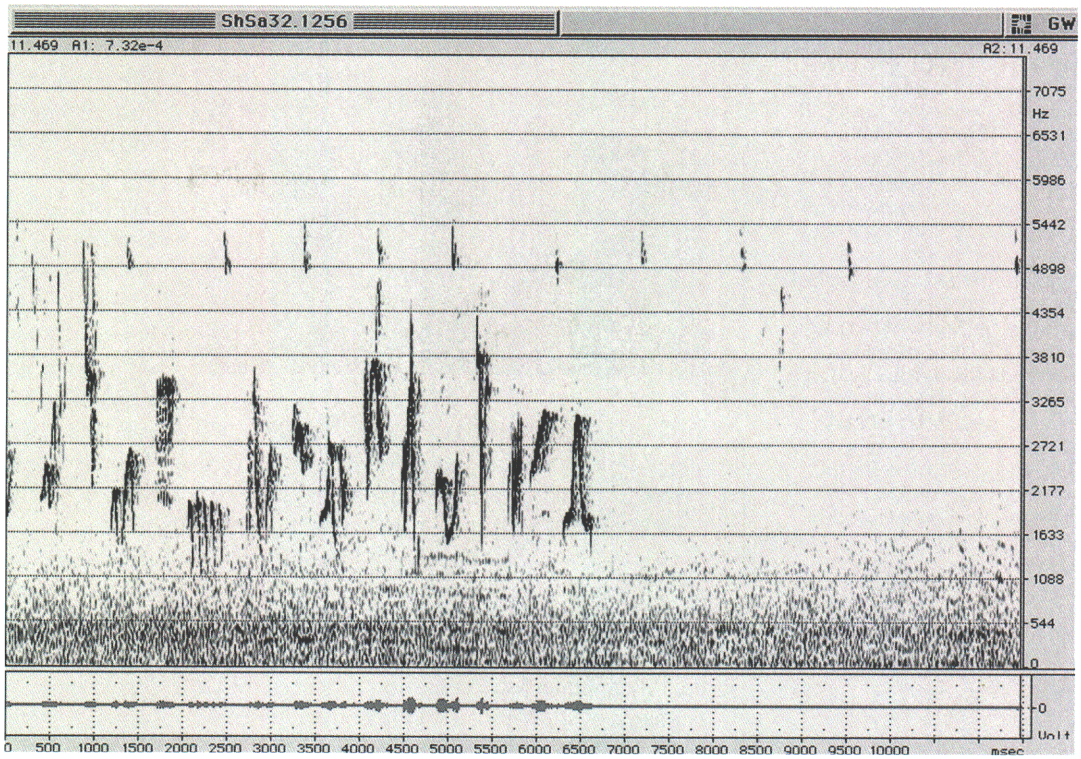
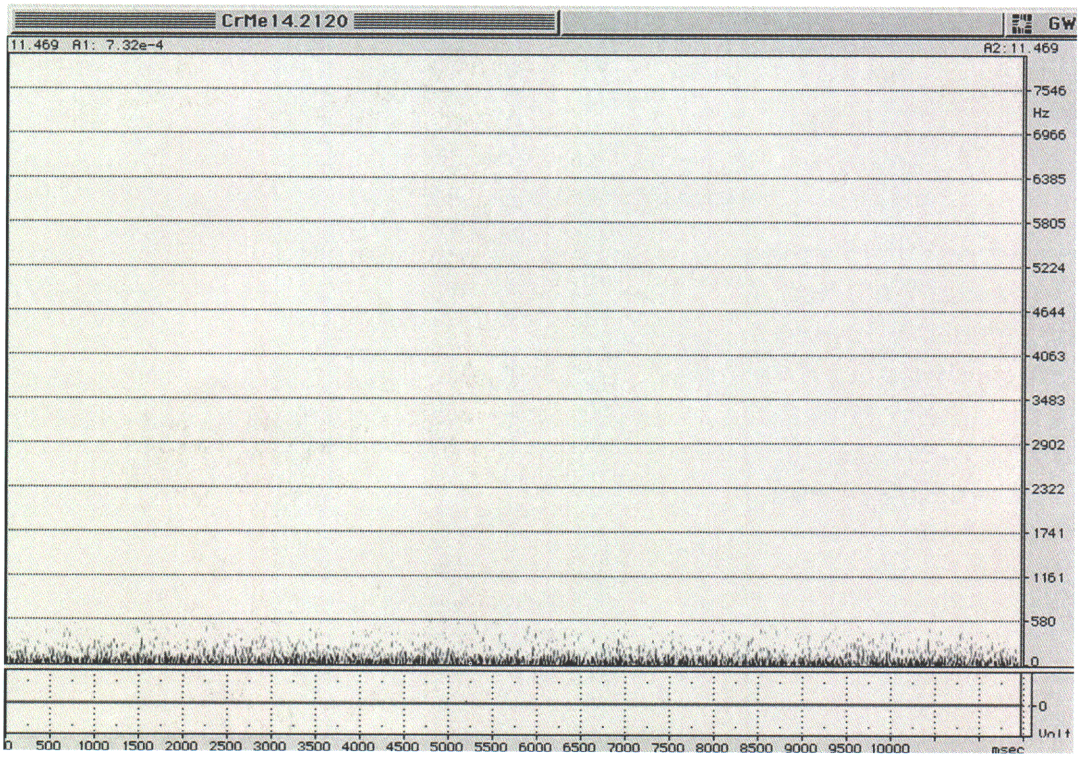
"This study focused on recording audio samples in the context of the totality of creature sounds in a given setting."





Spectrograms contrasting rich (above) and barren (below) biomes, Sequoia and Kings Canyon National Parks, California.

Horseshoe crab monitoring at Cape Cod National Seashore

by John Wullschleger and M. J. James-Pirri

NPS PHOTOS BY ABIGAIL MILLER

Enjoying a field-day retreat, NPS administrators from the Northeast Region lend their energies to the horseshoe crab spawning survey at Cape Cod National Seashore. Guided by NPS, USGS, and University of Rhode Island scientists, the managers measured and tagged crabs, which will allow researchers to estimate population size and assess migration. Left to right: Marie Rust (Northeast Regional Director), Johnnie Smith (Assistant to the Regional Director), Connie Rudd (Assistant Superintendent, Shenandoah National Park), Charles Roman (formerly with USGS, now with the North Atlantic Coast CESU), Beth Johnson (Regional Inventory and Monitoring Coordinator), Bob McIntosh (Associate Regional Director, Resource Stewardship, Planning, and Research), and Sandy Walter (Deputy Regional Director).

THE ATLANTIC HORSESHOE CRAB *(Limulus polyphemus)*, a species more closely related to spiders than to true crabs, inhabits coastal waters from Maine to the Yucatán peninsula. Although horseshoe crabs are not standard fare at seafood restaurants, they are economically and ecologically important. Horseshoe crabs are harvested for bait in conch and eel fisheries and to obtain limulus amebocyte lysate, a substance used by the biomedical industry. In addition to their intrinsic value, horseshoe crabs are an important link in the food chain. Adults are eaten by juvenile loggerhead turtles, a species that is federally listed as threatened, and the crabs' eggs, which are deposited on sandy beaches during high tides, are a preferred food item for many invertebrates, fish, and migratory birds. Horseshoe crab populations along the Atlantic Coast of the United States have recently been in decline. While the reasons for the coastwide decline are not known, human harvest is believed to be a contributing factor.

In 2000 concern over declining numbers led National Park Service managers to close Cape Cod National Seashore to the harvest of horseshoe crabs. This closure was initially opposed by the State of Massachusetts, which contended that the National Park Service usurped state authority to manage the harvest of fish and shellfish. It was subsequently determined that the closure was within NPS authority because horseshoe crabs are not classified by the state as either fish or shellfish. The national seashore currently remains closed to the harvest of horseshoe crabs; however, the issue underscores the need for better information about crab populations.

Park managers took the first step toward acquiring the information needed to manage and conserve horseshoe crabs by contracting with the University of Rhode Island to conduct spawning surveys in 2000 and 2001. The work was partially funded by the NPS Biological Resources Management Division and conducted in cooperation with the Massachusetts Audubon Society and the U.S. Fish and Wildlife Service. Surveys were undertaken on beaches and in other habitats during high tides from May through July. Researchers collected data to estimate spawning densities, sex ratios, and egg densities. Spawning crabs were measured and classified by age group based on the appearance of their hard outer covering, known as the carapace (carapaces of older crabs show greater wear and higher numbers of encrusting organisms). Crabs were also marked with plastic tags that allowed researchers to estimate population size and assess migration.

The final report, "Population Demographics and Spawning Densities of the Horseshoe Crab, *Limulus polyphemus*, within Cape Cod National Seashore, Cape Cod Bay and Monomoy National Wildlife Refuge, Massachusetts," notes that spawning densities were low at most sites. The highest spawning densities were observed in Monomoy National Wildlife Refuge, followed by Pleasant Bay in Cape Cod National Seashore. Size and age structure varied among locations, with the largest crabs of both sexes found at the wildlife refuge, followed by Pleasant Bay. Overall egg and larval densities were also low and were not correlated with spawning density. Recapture data for tagged crabs indicated that a few individuals traveled long distances, and the close proximity of most recaptured crabs to their original location suggests that spawning populations are generally discrete.

Although the demographic and density data cannot currently be tied to particular causes, this information provides a basis for identifying future trends in crab populations in Cape Cod National Seashore and the surrounding area. Better understanding of population dynamics and spawning densities of the Atlantic horseshoe crab will allow the National Park Service to make management decisions that protect the species, ensuring its continued contribution to the region's ecosystem and economy. ■

"Better understanding of population dynamics and spawning densities of the Atlantic horseshoe crab will allow the National Park Service to make management decisions that protect the species."

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CESUs in the Intermountain Region: Integrating natural and cultural resource research, technical assistance, and education

by Kathy Tonnessen, Pat O'Brien, and Ron Hiebert

"The CESUs of the NPS Intermountain Region ... are integrating natural and cultural assistance to parks."

THE COOPERATIVE ECOSYSTEM STUDIES UNITS (CESUs) of the NPS Intermountain Region began an experiment in 2002 to expand their scope: they are integrating natural and cultural assistance to parks through the various CESU partners. The CESU network is a biogeographic-based partnership of universities, nongovernmental organizations, and federal agencies that provide federal resource managers with high-quality scientific research, technical assistance, and education. This network is engaged in studies of natural and cultural resources and social science.

A cultural resource specialist, Pat O'Brien, moved from the regional office to a position at the Desert Southwest CESU at the University of Arizona, Tucson. The other two CESUs in the region are in the midst of advertising for cultural resource specialists to be duty-stationed at the University of Montana, Missoula, and Northern Arizona University, Flagstaff. These three "cultural resource brokers" will provide the interface between natural and cultural resources and assist parks in finding partners to help with research, technical assistance, and education.

Examples of projects that combine natural and cultural resource management include archeological and paleontological surveys that serve to protect cultural resources while increasing our understanding of natural resource use through time. At Bent's Old Fort, Colorado, researchers from the University of Montana and Colorado State University are pursuing hydrologic studies to determine the cause of basement flooding of the fort. In recent years the water table throughout the Arkansas River Valley has risen because of changes in irrigation and river hydrology. A recently created, 55-acre wetland surrounds 50% of the fort, and groundwater from that wetland is seeping through the fort's foundation. Researchers have installed groundwater wells that are monitored regularly by park staff to collect seasonal data and detect changes in the water table. This technical assistance provided by the Rocky Mountains CESU is allowing park managers to understand the cause of the flooding and to plan a dewatering project to protect the structures in the park.

NORTHERN ARIZONA UNIVERSITY, PATTY WEST

NORTHERN ARIZONA UNIVERSITY, PATTY WEST

The oral tradition of passing on ethnobotanical information has decreased for many Navajo as a result of changing lifestyles. A CESU-sponsored investigation of ethnobotany at Navajo National Monument is documenting this knowledge before it is lost, including that retold by Navajo elder Keal Clitso (right) in the monument's Betatakin Canyon (top). The information will be used in park and Navajo Reservation resource management, interpretation, and environmental education.

At Saguaro National Park, Arizona, researchers associated with the Desert Southwest CESU devised a plan for a study of the annual saguaro fruit harvest by the Tohono O'odham (Papago) tribe in the Tucson area. For centuries the Tohono O'odham have used the fruit of the saguaro cactus as a food source, and the harvest and processing of the fruits have become a central cultural focus of the tribe. An ethnographic inspection of this annual event will look at the native plant, its range of growth and various natural properties, and the role it plays in native mythology and culture.

At Navajo National Monument, Arizona, a project funded through the Colorado Plateau CESU involves Northern Arizona University,

A researcher prepares to install equipment to record seasonal changes in the water table at Bent's Old Fort, Colorado. The hydrologic study, coordinated by the Rocky Mountains CESU, will help diagnose the cause of flooding in the basement of the reconstructed historical fort and suggest remedies.

NPS PHOTO BY FRAN PANNEBAKER

Navajo Nation Historic Preservation, and the National Park Service in an investigation of Navajo knowledge and use of plants. The Southern Colorado Plateau Inventory and Monitoring Network is surveying existing vegetation in the monument. This collaborative effort will develop integrated ethnobotany documentation, interpretation, and community school-based environmental education. The work will result in culturally appropriate resource management recommendations for use by Navajo National Monument and the Navajo Nation Division of Resource Management.

With the addition of cultural resource specialists at the three CESU host universities of the Intermountain Region, more applications of research are possible that combine the natural, cultural, and social sciences to meet park management needs. The wide array of expertise among CESU researchers at federal agencies and universities allows for this integration and flexibility. ■

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Park Flight: Connecting people and protected areas through technical exchange

by Carol Beidleman

"The international cooperation sparked by such programs is critical for the success of species that spend part of the year in one country and part of the year in another."

THE SCENE CAPTURED THE ESSENCE OF THE PARK Flight Migratory Bird Program. In the tropical rainforest of Pico Bonito National Park in Honduras, three biologists from the United States and three interns from Mesoamerica were reunited in November 2002 for a workshop to improve knowledge and coordination of migratory bird monitoring programs across the hemisphere. These internships, coordinated through the NPS Office of International Affairs Volunteers-in-Parks program, provide an opportunity for technical and cultural exchange and enhance opportunities for collaboration on migratory bird conservation.

The international cooperation sparked by such programs is critical for the success of species that spend part of the year in one country and part of the year in another. Innovative programs like Park Flight are important for keeping resource managers abreast of issues that might affect migratory species at either end of their journey. Initiated in 1998 and enhanced by funding from the Natural Resource Challenge, Park Flight is a partnership among the National Park Service, the National Park Foundation, American Airlines, the National Fish and Wildlife Foundation, the U.S. Agency for International Development, and the University of Arizona CESU (see page 34).

NPS PHOTO

Park Flight international interns reunite with biologists from the United States at a workshop in Honduras to coordinate migratory bird monitoring programs across the hemisphere. Pictured from left to right are Alexis Cerezo (Guatemala), Rachel Mazur (Sequoia–Kings Canyon National Park), Belkys Jimenez (Panama), David Mizrahi (New Jersey Audubon Society), Edgar Castañeda (Nicaragua), and Bob Kuntz (North Cascades National Park); missing is Phil Correll (New Jersey Coastal Heritage Trail Route). Each Mesoamerican country's Park Flight grantees received new binoculars at the workshop, donated by Optics for the Tropics. Park Flight is dedicated to conservation of migratory bird species in U.S. and Mesoamerican national parks and protected areas.

At the Honduras workshop, several of the interns gave an overview of their national park experiences. They are all biologists who manage bird conservation programs in their home countries. Alexis Cerezo from Guatemala spent 10 weeks at Sequoia and Kings Canyon National Parks, where he and Miguel Ramirez banded birds at Monitoring Avian Productivity and Survivorship stations, conducted backcountry monitoring, and gave interpretive programs. Alexis said it was "the most beautiful place he had ever seen in his life" and expressed appreciation for the trust accorded to him by NPS Wildlife Biologist Rachel Mazur.

Edgar Castañeda from Nicaragua, one of three interns hosted by North Cascades National Park, assisted with a Cornell Citizen Science bird monitoring project, helped plan a migratory bird exhibit, and gave a presentation to Spanish-speaking families from Skagit County. He said Bob Kuntz and the other staff at North Cascades "treated him like family." Belkys Jimenez from Panama interned with the New Jersey Audubon Society and New Jersey Coastal Heritage Trail Route, where she assisted with interpretive walks, songbird banding, and hawk counting. She left New Jersey eager to start a hawk-counting station in Panama. Each of these activities gave the interns an opportunity to increase their understanding of migratory bird management in the United States and improve their English skills. Both the interns and host parks found the exchange experience professionally and culturally rewarding.

Another important component of the Park Flight Program is providing technical assistance to Mesoamerican bird conservation projects, with NPS expertise matched to needs identified by Mesoamerican partners. In 2002 Park Flight gave technical assistance in five Mesoamerican countries, coordinated through the NPS Office of International Affairs. Eric Finkelstein of Amistad National Recreation Area, Texas, provided interpretive expertise for the development of bird-watching trails in El Imposible and Montecristo National Parks in El Salvador. At the same time, Steve Burns, a landscape architect with the NPS Long Distance Trails Office in Santa Fe, New Mexico, designed a bird-watching route between these two national parks to promote avitourism. Another NPS landscape architect, Kevin Percival, developed a site plan for a visitor reception area at Mombacho Volcano Natural Area, Nicaragua.

Environmental educators Roy Simpson, from Tumacacori National Historical Park, and Sarah Koenen, from George Washington Memorial Parkway, provided training and recommendations for the Panama and Mexico Park Flight projects, respectively. Edgar Castañeda received technical assistance in Nicaragua the previous year. The Park Flight Program made it possible for him to participate in activities at both ends of the migration route, completing the migratory bird management and monitoring link across the hemisphere. ■

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NPS PHOTO AND GRAPH

Monitoring glacier change in the North Cascades

by Rob Burrows and Jon Riedel

Glaciers in North Cascades National Park, Washington, have retreated rapidly for most of the past 150 years, with a 44% reduction in ice cover. However, steady retreat has slowed periodically because of 5- to 10-year-long cold and wet periods, including 1997 to the present. More than 300 glaciers in North Cascades National Park and its contiguous units, Lake Chelan National Recreation Area and Ross Lake National Recreation Area, are vital components of Pacific Northwest aquatic and terrestrial ecosystems and hydrologic systems. These glaciers influence stream flows, flooding, soil development, vegetation distribution, water quality, and water delivery to hydroelectric projects, and are important indicators of climate change.

The National Park Service has monitored mass balance on three glaciers in North Cascades National Park since 1993 (four since 1995), tracking total winter snow accumulation and summer melt. In 2002, above-average winter snowfall led to minor growth of three of the four glaciers. Glaciers provided up to 40% total summer stream runoff and meltwater during extremely dry conditions in late summer and throughout the fall, helping maintain flows for threatened salmon species. Annual variations in balance match other glacier studies and climate records in the Pacific Northwest and are correlated to climate indexes such as El Niño, or Southern Oscillation, and the Pacific Decadal Oscillation.

Partners providing data, funding, and volunteers include the Earthwatch Institute, Seattle City Light, the USDA Natural Resource Conservation Service, and the U.S. Geological Survey. Natural Resource Challenge funding is integral to the stability of this program. In 2002 the Challenge also funded initiation of a glacier monitoring program at Mount Rainier National Park, with another to begin in one to two years at Olympic National Park. ■

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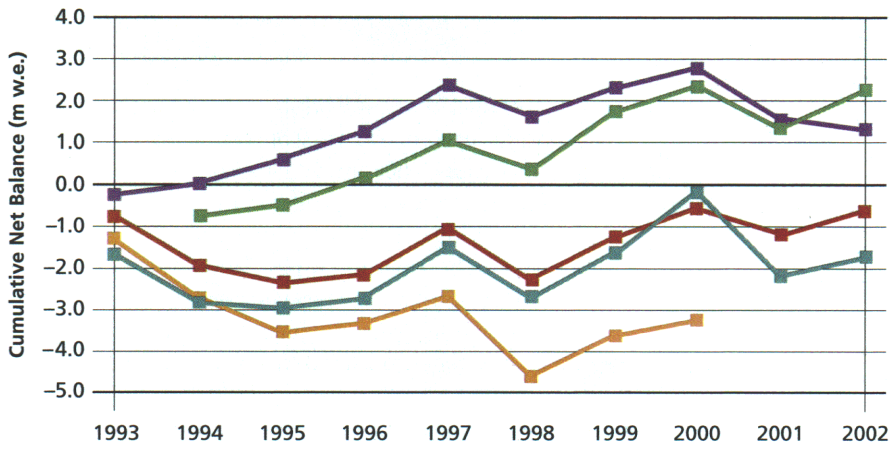
Legend

- Noisy
- Silver
- North Kiawatti
- Sandalee
- South Cascade

"m w.e." stands for meters of meltwater equivalent

CUMULATIVE GLACIER CHANGE IN THE NORTH CASCADES



AWARD-WINNER PROFILE

Tonnessen finds success as CESU coordinator

COURTESY OF KATHY TONNESSEN

Kathy Tonnessen

Dr. Kathy Tonnessen describes herself as tenacious, smart, organized, and persistent. And she's right on. All these attributes have contributed to her success as research coordinator of the Rocky Mountains Cooperative Ecosystem Studies Unit (CESU). For her accomplishments in this new role Kathy won the Director's Award for Natural Resource Research in 2002.

Two years ago Kathy was selected by the National Park Service as one of its first CESU coordinators in the country. After relocating to Missoula, Montana, her task was to assemble a team of researchers and technical specialists through the University of Montana with whom the National Park Service could collaborate on park research questions. Then she had to find creative ways to fund the variety of research projects from the 15 national parks served by this CESU. Kathy says it was not an easy task: "It was just starting from scratch. There were no people, no organization; it was a lot of work."

The role Kathy plays now has been called "marriage broker"; she brings together parks that need research with scientists who need field time. The resulting partnership of the Rocky Mountains CESU is functioning well and has addressed many national issues, such as wildlife and fishery diseases, management of ungulate populations, air quality, exotic plant management, and threatened and endangered species.

Kathy's work with the Rocky Mountains CESU has set a high standard after which other CESUs are being modeled. ■

Elk effects and management considerations studied at Rocky Mountain

by Therese Johnson

Elk management in Rocky Mountain National Park (Colorado) is a complex issue that has concerned park managers and the public for many decades. Elk migrate outside the park seasonally, necessitating a regional management approach among various agencies responsible for land and wildlife management, each with its own objectives and management constraints. The issue is complicated by interactions among multiple natural resources and the residual impacts of historical land use and wildlife management practices. It is controversial because of value conflicts among stakeholders regarding desirable elk numbers and the acceptability of the management actions required for ecosystem restoration.

In 2002 the National Park Service and the U.S. Geological Survey completed a large-scale research initiative designed to assess the role of elk and other factors (e.g., hydrology, climate, forage competition, predation) in influencing ecosystem conditions. Numerous investigators conducted 13 interdisciplinary yet integrated studies using both field study and computer modeling approaches.

Results suggest the current elk population is larger and more concentrated than would be expected under natural conditions. The field studies show that willows (*Salix* spp.) have declined on the core elk winter range because of a variety of factors, including intense foraging by elk and changes in water flow and levels related to large declines in beaver. Model results predict that further shifts from biologically diverse willow and aspen communities to less diverse grasslands will occur if elk browsing is not reduced. The model also predicts that restoring natural conditions will require a combination of long-term, intensive management actions to redistribute and reduce elk numbers, restrict elk access to willow and aspen communities, and restore hydrologic conditions. The research results provide the strong scientific basis that will be critical to making and successfully implementing management decisions in the future. Rocky Mountain is developing an Elk and Vegetation Management Plan/Environmental Impact Statement in cooperation with other agencies responsible for land and wildlife management in the region. ■

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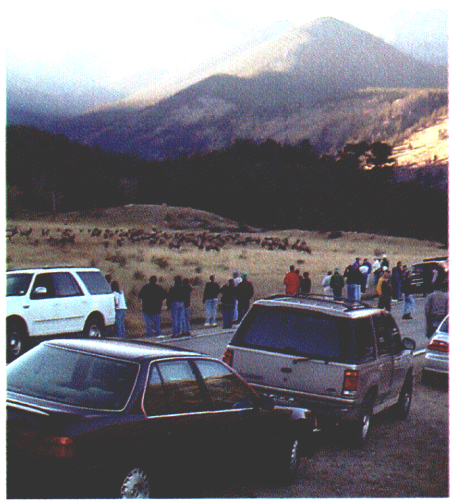

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PARTNERSHIP PROFILE

A model for international conservation of birds

by Gary Johnston

NPS PHOTO

Park Flight coordinator Carol Beidleman (left) with Mexican colleagues: monitoring expert and professor Fernando Villaseñor Gómez and environmental educator Aída Hernández Fernández.

The coordination of the Park Flight Migratory Bird Program (see page 31) is made possible through the Desert Southwest CESU, hosted by the University of Arizona. Through the CESU, Research Specialist Carol Beidleman devotes her considerable knowledge, experience, and capacity to the program, the National Park Service, and the other program partners. As a former NPS employee, she understands and appreciates the NPS mission and operations. Additional experience with The Nature Conservancy and involvement with Partners in Flight honed her program coordination skills and ability to develop effective partnerships for international migratory bird conservation. The CESU model is effective in giving her the flexibility and autonomy necessary to coordinate the activities of the many program partners. Carol and her program are examples of successful international conservation efforts. ■

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Survey adds to understanding of ancient life-forms

by Elaine Hale

NPS PHOTO

Trace fossils such as these feeding structures reveal life habits and activities of extinct animals and plants and give clues to ancient environments. Worm cast fossils record the size and activities of animals whose soft body parts would not otherwise be preserved.

Under Wyoming's summer sun in August 2002, an interdisciplinary, interagency team conducted a paleontological survey of the middle Cambrian exposures on Trilobite Point in Yellowstone National Park that added to the scientific understanding of ancient life-forms and their environments. The research effort also built on the National Park Service's growing commitment to partnerships; paleontologists from Fossil Butte National Monument (Wyoming), the Smithsonian Institution's National Museum of Natural History, the Yellowstone Gateway Museum, and Russia joined park professionals on the research team. The Yellowstone Park Foundation provided project funding.

The survey team identified numerous fossil-bearing locations that yielded a diverse collection of species, including three distinct genera of trilobites, early arthropods. Previous research on trilobites found on Yellowstone National Park's Mount Holmes contributed to the development of speciation theories for these organisms. Brachiopods, hyoliths, fossil fragments of sponge spines, and crinoids were also collected. Trace fossils of worm burrows and tracks provided evidence of animal behavior that gives clues to ancient environments. The inventory clearly demonstrates that the sedimentary rocks of the Cambrian period in Yellowstone possess fossil information concerning the "Cambrian Explosion," the relatively sudden appearance of complex multicellular organisms. The baseline information gathered by the survey gives researchers, resource managers, and resource protection rangers a better understanding of fossil resources and the threats facing them. A full report of the project will be available in May 2003; the collected specimens will be available for research and display at the new Yellowstone Heritage and Research Center, to be completed by summer 2004. ■

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Monitoring and preserving dark skies

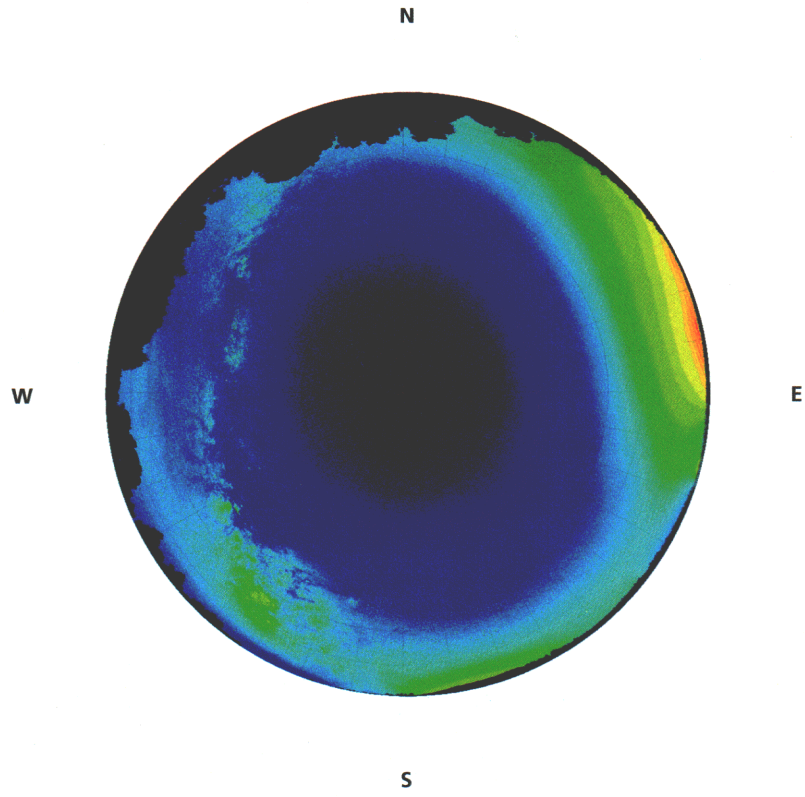
by Chad Moore and Dan Duriscoe

Experiencing a night sky filled with a blanket of stars becomes increasingly difficult at national parks. The growing populations in the western United States and the spread of development into rural areas have made light pollution a significant management issue for the National Park Service. In 2002 the NPS Night Sky Team, composed of park scientists and managers, continued efforts to monitor and preserve dark night skies, focusing on strategies to address impediments to protection. Obstacles within the Park Service include a lack of awareness of light pollution as a threat to wilderness values and cultural heritage, an absence of baseline information about this resource, and inefficient facility lighting.

The team tackled the awareness problem with an outreach effort to park managers and the public. Research presented at a conference cohosted by the Night Sky Team demonstrates that artificial night lighting not only diminishes the visitor experience but also has ecological consequences, influencing the behavior, biology, and survival of animals. A National Public Radio program examined endangered night skies in national parks, and a special issue of the *George Wright Forum*, edited by Joe Sovick, chief of recreation and partnerships for the Intermountain Region, received widespread attention.

Collecting baseline inventories for several parks represented a major effort in 2002. Astronomers at the U.S. Naval Observatory and the Lowell Observatory (both in Flagstaff) provided invaluable assistance with the development of research methods. More than 40 data sets now cover many southwestern parks. Preliminary analysis of the data shows that near-pristine skies can be found in those areas farthest from major cities and describes impairment caused by light pollution sources. For example, data from Walnut Canyon National Monument, 8 miles from Flagstaff, Arizona, indicate that although light from the city obviously causes light pollution, the night sky is far darker than would be expected (see image). The community has adopted lighting ordinances and retrofitted many outdoor lights. Scientifically sound information is vital for tracking mitigation efforts and encouraging public support.

NPS PHOTO



This panorama shows light levels in the night sky over Walnut Canyon National Monument, Arizona. Although Flagstaff, population 75,000, is evident to the west, the sky is much darker than would normally be expected given the town's proximity and population. A coalition of observatories, government agencies, private companies, and the public has enacted lighting ordinances and retrofitted many outdoor fixtures to improve lighting efficiency. Scientific records like this are useful for tracking mitigation efforts and encouraging public support to preserve dark night skies.

In 2003 the Night Sky Team will expand efforts nationwide and seed individual inventory and monitoring networks with "satellite" night sky teams. ■

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"We need a census of the fauna and flora that extends beyond the vertebrates and flowering plants to the teeming populations of smaller organisms ... from insects to fungi and eventually microbes.... Any one of those species ... could be a keystone species."

Edward O. Wilson, Discovery 2000 Conference

Taking Stock of Biodiversity

NPS PHOTO BY MICHAEL WILDERMAN

Funded by the Natural Resource Challenge, vascular plant surveys at Thomas Stone National Historic Site brought to light rich biodiversity in 2001 and 2002. Resource specialists with the National Park Service documented 375 plant species in the small historical park, including many that are listed as rare or newly recorded in Maryland. (The image depicts NPS Biologist Brent Steury conducting a vascular plant survey in Anacostia Park, Washington, D.C.)

The National Park Service is beginning to take stock of the biological diversity—the variety of species, ecosystems, and genetics—preserved in the national parks. For several years the Natural Resource Challenge has provided critical funding for nationally coordinated, systematic biological inventories of vascular plant and vertebrate animal species. These surveys are under way throughout the National Park System, and a few highlights are reported in this chapter. Adding to this emerging knowledge are independent park studies and the partnership-oriented All Taxa Biodiversity Inventory, a model developed at Great Smoky Mountains National Park that is being replicated at other national parks. These scientific efforts are developing important, basic information for improved park management. The surveys being undertaken today throughout the National Park System are a good start, but eventually, comprehensive inventories of all life-forms will be necessary to gain a thorough understanding of how species interrelate and how they function in self-sustaining ecosystems. As the best examples of remnant ecosystems, national parks are particularly well suited to the scientific exploration of biodiversity. This role will only become more important in the future and is vital to park preservation today.

New and rare species found in small Maryland park

by Brent Steury and Betsie Blumberg

THOMAS STONE NATIONAL HISTORIC SITE IS A small cultural park in Maryland. It occupies 322 acres of fields and woodlands with upland seeps and pocket wetlands. In the past, management has focused on cultural resources. However, the Natural Resource Challenge is expanding that focus and the park's natural resources are now being inventoried. In fall 2001 and spring and summer 2002, inventories of vascular plants at the park identified several state-listed rare, threatened, and endangered species.

"Natural resource inventories are bringing to light the locations of rare, threatened, and endangered species."

The initial preliminary vegetation community classification study was conducted by a team of natural resource specialists led by Chris Lea of Assateague Island National Seashore. It was undertaken to produce vegetation descriptions for a vegetation map of the park as part of the NPS National Vegetation Mapping Program. That study was followed by a three-day survey by Brent Steury, biologist with National Capital Parks–East, who added 178 plant species to those reported in the preliminary study and also noted some state-listed rare insects.

Sedges are common in wet places. One species, *Carex styloflexa*, bent sedge, previously recorded as rare in Maryland, was found in sufficient numbers at Thomas Stone and other Maryland parks that it is no longer listed. However, two new-to-Maryland varieties of *Carex* were observed in the surveys at the park. Two other sedges recorded are listed as "watchlist" (21 to 100 occurrences in Maryland) and "status uncertain," respectively.

Two trees listed as state rare species, *Gymnocladus dioica* (Kentucky coffee tree) and *Juglans cinerea* (butternut), were observed. These were apparently planted around the historic Thomas Stone home. Two wildflowers, an endangered Asteraceae and a Boraginaceae listed as "state rare (6 to 20 occurrences) to watchlist" were recorded. And of particular interest, a grass believed to be extirpated in Maryland was noted growing near, but not within, the park, a find that represents the only known population of that fescue in the state.

A butterfly, *Hermeuptychia hermes*, listed as "state rare to watchlist" was sighted during the plant inventory in May. This was the earliest known observation of the Carolina satyr butterfly in Maryland. Four individuals were seen, documenting its status as a resident breeding species. On the same day, a dragonfly, Uhler's sundragon *(Helicordulia uhleri)*, listed as "watchlist" was sighted. Another dragonfly, the calico pennant *(Celithemis elisa)*, was observed to be common at the park during the June plant inventory. This was a first record for Charles County, Maryland.

The ranking system used here was developed by The Nature Conservancy and has been adopted by all 50 state Natural Heritage Programs. Natural resource inventories are bringing to light the locations of rare, threatened, and endangered species. In small parks like Thomas Stone, natural resource treasures are being discovered. Managing this information requires resolving a conflict between two National Park Service commitments: sharing scientific information and protecting the species. This issue is being addressed as the protocol for managing these data is developed. Meanwhile, at Thomas Stone, inventories of mammals, reptiles, and amphibians are under way, and birds and fish will be next. ■

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Uncharted territory: Exploring life in Yellowstone National Park's hot springs

by Ann Rodman and Kendra Maas

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Biological Science Technician Kendra Maas samples hot water organisms in Yellowstone National Park. Adapted to extreme environments, filamentous bacteria (inset, top), layered bacterial mats (inset, bottom), and other microbes are virtually unexplored in the park. The inventory will help protect this valuable resource and improve our understanding of these amazing and potentially beneficial organisms.

YELLOWSTONE NATIONAL PARK IS HOME TO THE most varied and largest intact geothermal area in the world. High-temperature natural systems comprising spectacular geysers, hot springs, mud pots, and steam vents include a virtually unexplored wealth of living organisms that have the potential for remarkable scientific, social, and economic benefits. In 2002, with funding from the Natural Resource Challenge through the NPS Biological Resources Management Division, Yellowstone embarked on a collaborative, multiyear research effort with Portland State University and the University of New Mexico to create a baseline inventory of the microbial communities in geothermal areas throughout the park.

Yellowstone National Park has been inventorying the chemical and physical characteristics of its geothermal ecosystems for years; however, very little is known about the biodiversity, ecology, and distribution of the thermophiles within these systems. Thermophiles are microorganisms that thrive in high temperatures and, in Yellowstone National Park, extremes of pH. In 1996 the list of thermophiles in the park included only 35 species. Park staff searched the scientific literature in 2000 and 2001 for information about park thermophiles. Documented in the literature were 406 organisms from 105 different pools, meaning that fewer than 1% of the park's hot springs have been studied for thermophiles!

Research efforts got under way to correct this gap in spring 2002. The research team began by testing collection protocols and refining laboratory techniques using 18 samples taken from park thermal areas. Until the early 1990s, measurement of microbial species diversity was restricted to the small (<1%) portion of microorganisms that could be grown in petri dishes. This limitation has been partially alleviated by the development of molecular techniques based on gene sequences in small pieces of ribosomal RNA that allow for the characterization of microorganisms without the need to grow them in the laboratory.

The 18 samples were analyzed to reveal 71 unique gene sequences. Each gene sequence represents a distinct organism. These sequences were then compared with all sequences listed in GenBank, a large database of gene sequences hosted by the National Institutes of Health. Fifty-eight of the 71 sequences matched a known organism in GenBank. Some of the remaining 13 sequences will represent previously unknown organisms.

In summer 2002 the research team chose 300 sampling locations from a database of 6,500 possible sites. The sampling sites represent the full range of pH and temperature combinations found in the park. From June to September the team collected 216 samples from 5 of the park's 12 major thermal areas. Digital photographs and biomass samples were taken at each site in addition to readings of pH, temperature, and precise location. Samples showed a wide variation in pH levels, from 1.7 to 9.3. In the fall the ribosomal RNA was extracted and analyzed from 80 of the 216 samples. The results will set priorities for sampling during summer 2003.

The process of inventorying the biological characteristics of Yellowstone National Park's thermal areas is crucial to developing a thorough understanding of the kinds of organisms that live in these high-temperature systems and how they change over time. Good science will allow park managers to identify and address threats that can alter these ecosystems and change the composition of microbial communities, including low aquifer recharge rates, landslides, floods, energy development, and visitor impacts. Until a baseline inventory is accomplished, some amazing, and potentially beneficial, organisms will have incomplete protection simply because their existence is not known. ■

"High-temperature natural systems ... include a virtually unexplored wealth of living organisms that have the potential for remarkable scientific, social, and economic benefits."

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Bat inventory at John Day Fossil Beds National Monument

by Lisa Garrett

BEFORE 2002, BIOLOGISTS HAD LITTLE knowledge about the bat species inhabiting John Day Fossil Beds National Monument in eastern Oregon. This lack of information made it difficult for resource managers to know how any of the bats were faring in the park. Thanks to funding from the Natural Resource Challenge, researchers from the University of Idaho, working under a cooperative agreement with the National Park Service, documented 14 bat species during the 2002 mammal inventory at the monument.

"The success of the 2002 bat inventory illustrates how well the Natural Resource Challenge is enabling the National Park Service to take a leading role in the preservation of North American biodiversity."

The objective of the inventory was to document 90% of the potential mammal species in the monument. Special emphasis was placed on bats in 2002 because they comprise a significant proportion of the mammal species thought to reside in the monument. The inventory resulted in the documentation of all the species of bats expected to occur in eastern Oregon.

Inventory biologists sampled bats using mist nets and an ultrasonic detection system called AnaBat to identify bats by echolocation calls. The AnaBat II Bat Detector is part of a system that records the signals of bats for computer analysis. The ultrasonic echolocation signals of bats are converted by the system into electronic signals that can be recorded and processed to assist with the identification of the species. Biologists identified bats captured in mist nets and recorded their echolocation calls as the bats were released and flew overhead. Biologists used this library of recorded calls to compare the calls of bats that were recorded but not captured with calls emitted from positively identified bat species.

The pallid bat *(Antrozous pallidus)*, silver-haired bat *(Lasionycteris noctivagans)*, Yuma myotis *(Myotis yumanensis)*, and Townsend's big-eared bat *(Corynorhinus townsendii)* are listed as "species of concern" by the U.S. Fish and Wildlife Service and as threatened or vulnerable species by the State of Oregon. These species are targets for a research study in summer 2003, which is being funded as part of this inventory effort. Biologists from the University of Idaho will use radiotelemetry techniques to locate summer maternity roosts, temporary night roosts, and sites of winter hibernation for the designated bat species of concern.

John Day Fossil Beds National Monument is an ideal area to focus bat conservation efforts for a number of reasons. The monument itself contains abundant natural and artificial structures that are well suited for both summer and winter use by bats. It also has as a primary management objective the conservation of natural and historical resources and is actively engaged in ecological restoration of riparian and upland vegetation, which bats rely on for roosting and foraging. Because the monument consists of three widely separated parcels of land that are situated within a matrix of federal and tribal lands, bat conservation within the monument can contribute to maintaining healthy bat populations in adjacent landscapes where natural resource conservation is a top management priority.

The 2002 bat inventory project, in combination with additional research in summer 2003, will give researchers critical information on roost locations and habitat characteristics. This knowledge will enable National Park Service staff to address the conservation needs of local bat populations. Information from the inventory and telemetry work can be used to direct monitoring and conservation activities at roosts. Potential disturbance from recreation, paleontology, prescribed burning, and other monument activities can also be minimized with information from this project. The success of the 2002 bat inventory illustrates how well the Natural Resource Challenge is enabling the National Park Service to take a leading role in the preservation of North American biodiversity. ■

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Listed as a species of concern by the U.S. Fish and Wildlife Service, the pallid bat was one of 14 bat species inventoried at John Day Fossil Beds National Monument. The study and additional research in 2003 will give managers important information on roost locations and habitat characteristics for local bat populations.

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The status of endangered species in national parks: An update

by Loyal A. Mehrhoff and Peter A. Dratch

"More than $1.5 million has been added to park base budgets to enhance programs for conserving endangered species."

THE NATIONAL PARK SERVICE PLAYS A KEY ROLE in restoring plants and animals protected under the U.S. Endangered Species Act. In 2002, 364 federally listed species of plants and animals occurred on lands managed by the National Park Service. An additional 56 species on NPS lands are either proposed for or are candidates for listing; 4 species are managed by the Park Service in a manner that precludes the need for listing (Table 1). Plants comprise the largest group of listed species in the national parks, although a large number of mammals, birds, and fish are also listed (Table 2). Parks in Hawaii, California, and the Southeast contain the greatest number of listed species (Table 3).

In FY 2002, the Natural Resource Challenge provided significant funding to help endangered species. More than $1.5 million has been added to park base budgets to enhance programs for conserving endangered species. In addition, the Natural Resource Preservation Program funded $1.6 million for projects benefiting listed species. These funds are being used to hire additional resource managers and to undertake projects that benefit endangered species. Numerous park projects have benefited from the increases: 20 threatened and endangered plant species in Hawaii Volcanoes National Park are being stabilized; endemic fox populations in Channel Islands National Park are being protected; migrating loggerhead sea turtles are being tracked by satellite; caves important to bats are being gated for protection; populations of wolves, northern spotted owls, and bull trout are being monitored; and populations of seabeach amaranth, harperella, red-legged frogs, and greenback cutthroat trout are being reestablished.

Providing national coordination on threatened and endangered species in the National Park System, the NPS Endangered Species Program accomplished two key goals in 2002. First, staff developed a database detailing the status and trends of endangered species in each park. This database allows the national office, regional offices, and parks to better understand

Table 1. Number of species in the National Park System managed under provisions of the Endangered Species Act

Status	Number of Species
Endangered	261
Threatened	96
Experimental	7
Proposed	4
Candidate	52
Managed via Conservation Agreement	4
Total	424

Table 2. Number of federally listed, proposed, and candidate species in the National Park System by group

Group	Number of Species
Plants	181
Mammals	56
Birds	59
Reptiles	22
Amphibians	6
Fish	50
Insects	13
Snails/Mollusks	33
Other Invertebrates	4

Table 3. Areas in the National Park System with the greatest number of federally listed, proposed, and candidate species

Park	Number of Species
Haleakala National Park (Hawaii)	50
Hawaii Volcanoes National Park (Hawaii)	41
Golden Gate National Recreation Area (California)	35
Channel Islands National Park (California)	34
Point Reyes National Seashore (California)	28
Kalaupapa National Historical Park (Hawaii)	23
Everglades National Park (Florida)	22
Santa Monica Mountains National Recreation Area (California)	21
Natchez Trace Parkway (Mississippi)	21
Mammoth Cave National Park (Kentucky)	16

Table 4. Population trends of federally listed, proposed, and candidate species in the National Park System

Status Trend in National Parks	Number of Populations	Percentage of Populations
Not at risk	90	8.9
Stable	204	20.0
Increasing	86	8.5
Declining	96	9.5
Extirpated	187	18.4
Unknown	352	34.7
Total	1,015	100.0

the overall success of the National Park Service in protecting and restoring endangered species. For example, the information shows that approximately 37% of the known populations of listed and candidate species in parks are either stable, improving, or not at risk; but it also shows that the status for at least 350 populations has not been determined (Table 4). Using the database, managers can identify species in decline and propose appropriate management actions. As systematic efforts to gather this information continue, the National Park Service will be able to assess how these data are changing and how much progress is being made toward recovering species. Second, the program received funding to collect and store seeds from endangered plants for future use in restoration. The National Park Service intends to collect and store seeds from more than 150 endangered, proposed, and candidate plant species and is cooperating with the USDA National Center for Genetic Resources Preservation (National Seed Storage Laboratory) and the Center for Plant Conservation in this effort.

In the future the National Park Service will increasingly emphasize improving the status of declining species and restoring species that have been extirpated from parks. The overall goal is to make national parks as biologically whole as possible—to maintain current park species and restore them when it makes sense to do so. ■

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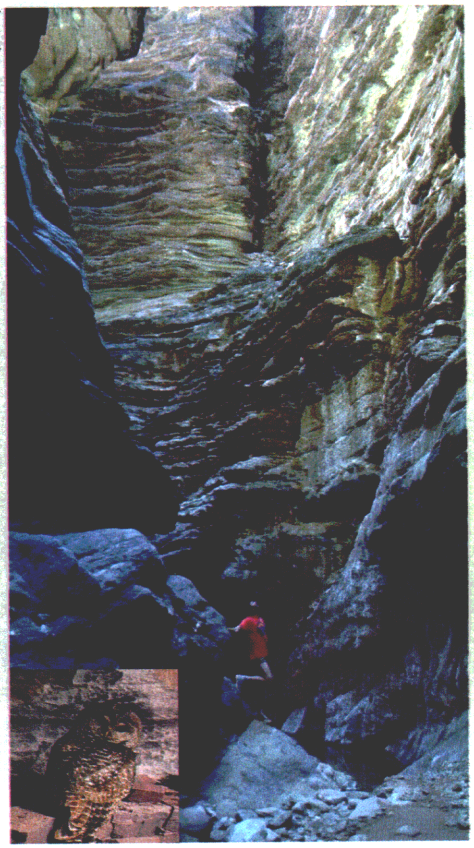

NPS PHOTO (BOTH)

Mexican spotted owl survey at Grand Canyon

by R. V. Ward

The Mexican spotted owl *(Strix occidentalis lucida,* inset*)*, federally listed as threatened in 1993, has long been considered by scientists to be a resident of old-growth coniferous forests in the Southwest. Owl surveys at Grand Canyon National Park in 2001 and 2002, however, uncovered 53 Mexican spotted owls in rugged, rocky canyon habitat. Finding this number of owls living in an unusual habitat type represents a significant increase in the known population of this species in Arizona.

Roosts and nests were generally located on rock shelves rather than in the few coniferous trees available. Field crews reached remote backcountry locations on extended backpacking trips and on seven raft trips through the Grand Canyon on the Colorado River. Owls responding to human imitations of their characteristic four-note hoots frequently came within 10 feet of the surveying crews. Surprisingly, several owls were also located below the canyon rims immediately adjacent to the park's developed areas.

These findings resulted in the establishment of 39 Protected Activity Centers surrounding the owl locations, ranging from 700 to 1,000 acres and subject to the management recommendations contained in the Mexican Spotted Owl Recovery Plan. The data have also facilitated consultation with the U.S. Fish and Wildlife Service as required under the Endangered Species Act for the numerous development projects under way at Grand Canyon National Park, including a trail system expansion and improvements in the transportation system. This project, which was supported by a Natural Resource Preservation Program, exemplifies the important link between good science and sound resource management in the National Park System. ■

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Hopes high for condor nesting success

by Elaine F. Leslie

Biologists' hopes ran high in 2002 for breeding California condors in Grand Canyon National Park, Arizona. In March, following months of observing condor courtship and attempts to locate appropriate caves and ledges for nesting, park biologists confirmed that two pairs of condors were nesting just off the South Rim in clear sight of biologists and the public.

Condors typically lay one egg and incubation lasts 60 days. The park organized a Nestwatch Program; more than 20 volunteers from across the state recorded incubation shifts and foraging behavior of the four adult birds from sunrise to sunset. For the first time park staff had an opportunity to collect behavioral data on condors nesting in the Arizona wilds.

The nests faced each other on opposing cliffs, and nest watching became an interpretive event. National Park Service biologists provided scopes and binoculars and helped park visitors view the nests. Just days before the hatching, biologists and the public watched as condor incubation shifts ceased abruptly for both pairs, indicating nest failures.

Biologists were not surprised by the failed nests because the parent condors were young and inexperienced. Other possible causes of the failed nests include attacks by predators such as ravens and the parents' possible exposure to lead in the environment, which can affect egg viability. Rangers rappelled to one of the failed nests and retrieved eggshell frag-

Small parks, big biodiversity

by Brent W. Steury

Inventory efforts under way throughout the National Park System highlight the biological importance of small parks. Piscataway and Fort Washington Parks in Maryland are no exception. From 1995 to 2002 the park biologist at National Capital Parks–East undertook an inventory of vascular plants for both national parks. Although the combined area of the two parks is just 4,800 acres, the inventory yielded a total of 988 vascular plant taxa, representing 973 species. A voucher specimen, a sample deposited in the park's herbarium, or photographic documentation was obtained for each taxon. Additionally, historical occurrences of plants were determined through searches of other local herbaria.

Discovering such a rich diversity of plant life only 10 miles south of the nation's capital was surprising. Less surprising was the discovery that nonnative plants comprised 25.3% of the parks' vascular flora. Seventeen species are known only from historical records and 31 plants are listed as endangered or threatened by the State of Maryland. An additional 49 species located during the survey are included in the state list of rare, threatened, or endangered plants of Maryland, with state rankings from uncommon to highly rare.

A paper containing the complete vascular plant species list for Piscataway and Fort Washington Parks and descriptions of the plant communities, historical land use, and physiography of the parks will be published in a 2003 edition of the journal *Castanea*. Park resource managers will use the inventory results in future vegetation mapping projects, exotic plant control efforts, and long-term monitoring of rare plant populations. ■

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Maroon Carolina milkvine *(Matelea carolinensis)* is one of 31 species documented in the inventory that has state endangered or threatened status.

ments for laboratory analysis. They also recovered pieces of bone from the late Pleistocene and historical times, evidence that condors inhabited the same nest site 10,000–11,000 years ago and in the late 1800s.

One of the most endangered birds in the world, the condor was reintroduced to northern Arizona in 1995 in an effort to restore this component of the ecosystem that had been absent for more than 100 years. Because of this endeavor there are now 33 wild condors in Arizona. Although challenges still face the program, biologists are eager for the 2003 breeding season, as four pairs of condors will be of breeding age. Two pairs have already returned to the 2002 nesting sites and a third nest has been located on the North Rim. The fourth nest remains to be found. ■

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NPS PHOTO

AWARD-WINNER PROFILE

Brewster leads Yellowstone through precedent-setting issues

NPS PHOTO

Wayne Brewster

Wayne Brewster's leadership ability has allowed him to set precedents. This talent also brought him something else: this year's Director's Award for Natural Resource Management.

Wayne came to Yellowstone National Park in 1991 when the park faced some of the most contentious and complex issues in its history. Although some people would have shuddered at the challenges, Wayne considers himself lucky. "I've been fortunate to be in the right place at the right time. I've been a part of projects that will make a difference for a long time, and that's the rewarding part." Wayne had two particularly complex missions on his agenda and tackled them both with success.

First was the reintroduction of wolves into Yellowstone. The year 2002 marked the eighth year of the experiment and the third successive year in which more than 30 pairs have reproduced throughout the Rocky Mountain recovery area, thus preparing the animal for possible removal from the threatened species list. This project started when Wayne collaborated with the U.S. Fish and Wildlife Service to author the environmental impact statement, which drew the largest public response (280,000 comments) in the Department of the Interior's history. Nearly all the predictions in the statement have been fulfilled except two: the anticipated time and cost were inaccurate. Wayne has overseen a program that is ahead of schedule and under budget.

The second mission was completion of an interagency bison management plan, which had begun a decade earlier. Bison carry brucellosis, a disease that can cause fetal abortions in cattle. Until 2000, when cold weather forced bison outside the park, the Montana Department of Livestock and Department of Wildlife and Parks, and NPS staff at Yellowstone summarily killed these animals. But in 2000, Wayne's efforts to change this system paid off when the plan was implemented. The plan balances the goals of reducing the risk of transmission of brucellosis to cattle with the preservation of 2,300–3,000 free-roaming bison. Although some bison that leave the park may continue to be killed, they are first tested for brucellosis. Those testing negative may be allowed to remain outside the park in limited numbers in special management zones.

Wayne has been described as the "field commander" for his involvement in both of these long-pressing issues. ■

Discovering life in the national parks

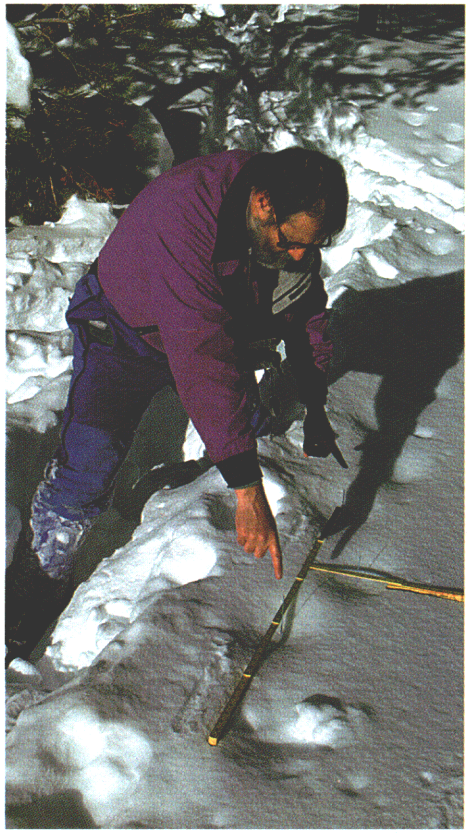
by Ben Becker and Christie Denzel Anastasia

"If we were to visit another planet the first thing we would do is conduct a systematic inventory of that planet's life. Oddly, enough, we have never done that for our own planet."

—Edward O. Wilson

As the National Park System becomes an increasingly important repository for many of North America's disappearing species, the National Park Service has made inventorying biological diversity a priority. An emerging model for inventorying life in national parks is the All Taxa Biodiversity Inventory (ATBI), an inventory system that documents *all* the organisms in a natural system. The information generated through the ATBI process is used to develop conservation and management strategies. The successful implementation of an All Taxa Biodiversity Inventory at Great Smoky Mountains National Park, Tennessee and North Carolina, has spurred Point Reyes National Seashore in California to do the same. In 2002, Point Reyes began the National Park Service's first *marine* ATBI.

The Pacific Coast Learning Center at Point Reyes National Seashore organized more than a dozen community groups, scientists, and educators to initiate an ATBI process for Tomales Bay, California. Although threatened by pollution, sedimentation, and invasive species, Tomales Bay remains one of the most pristine bays on the West Coast of North America. The bay provides critical habitat for many



Dr. Jim Halfpenny, coauthor of the Lynx project study and animal track expert, examines possible lynx tracks found near Mud Volcano in Yellowstone National Park. Gait patterns, stride, and straddle measurements help wildlife researchers determine if the tracks belong to lynx.

Found: The missing lynx!

by Kerry Murphy

Biologists continue to find positive evidence of Canada lynx *(Lynx canadensis)* presence in Yellowstone National Park (Wyoming, Montana, and Idaho). In February 2002 they found probable tracks of this federally listed threatened species during snow tracking surveys, and at the end of April, mitochondrial DNA samples from the previous summer's hair-snaring survey tested positive for Canada lynx. Further tests confirmed that the hair-snared lynx was female.

The biologists collected the hair sample using the National Lynx Detection Protocol developed by scientists at the Rocky Mountain Research Laboratory at the University of Montana. Under the protocol, each transect consists of five stations spaced at 100-meter intervals. In 2001, biologists deployed 32 hair-snare transects. Each station comprises a hair-snare, which is a 4x4-inch carpet square with small nails and ground catnip leaves, placed 18 inches above ground, and a scent pad consisting primarily of oil from beavers hung nearby. Attracted to the scent pad, lynx rub against the hair-snare. Samples are collected by biologists at two-week intervals, stored in vials with a drying agent, and then sent to the university's Carnivore Conservation Genetics Laboratory for DNA analysis. There, DNA is chemically extracted and specific regions of the DNA molecule are replicated using a polymerase chain reaction. Restriction enzymes and a gel are used to identify DNA fragments that originate from lynx. If needed, additional tests can be used to estimate the cat's sex.

Yellowstone National Park managers hope for continued success in locating lynx as they enter the third year of a three-and-a-half-year survey. ■

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species and natural communities. The project has already secured more than $85,000 in nongovernmental grants, established science and education teams, and begun collecting data on birds, mammals, algae, invertebrates, and fish. Plans are also under way for mudflat monitoring by high school students, and an invertebrate "bioblitz," an opportunity for taxonomic specialists to rapidly identify collected species. This systematic inventory will help preserve species and habitats, inspire stewardship through participation in education initiatives, and create a model for marine biodiversity research. ■

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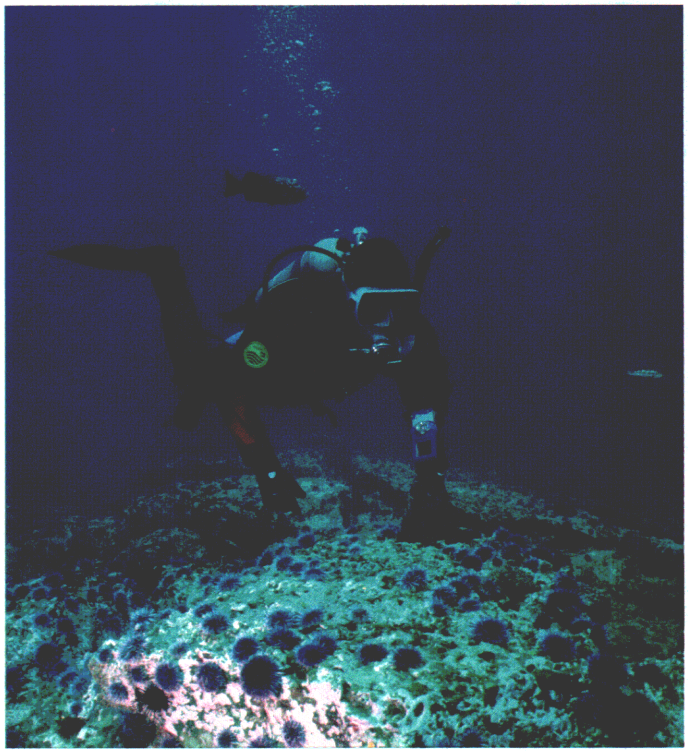
Pacific angel shark, Point Reyes National Seashore.

"The marine world may be degrading faster than our terrestrial one as pollutants pour into it from the land and sky, and stocks of many species decline from overfishing."

National Park System Advisory Board, *Rethinking the National Parks for the 21st Century*, 2001

Marine and Coastal Resource Preservation

NPS PHOTO BY DAN RICHARDS



As a result of fishing, reefs dominated by purple sea urchins, brittle stars, and sea cucumbers have replaced 80% of the kelp forests in Channel Islands National Park since the park was established in 1980. Twenty-four years of marine monitoring revealed these and other alarming changes in ecosystem health and helped secure the designation of 10 marine reserves in or near the park in 2002.

Although they cover approximately 70% of the planet, oceans are one of the least studied environments on Earth. For centuries, the relative inaccessibility of the seas has contributed to our ignorance of their vast resources. But science is progressively illuminating what was once unknowable and hard to imagine—that the oceans are fragile and must be conserved if they are to thrive and continue to sustain, enlighten, and inspire us. Knowledge is vital in the conservation efforts now unfolding to preserve marine ecosystems, and the National Park Service has a leading role to play in them. In 1998 an executive order, followed by urging of the National Park System Advisory Board, boosted efforts to study and protect coral reefs and marine life in the national parks. As a result, coral reef parks are collaborating more and are either beginning to monitor reefs or refining their monitoring protocols. Partners continue to pioneer ways to gather management information through logistically difficult studies. Especially promising is the designation of fully protected marine reserves in Channel Islands and Dry Tortugas National Parks over the past two years, which are expected to help replenish sea life far beyond the boundaries of these national parks. Several of these themes are explored in the following articles about marine and coastal resource protection in 2002.

Science, partnerships, and persistence begin to restore lost marine ecosystems and fisheries at Channel Islands National Park

by Gary E. Davis

DURING THE 1980S AND 1990S, FISHING dramatically altered marine ecosystems in Channel Islands National Park, California, reversing nearly 30 years of National Park Service stewardship. Alarmed by more than two decades of scientific data showing declines in ocean vital signs in the park, the National Park Service and some experienced recreational fishers requested that the California Fish and Game Commission designate a network of reserves in the park. The purposes of the reserves were to rebuild populations of sea life depleted by fishing, to restore ecosystem integrity, and to sustain fisheries in the future. Four years of community negotiations and public hearings followed the request, culminating in 2002 in a commission decision to establish 10 marine reserves in and near the park (nine in park waters and one within a mile of the park). State regulations, scheduled to take effect in April 2003, create a network of 1,200- to 20,000-acre reserves, totaling nearly 75,000 acres, that will replenish depleted populations and preserve marine ecosystems for exploration, inspiration, and education.

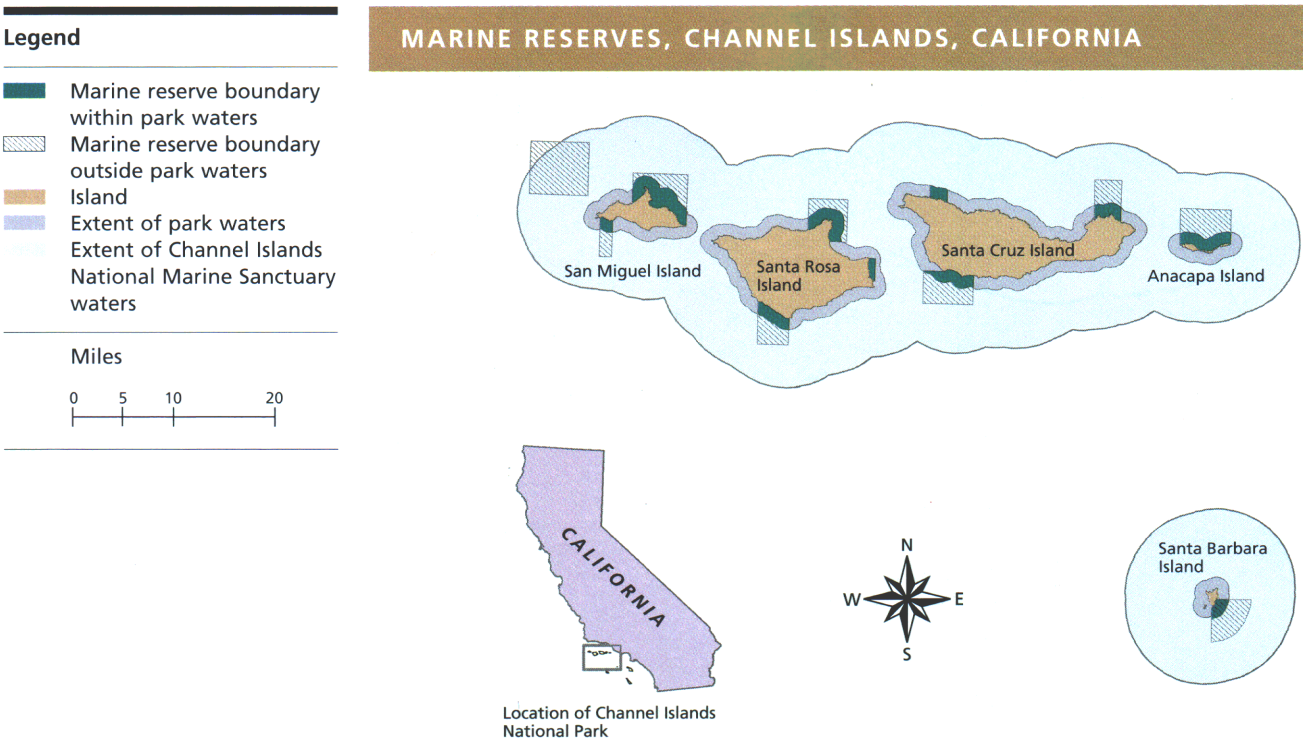
"This generation must ... protect the integrity and resilience of ocean ecosystems by creating networks of fully protected marine reserves."

National Park Service stewardship of submerged resources at the Channel Islands began in 1949 with Channel Islands National Monument. Concern over declining populations of sea life led the National Park Service to curtail fishing in half of the monument in the 1960s. The number and size of lobster, abalone, and fish in the protected zones of the monument rapidly increased. When fished populations along the mainland coast and at other nearby islands began to decline sharply in the 1970s, a fisherman complained to the State of California that the ban prevented him from taking state-owned lobster. In 1978 the U.S. Supreme Court affirmed that California indeed owned the lobster in the monument by virtue of the 1953 Submerged Lands Act. The Court's decision eliminated 15 years of NPS protection, and fishing resumed under state control throughout the monument. Only a 37-acre portion of the Anacapa Island Ecological Reserve remained protected from fishing.

The California Channel Islands and surrounding waters have been recognized as special places by state designations as ecological reserve, nature reserve, area of special biological significance, and research natural area, and by federal designations as national park, national marine sanctuary, and biosphere reserve. Partnerships have been an essential part of conservation in this region for a long time. Congress created Channel Islands National Park in 1980 by expanding Channel Islands National Monument. The expansion explicitly added 119,000 acres of submerged lands and waters. This act ushered in a new era of state and federal cooperation at the islands. The National Park Service cooperated with the State of California and the U.S. Department of Commerce to implement a scientifically rigorous ecological monitoring program to measure changes in the health of the new park's island and marine ecosystems. More than 400 scientists from state and federal agencies and universities have helped to monitor and assess the health of kelp forests, rocky intertidal communities, beaches and lagoons, seabird colonies, and pinniped rookeries in the park over the past 24 years.

Monitoring revealed alarming changes in ecosystem health caused by fishing. For example, many species taken by fishing, such as pink abalone *(Haliotus corrugata)* and red sea urchin *(Strongylocentrotus franciscanus)*, declined rapidly, whereas species not taken fluctuated normally with environmental conditions. Elsewhere, the only place where fished species persisted for a time was the protected portion of the Anacapa Island Ecological Reserve. Kelp, rockfish, abalone, and red sea urchin populations declined drastically. California closed fisheries or severely restricted them in the 1990s to prevent extinctions and encourage population recovery. White abalone *(Haliotis sorenseni)* was listed as the nation's first endangered marine invertebrate, a species whose center of distribution had been the Channel Islands.

The findings also indicated that fishing removed the large predators (such as California sheephead, rockfishes, and lobster) and competitors (such as red sea urchin and abalone) needed to hold hordes of small purple sea urchins *(Strongylocentrotus purpuratus)*, brittle



A new network of 10 fully protected marine reserves in Channel Islands National Park and Channel Islands National Marine Sanctuary will reverse a 20-year decline in kelp forest productivity and biodiversity and help sustain local fisheries.

stars *(Ophiothrix)*, and sea cucumbers *(Cucumaria)* in check. Unconstrained, these species overgrazed reefs and kelp forests, excluded other species, and prevented young kelp plants from settling. Starvation and disease now control these species, resulting in wild boom-and-bust cycles.

"To restore and sustain ecosystems and to support fisheries, the latest understanding of marine species and ecosystems must be applied to the development of conservation strategies that are based on ecosystems rather than on individual species."

Monitoring also revealed that marine systems were much less resilient to natural disturbances after years of fishing. Storms associated with major El Niño events opened holes in kelp forest canopies. At most sites the canopy recovered a few years after storms, but after each event, purple sea urchins and brittle stars overran a few more areas. By 1999 nearly 80% of the kelp forest in the park was gone. Without kelp as food and shelter, depleted abalone and red sea urchin populations could not recover. In the "urchin barrens," areas overrun with purple urchins and brittle stars, fewer than 200 of the 1,000 species found in healthy kelp forests remained.

In addition, persistent organic compounds, such as DDT and PCBs, contaminate marine food webs, stressing fish and wildlife. The relative effects of pollution and fishing were revealed by comparing populations in areas affected by both fishing and pollution with populations in the protected area in the reserve. In the reserve, which was bathed in polluted water but free of fishing, kelp forests remained intact and large predators survived and kept other species in check. In other words, the reserve's kelp forests were resilient. They recovered quickly after storms and El Niño events, providing a thousand species with food and shelter. From these observations it was clear that fishing impaired the park's balanced, healthy ecosystem.

Monitoring vital signs of kelp forests in the park and recent advances in ecology revealed fatal flaws in conservation strategies. In the past, fishery scientists thought that the high potential reproductive capacity of older, mature fish was surplus to the needs of the species. For this reason managers believed that fisheries could be sustained by harvesting all the big fish and leaving only young fish to reproduce. Today it is clear that many species need the huge reproductive capacity of old fish to exploit opportunities for population gains provided by rare, extreme environmental events and to overcome predators and competitors. This need has become more evident as technology has advanced.

"State regulations ... create a network of ... reserves ... that will replenish depleted populations and preserve marine ecosystems for exploration, inspiration, and education."

Although it was unknown in the past, remote and isolated patches of habitat at the islands provided refuge for old fish, which sustained fishing elsewhere. Modern technology, including fast boats with electronic fish finders and satellite navigation, eliminated these important havens by giving people access to even the most remote reefs and underwater canyons where remnant populations of large, old fish survived.

Research has shed new light on the complex functioning of marine ecosystems. Interactions among species are powerful forces that bind components of ecosystems together, but fishing removes selected species and dissolves those bonds. Fishing caused unintended consequences that cascaded through the park for decades and reduced productivity and biodiversity. To restore and sustain ecosystems and to support fisheries, the latest understanding of marine species and ecosystems must be applied to the development of conservation strategies that are based on ecosystems rather than on individual species.

To ensure that the people who follow us have opportunities to enjoy the sea's bounty—not only the wealth of food it provides but also its enduring beauty and inspiration—this generation must explicitly protect the integrity and resilience of ocean ecosystems by creating networks of fully protected marine reserves. Only in this way can we restore the fishing-weakened ecological interactions upon which resilient marine ecosystems depend, reestablish the lost reproductive capacity of depleted species, and provide insurance against human ignorance and arrogance. The new reserve network in Channel Islands National Park is a good beginning. ■

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NPS PHOTO BY DAN RICHARDS

Giant kelp can grow 2 feet a day and forms towering forests more than 100 feet tall that harbor nearly 1,000 species of fish, invertebrates, and algae on rocky reefs in the cool, clear water around the California Channel Islands. The new network of 10 fully protected marine reserves in the national park and Channel Islands National Marine Sanctuary will reverse a 20-year decline in kelp forest productivity and biodiversity and help sustain local fisheries.

Partners plan for fishery's future in Biscayne National Park

by Todd Kellison and Rick Clark

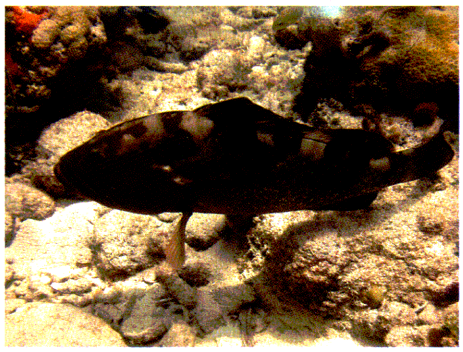
"In tandem with long-term monitoring data … these studies suggested that fishery resources were in need of prompt and diligent management efforts."

LOCATED ON THE SOUTHEAST COAST OF FLORIDA, Biscayne National Park is the largest marine park in the National Park System, with 95% of its 173,000 acres covered by water. The park's diverse marine habitats include expansive coral reefs, seagrass meadows, and mangrove fringes that support productive fish and invertebrate communities. Like many coastal systems worldwide, the waters encompassed by the park have been subjected to the impacts of human influence, including population growth and related recreational and commercial fishing pressure.

Concerns about the condition of Biscayne's fishery resources became apparent in 2001, when a "Site Characterization" report concluded that approximately 70% of targeted species were overfished and that the number and size of most of the key targeted species appeared critically low within the recreational fishery. It also stated that exceptionally high and sustained exploitation pressures seem to have precipitated "serial overfishing" of key fishery resources, where depletion of a targeted species leads to the targeting and subsequent depletion of other species. Preliminary results from a fish and habitat census conducted by Drs. Jerry Ault (University of Miami) and Jim Bohnsack (National Oceanic and Atmospheric Administration and National Marine Fisheries Service) in May 2002 reinforced these findings, indicating that the size of reef fishes such as groupers and snappers was smaller in Biscayne than in areas characterized by lower fishing pressure. Ault said, "It took me … 24 dives in Biscayne National Park before I saw my first legal-sized fish, either snapper, grouper, or grunt." In tandem with long-term monitoring data at the park, these studies suggested that fishery resources were in need of prompt and diligent management efforts.

Given the park's mandate to conserve its resources for future generations, Biscayne is in the process of developing a fishery management plan to improve its long-term ability to manage and conserve fishery resources. The plan is the first of its kind in the National Park Service to be based on quantifiable desired future conditions (i.e., specific conditions to be met regarding size and abundance of fishery populations, issues related to catching nontarget species, fishing gear impacts on essential fishery habitats, and visitor experience), and will include a range of management alternatives that, when initiated in 2003, will directly contribute to the long-term protection and perpetuation of Biscayne's marine resources.

Critical to the success of the plan's development and future implementation have been the inclusion of public input, the establishment of a groundbreaking memorandum of understanding with the Florida Fish and Wildlife Conservation Commission, and the development of partnerships with the National Marine Fisheries Service and the University of Miami. In concert with the National Park Service, these partners share an interest in contributing to and supporting interagency and regional strategies to manage stocks of fish as a biological unit, transcending state and federal jurisdictional boundaries. This approach recognizes that measures to end overfishing and to rebuild stocks are most effective when implemented over the range of the biological stock and not limited to jurisdictional boundaries. As such, the cooperative approach underlying the development and implementation of the fishery management plan provides an excellent protocol to develop strategies for responsible management and conservation of fishery and other consumptive resources within the National Park System. ■



NPS PHOTO BY TODD KELLISON

Scientific surveys of key reef species such as grouper (right), snapper, and grunts indicate that the abundance and size of these species have declined because of increasing fishing pressure. With the support of state, federal, and university partners, the park is developing a fishery management plan to address overfishing and rebuild fish stocks.

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Protecting surf in the national parks

by Rebecca Beavers and Adam Stein

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Surfers congregate at the end of a seawall at the Sandy Hook, New Jersey, unit of Gateway National Recreation Area. A recreational resource, the focused wave energy threatens to erode the shoreline and park access road. Through careful planning the National Park Service protected park infrastructure in 2002 without adversely affecting surfing.

IN MANY REGIONAL SURFING CIRCLES, NATIONAL parks are synonymous with excellent surfing. Cape Hatteras, Cape Canaveral, and Gulf Islands National Seashores have abundant opportunities that draw thousands of surfers each year. Ocean Beach in Golden Gate National Recreation Area and Malibu in Santa Monica Mountains National Recreation Area are two of the numerous West Coast locations visited by many of California's 600,000 surfers. As a recreational resource, surf is of primary importance to surfers and surf-related visitors. But it also influences the aesthetic experience of many other park visitors and in some cases is culturally significant. Unfortunately the locations, characteristics, and threats to surfing areas in the national parks have not been well documented. The National Park Service has begun to gather information on this valuable natural asset in order to enhance its protection.

In 2002 the NPS Geoscientists-in-the-Parks program and the Surfrider Foundation jointly funded an inventory of surfing resources in the National Park System. This project included surfing locales or breaks from the Great Lakes to American Samoa and identified 85 surfing spots in 25 separate national park units, with 28 units still under study. The inventory documented the type, season, and level of use of each area, along with management issues that could affect the surf. It also identified surfing resources with major cultural significance or especially high levels of use. Many parks were unfamiliar with their surf breaks and will benefit from the findings, such as digital data, which will be reported to managers in 2003. The information will be easily applicable to park management issues because the data will also be made available in a Geographic Information Systems (GIS) database.

A recent case study at Sandy Hook in Gateway National Recreation Area illustrates how one park dealt effectively with a management problem involving a prized surfing resource. The surf in "Big Cove" is the result of a lengthy New Jersey seawall that extends into the southern boundary of the park, producing waves that are enjoyed by surfers. However, this focused wave energy threatens to erode the shoreline along the only road accessing northern portions of the park and other infrastructure. In developing plans to protect this critical area, park staff reviewed shoreline monitoring data on the erosion problem and discussed management options with surfing organizations. The combination of open communication and scientific information enabled the park to make an informed decision that benefited all parties. In 2002 the park replenished beach sand to protect park infrastructure, but in small enough quantities and at a distance far enough away from the surf break to ensure its preservation. Russ Wilson, superintendent of the Sandy Hook unit, summed up the positive outcome. "Through an open dialogue ... we have made several changes in the design to the interim beachfill project.... We are pleased that we could work together to design a project to satisfy the needs of the National Park Service, while ... working to minimize any potential adverse effect on surfing." ■

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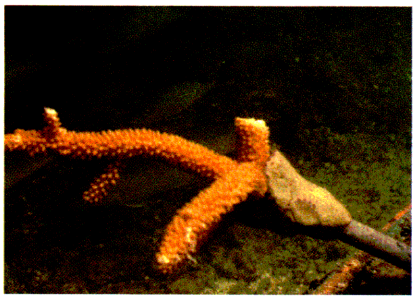
JEFF FLINDT, *SURFING MAGAZINE*

Surfers enjoy a breaker at Assateague Island National Seashore, one of at least 25 units in the National Park System with significant surfing resources. An ongoing survey of surfing areas in the national parks is developing information for management of this recreational park resource.

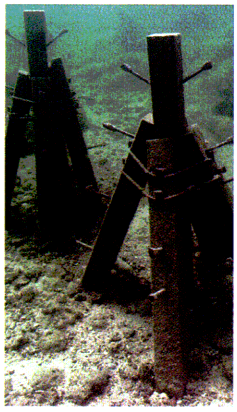
Building a coral nursery at Biscayne National Park

by Richard Curry, Daniel DiResta, and Shay Viehman



NPS PHOTO BY V. CORNETT

With more than 20 boats running aground on coral reefs annually in Biscayne National Park, Florida, the National Park Service is challenged to protect the park's coral reefs. Add to that other disturbances such as coral disease, storms, and destructive fishing and the problem is multifaceted, requiring an integrated management strategy. Part of the solution lies in an innovative restoration program being pioneered at the park that focuses on rebuilding damaged coral reefs with coral grown in a nursery (photo, bottom). In 2002 the nursery was expanded greatly to provide material for future restoration projects.



NPS PHOTO BY SHAY VIEHMAN

The operational principles used in this hard-coral nursery are identical to those for conventional plant nurseries: manipulating environmental conditions to attain maximum growth, size, and survivability. The only difference is time; where plant nurseries cycle their product in one to four years, coral nurseries may require 10 times that.

Park scientists and volunteers populate the nursery by rescuing damaged coral fragments (photo, top) that would die if not transferred to a stable and secure location. The vessel groundings that occur on the coral reefs in the park provide more than enough material for the nursery; no additional collections are made from undamaged reefs. The park will increase its nursery stocks by dividing the damaged colonies brought in from the reef and by fragmenting those coral colonies that have reached a suitable size (>15 centimeters, or about 6 inches).

Unlike the few other hard-coral nurseries worldwide, the four nursery sites at Biscayne are located in well-protected areas, providing easy access for monitoring and maintenance. These sites also facilitate simple experiments focused on enhancing growth and regulating growth inhibitors such as algae. Volunteers from local schools and the public assist in research and implementation of optimal nursery maintenance techniques. Other partners are the University of Miami, the National Oceanic and Atmospheric Administration, and the University of North Carolina, which are developing techniques for capturing coral sperm and eggs during annual spawning and growing them into juvenile corals in order to further increase nursery stocks. Soon, nursery-grown corals will provide an environmentally sensitive option for use in coral reef restorations. ■

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Marine fisheries regulation in national parks

by Cliff McCreedy

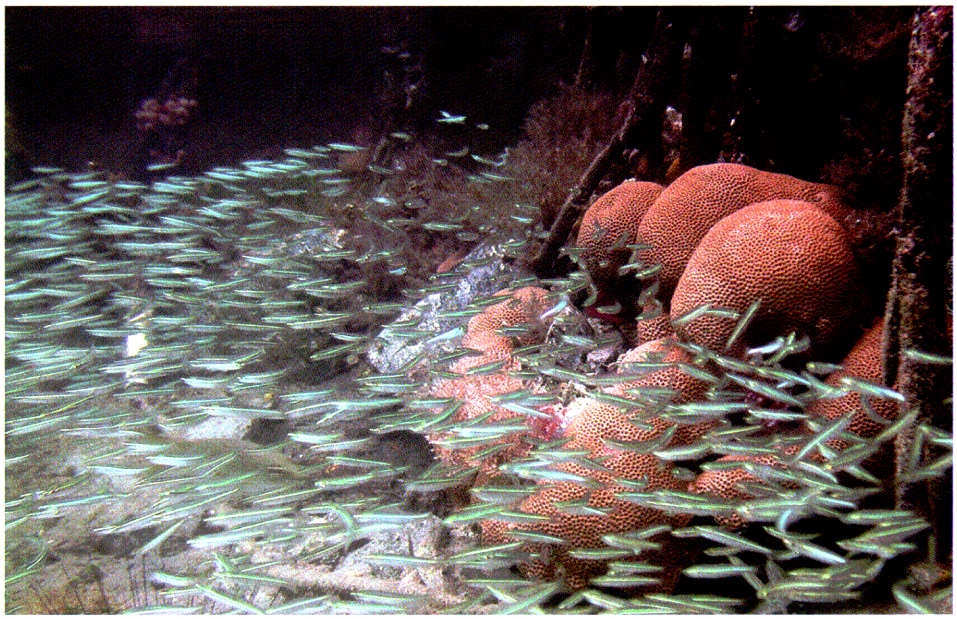
The National Park Service manages 64 park units located on the coasts of the Atlantic and Pacific Oceans, the Gulf of Mexico, and the shores of the Great Lakes. Approximately 3 million acres of submerged lands and surrounding waters of these units protect different facets of our coastal heritage, including coral reefs, coastal bays, estuaries, kelp forests, and fjords.

Fisheries management in the national parks follows regulations and management policies founded in the NPS Organic Act of 1916, which directs the National Park Service to conserve these areas unimpaired for the enjoyment of future generations.

Leading role for NPS in Coral Reef Task Force

by Cliff McCreedy

Twenty-seven percent of coral reefs have been lost or seriously degraded worldwide and another 60% are threatened, according to the Global Coral Reef Monitoring Network and the World Resources Institute. Charged by Executive Order 13089 to protect the nation's imperiled coral reefs, a task force of 17 federal, state, and territorial agencies are coordinating their responses to threats from impaired water quality, overfishing, coral bleaching, and disease. As part of the Department of the Interior, the National Park Service is a key player in these efforts under the U.S. Coral Reef Task Force, cochaired by the Assistant Secretary for Fish and Wildlife and Parks, Harold Craig Manson. And with more than 275,000 acres of coral reefs, the 10 coral reef national park units not only offer outstanding recreational opportunities but also a chance to protect their biodiversity and astonishing natural beauty for future generations to enjoy. Assistant Secretary Manson said, "We need to develop an inventory of coral reef resources, conduct an assessment of the state of reefs, and monitor their health over the long term. We need to take action now to reduce pollutants and sedimentation on reefs" and "stop the overharvesting of coral reefs and the fish and animals that depend on them."



NPS PHOTO BY MATT PATTERSON

Mangrove prop roots, coral heads, and fish in the recently designated Virgin Islands Coral Reef National Monument.

The NPS Water Resources Division is providing national policy and planning support to the task force and helping parks to meet the challenge from the assistant secretary. The National Park Service is pursuing cooperative programs with states, territories, and federal partners to manage and restore reef fish populations (see page 50) and to address sources of sedimentation and pollutants in coastal park watersheds. In 2001, Dry Tortugas National Park set aside the 46-square-mile (119-square-kilometer) research natural area as a no-take reserve to protect shallow seagrass beds, coral reefs, and mangrove communities. General management plan updates are under way to implement no-take reserves at the new Virgin Islands Coral Reef National Monument and at the expanded Buck Island Reef National Monument. ■

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Current policies allow recreational fishing in parks consistent with state regulations and 36 *Code of Federal Regulations* part 2.3, except where specifically prohibited. However, commercial fishing is allowed only where authorized by law or treaty rights. Cooperative management and collaboration are critical to protect marine fisheries because NPS and state agencies frequently share jurisdiction over coastal resources. In some parks, statutory provisions control whether or not commercial fishing may occur and whether overall fisheries jurisdiction is held by the National Park Service, the states, or both concurrently. Although the National Park Service retains authority to implement regulations that are more restrictive than state regulations, joint planning is frequently the best approach to protecting biological integrity and the quality of recreational fishing in the national parks. ■

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AWARD-WINNER PROFILE

Bond's ability to see the big picture helps preserve Big Island park

NPS PHOTO

Stanley Bond (left) and a hula teacher play wooden drums made from dead milo trees harvested in Kaloko-Honokohau. The park allows hula groups to use dead wood that would otherwise be cut and chipped by the park as a way to fulfill their mission to perpetuate native Hawaiian traditions.

Dr. Stanley C. Bond is employed by the Kaloko-Honokohau National Historical Park in Hawaii, and he's good at his job. For Stan, it's the ability to see the "big picture" that distinguishes him. "I take a holistic look at the park; I understand how everything works together to interpret native Hawaii." And it's the challenge to keep all the parts working that motivates Stan to overcome all obstacles. His environmental leadership earned him the 2001 Trish Patterson Student Conservation Association Award for Natural Resource Management in a Small Park, presented in 2002. He did something no one else had ever done: he presented his concerns about the protection and preservation of the park's resources to the State of Hawaii Land Use Commission, and he prevailed.

In spring 2000 a plan to build an industrial park directly upslope from Kaloko-Honokohau required Stan's professional attention. He foresaw the negative impact that pollutants from the site could have on the park: two brackish water fishponds, almost 600 acres of marine and coral reef habitat, several threatened and endangered species, and other hydrobiological resources were in danger. The county did not have adequate sewage treatment, storm-water runoff control, or roadway infrastructure, and until it did, a project of this magnitude would be detrimental to the park. Because Stan's training is in archeology, he gathered helpers: a marine biologist and a brigade of experts in all forms of water sciences, a Department of the Interior solicitor, stakeholders, and community groups. Together they worked for strict conditions to be placed on the project to protect the park. After a two-year struggle, the Land Use Commission concurred with the recommendations of Stan and his crew.

Stan's foresight, motivation, and leadership set a new standard by which Hawaii and the rest of the United States will view their natural resources in the future. ■

Tribute to Dr. James R. Allen

by Mary Foley

On 30 July 2002, the National Park Service lost a valued treasure. While commuting to his office in Boston, USGS Coastal Geomorphologist Dr. James R. Allen suffered a heart attack and died. Jim was the National Park Service's key science advisor on major coastal erosion issues. He knew everything about coastal dynamics, and what he did not know he would strive to learn and understand. He was well respected and trusted.

Jim was passionate about the role of science in public policy decision making. The National Park Service does not need its scientists to serve as advocates for natural resource protection, he would argue; it needs good science to guide its decisions. He was a great teacher, patiently instructing park managers, interpreters, lawyers, legislators, and coastal scientists alike on the state of the knowledge and complexities of shoreline dynamics in our national parks. The National Park Service, the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, and countless other state and federal agencies have benefited from his sound counsel.

Jim leaves a legacy of accomplishments in the National Park System. He had recently completed a major scientific investigation on erosion processes at Fire

Inventory and mapping of coastal resources in Glacier Bay National Park

by Phoebe Vanselow

NPS PHOTO

In 1989 the *Exxon Valdez* oil spill highlighted the need for detailed baseline data on Alaskan coastal resources to help guide response and recovery efforts. Baseline information also helps managers detect change over time, both natural and human-related. In 2002, Glacier Bay National Park and Preserve completed its sixth field season of the Coastal Resources Inventory and Mapping Program. The program focuses on the development and implementation of an accurate, repeatable, and affordable inventory protocol that can be passed on for use on other coastlines in Alaska and beyond. To date, more than 880 miles of coastline in Glacier Bay National Park has been mapped, including all of Glacier Bay proper.

During low-tide "windows," teams of two scientists walk the coast, dividing the shoreline into segments based on changes in substrate and slope. For each segment a variety of physical and biological attributes are described and digital images are recorded. The precise boundaries of the segments are drawn on aerial photo enlargements of the coastline. After data processing, all of the information is accessed via an easy-to-use database that allows one to "walk the coast" and display for any segment its exact location, an aerial photo of that segment, ground photos showing what the beach actually looks like, and all coastal resource data associated with the segment.

In 2003, fieldwork using the current protocol will wind up. The more exposed, homogeneous shoreline of the outer coast of the park will likely be mapped using aerial videography. A public version of the database will be online in the next year or two, giving other researchers, oil spill responders, and the public easy access to the data with the ability to focus on what interests them most. Additional information is available at http://www.nps.gov/glba/learn/preserve/projects/coastal/index.htm. ■

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Island National Seashore, New York, that will contribute greatly to the long-term preservation of the park. He was also instrumental in establishing the Boston Harbor Islands National Recreation Area in Massachusetts. He provided the detailed geological analysis that supported the finding that this system of islands was indeed nationally significant and should be included in the National Park System. He lent his expertise to the newly developing Vital Signs Monitoring Program through the design of a shoreline monitoring protocol for all the seashore parks in the Northeast Region. Jim's protocols will be used for decades to come.

Jim was dedicated to protecting the fragile coastal ecosystems of our national parks. He was also passionate about the accuracy of scientific information and its application to park management issues. These attributes will be difficult, if not impossible, to replace. Dr. James R. Allen will be sadly missed. ■

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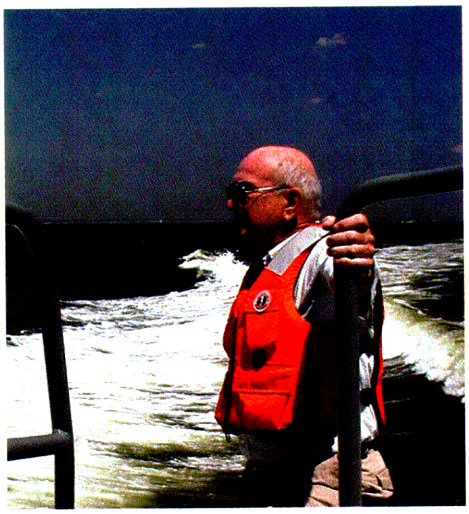

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Jim Allen

"We have to know what we have, how and why it is changing, what changes we can accommodate, and which we must combat."

Fran Mainella, Science and Learning Center Dedication, Crater Lake, 22 August 2002

Assessing and Managing Threats

NPS PHOTO

Etched into a saguaro cactus, the Mexican state name "Sinaloa" betrays the path of illegal aliens and drug smugglers entering the United States at Organ Pipe Cactus National Monument. Stepped-up efforts to shut down these activities at populated areas along the U.S.-Mexico border have led to an alarming increase in crossing attempts in remote areas like Organ Pipe.

A large part of the stewardship of the national parks is the assessment and management of influences and activities that are or could be damaging to park resources. This essential duty entails anticipating and detecting resource degradation and taking action to maintain resource quality. It involves attentiveness, rational planning, and diligent, hands-on intervention based in science. And it requires weighing a wide range of needs and potential responses. This year's articles highlight the astonishing variety of challenges and the search for fair and effective management solutions. They tell of monitoring resource impacts from illegal border crossings, containing an oil well blowout, the worrying spread of infectious wildlife diseases, negotiating water resource protection in the desert Southwest, restoring an island ecosystem infested with nonnative rats, determining legal limits for noise pollution, and other issues. In each case the National Park Service is striving to provide opportunities for people to continue to enjoy unimpaired park resources.

Monitoring border resource impacts in Organ Pipe Cactus National Monument

by Ami Pate

MAPPING FOOTPRINTS, WATER JUGS, AND SALSA cans is an unusual new task for biologists in the Sonoran Desert borderlands of Arizona. After years of observing increasing resource impacts caused by migrants and smugglers, Organ Pipe Cactus National Monument developed a formal monitoring protocol to quantify the problem in 2002.

"This unprecedented flow of illegal traffic and the subsequent increase in law enforcement activities have had devastating impacts on wilderness resources."

Until the mid-1990s, Organ Pipe's 30-mile southern boundary was considered a tranquil stretch of the international border. Resource damage was light and sporadic, even though most of the monument's boundary land is accessible from Mexico by dirt roads or paved highway, with only a four-strand barbed-wire fence between the two countries to exclude livestock. Some vandalism of historic structures and wood cutting occurred close to the border, a few migrant trails were used seasonally, and drug smugglers were occasionally apprehended. Only a few Border Patrol agents and park rangers patrolled the area.

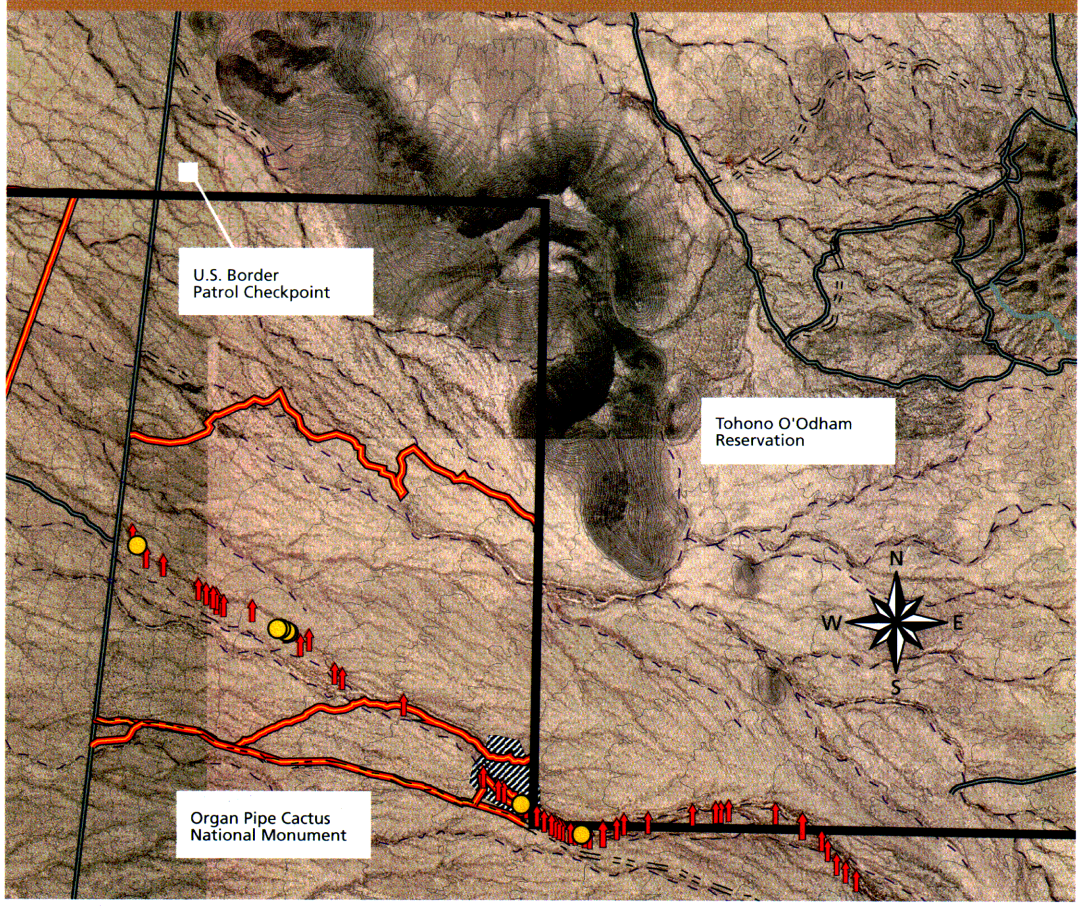
From 1993 to 1995 the Border Patrol launched a series of enforcement operations in El Paso, San Diego, and Nogales that effectively rerouted border crossers to remote southwestern desert lands, including the designated wilderness of Organ Pipe Cactus National Monument. In 2001 an estimated 200,000 people entered the monument from Mexico. In the same year, Organ Pipe law enforcement rangers seized 14,700 pounds of marijuana, more than in all other units of the National Park System combined. Park managers estimate that "unofficial" wilderness use exceeds permitted use by at least a hundredfold.

This unprecedented flow of illegal traffic and the subsequent increase in law enforcement activities have had devastating impacts on wilderness resources. Foot trails, discarded bottles, cans, and clothing are commonly found throughout the monument. Rest areas or "bivouac sites" are denuded of brush and cactus seedlings. Several highly used migrant and smuggler trails intersect important water holes and cultural resources. Habitats for endangered species such as Sonoran pronghorn and ferruginous pygmy owls are under siege. Off-road vehicle tracks, abandoned vehicles in fragile desert terrain, and graffiti on rocks and cacti are other examples of ongoing wilderness degradation that create a

NPS PHOTO

Scientific monitoring was expanded in 2002 and revealed a staggering amount of resource disturbance from illegal foot traffic and extensive off-road driving, including abandoned vehicles, trash, fire pits, and rest sites.

ILLEGAL IMMIGRATION ROUTES AND FERRUGINOUS PYGMY OWL BREEDING TERRITORY, ORGAN PIPE CACTUS NATIONAL MONUMENT



NPS MAP BY BRIAN BARNS, ADAPTED BY NATURAL RESOURCE INFORMATION DIVISION

Human competition for water sources used by wildlife such as the endangered Sonoran pronghorn is a concern of park managers, as are footpaths that cross breeding territory of the endangered ferruginous pygmy owl.

"Park managers estimate that 'unofficial' wilderness use exceeds permitted use by at least a hundredfold."

need for daily foot, vehicle, and aerial patrols by a variety of law enforcement agencies.

With funding from the National Park Service's Mexican Affairs Office in spring 2002, Ecological Monitoring Program coordinator Bryan Milstead and cartographic technician Brian Barns designed a monitoring program to assess the extent of these border impacts. They established five east-west belt transects in the four geographic corners and center of the monument. One well-traveled, north-south migrant trail was also surveyed. A total of 100 kilometers (62 miles) was walked from January to March. All human disturbances encountered within 20 meters of the transect center line were mapped with a geographic positioning systems unit and described. When possible, resource managers walked the transects with law enforcement rangers, who contributed valuable professional experience in detecting the presence of human activity.

Data from this monitoring project are being used in GIS models and in educational presentations for interagency managers, scientists, and the public. In November 2002, resource management staff began the second round of transect data collection. Monitoring will be conducted semiannually to assess trends and patterns of backcountry impacts to assist managers in formulating strategies for protecting the monument's resources in the future. ■

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Oil well blowout at Obed Wild and Scenic River

by Pat O'Dell and Rick Dawson

"The crew was unable to prevent the stream of oil from ... cascading down the cliffs into the creeks of Obed Wild and Scenic River."

ON THE AFTERNOON OF FRIDAY, 18 JULY 2002 in Morgan County, Tennessee, oil and gas drillers labored on a bluff high above the confluence of Clear and White Creeks of the Obed Wild and Scenic River. The crew was ill-prepared for what they would find: a high-pressure, high-flow-rate oil zone. Oil surged into the well from 2,500 feet below the surface, quickly filling a pit at ground level. With no equipment for closing the well, the crew's grip on the situation was tenuous at best. Within hours, oil and gas poured from the well while workers scrambled to contain the worst of the mounting spill volume with vacuum trucks and hurriedly built pits and dikes. The crew was unable to prevent the stream of oil from seeping into the ground, breaching dikes, and cascading down the cliffs into the creeks of Obed Wild and Scenic River. On Saturday morning, a single spark became a huge fireball that ate its way through volatile vapors rising from the oiled waters, leaving pools and trails of burning oil in its wake.

By Saturday afternoon, the response to this event was in full swing as local, state, and federal emergency workers converged on the site. Firefighters suppressed the incidental fires, and specialized oil well firefighters mobilized from Texas to squelch the well fire. Park staff joined in the battle by providing operational assistance and important natural resource information to incident command. Once the fire ended, an NPS petroleum engineer with the Geologic Resources Division was called in to assess remaining threats to park resources posed by the oil well. Also, a team of experts from the National Park Service, the State of Tennessee, and the U.S. Fish and Wildlife Service directed a natural resource damage assessment. Under the Oil Pollution Act, the company responsible for the spill is liable for all oil removal costs and damage caused by the spill, including compensation for affected natural resources. The measure of natural resource damage is the cost of restoring, rehabilitating, replacing, or acquiring the equivalent of the damaged natural resources, the loss in value of the resource pending restoration, plus the reasonable cost of assessing those damages.

NPS PHOTO

A fiery oil well blowout rages on a bluff above Obed Wild and Scenic River, dumping petroleum into Clear Creek in the national park. Scorched trees along the bank and pockets of burning oil are remnants of the fireball that roared through the valley hours earlier.

Response and damage assessment are critical elements of a common challenge: balancing the rights and needs of extractive mining and petroleum industries while ensuring protection of parks' valued resources. The National Park Service is becoming more proficient at incident response and the process of damage assessment—good news for parks like Obed and Big South Fork, which are situated in Tennessee's most prolific mineral production areas. The most important task is making the industry and its regulators aware of the locations and values of important natural resources like those found in the Obed Wild and Scenic River. Once these resources are brought to their attention, oil and gas developers generally begin taking the necessary steps to protect them.

Renewed interest in prevention nearly always follows an accident of this size, and rightly so. Within days the State of Tennessee directed operators to use blowout prevention equipment and is now in the process of reviewing its entire oil and gas program to avoid a repeat disaster. The National Park Service will participate in that review process to ensure that park resources are protected. This action comes just in time, as news of the gusher has excited the oil and gas community and new wells are already being drilled in drainages near the park. The balancing act continues. ■

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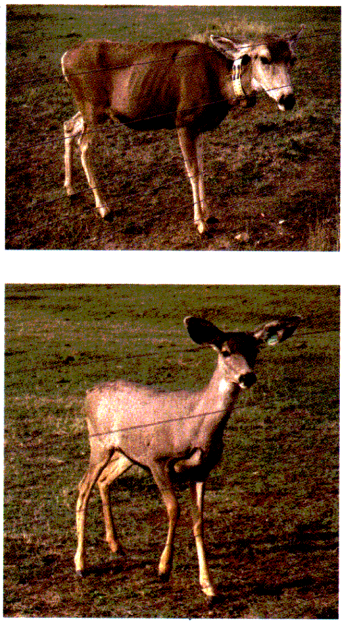
Chronic wasting disease: An emerging infectious disease of concern

by Margaret A. Wild



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A fatal brain malady of unknown origin, chronic wasting disease has been documented in free-ranging elk and deer in several western and midwestern states. Sick animals (top, compare with healthy deer, bottom) are thin, lose their fear of humans, and develop a blank stare; additional signs of illness may include drooping ears; excessive salivation, drinking, and urination; and eventually tremors and incoordination.

"WEST NILE VIRUS APPEARS THROUGHOUT United States." "Amphibians decline due to Chytrid fungus." "Chronic wasting disease threatens deer and elk." Conservationists, hunters, public health officials, and the general public take note of such headlines because these emerging infectious diseases pose a threat to natural resources in various areas of the country, including national parks.

Chronic wasting disease is not a new discovery, but the attention focused on it in recent years is unprecedented in wildlife health management. The disease first appeared in Wyoming and Colorado, including Rocky Mountain National Park, more than 20 years ago. Although the origin of the disease is unknown, it is believed to be an exotic disease process that is the result of human intervention. Concern about chronic wasting disease increased with the recent detection of it in several new locations. Since 1997, chronic wasting disease has been found in 25 elk and deer farms throughout the United States and in free-ranging deer in Nebraska, South Dakota, Wisconsin, Illinois, and New Mexico. Increased surveillance will likely lead to identification of additional areas of infection in coming years.

Chronic wasting disease belongs to the family of fatal brain diseases known as transmissible spongiform encephalopathies. Related diseases include scrapie of sheep, bovine spongiform encephalopathy (mad cow disease), and human Creutzfeldt-Jakob disease. These diseases are not caused by viral or bacterial infections, but scientists have noted accumulations of abnormal prion proteins in the brains of affected animals.

NPS PHOTO BY DAN RODDY

Rocky Mountain National Park uses tonsillar biopsy of anesthetized deer to identify chronic wasting disease before symptoms appear.

Because of the unique nature of the disease agent, scientists have had to determine new methods for detection, diagnosis, and possible treatments.

Diagnosis of chronic wasting disease has traditionally been made using brain samples collected postmortem from deer and elk. New developments have led to a live animal test for deer using tonsillar biopsies obtained from anesthetized deer. Unfortunately this technique is not currently applicable to elk because of differences in the accumulation of prion protein in the tonsils of elk and deer. While this intensive testing approach is not practical for all management situations, it is being applied in Colorado's Rocky Mountain National Park and South Dakota's Wind Cave National Park, where chronic wasting disease is a significant threat to resources.

At other national parks, managers are encouraged to be on the lookout for the disease. It should be suspected in deer and elk more than 17 months old that are thin and exhibit behavioral abnormalities, such as loss of fear of humans. Additional clinical signs include a blank stare, drooping ears, excessive salivation, excessive drinking and urination, and, terminally, tremors or incoordination. Targeted surveillance, in which any deer or elk with clinical signs similar to those of chronic wasting disease are collected for diagnostic testing, is an effective and easily applied management technique.

Much remains to be learned about chronic wasting disease. The specific route and mechanism of disease transmission have not been identified, but are believed to be from animal to animal or contaminated environment to animal via saliva or feces. Although investigations have found no evidence that the disease occurs naturally in species other than deer and elk, the agricultural community and public remain concerned that domestic livestock or humans could become infected. Yet the disease itself and management actions to control it present a real threat to populations of deer and, to a lesser extent, elk. For these reasons chronic wasting disease will likely remain in the headlines and on the minds of conservationists for years to come. ■

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Recent decisions protect resources at Lake Mead

by Dan McGlothlin

NEGOTIATED SETTLEMENTS IN 2001 AND 2002 involving the National Park Service, Bureau of Land Management, and U.S. Fish and Wildlife Service resulted in agreements with water developers in the watersheds of the Virgin and Muddy Rivers to protect resources administered by the Department of the Interior from impacts attributed to pumping groundwater. These agreements are supported by a series of decisions made by the Nevada State Engineer.*

"The effect of extensive groundwater pumping on stream flows, spring flows, and associated plants and animals is unknown."

The watersheds in question include a large area of eastern and southeastern Nevada, which drains generally southward toward the Colorado River at Lake Mead. Groundwater flows among the area's 29 hydrographic basins through a system of aquifers. This system has been termed "The Colorado Regional Ground-Water Flow System of Nevada" or simply the "Colorado System" by the United States Geological Survey (USGS).

Many water resources associated with the Colorado System can be seen at Lake Mead National Recreation Area (Nevada), including tributary streams that flow into the lake, and springs that discharge on lands adjacent to the shores of the lake. The Virgin and Muddy Rivers flow through the park into the lake's Overton Arm. Eight named springs and additional seeps occur on lands on the west side of the Overton Arm, including the large-volume, warm-water Rogers and Blue Point Springs.

Since 1989, applications for groundwater rights in desert basins near the park increased beyond previously determined rates of sustainable yield. The effect of extensive groundwater pumping on stream flows, spring flows, and associated plants and animals is unknown. In response to this uncertainty, the National Park Service is participating in the Nevada water rights permit process to ensure that park water rights are fully considered in water allocation decisions. The National Park Service is also assisting the state engineer by gathering scientific information to improve understanding of impacts from pumping.

NPS PHOTO

Springs and streams at Lake Mead National Recreation Area diversify the desert landscape, supplying scarce water to wildlife and vegetation. Some of these water resources are fed by aquifers extending far beyond park boundaries, and may be vulnerable to groundwater pumping to meet growing human needs in the Las Vegas area.

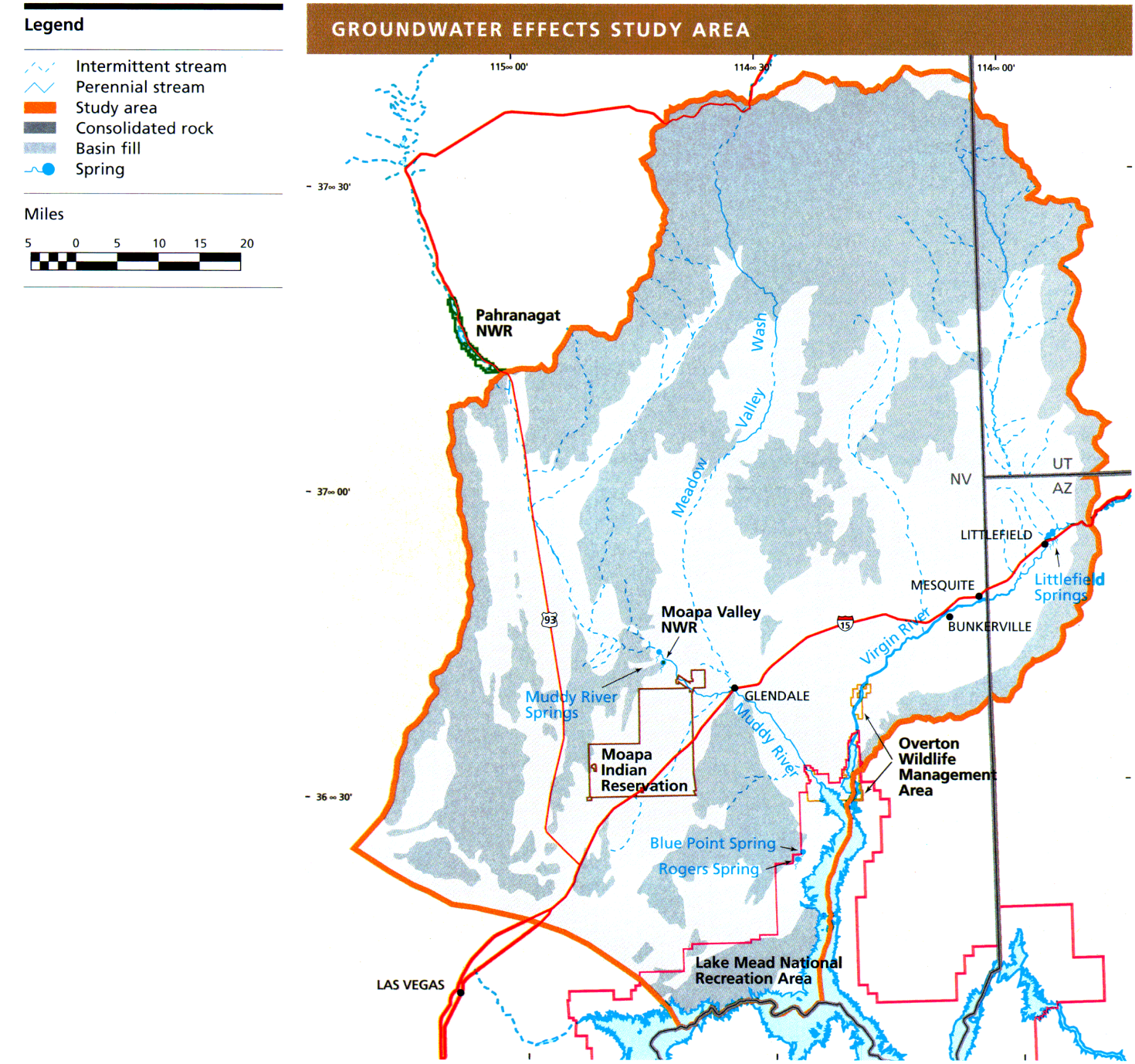
*State Engineer's Ruling Nos. 5008, 5115, 5167, and 5181 and State Engineer's Order No. 1169.

Why is the National Park Service concerned about groundwater far from the park boundary? Groundwater withdrawals have the capacity to intercept the sources of rivers and springs that flow into Lake Mead National Recreation Area. However, without adequate scientific information, it is difficult to understand the sustainability of large groundwater withdrawals from the Colorado System and the effects that groundwater development will have on park resources. Because the state engineer allocates water basin by basin, approved developments could change the direction and magnitude of interbasin flow, disrupting the discharge of groundwater to streams and springs.

To address this problem the National Park Service and the U.S. Fish and Wildlife Service are developing a three-dimensional groundwater flow model. Intended for use in estimating the potential effects of groundwater pumping in southern basins of the lower Colorado System on the resources of the Moapa National Wildlife Refuge and Lake Mead National Recreation Area, the model encompasses an area of approximately 300 square miles across 10 hydrographic basins. Model development, begun in 2001, is aided by ongoing cooperative studies with the USGS and Southern Nevada Water Authority to investigate the system's complex hydrogeologic framework, improve water budget estimates, and incorporate groundwater pumping data.

Until sufficient information can be gathered regarding the long-term implications of groundwater removal, the state engineer has carved out a conservative middle ground to address both water resource protection and the possible development of additional groundwater. The state engineer, in several decisions issued in 2001 and 2002, concluded that "only by gradual, staged development can the additional science be obtained which will allow a better understanding of the ... aquifer(s) and the effect new appropriations will have on interbasin flows and the direction of groundwater movement." The agreements between the National Park Service and the water developers implement this strategy through monitoring, management, and mitigation provisions.

Limiting additional development and encouraging early detection of impacts further the understanding of the hydrogeologic complexity of the lower Colorado System and aquifer responses to pumping. This information will be



The National Park Service, U.S. Fish and Wildlife Service, and water developers near Las Vegas, Nevada, are studying a 300-square-mile area to gain a better understanding of the effects of groundwater pumping on water resources in Lake Mead National Recreation Area and Moapa National Wildlife Refuge.

used to refine the groundwater flow model, giving the National Park Service and other Department of the Interior bureaus the opportunity to create a very powerful tool for estimating the effects of any existing or proposed groundwater withdrawals from the system. It also can be used to illustrate the time it will take for water levels to recover after pumping ceases. This tool and the results that can be generated with it are proving very useful. To date, the model has been used in negotiating settlement of protests, in constraining adaptive groundwater management options, and as evidence in an administrative hearing before the state engineer. It also demonstrates the National Park Service's commitment to cooperate, consult, and coordinate science-based decision making to ensure protection of park water rights and resources. ■

Map—Geology modified from Plume and Carlton (1988). Base modified from USGS digital data, 1:100,000 and USGS GAP Analysis data.

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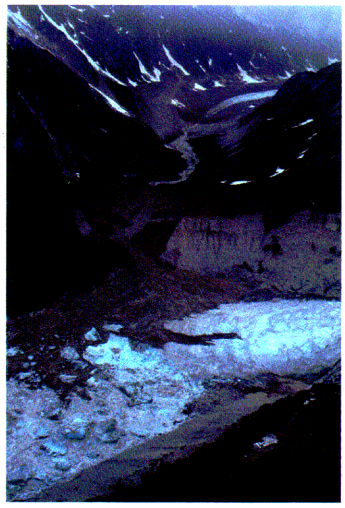
Bank stabilization studied at Klondike Gold Rush

by Meg Hahr and Theresa Thibault



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A moraine in the Taiya River watershed in Klondike Gold Rush National Historical Park released 10 million cubic yards of debris in July 2002, suddenly filling a glacial lake. The resulting flood threatened visitors, historic structures, and park facilities in the gold rush town of Dyea.

SINCE ITS INCEPTION, KLONDIKE GOLD RUSH National Historical Park (Alaska) has been faced with a particularly complex natural resource management issue regarding important cultural resources and a highly dynamic river. Established in 1976 to preserve historic structures and trails associated with the Klondike Gold Rush of 1898, the park also contains significant natural resources including salmon, bald eagles, grizzly bears, glaciers, and a productive estuary. Another valued park resource is the Taiya River, a free-flowing, glacial meltwater river affected by coastal, stream, and tectonic processes. This extremely dynamic river drains approximately 188 square miles of glaciers and coniferous forest and is prone to spontaneous channel migrations and catastrophic flooding.

The river's unpredictable nature was highlighted on 23 July 2002, when a landslide of 10 million cubic yards of moraine material suddenly filled a glacial lake in a tributary drainage, generating a tremendous flood that swept through the park, threatening visitors, cultural resources, and park facilities. Over the last century, the Taiya River has wandered widely over its floodplain, causing the removal of more than 30% of the historic gold rush town of Dyea, part of a National Historic Landmark District. To date, a total of 345 archeological features have been found in Dyea along with an uncounted number of historic artifacts.

In its 1996 general management plan, the park resolved to evaluate the Taiya River erosion issue and find a way to prevent additional loss of cultural resources in the Dyea area. Although stream bank stabilization projects are permitted under *NPS Management Policies* for situations in which "there is no other feasible way to protect natural resources, park facilities, or historic structures," park resource managers were reluctant to pursue this alternative given the likelihood of impacts on natural resources. An impediment to effective management has been technical issues associated with interpreting historical hydrologic data from USGS gauging stations, aerial photos, and bank retreat monitoring efforts.

In 2002 the park received technical assistance from the NPS Water Resources Division and the Geologic Resources Division to evaluate the existing information and recommend a scientifically sound course of action. After two site visits, NPS Hydrologist Rick Inglis and Geomorphologist Hal Pranger concluded that the Taiya River would eventually migrate through and destroy the remaining portions of Dyea if the channel bank is not stabilized. Although protection of the bank is possible using conventional methods, the geoscientists recommended that the park consider engineered logjams, a new ecologically sensitive approach. In-stream structures of interlocking, native wood debris, engineered logjams are designed to imitate natural logjams and stream processes to achieve physical and ecological objectives including aquatic habitat restoration, flood control, and bank protection.

The park is exploring the feasibility of constructing engineered logjams to protect at-risk resources in the Taiya River floodplain. Information gained from the Water and Geologic Resources Divisions will likewise assist managers in locating potential sites for park facilities that may be developed in the future. Park resource managers are coordinating with other landowners along the river to meet human needs in the watershed without compromising the outstanding natural resources of the ever-changing Taiya River system. ■

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NPS PHOTO

The National Park Service has relocated the McDermott cabin, thought to be a toll station for gold rush stampeders crossing the Taiya River to reach the start of the Chilkoot Trail. The Park Service is also studying the possibility of an ecologically sound way to stabilize the riverbank to protect the park's cultural and natural resources.

Reducing the impacts caused by U.S. Army Corps of Engineers activities in coastal national parks

by Julia Brunner and Rebecca Beavers

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Altered by filling and building seaward of the natural beach, the shoreline of Ocean Beach in Golden Gate National Recreation Area is eroding. The Army Corps of Engineers, City of San Francisco, and National Park Service recognize the origin of the problem and are coordinating a solution to protect vulnerable infrastructure and preserve coastal processes and recreational park values such as surfing.

THE U.S. ARMY CORPS OF ENGINEERS (THE CORPS) builds and operates hundreds of flood control, environmental protection, and other civil works in and adjacent to units of the National Park System. Totaling millions of dollars, these projects include dredging of navigation channels, disposal of dredged sediments, replenishment of beach sand, construction of structures such as riprap and jetties, and, increasingly, "ecosystem restoration."

Some of these projects are completed upon a national park's request to benefit park resources. For example, the Corps is using a combined approach of riprap, sills, and constructed wetlands along selected segments of 17 miles of Jamestown Island's shoreline to stop riverbank erosion and protect archeological resources at Colonial National Historic Park, Virginia. Similarly, the Corps has replenished the beach within Gulf Islands National Seashore, Mississippi, to protect cultural resources at Fort Massachusetts. At Jean Lafitte National Historical Park and Preserve, Louisiana, the Corps is helping the park to protect thousands of acres of globally rare, floating estuarine marshes from erosion.

Formerly, some Corps projects have resulted in adverse effects on national parks. Previously at Cape Hatteras National Seashore (North Carolina), for example, the Corps deposited dredged material beyond the littoral (sediment) system, which hastened beach erosion and affected visitor enjoyment, infrastructure, and cultural resources. Additional erosion problems attributed to Corps-constructed jetties have occurred at Padre Island (Texas) and Assateague Island (Maryland) National Seashores.

Concerned about these impacts, several national parks are taking a proactive, two-pronged approach with the Corps. First, instead of simply reviewing documents detailing Corps project proposals in parks, five parks in 2002 sought (and three obtained) "cooperating agency" participation in the planning process in order to elevate concerns about preserving park resources. Second, these parks also require that Corps activities within park boundaries be conducted with NPS permission, typically a special use permit. These national parks are not attempting to hinder the Corps's mission; instead they are allowing Corps activities in parks to proceed subject to the terms and conditions necessary for protecting park resources, values, and visitor safety.

The results of this new relationship are positive. Fire Island National Seashore (New York), for example, as a cooperating agency helped the Corps recognize the value of using natural dune restoration in its Storm Damage Reduction Environmental Impact Statement. At Jean Lafitte's Barataria Preserve unit, Louisiana, the Corps agreed to abandon plans for bankside disposal of dredge spoil from a channel maintenance project, and will instead pump the material into a park-designated area, restoring 50 acres of marsh lost to erosion. On the other flank of the Barataria Preserve, where the Corps is constructing a hurricane protection levee for the suburbs of New Orleans, it redesigned borrow pits to enhance wildlife habitat and minimize impacts to hydrological function and the cultural landscape. Likewise, the input of Cape Hatteras National Seashore, North Carolina, in a Corps dredging project mitigated impacts to a wetland. Gulf Islands National Seashore's input on two dredging and restoration projects may increase the scope of alternatives. Assateague Island National Seashore is collaborating with the Corps to mitigate the impacts of the Ocean City inlet by restoring the natural sediment budget. Based on the response of the first phase of the project to several mild storms, the restoration appears to be performing exactly as planned. Finally, Golden Gate National Recreation Area is working closely with the Corps, the City of San Francisco, and other entities to ensure consideration of park resources and values in plans for protecting vulnerable municipal infrastructure along the eroding shoreline of Ocean Beach.

Like any new strategy, this one will take time to implement effectively throughout the National Park System. Clearly, the new NPS approach is stimulating better Corps project design and implementation and enhancing protection of NPS coastal resources. The Geologic Resources Division can help national parks lacking staff or expertise to adopt this approach elsewhere. ■

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NPS PHOTO

The National Park Service, Army Corps of Engineers, State of New York, and other entities are coordinating a potential beach nourishment project that addresses erosion of Fire Island National Seashore (shown here), adjacent state and county parks, and other public and private property on the barrier island. The national seashore obtained cooperating agency status in the project, and is encouraging the establishment of undulating dunes, areas where surf can safely wash over the island, and the incorporation of stabilizing dunes grasses.

Park soundscapes protected in litigation

by David Jacob

The National Park Service strives to preserve and restore the natural quiet and sounds associated with the physical and biological resources of the national parks. Disturbances are evaluated against the environment of sound that exists in the absence of human-caused noise. In 2002, this policy was addressed in two significant court decisions that involved intrusions on natural "soundscapes" in national parks from aircraft.

The first, *Grand Canyon Trust v. Federal Aviation Administration*, dealt with the proposed replacement of an airport in St. George, Utah, with a new one to be located near Zion National Park. The U.S. Court of Appeals, District of Columbia Circuit, ruled that the Federal Aviation Administration (FAA) did not adequately address the cumulative effects of the new airport in the environmental assessment and therefore failed to satisfy the National Environmental Policy Act. The court held that rather than analyzing only the increase in noise from the new airport over the existing one, the environmental assessment should have considered the total noise impact of the replacement airport on the park, including noise from other regional airports and human activities.

The second case, *U.S. Air Tour Association v. FAA*, involved overflights of Grand Canyon National Park. Pursuant to the Overflights Act, the National Park Service defined the term "substantial restoration of the natural quiet" as requiring that 50% of a park experience natural quiet for 75% of the day. The National Park Service interpreted "the day" to mean a 12-hour daylight period in which this threshold was not to be exceeded; the FAA interpreted it to mean an average annual day, or the amount of noise per day averaged over an entire year. The same court as presided in the Grand Canyon Trust case remanded the issue to the FAA for further consideration, noting that the FAA's interpretation appeared inconsistent with the NPS definition of the term and the underlying premise that aircraft should be regulated to enhance the experience of park visitors. The court also remanded the FAA's methodology for projecting impacts because it excluded noise from aircraft other than park air tour aircraft. ■

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Ensuring acceptable risk for Mojave National Preserve springs

by Chuck Pettee

NPS PHOTO BY ANNIE KEARNS

Unnamed spring, Providence Mountains, Mojave National Preserve, California.

After months of negotiation, an agreement was reached in 2002 between the U.S. Department of the Interior and Metropolitan Water District of Southern California to protect spring flows at Mojave National Preserve. At issue was the water district's proposed Cadiz Ground Water Storage and Dry Year Supply Project for a desert basin near Mojave National Preserve.

The project would divert surplus Colorado River water and store it underground. During dry years both the stored water and groundwater would be withdrawn and sent to users in southern California. Groundwater withdrawals introduce the potential of altering flows at the preserve's springs. The Department of the Interior's approval of a right-of-way permit for the project hinged in part on preventing such impacts.

AWARD-WINNER PROFILE

Using science to bring life back to the Everglades

NPS PHOTO

Bison statuette, awarded to winners of the Director's Awards for Natural Resource Stewardship.

Dr. Robert "Bob" Johnson was honored in 2002 with the Director's Award for Natural Resource Stewardship. For 12 years Bob has been instrumental in protecting and restoring the resources at Everglades National Park. His leadership has proved invaluable and his persistence worthwhile. Bob's approach to problem solving using a science-based decision-making process aided in his success.

Once home to a free-flowing river that provided clean water from Lake Okeechobee to Florida Bay, the Everglades has been in decline for a half century. A booming population, coupled with the agriculture industry, has altered natural water flow patterns and water quality, affecting birds, other wildlife, and vegetation, and has driven the natural environment to near collapse. The Comprehensive Everglades Restoration Project is a plan to restore the Everglades and is the largest and most complicated environmental project in the world. It calls for a series of ecologically sensitive improvements to water control systems, which will take place over more than 20 years. This project was authorized by the Water Resources Development Act of 2000, and the National Park Service helped in its creation.

Bob has been involved since the beginning, guiding the project by obtaining the necessary funding and personnel. He was responsible for coordinating the technical and scientific input of NPS resource staff from the south Florida parks and for the development of simulation models for ecological and hydrological responses. He also helped to bring the science of Everglades restoration to multiple forums, including Native American tribes; state, local, and federal agencies; and nongovernmental organizations.

Overall, Bob's achievements illustrate how science is essential in ecological restoration and protection. He is an indispensable leader of the Comprehensive Everglades Restoration Project, which, if successful, will be a model for wetland restoration projects worldwide. ■

After months of data analysis, the technical experts could not resolve differing opinions about the potential for impact. The stalemate was broken when the water district accepted the risk associated with the technical uncertainty and committed to operate the project to prevent interference with spring flows. The water district would get less water than planned if its assumptions were wrong. A Ground Water Monitoring and Management Plan was developed to ensure that protecting spring flow was undertaken in a cost-effective and technically adequate manner. The plan requires that pumping be monitored by a network of wells and that the monitoring system be managed to adapt to changing data needs. The intent is to develop models for forecasting the effects of pumping so that mitigation occurs early enough to prevent future changes in spring flows. This is necessary because spring flow changes may not occur for decades after pumping, when it is too late for mitigation. ■

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NPS PHOTO BY BRUCE BADZIK

Anacapa Island restoration continues

by Carol DiSalvo

Black rats *(Rattus rattus)*, an exotic species introduced to the California Channel Islands before 1940, were a serious threat to the islands' native species. The rats preyed on reptiles, amphibians, marine and terrestrial invertebrates, and the young and eggs of island-nesting seabirds. On Anacapa Island, part of Channel Islands National Park, these ravenous predators prevented two rare bird species, the Xantus's murrelet *(Synthliboramphus hypoleucus)* and ashy storm-petrel *(Oceanodroma homochroa)*, from nesting successfully.

The Anacapa Island Restoration Project is the effort of the National Park Service in conjunction with a partner, Island Conservation and Ecology Group, to restore the island's habitat for native species. In November 2002 the second phase of the project got under way with the application by helicopter of the rodenticide brodifacoum on middle and west Anacapa islets; the treatment was modeled on the successful baiting of rats on east Anacapa Island in 2001. The project was developed with public and environmental input through NEPA (National Environmental Policy Act), a planning process that evaluated several management options. As part of the process, the National Park Service applied for and received an exemption from the Environmental Protection Agency permitting use of the rodenticide on the park's natural areas.

Concern about the possible inadvertent poisoning of migratory birds, birds of prey, and native rodents prompted the National Park Service to implement a number of risk-reduction strategies. The project was designed around a specific biological window, November through December, when bird activity is low and the rats are more willing to accept the bait because other food sources are less available. The National Park Service also live-trapped native mice and birds of prey before applying the rodenticide; these animals were released after the threat of poisoning passed. A deflector attached to the bait hopper (arrow in photo) increased precision of the bait application on the steep hillsides of the island. Project staff conducted intensive search and removal of rat carcasses for 13 days after the baiting, followed by less intensive searches. Bird and wildlife populations were also extensively monitored before and after the bait application to assess efficacy and any unwanted impacts of the treatment.

Monitoring indicates that east Anacapa Island apparently is free of black rats a year after treatment. Researchers found an intact Xantus's murrelet egg, which was notable because rat depredation of eggs had been repeatedly recorded in the past. Survival of juvenile lizards and salamanders on rat-free east Anacapa was double that on middle Anacapa. More than 150 native deer mice released on east Anacapa are breeding and their numbers had increased to approximately 1,000 by the end of the breeding season. Although years of monitoring will be required to determine if black rats have been eradicated on Anacapa Island, the project is already helping native species rebound from the crippling impacts of this voracious exotic species. ■

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Air quality improving in many parks

by Dee Morse

The National Park Service's August 2002 report, "Air Quality in the National Parks—Second Edition," summarizes the results of 10 years of air quality monitoring activities in 32 national parks. According to the report, air quality is improving or remaining stable in more than half of the parks monitored, but restoring clean air to parks will require continuing efforts.

From 1990 to 1999, 28 parks were monitored for visibility. The report indicates that 22 of those parks showed improving visibility conditions. Acid rain monitoring to determine levels of sulfates and nitrates was conducted in 29 parks. Twenty-five parks showed a decrease in sulfate levels, while 14 showed a decrease in nitrate levels. Fourteen parks had lower levels of both sulfates and nitrates. Ground-level ozone concentrations were monitored at 32 parks. Results indicate that ozone levels improved in eight parks, but deteriorated in 16 parks.

More than 60 units in the National Park System are currently conducting monitoring activities to provide information on ozone levels, acid rain, and visibility impairment in parks. Air pollution affects many parks, but air quality monitoring conducted over the past 20 years documents that, in most parks, air quality is better than standards set by the Environmental Protection Agency to protect public health and welfare.

The report is published online at http://www2.nature.nps.gov/ard/pubs/aqnps.htm. ■

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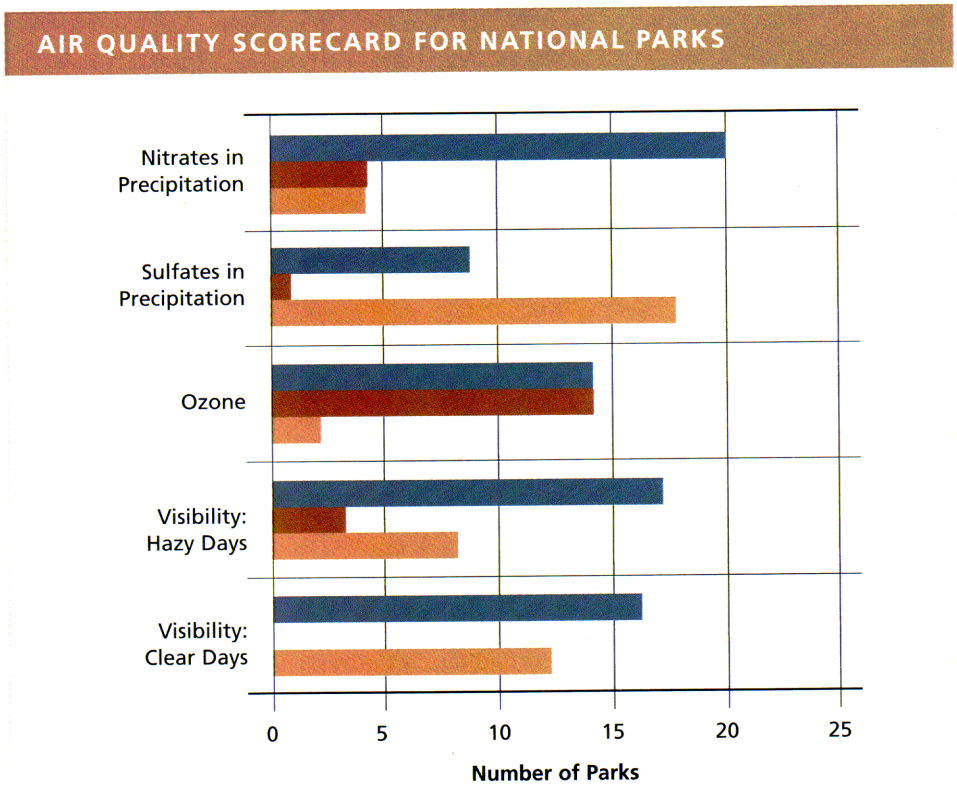
Legend

- Improving trend
- Degrading trend
- No change



"Following a human intervention of the right kind, Nature will often take over and heal itself. What is needed is not esoteric knowledge and technologies but simply good management and social will."

René Dubos, *The Resilience of Ecosystems*, 1978

Restoration

Once dominant in the understory of the Catoctin Mountain Park forest, the flowering dogwood was devastated by fungal disease in the 1980s and 1990s. This aesthetically and ecologically valuable tree species is being restored experimentally thanks to clones propagated from seeds and cuttings of a disease-resistant specimen discovered in the park.

If the creation of a national park, as Dr. Shirley Malcolm of the National Park System Advisory Board has said, "is a contract with the future," then restoration of park resources is reconciliation with the past. In recognition of what once was and should once again be, the National Park Service strives to restore degraded resources to health and function. Carrying out this vision involves an interesting blend of science and art. Ecological restoration integrates the professional training, technical know-how, creative talents, and judgment of ecologists, geologists, hydrologists, environmental engineers, endangered species experts, heavy equipment operators, and many other resourceful specialists. Whether working to restore dogwoods in the East, native plants in Hawaii, wetlands in the Rocky Mountains, or butterflies in the West as some of the following articles detail for 2002, the process is about hope that compromised ecosystems can be nudged toward wholeness and well-being. Results often take decades or longer to develop completely, and then—ironically—a skillful restoration may go unnoticed. Yet if the National Park Service fulfills this aspect of its contract with the future, its efforts to restore resources will not be unappreciated.

Restoring our native dogwood

by James W. Voigt

"The Catoctin dogwood project is an example of applying science to aid nature in dealing with a significant natural resource problem."

IN MAY 2002, 18 SPECIAL FLOWERING DOGWOOD trees *(Cornus florida L.)* blossomed for the first time at Catoctin Mountain Park, Maryland. What makes these trees special is their resistance to dogwood anthracnose, a lethal disease that for the last 20 years has ravaged the species at Catoctin and throughout much of the East.

Park Rangers Keith Langdon and Paul Strider first noticed diseased dogwoods at Catoctin in 1983, just four to five years after the earliest reports of a similar disease in New York and Connecticut. The disease is caused by a new species of the fungus *Disicula* (*D. destructiva* Redlin) that was first described through research funded by the National Park Service. Like many other devastating plant diseases, this causal agent is believed to be an exotic. The disease quickly progressed at Catoctin and by 1994 an NPS survey indicated that 77% of the native dogwoods had died, a significant loss. As one of the most abundant native understory species at Catoctin, flowering dogwood was of great aesthetic value and an important food source for wildlife.

In 1991 the National Park Service and the University of Tennessee began a research project to search for anthracnose resistance. Dr. Mark Windham of the Tennessee Agricultural Experiment Station collected seeds and bud wood from nine surviving trees at Catoctin. Dr. Windham propagated these trees and tested them for resistance under laboratory and field conditions. He found a high level of resistance in cuttings and seed from one particular tree, referred to as the "Presidential Tree" because of its location near Camp David. Progeny from this tree are now known as "Appalachian Spring." Several other trees were also found to be disease resistant and are being further evaluated for future planting at Catoctin.

The 18 specimens of Appalachian Spring planted at Catoctin in 2001 and 2002 are actually clones developed from the Presidential Tree by Dr. Windham. The Catoctin planting will test resistance in a natural setting. The trees were planted at four sites to evaluate differences in elevation, exposure, and canopy cover—factors that affect anthracnose development. The 3-foot-tall trees flowered beautifully in spring 2002 and appeared to be healthy throughout their first year. The park resource management staff and Dr. Windham will continue to monitor the health of these trees.

It is important to understand that Appalachian Spring and other putative disease-resistant flowering dogwoods are clones developed from selected individuals. The lack of genetic diversity in clonally propagated material is a disadvantage and a concern for the long-term restoration of a species in natural settings. One approach to overcome the lack of diversity will be to plant multiple resistant clones from other Catoctin trees in close proximity to the Appalachian Spring specimens to encourage cross-fertilization among themselves and remaining survivors in the area. The park is hopeful that this will expand disease resistance and diversity throughout the population.

The Catoctin dogwood project is an example of applying science to aid nature in dealing with a significant natural resource problem. Deliberately manipulating the genetic composition of a native species in a natural setting is controversial and should be thoroughly discussed and explored. (NPS Management Policies §4.4.1.2 deals with genetic resource management principles.) This approach, however, has potential for and relevance not only to the restoration of flowering dogwood but also to other disease-impacted species, such as the American chestnut. ■

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NPS PHOTO BY JIM VOIGT

The developer of the disease-resistant dogwood, Dr. Mark Windham, plants a specimen at the Catoctin Mountain Park Visitor Center with help from Superintendent Mel Poole. Future planting of clones developed from other disease-resistant park dogwoods may foster genetic diversity among the identical specimens.

Native plant rehabilitation in Hawaii Volcanoes National Park

by Rhonda Loh and Tim Tunison

NPS PHOTO

Students were key to the success of the restoration, collecting millions of native plant seeds.

RESTORING FIRE-DAMAGED 'OHI'A WOODLANDS in Hawaii Volcanoes National Park presents a daunting challenge to park managers. Trying to restore formerly dominant but fire-sensitive woody species like 'ohi'a *(Metrosideros polymorpha)* and pukeawe *(Styphelia tameiameiae)* is impractical given the widespread abundance of nonnative grasses and the inevitability of future wildfires. Instead, managers have adopted a rehabilitation approach to create a replacement community of fire-tolerant native plants that can survive and ideally spread in the new grass/fire cycle. This approach yielded positive results following the Broomsedge Fire, which occurred on 30 June 2000. By September 2002, visitors who walked through the burn could see signs of the revegetation effort.

Wildfires in the Hawaiian national parks are suppressed as a matter of policy because they inflict severe ecological damage. At Hawaii Volcanoes National Park, fire frequency has increased 3-fold and fire size 60-fold since the invasion and spread of broomsedge *(Andropogon virginicus)*, beardgrass *(Schizachyrium condensatum)*, and other nonnative grasses beginning in the 1960s. The most severely affected ecosystem is the seasonally dry 'ohi'a woodlands, where nearly two-thirds of the native community has been consumed by fire and replaced by nonnative savannas over the last 25 years. 'Ohi'a and pukeawe suffer high mortality in fire and individuals have difficulty reestablishing themselves after fire. In contrast, fire-adapted nonnative grasses recover vigorously and increase fine fuel loads up to three times more than in adjacent unburned areas, increasing the risk for future wildfires.

The Broomsedge Fire consumed 1,008 acres of 'ohi'a woodland and koa *(Acacia koa)* forest. Through funding provided by the interagency Burn Area Emergency Rehabilitation program, an aggressive campaign to revegetate the burn began within days of control of the fire. The goal in burned 'ohi'a woodlands is to establish fire-tolerant native plants that can survive and spread after future wildfires. Fifteen native species are identified as fire tolerant based on their ability to survive, recover, or recruit from seed after fire. Many of these species were once common to 'ohi'a woodlands but were removed by introduced feral goats that roamed the park over the last two centuries. Goats were eliminated in the mid-1970s, giving managers the opportunity to restore these important plant communities. The revegetation goal in koa forest is to establish two strips of dense native understory beneath the recovering koa trees to create vegetated fuel barriers that prevent future wildfires from spreading into nearby, biologically rich Kipuka Puaulu and across the park boundary to the Volcano Golf Course Subdivision.

More than 15,000 plants and 3,000,000 seeds of 23 native species have been restored in the burn, including thousands of mamane *(Sophora chrysophylla)* trees and 'a'li'i *(Dodonaea viscosa)* shrubs as well as rare kookoolau *(Bidens hawaiiensis)* and naupaka *(Scaevola kilaueae)* plants. Widespread participation from the local community, visiting students, and conservation groups, along with dedicated staff, has been the cornerstone for the success of the project. By the time the project is completed in June 2003, 31 native species, including 15 fire-tolerant species, will be established through a combination of direct seeding and outplanting into 850 plots scattered across the entire burn. Long-term monitoring will determine whether the plants established in the burn will continue to thrive and ultimately create a native plant community that survives future wildfires. ■

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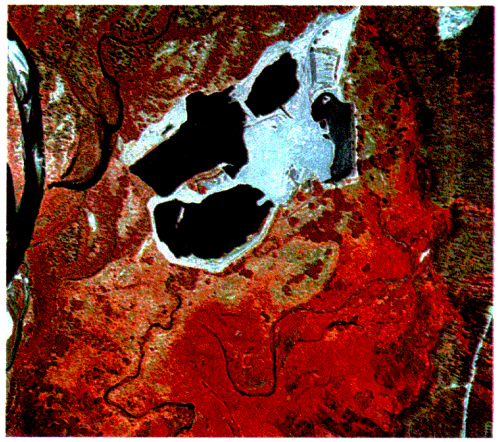
NPS PHOTO

Following the July 2000 Broomsedge Fire at Hawaii Volcanoes National Park, exotic grasses adapted to fire replaced native 'ohi'a woodlands that are fire-sensitive. The park replanted and reseeded the area with fire-tolerant native vegetation (not shown).

Field studies and funding partnerships help restore wetlands at Snake River gravel pit

by Joel Wagner, David Cooper, Michael Martin, and Steve Haynes

FROM THE 1950S THROUGH THE EARLY 1990S, the National Park Service and the Federal Highway Administration extracted thousands of cubic yards of gravel from the Snake River floodplain within the John D. Rockefeller, Jr., Memorial Parkway, Wyoming. The Snake River gravel pit, located approximately 1 mile south of Flagg Ranch, provided gravel for National Park Service road projects and maintenance activities in the surrounding area. Mining ceased in 1992 when the U.S. Army Corps of Engineers determined that the operation violated the Clean Water Act. Closure of the site left more than 60 acres of poorly vegetated waste piles, steep-walled borrow ponds, and sand and gravel stockpiles visible from U.S. Highway 89/287 and the Snake River. The park elected to resolve these regulatory and resource management issues by reclaiming the abandoned mine to a mix of wetlands, oxbow ponds, and uplands modeled after comparable features on the adjacent, undisturbed floodplain.



ENVIRONMENTAL PROTECTION AGENCY

A source of gravel for the John D. Rockefeller, Jr., Memorial Parkway and neighboring Yellowstone and Grand Teton National Parks from the 1950s to 1990s, the Snake River gravel pit created 60 acres of waste piles, steep-walled borrow ponds, and sand and gravel stockpiles.

"Restoration projects of this size and complexity require rigorous data collection and analysis, innovative design, ... careful supervision ..., and sufficient funding to do the job right."

The Federal Lands Highway Program and the State of Wyoming Abandoned Mine Lands Program contributed a combined $1.3 million, which was sufficient to complete the final design and implement the project. In early 2002, project partners produced final design drawings and specifications for the construction bid documents. An earthmoving contractor was selected in June and construction lasted from mid-July through October 2002. Under the direction of the design team and the on-site construction manager, the contractor reshaped more than 350,000 cubic yards of mine reject material and topsoil into 55 acres of sedge meadows, willow flats, stream channels, oxbow ponds, and upland features.

The NPS Water Resources Division, Colorado State University, and parkway managers from Grand Teton National Park collaborated on the restoration design. These partners based their design on extensive analysis of soil, vegetation, and hydrologic data collected within the mined area and in nearby undisturbed reference areas.

Data from 24 shallow wells and six staff gauges provided water-level information that is critical to wetland and riparian ecosystem design. Special factors to be addressed included the complex hydrology of the site, the need to protect existing western boreal toad breeding habitat, and appropriate use of topsoil that had been preserved during the mining process.

A unique aspect of the design process was the use of field experiments to evaluate the potential for willow establishment from natural seed dispersal. Designing the site to promote natural willow establishment saves money because fewer willow cuttings need to be planted and it helps ensure that the site will be a self-sustaining wetland-riparian ecosystem over the long term. Willow seed traps allowed the design team to evaluate distribution and abundance of seed dispersal across the site. Two experimental plots were also created to determine which combination of available soil types (sand, mine reject material, and topsoil) and water-table elevations would optimize willow establishment from seed. The experiment results guided placement of topsoil at critical elevations throughout the site.

In late spring and early summer 2003, contractors will plant more than 580,000 herbaceous wetland plants and 35,000 willow stakes in specified habitat zones. To ensure preservation of local genetic integrity, nursery contractors collected seed and willow cuttings from within 9 miles (15 kilometers) of the project site. With the

"The contractor reshaped … mine reject material and topsoil into … sedge meadows, willow flats, stream channels, oxbow ponds, and upland features."

NPS PHOTO (BOTH)

To restore the area, NPS contractors reshaped reject mine material and topsoil into precise but subtle configurations designed to re-create sedge meadows, willow flats, stream channels, oxbow ponds, and upland features.

A nearby reference site approximates how the area will look after more than 580,000 riparian plants and 35,000 willows are planted in 2003 and given time to mature.

help of the Natural Resources Conservation Service, upland zones will also be revegetated using local seed sources.

Restoration projects of this size and complexity require rigorous data collection and analysis, innovative design, much coordination among cooperators and regulators, tight design specifications, careful supervision of construction and planting phases, and sufficient funding to do the job right. But a final step—monitoring—should not be overlooked. Monitoring of vegetation, hydrology, and soil characteristics will continue for at least three years to document restoration of target wetland habitats and to identify any remedial treatments needed to ensure restoration success. ■

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Wetlands re-created at Fort McHenry

by Betsie Blumberg

The wetland that surrounded Fort McHenry during the War of 1812 is being re-created by the National Park Service, the National Aquarium in Baltimore, and many other partners.

The project has entailed the removal of phragmites, a non-native reed that reduces wetland biodiversity, the introduction of native plant species, the redesign of the area's hydrology, and the monitoring of water quality.

CAN A HUMAN-MADE WETLAND FUNCTION AS a tidal marsh? That is the question scientists are waiting patiently to answer at Fort McHenry National Monument and Historic Shrine, Maryland. The wetlands that surrounded Fort McHenry during the War of 1812 are being re-created with cooperation from the National Aquarium and 30 other public and private organizations. This long-term project in Baltimore is attracting the energies of local and national corporations, nonprofits, government agencies, schools, and the public, who are participating in the cleanup and managing the rehabilitation of wetland vegetation and waters. Their efforts are helping to create a functioning wetland where the original marsh was destroyed by almost three centuries of human assault.

In 1982, after the highway and tunnel for Interstate 95 had been cut through marshland adjacent to Fort McHenry, the State of Maryland was obliged by law to create equal acreage of wetland to replace what was lost. One site that was mitigated, but thereafter neglected, became an eyesore for visitors to the park. In 1997 the park, soon joined by the National Aquarium, began to clean up the 7-acre site and restore the 1812 landscape. At the start of the project, one-third of the area was paved with debris, including everything from old cars to hypodermic needles, and required heavy equipment and hundreds of volunteers to clear. Trash removal is ongoing because tidal flow carries trash in but wetland vegetation and clogged drainageways prevent it from flowing out. Since 1997, project partners have removed 996 tons of debris.

Normally, tides flush a marsh with a regular pulse. However, this has not been happening at this site because the concrete pipes, 3 feet in diameter and designed to lead tidewater past infrastructure to and from the wetland, have become clogged and trap debris. Neither the natural pulse nor the fish that would come with it get through. This situation should be corrected in winter 2002–2003 when cooperating engineers from the USGS, the National Oceanographic and Atmospheric Administration, and aquarium staff reconfigure the hydrology of the site.

Selecting vegetation to introduce was an experiment in itself. The water is brackish and salinity varies, sometimes becoming as high as 50% of seawater. Species successfully established include the salt bush *(Iva fruitescens)*, groundsel tree *(Bacchus halimifolia)*, and smooth cordgrass *(Spartina alternifolia)*. Many wildflowers and emergent aquatic species have spread naturally with good diversity, but all are threatened by the invasive common reed, *Phragmites australis*. To control it the partners have used techniques such as solar blankets (which heat the ground, killing vegetation), herbicides, and mechanical removal, followed by planting of native big cordgrass *(Spartina cynosuroides)*.

Only native flora have been introduced intentionally. When conditions are right, the fauna arrive on their own, most notably birds. One hundred thirty years ago, a physician and ornithologist at the fort made a list of 210 birds he saw in the wetlands. Recently bird-watchers have recorded 195 species there. (A few on the original list have since become extinct, such as the passenger pigeon.)

This new wetland already supports an increasing variety of living things, and the beginning of a peat layer has been detected. But the development of a spongy peat substrate that filters the pulsing tide and that characterizes a salt marsh is a slow process of deposition and accumulation of organic material. Natural wetlands in the Chesapeake Bay are 10,000 years old. Meanwhile, volunteers helping with cleanup, schoolchildren learning about wetlands, local industries complying with recent antipollution regulations, bird-watchers cataloging species, and park visitors who view the marsh from the historic fort are all watching to see what's happening in the new salt marsh. ■

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Trash interferes with the proper function of the wetland and is removed regularly by the partners and volunteers. Left unchecked, the debris clogs pipes linking the wetland and the harbor and stops tidal pulses that carry fish, replenish oxygen, and promote wetland vitality.

Keeping Canada thistle under control at Agate

by Ruthann Knudson

"This ... program is a regional model for thistle control on private and public lands."

WHEN NEBRASKA'S AGATE FOSSIL BEDS NATIONAL Monument was authorized in 1965, the federal government owned no land within the new park's boundaries. All of the park's 3,055 acres were originally private ranchlands, most of which had been grazed since the 1880s. After grazing was discontinued in 1974, the Canada thistle *(Cirsium arvense)* began to flourish in the Niobrara River valley.

In 1997, Agate mapped 125 acres of Canada thistle within park boundaries. Following an aggressive management program, only 25 acres of parklands were still infested with thistle by 2002. The thistle control project's success can be attributed to persistent efforts over many years, including integrated pest management, surveying and follow-up monitoring, partnerships, interpretation, and competing for funds to support staff. In 2002 the Midwest Region recognized the success of this program with the nomination of Agate's Maintenance Lead Supervisor, William Matthews, for the Director's Award for Natural Resource Management Through Maintenance for his leadership in this important program.

The program involved a partnership with a regional noxious weed control consortium of federal, state, county, and private landowners and managers. It included the release of stem-mining weevils *(Ceutorhynchus litura)* or gallflies *(Urophora cardui)*, mowing thistle growth just before seed head establishment, and application of herbicide (Telar) after the first hard frost. Over the years, permanent and seasonal park staff completed mowing activities. Park staff or contract workers under supervision of the county's noxious weed program applied herbicides. An intern or seasonal biotechnician funded by the Natural Resource Preservation Program documented the program.

A Geographic Information Systems database available at the park contains information on all relevant areas of biocontrol, mowing, and chemical application. Reports on the results of the 2001 and 2002 programs are also on file at the park. Visitors can learn about the weed control program by reading a site bulletin or visiting a wayside exhibit funded by the Friends of Agate Fossil Beds, Inc.

The park is currently developing an environmental assessment of the use of fire on parklands and an accompanying fire management plan. The relationship between thistle management and fire activities is an important element in the assessment and plan. This successful, well-documented program is a regional model for thistle control on private and public lands and is beginning to be used as such by regional resource managers.

Success in a control program such as Agate's is a function of several factors, including persistence, team performance, and the right weather conditions. Soil moisture is a critical factor in the overwintering success of stem-mining weevils, mowing access, and herbicide applications. The 2002 summer drought inhibited thistle growth in general, but allowed park management to get into all the ordinarily wet meanders along the river valley. The result was an outstanding success. The task ahead is to work with all these factors to keep thistle contained into the future. ■

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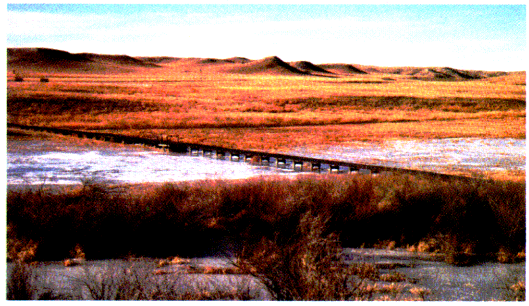
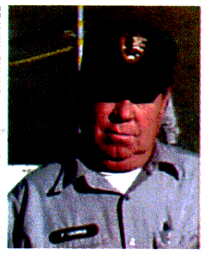


Persistence, collaboration, and technical know-how, in addition to favorable weather conditions, contributed to the success of the eradication program. Drought in 2002 inhibited thistle growth generally, but also allowed resource managers to extend their treatment to normally wet meanders of the Niobrara River.

Considered a noxious weed throughout much of the United States, Canada thistle flourished at Agate Fossil Beds National Monument after grazing was discontinued in the park in 1974. An intensive, integrated management program reduced the nonnative species from at least 125 acres in 1997 to just 25 acres in 2002.

AWARD-WINNER PROFILE

Harris recognized for precision and leadership in heavy equipment operation



NPS PHOTO BY RICHARD MAYLE

Paul Harris

Paul Harris is a heavy equipment operator at Redwood National and State Parks, California. Since he began in this position more than a decade ago, Paul has taken his job to the next level. Paul's skill has helped make ecological restoration projects a success by turning the vision of scientists into reality. "I enjoy putting the landscape back to where higher intelligence thinks it needs to be," he says. His accomplishments earned him the 2002 Director's Award for Excellence in Natural Resource Stewardship Through Maintenance.

Presenting the award last August, Mike Soukup, NPS Associate Director for Natural Resource Stewardship and Science, introduced Paul as "the surgeon general of the National Park Service maintenance force." Paul is known for his superior ability to operate equipment and direct crews in environmentally sensitive areas. For Paul the skill comes naturally: "I'm just accomplishing the tasks that need to be done; I try to improve the roads and parks without harming anything important." Paul manipulates massive machinery to perform delicate and precise tasks. His talent was put to the test in returning 3 acres of paved sawmill yard to the original stream and wetland configuration established by hydrologists. Known as the Elk Meadow Day Use Area, it is now the focal point for visitor observation of Roosevelt elk, great blue heron, kingfisher, and green-winged teal, among other wildlife. For Paul to complete this project, he needed to operate an excavator on slopes of 60%.

Paul's capabilities have earned him great respect and a reputation that has spread throughout the region. He is a leader in his field and has managed to "operate" on steep terrain without a single accident. His goal every day is to keep himself and his crew safe. "We all want to go home at night; that's what matters the most to me." Paul's ability has given him the opportunity to work on projects at Santa Monica Mountains National Recreation Area, also in California, and Puukohola Heiau National Historic Site, Hawaii. At Santa Monica Mountains he removed 2 miles of road that was in the middle of an ecologically sensitive riparian canyon. At Puukohola Heiau, Paul was instrumental in removing almost 2,000 feet of road through archeological and burial sites. This additional work sometimes kept him away from his family for up to a month at a time, but he never complained; his dedication to the task at hand was always a priority.

Paul works routinely with wildlife biologists, geologists, hydrologists, and archeologists who make up the resource staff at Redwood. In helping to formulate strategies for the restoration projects, Paul is a true leader and is always willing to listen. He is a team player who allows his ability to speak for itself. ■

NPS PHOTOS (BOTH)

Paul Harris's precision earthmoving skills (before, top) resulted in the 2001 re-creation of Elk Meadow (after, bottom), a wetland at Redwood National Park, California, that had been used for several decades as a storage area for logs awaiting processing at a sawmill.

Restoration accomplishments at Civil War earthworks

by Terri Hogan

Vegetation monitoring completed in 2002 at Stones River National Battlefield, Tennessee, confirms the successful establishment of native grasses on the earthworks of Fortress Rosecrans. Constructed in 1863, Fortress Rosecrans was the largest enclosed earthen fortification built during the Civil War. When the National Park Service acquired 26 acres of the site in 1993, it was engulfed in exotic plants. To preserve and interpret this historic structure and cultural landscape, park staff implemented a restoration plan.

The plan involved cutting woody species, treating invasive plants with herbicides, and planting warm-season native grasses. The native grasses were selected to revegetate the earthworks because they have extensive root systems that stabilize the structures. The native species are also adapted to the hot, often dry conditions and low-nutrient soils of middle Tennessee. Once established, these plants require less maintenance, which reduces the impact of human activity on the structures. The Cultural Resources Stewardship Division of the Southeast Region is compiling proto-

Water diversion structure aids fish and agriculture

by Kenneth Hyde

In 2002 a new water diversion structure and fish screen in John Day Fossil Beds National Monument, Oregon, restored fish travel in Rock Creek and reduced withdrawals needed to irrigate historical hayfields. Since 1899, irrigation water has been diverted from the creek to two hayfields in the monument. Limited water reached the fields because of seepage while traveling 2 miles in an unlined ditch. Stacked rocks diverted much of the creek's water during summer and blocked passage upstream for most fish species. The diversion hampered colder-water fish, such as the threatened summer steelhead *(Oncorhynchus mykiss)*, limiting their ability to reach cooler water during hot summers.

In 2002 a partnership with the Grant Soil and Water Conservation District and the Oregon Department of Fish and Wildlife, and funding from the NPS Recreational Fee Demonstration Program, allowed construction of a technologically advanced diversion structure and fish screen to encourage fish passage. The new diversion employs a channel that allows all fish species to pass in summer. The diversion stanchions lie flat in winter, facilitating natural stream-related processes. The fish screen returns fish entering the irrigation ditch back to Rock Creek within 50 yards of the diversion, so they are not entrapped in the ditch or fields. In 2003 the park will install pipe in the remaining unlined segments of the ditch, improving water delivery. ■

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NPS PHOTO BY KEN HYDE

cols and lessons learned from the restoration process into an earthworks management manual.

Park staff monitored plots in 2000, 2001, and 2002. Analysis of these data in 2002 reveals that native grass cover has increased significantly. Native forbs, invasive species, and vines also appear to be increasing; however, these trends are not statistically significant. These findings will be used to adjust management practices. Today, as a result of science-based restoration efforts by cultural and natural resource managers, the historic structures are stabilized, native species have regained their place in the landscape, and exotic species are managed. ■

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NPS PHOTO BY SCARLETT DAVIS

NPS PHOTO

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Helicopter tree removal improves butterfly habitat

by Daphne Hatch

During three days of near-perfect weather in late February 2002, the collaborative efforts of more than 100 people culminated in the helicopter removal of invasive Monterey pine trees *(Pinus radiata)* from 10.5 acres within Golden Gate National Recreation Area (California). The trees were removed to improve habitat for the mission blue butterfly *(Icaricia icarioides missionensis)*, a species listed as federally endangered. The butterflies feed on lupines *(Lupinus albifrons)*, which the Monterey pine trees deprive of sunshine and water. When the lupines die, so do the butterflies.

A high public profile accompanied the project because the restoration area is within view of the Golden Gate Bridge. Success hinged on a number of factors, including timing and clear communication with the public. Timing the project was complicated by the bird nesting season (March to August), the flight season of the butterfly (March to July), summer fog, and the raptor migration at Hawk Hill (August to December), the project's location. The trees to be removed were on steep slopes in the midst of butterfly habitat, with the roots of some trees damaging coastal defense fortifications. Additionally, the project involved road closures and detours that affected the public.

After careful analysis, park staff chose tree removal by helicopter as the most suitable method to minimize ground disturbance on steep slopes in sensitive habitat. Winter presented the best opportunity for removing the trees, avoiding the fog and minimizing conflicts with hawks and butterflies. An outreach campaign for park visitors and the media resulted in strong public support and cooperation. Not only did the project restore endangered species habitat, but it also protected coastal defense fortifications, enhanced scenic vistas, and improved visibility of the hawk migration. The Recreational Fee Demonstration Program provided funding for the project. ■

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Creating pollinator-friendly plant communities in an urban park

by Gopaul Noojibail

Pollination of flowering plants by animals provides a service to society that is both biologically significant and economically important. Unfortunately, native pollinators such as bees, butterflies, and moths have been on the decline in recent years, and some experts believe that these declines are reaching crisis levels. In 2002, National Capital Parks–Central initiated an experimental project to increase native insect pollinator populations in Washington, D.C., and the National Capital Region. The effort sought to restore native plant communities in East Potomac Golf Course (photo, shown three months after seeding), located on national parkland in downtown Washington, D.C.

NPS PHOTO BY GOPAUL NOOJIBAIL

East Potomac Golf Course is an important natural oasis in a predominantly urban landscape that can serve as an example of how habitat renewal can be achieved within urban areas. Once restored, roughs and out-of-play areas within the golf course will function as refuges for plants and their insect pollinators, increasing pollinator movement throughout the region. Native plant communities also offer the benefit of low, long-term costs once established. Information on the effectiveness of restoring pollinator habitat generated by the project will be used to make decisions about the placement of additional sites within the region.

The golf course is host to more than 115,000 visitors a year; this project will significantly increase its interpretive and educational significance, giving park staff the opportunity to communicate the value of golf courses to both urban and regional ecosystems. ■

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Fire Ecology Program gets organized

by Greg Eckert

As a result of congressional funding of the National Fire Plan, the NPS Fire Management Program has hired more than 30 fire ecologists and stationed them at national and regional offices and in national parks. Most of these staff are qualified as professional scientific ecologists, having met the eligibility requirements for a series 408 ecologist; a few are working toward these qualifications through university graduate degree programs or continuing education. Impetus for the Fire Ecology Program developed from an increasing need for technical expertise in several areas:

- Collection, analysis, and interpretation of fire effects data
- Adaptive management
- Liaison between fire and resource management at park, regional, and national levels
- Collaboration with other government agencies and nongovernmental organizations
- Various levels of park management planning (general, resource, fire, and prescribed fire)
- Landscape-level assessments

The Fire Management and Natural Resource Program Centers called for the new emphasis on integrating natural resource and fire management. The Fire Ecology Program will work to provide the best science for managers addressing risks of how and where to apply fire on the landscape or to withhold it. In addition, it is working with the Natural Resource Program Center (NRPC) to design a workshop for developing conceptual ecological models, identifying desired future park conditions, assessing risks related to fire, and interdisciplinary planning. A pilot version of this course will be held in spring 2003.

The Fire Ecology Program has historically revolved around monitoring long-term ecological trends associated with prescribed fire in a limited number of national parks. The recent staffing increases will enable the program to provide services to all regions and many more park units. In addition, the scope of the program will grow to include monitoring fire effects for both prescribed and wildland fire and data storage and analysis. New fire effects monitoring software is being developed to facilitate broader analysis, including spatial analysis. The new application will support monitoring techniques and protocols associated with fire and resource management. All fire monitoring data will be archived in regional and national databases and made available over the Internet.

The Fire Management Program Center is hiring a fire ecologist to be located at the NRPC office in Fort Collins, Colorado. This position will manage the national fire effects database and the new software application and serve as a liaison between the Fire Management Program and the Natural Resource Program Center.■

NPS PHOTO (BOTH)

These photographs compare a vegetation plot at Everglades National Park, Florida, that has experienced normal fire frequency and intensity (top) with one that has not had fire for 30 years. With its unnaturally thick vegetation, the fire-exclusion site would require mechanical and other treatments before fire could be restored as a natural process. The Fire Ecology Program will provide support for fire management and restoration in park landscapes.

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"A complete faunal investigation, including the four steps of determining the primitive faunal picture, tracing the history of human influences, making a thorough zoological survey and formulating a wild-life administrative plan, shall be made in each park at the earliest possible date."

George M. Wright, Joseph S. Dixon, and Ben H. Thompson, "Policy Recommendations in Fauna of the National Parks of the United States," 1933

Looking Ahead

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Clockwise from top left: Tree snail *(Liguus fasciatus)* and bromeliad, Big Cypress National Preserve, Florida. Gray fox *(Urocyon cinereoargenteus)*, Big Bend National Park, Texas. Alligator *(Alligator mississippiensis)*, Everglades National Park, Florida. Harlequin ducks *(Histrionicus histrionicus)*, Yellowstone National Park, Wyoming.

Editor's note: John Reynolds retired in August 2002 as Pacific West Regional Director. Son of a park ranger, John grew up in several national parks and spent nearly 40 years with the National Park Service in such positions as Deputy Director, Manager of the Denver Service Center, and Superintendent of Santa Monica Mountains National Recreation Area. Always thoughtful and professional, John shares his perspective on this bureau, its roots, and the future.

Reflections on a career: Glimpsing the future?

by John Reynolds

I REMEMBER MY EXCITEMENT AS I DEVOURED page after page of Dick Sellars' fabulous 1997 book, *Preserving Nature in the National Parks*. Although over 50 and with more than 35 years invested in my career with the National Park Service, I was gripped with a clear understanding of the thoughts that had been trying to find meaning as they caromed around and evolved in my brain. I realized that Dick's historical recounting of the National Park Service's decades-long neglect of natural resource preservation validated the conclusions that my life in the national parks and the National Park Service had led me to.

I have heard this evolution of thought called a "deathbed conversion," but I don't think this is either true or fair to those thoughtful individuals to whom the appellation is often attached. Why? Because they, like me, arrived at these conclusions through deep introspection about the mission of the Service in relation to an ever-changing society and its effects upon the national landscape.

It all started for me in 1942. I was born late that year, the son of a new Yellowstone park ranger. Educated as a forester, he and my mother had been teachers before coming to Yellowstone and the Service they grew to love. Son and daughter of eastern Oregon ranchers gone broke in the depression and veterans of several summers on Forest Service lookouts, they flourished outdoors. As a forester, educator, and outdoorsman, my dad (and I) arrived when, as *Preserving Nature* makes clear, the philosophy of the National Park Service was dominated indelibly by the leadership and thinking of foresters, park rangers, and landscape architects. Dad was the first two; I was to become the latter.

A little over a decade later the most influential national program in the history of the National Park Service was born: Mission 66. Dedicated to making the fit between visitors and the parks more comfortable and the experience more informed and inspirational, it changed the face of the parks that most visitors saw. It stamped the National Park Service as a bureau dedicated to visitor enjoyment above all else. It welcomed the touring masses. It recognized forthrightly the power inherent in the idea that visitors who enjoyed the parks were the best constituents the Service could ever have.

Near the end of this euphoric era I became a landscape architect. I joined at the end of Mission 66 and the beginning of an era of unprecedented park expansion. It was a heady time!

Thirty or so years later, Sellars' book struck a nerve that ran deep into the soul of an evolving National Park Service. George Wright had been dead for some 60 years and the 1963 Leopold Report was more than 30 years old. Suddenly, within two years, the second great influential national program with the power to change the core of the bureau was born: the Natural Resource Challenge. Oddly, perhaps, its germination was not from the minds of "young rebels;" instead, it was from men and women in the twilight of their careers. These were dedicated careerists who had fought the wars of the National Park Service for a long time, who had thought deeply about its mission, and who had observed carefully what was happening to American society and the landscape. A deathbed conversion it was not. A last contribution in careers of nearly all-encompassing caring is more truthful.

The Challenge so born was informed and grew to its robust final design with the involvement of folks newer to the Service who understood the new "guts" of managing natural resources. Presented expertly, honestly, and with professional fervor, it grabbed the attention of two administrations and the Congress. Though not finished yet, in either its funding or its implementation, it is already having an indelible effect on how the National Park Service conducts its business. It has begun to bring long-needed balance to carrying out the core legislated mission of the National Park Service to the biological and physical (as well as cultural) resources of the parks. As importantly, it is helping to ensure that future visitors will get the authentic experiences that the framers of the Organic Act envisioned for them.

It is no secret that I am proud to have been deeply involved over the last four years of my career in making the Challenge a reality. What is somewhat more of a secret is how it made me think more deeply about the future. And so, finally, to the point of this little essay, and a return to my youth.

It is easy today to say that my dad and his peers were wrong. It is even easier to say that the architects (specifically the landscape architects, for they were the ones who held the power) of Mission 66 were wrong. It is easy … and wrong.

They did their jobs based on what they knew, and in remarkable response to the pressures of our society then. The "natural" parks were very remote in 1955. You had to want to get to them. They were destinations. They were assumed to be healthy. After all, they were national parks, the most protected natural places in the world! And to be saved forever, they needed a popularly based constituency. Mission 66 gave that to the parks, and its effects, arguably, are still the basis for popular support of the National Park Service today, some 50 years later.

"Sellars' book struck a nerve that ran deep into the soul of an evolving National Park Service."

Park Ranger Harvey Reynolds enjoys a moment in 1943 with his young son, John, in Yellowstone National Park, Wyoming.

As Sellars pointed out, however, that is not all of the story. The history that he traces is true. But the untold story is the future. What does it hold, and more importantly, how does the National Park Service position itself to deal with it?

First, we need to assess the present, a time and more critically a condition, when the parks are no longer remote from either visitors, industry, or the by-products of burgeoning population. Access is relatively easy today, but in the days when our mores as staff of the National Park Service were being established, the effects of civilization seemed benign. More people clamor to be refreshed and inspired by visiting parks than ever before. Biological integrity is not ensured, even in the short term. The aesthetically driven way we dealt with preservation issues in the past is no longer sufficient in response to the Organic Act. We know more, and what we know changes what must be done. The problem, though, is that the expectation of the majority of citizens and their political representatives is still deeply rooted in Mission 66 mentality.

The basic values for the existence of national parks have evolved from being just beautiful nature reserves and vacation destinations to enjoy and be inspired by to being cherished additionally as bastions of biological, physical wilderness and places of historical authenticity and integrity. At the same time, expectations for "visitor enjoyment" have evolved from people who visit primarily as leisure-time vacationers to virtual visitors, such as those who enjoy national parks as bases for heritage education. This includes partners in conservation service and participants in school programs through college and beyond. The needs of our citizens have changed and expanded, and with them opportunities to serve.

If this is the present forecasting the future, how does the National Park Service get there? First, the National Park Service must lead its own way into the future. Every employee—career, political, or temporary—must take responsibility for shaping the future. Second, both the career and political leadership have the responsibility to unstintingly represent the Organic Act and use it as their personal philosophical and ethical guide to decision making. Third, from top to bottom, they must connect the public to the parks for the benefit and enjoyment of the people. And finally, they must retain and grow the confidence of the public for the parks.

To do so will require that the National Park Service:

1. Complete and institutionalize the Natural Resource Challenge.
2. Embrace and practice conservation biology both in the parks and with conservation partners, with whom the parks share animals and ecosystems that extend beyond park boundaries.
3. Staff parks and other offices with highly qualified science and resource management professionals.
4. Fully implement the Message Project—an analysis of marketing and graphic identity strategies for application in NPS communications—and provide superb information, interpretation, and in-park experiences.
5. Offer the parks as authentic bases for educational opportunities through partners, schools, and off-site media.
6. Know more about the natural history of the parks than anyone else, both in quantity and content, and embrace all-taxa inventories.
7. Learn to partner as often as possible with other agencies and nongovernmental organizations with complementary programs to preserve park resources and create constituents for the future.
8. Retain the heritage of aesthetic excellence for which the parks are known.

These actions can form the base of a future as wonderful as the past has been, but a future that has evolved to meet tomorrow's demands and opportunities. If that happens, the legacy of Dick Sellars and the "deathbed conversions" will serve the nation as well as the first 87 years of the National Park Service's history has. ■

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