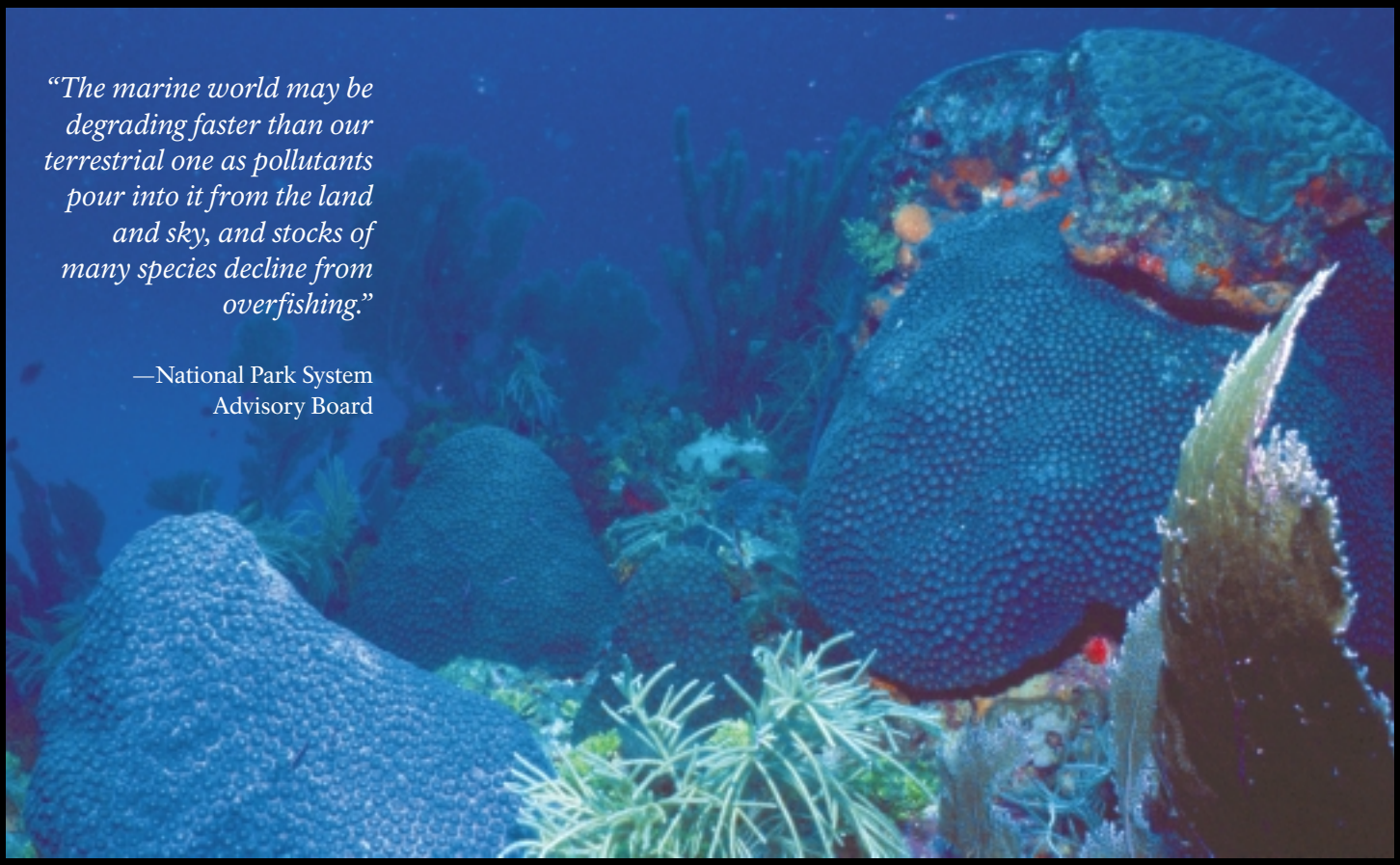
National Park Service
U.S. Department of the Interior

Natural Resource Program Center
Natural Resource Information Division

Dr. Jiangang Luo, University of Miami

Natural Resource Year in Review—2001

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



"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

Dr. Jiangang Luo, University of Miami

(Cover) A red grouper pauses on the seabed of Dry Tortugas National Park, Florida, surrounded by gorgonian soft coral, sponges, and algae. Designation of a research natural area in the national park in 2001 will help protect important nurseries for sea life throughout the region (see cover article, page 31).

(Above) The underwater world of Dry Tortugas National Park includes a wide variety of marine species such as great star, brain, and gorgonian corals, sponges, and algae, pictured here. Coral reefs are focal points of the biological diversity preserved in the recently designated research natural area of the national park.

Contents

Meeting the Challenge

Other Developments

Science-Based Management

Other Developments

National Parks as Laboratories

Rock Creek Park, Bill Yeaman

Other Developments

Marine and Coastal Resource Protection

Dr. Jiangang Luo, University of Miami

Other Developments

Managing Risks

Other Developments

Restoration

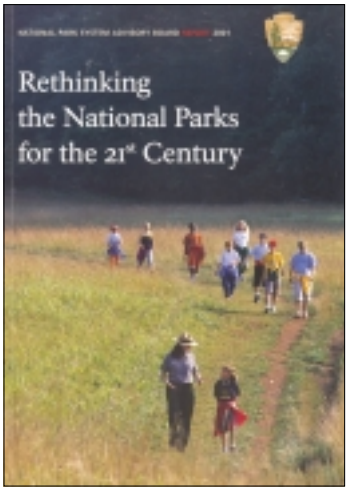
Rachel Mazur

Other Developments

Collaboration and Public Participation

Other Developments

Looking Ahead



Year at a Glance–2001

January

The Research Permit and Reporting System goes on-line, streamlining the permitting process for researchers and parks alike. The Internet-based system also facilitates annual reporting required of researchers.

President Clinton signs executive orders establishing Virgin Islands Coral Reef National Monument and greatly expanding Buck Island Reef National Monument.

The Record of Decision for the Colorado River Surplus Criteria Environmental Impact Statement (EIS) is signed, protecting Lake Mead and Lake Powell water supplies and Colorado River resources. The criteria do not allow surplus water to be released from Lake Mead unless certain thresholds are met to protect water supplies. Additionally, the EIS requires recommendations for an experimental flow program for Glen Canyon Dam to protect resources.

February

Managers of national parks and neighboring national marine sanctuaries meet in Shepherdstown, West Virginia, to increase coordination and cooperation in managing marine protected areas and programs. The meeting is prompted by a new general agreement between the National Park Service and NOAA, administrator of the National Marine Sanctuaries Program.

The National Park Service convenes a Colorado River Summit in Salt Lake City. Discussions focus on the effectiveness of NPS participation in Colorado River management decision-making processes in protecting natural and cultural resources of the National Park System. The summit results in recommendations to form NPS Colorado River basin steering and technical committees comprising park, regional, and Water Resources Division staffs and to hire an NPS Colorado River basin coordinator to be duty-stationed in Salt Lake City.

The National Park Service announces the selection of five additional Exotic Plant Management Teams and expansion of the Florida partnership team. Funded by an FY 2002 budget increase, the expansion follows demonstrated effectiveness in 2001 by the first four teams in identifying, treating, inventorying, and monitoring exotic plants in parklands.

March

A reintroduced California condor lays an egg in Grand Canyon National Park, the first egg laid by a condor in the wilds of Arizona in more than 100 years. Although the egg breaks, biologists involved in the species' recovery in Arizona are hopeful that successful breeding is imminent.

National Park Service officials testify before the House Subcommittee on Interior Appropriations regarding the role of the Natural Resource Challenge in park natural resource protection. The exchange is positive and illustrates many benefits of the Natural Resource Challenge for parks and Americans.

Park Service staff and partners gather at Point Reyes National Seashore to discuss how newly funded learning centers can best connect the public, scientists, and resources. Throughout the year park staffs focus on refurbishing facilities and developing programs and partnerships to enhance research and education.

"Promoting Conservation through Cooperation" is the theme of a new brochure published by the National Natural Landmarks (NNL) Program. The brochure details the program's successes in partnering with state, federal, and private NNL owners.

April

U.S. Geological Survey Director Chip Groat recognizes Dr. Gary Williams and Dr. Steven Fancy of the NPS Inventory and Monitoring Program and Great Smoky Mountains National Park inventory and monitoring coordinator Keith Langdon as "Ambassadors for Science."

May

National Park of American Samoa assembles coral reef experts to identify monitoring strategies that are realistic for a park with limited staff and remote marine protected areas. The process results in a list of vital signs for monitoring that would track changes in the condition of the park's reefs over time. The meeting also establishes a framework for the NPS coral reef monitoring program in the Pacific West Region.

June

Speaking at Everglades National Park, President Bush nominates Florida State Parks Director Fran Mainella to head the National Park Service as its 16th director.

Air quality experts and resource managers with the National Park Service meet with airborne contaminants scientists from universities and other agencies in Seattle to develop strategies for assessing environmentally toxic airborne pollutants in

western U.S. national parks. Monitoring will begin in Spring 2002 and will focus on persistent organic pollutants such as DDT, PCBs, and furans, and metals such as mercury, which tend to accumulate at higher levels of the food chain.

Representatives of the 10 Cooperative Ecosystem Studies Units (CESUs) meet to assess the network's progress in its first two years. Scientists, scholars, administrators, and procurement specialists from federal, state, university, and partner organizations discuss ways to improve coordination and cooperation among the CESUs.

July

Secretary of the Interior Gale Norton approves the Dry Tortugas General Management Plan and the record of decision is signed. Upon completion of a rulemaking process to change the park's fishing regulations, the Dry Tortugas Research Natural Area will be the largest fully protected marine area in the National Park System.

August

President Bush visits Rocky Mountain National Park, participating in trail maintenance and fire fuels reduction projects.

The National Park System Advisory Board publishes its report *Rethinking the National Parks for the 21st Century.* Among the many recommendations for the future, the report emphasizes the importance of biodiversity preservation, relevance of parks for all Americans, and the expanding roles of education and research focused on the national parks.

National Park Service and USGS staffs meet in Phoenix to plan a unified approach to monitoring park vital signs. The 90 participants, all associated with the recently established monitoring networks, recommend improvements in the organization and development of integrated natural resource monitoring efforts in the National Park System.

September

A Russian scientific delegation visits Yellowstone National Park to view America's wild bison. The Russians and the National Park Service are collaborating on the development of a safe and effective brucellosis vaccine for possible use in Yellowstone bison. Eventual use of a vaccine would reduce the risk of transmission of the disease from bison to cattle grazing near the park.

October

Associate Director Mike Soukup presents the Director's Awards for Natural Resource Stewardship to recipients in Jacksonville, Florida. For the first time the awards include a new category: professional excellence in natural resources.

November

The FY 2002 appropriation for the National Park Service provides $20 million for the third year of the Natural Resource Challenge. The funding builds on several functions, adding seven park vital signs monitoring networks, eight learning centers, and five exotic plant management teams, and increasing resource project funding. Expanded air quality monitoring and watershed-based aquatic resource specialists are also funded. The appropriation also provides $350,000 to put the National Cave and Karst Research Institute on a permanent footing and hire a permanent director. The institute has been operating for nearly two years under an interim director.

Grantees of the Park Flight Program gather at Grand Canyon National Park to discuss the international conservation of Neotropical migratory birds, to learn interpretive and educational techniques relating to birds, and to meet program counterparts from the United States and Mesoamerica. Simultaneous translation removes the language barrier and participants return home having had a rich exchange of information, culture, and goodwill.

An NPS vital signs monitoring workshop is held in Fort Collins, Colorado, to initiate the water quality monitoring program that was funded in FY 2001. Monitoring network representatives, presenters, instrumentation specialists, and Water Resource Division staff participate.

December

Director Fran Mainella signs a memorandum of understanding (MOU) promoting partnerships for the conservation of amphibians and reptiles. Under the MOU, the National Park Service will cooperate with other federal agencies in "the identification of species, communities, ecosystems, areas, and other landscape features important to amphibian and reptile conservation."

The last of five stipulations is signed in the Little Colorado River Adjudication in Arizona to resolve water rights issues in six parks (Grand Canyon and Petrified Forest National Parks; Hubbell Trading Post National Historic Site; and Sunset Crater, Walnut Canyon, and Wupatki National Monuments).

Foreword

"The founding mission of the Park Service [is] to insure that these special places will never be impaired, and will be available to inspire and inform future generations."

—National Park System Advisory Board

John Epperson, Denver Post

Sharing stewardship

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I am honored to serve as the 16th Director of the National Park Service. I welcome the extraordinary responsibility to care for the special places and resources that tell the story of this great nation's natural and human history preserved in the National Park System.

We have a fundamental challenge to document and understand the natural resources in our care, to come together to prevent their impairment, and to preserve parks for people forever. The *Natural Resource Year in Review* for 2001 reflects our serious scientific effort and recounts what we have found. As this report reminds us, preserving park natural resources is a complex and incredibly varied endeavor that requires scientific knowledge, technical expertise, teamwork, and commitment. I share in this fundamental challenge.

The *Year in Review* touches on many areas I find critical to the well-being of our national parks. In recent years, the Natural Resource Challenge—which we often call simply the Challenge—has given us great hope and helped us become more effective park caretakers by integrating science systematically into our management strategies. This initiative is focusing our energies on gathering scientific information on the abundance, distribution, and condition of park natural resources—information critical for decision making. It also is creating many other capabilities, described in the *Year in Review*, that improve our management of park natural resources.

The Challenge owes its genesis to the realization over the past decade of the need to emphasize natural resource protection and science in park management. The catchphrases "Parks for Science" and "Science for Parks" have never been more apt than now, and many of the articles in this publication illustrate the contributions of science to park management and parks to the world of science. The connections among parks, science, and society are strengthened by the establishment of learning centers around the National Park System (see the article on page 4). As they become operational, learning centers provide support for basic research in parks and facilitate assimilation of science into park management. They also stimulate public learning about the natural world, our place in it, and the preservation of parks.

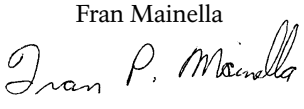
Another area of critical concern—partnerships—is reflected throughout this report. The potential for useful scientific inquiry is virtually limitless. Almost every article in the *Year in Review* describes some role of partnerships in our scientific successes. It is essential that we nurture the support of academic, not-for-profit, other agency, and even industrial research that can advance our knowledge and analysis of the resources entrusted to us. We need professional park staffs to provide information to managers, but the enduring relationships with partners who can supplement our capabilities with technical know-how and complementary skills dramatically extend the value and impact of what our staffs can accomplish. I am encouraged by the extent to which we have fruitful, productive partnerships and support their continued growth.

We are indeed very fortunate to have the support and enthusiasm of the Bush Administration and Congress for the national parks. President Bush enjoys the national parks and appreciates their importance for personal growth and reflection. He wants to see them preserved and acknowledges that science is an important tool in this. In June 2001 he nominated me as NPS Director from Everglades National Park, where the federal government and the State of Florida have begun the world's largest, most comprehensive ecological restoration effort (see the article on page 49). In a late-summer visit to Rocky Mountain National Park, he took time to help build a trail and lend his support to the fire management program. In the fall he described his sense of awe amid the big trees of Sequoia National Park in a speech that announced funding for the maintenance backlog of facilities throughout the National Park System. His budget for FY 2002 incorporated several provisions for bolstering natural resource management, including $20 million in new base funding for the Natural Resource Challenge.

Interior Secretary Norton is also a strong park advocate. She was a driving force behind designating November 10–12 as the "National Weekend of Unity and Hope and Healing," which recognized the parks' symbolic and practical importance to a nation seeking renewal after September 11.

The *Natural Resource Year in Review* illustrates well that we have a solid foundation of professional staff, talented partners, and a devoted public sharing in the stewardship of our national parks. It exemplifies the pride, teamwork, and excellence necessary for continued effectiveness in preserving park natural resources.

Fran Mainella



"We have a fundamental challenge to document and understand the natural resources in our care."

Director Fran Mainella

(Opposite) President Bush lends his help to reduce fire fuels in a pine forest at Rocky Mountain National Park. In 2001 he visited three national parks across the country and announced his support of various programs to enhance their management.

Introduction

"The long-delayed scientific inventories of invertebrates and microbes in the national parks, now just getting under way, must be accelerated to determine which species are aboard and which ones need focused protection."

—National Park System Advisory Board

Courtesy of Jeff Selleck

The year 2001 in review

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Each edition of *Year in Review* attempts to recap and reflect upon the events of the year that affected the natural resources of our national parks. In 2001 there were several major forces at work, as well as the events of September 11, that made this year more than business as usual.

The first major force was political transition. Because President Bush had voiced support for the Natural Resource Challenge in his campaign, and Secretary Norton was familiar with it even before she was confirmed, the aggressive natural resource program embodied in the Challenge has fared very well during the transition of administrations. In March we had an extraordinary opportunity in the form of a congressional hearing on the Challenge. As reported on page 2, there was great interest among members of Congress in the natural resources of national parks and the idea that the National Park Service is moving ahead to be a credible authority on the issues that challenge the long-term preservation of our national parks. In June, President Bush nominated Fran Mainella as our new Director, and she has continued to rally support for the Natural Resource Challenge as we look toward FY 2003.

Another extraordinary event was the release of the National Park System Advisory Board report *Rethinking the National Parks for the 21st Century*. In the chapter "Protecting nature, protecting ourselves," there are strong recommendations for a more representative reflection, especially in the marine environment, of the nation's natural heritage in the National Park System. There is also an overriding theme of reaching the American public to connect them with that heritage. We hope this report and those themes will catalyze a new public interest in the roles that national parks could play in our society's future. Throughout the *Year in Review* you will find brief excerpts from that report and a brief analysis of its implications for natural resource management into the future (see page 69).

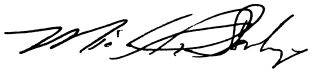
Nearly everything was eclipsed on September 11. There is no way to comprehend the implications of those events for a modern technological society. For many, there were unmistakable—sometimes direct—implications, especially in the parks of New York City. For our staff in Washington, that sense was heightened by evacuations, irradiated-to-crumbling mail, and other security measures. After a year of planning, our division and the Administration Division moved on September 17 from the main Interior building to an office building at 18th and G Streets to accommodate the upcoming renovation of main Interior. At midday we were told to stop unpacking. Our new offices (and furniture) had been requested (for security reasons) by the White House. The next day we were back in main Interior to empty offices with no phones. We are still here. All employees received the Associate Director's Resilience Award.

The year closed with a shutdown of the Department of the Interior's public Internet access related to long-standing issues of Indian Trust revenues and recent litigation. It was another lesson in precarious dependency on technological advances. Our automated research permit system (reported on page 6) and our Sabbatical-in-the-Parks Program, among others, were heavily impacted. We hope our constituencies were able to remember the old ways to reach us.

The best surprise was the emergent properties of the network concept applied primarily to monitoring park natural resources (see page 1). There is growing evidence that networks of parks with similar resources are finding great advantages to working together to solve common issues. Although the network idea has been used to implement biotic inventories, as reported in this publication, it was initially developed as a more efficient approach to monitoring. The infrastructure and the increased sharing of resources represented by the park vital signs networks will, we think, last indefinitely—providing expertise, monitoring designs, and a growing body of resource information that benefit all parks beyond what they could achieve alone. The future challenge for the National Park Service will then be to forge that information into a functional understanding of how the resources of each network and each park work. The attainment of a real understanding of the natural processes that govern park resources will be of immense value not only to the management of parks but also to the communities and regions to which they are inextricably connected.

The year 2001 was very interesting.

Michael A. Soukup



"There is growing evidence that networks of parks with similar resources are finding great advantage in working together to solve common issues."

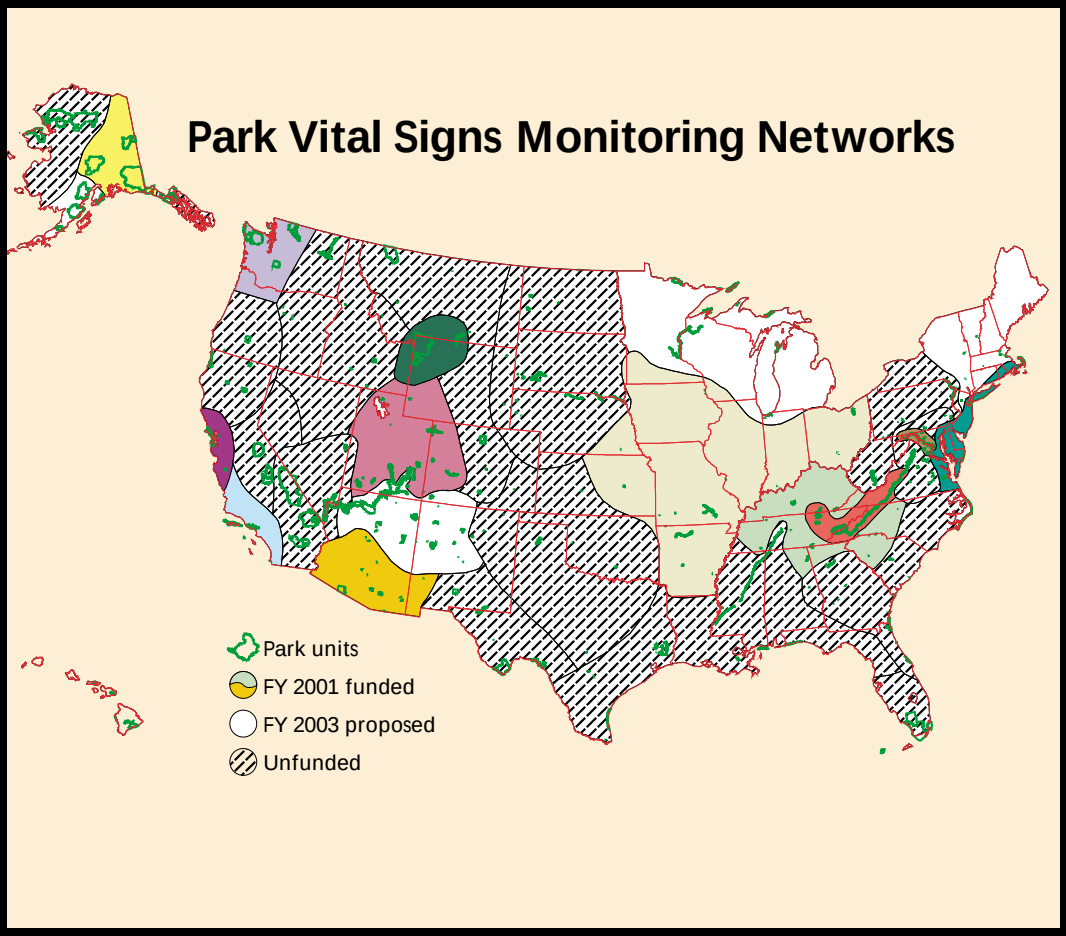
Associate Director Soukup

(Opposite) Dragonfly at Buttrill Spring, Big Bend National Park, Texas.

Meeting the Challenge

"The Park Service must have the expertise to … protect park resources in landscapes that are increasingly altered by human activities."

—National Park System Advisory Board



As 2001 came to a close, the National Park Service marked the third year of important milestones under the Natural Resource Challenge, its multiyear plan to advance the management and protection of natural resources in the National Park System. Articulated in 1999, the Challenge outlines numerous improvements needed to maintain and restore the rich natural heritage found in national parks. Congress increased NPS funding by $15.2 million in FY 2001 and $20 million in FY 2002. This funding enabled or enhanced numerous scientific research and resource management projects, many of which are described in articles in this chapter and throughout this report. Resource inventory and monitoring, learning centers, and exotic plant management teams have benefited greatly in 2001. More importantly, the scientific information and knowledge developed as a result of the Challenge are improving the ability of NPS managers to preserve and protect the National Park System's enormous diversity of landscapes and living things for the American people.

A long-term commitment to protecting park natural resources

By Steve Fancy

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Knowing the condition of natural resources in national parks is fundamental to the ability of the National Park Service to protect and manage parks. As part of the Natural Resource Challenge, the Park Service is addressing this need by providing parks with new funding and professional staff to monitor natural resources. In FY 2001 the National Park Service provided operational monitoring funding, obtained through the Natural Resource Challenge, to five monitoring networks (for 55 parks). Challenge funding also supported initial planning and design activities in an additional seven networks (46 parks) and four previously unfunded, prototype monitoring programs.

The strategy for implementing monitoring in approximately 270 parks that contain significant natural resources involves two components: a network of 11 experimental or "prototype," long-term ecological monitoring (LTEM) programs begun in 1992, and 32 vital signs monitoring networks of parks linked by geography and shared natural resource characteristics. The network organization will facilitate collaboration, information sharing, and economies of scale in natural resource monitoring. The level of funding available through the Natural Resource Challenge will not allow comprehensive monitoring in all parks, but will provide a minimum infrastructure for initiating natural resource monitoring in all parks that can be built upon in the future. The prototype programs, however, are and will be engaged in more intensive monitoring than the newly funded networks and will be able to provide leadership and expertise based on their experience.

Through the Natural Resource Challenge, each network of parks will receive long-term funding and five to nine new positions to develop a core program that focuses on the most significant indicators of long-term ecological trends and the most critical natural resource information needs among the parks in the network. A board of directors made up of park superintendents and others guides the networks by specifying the desired outcomes and evaluating the performance of the network's monitoring program. Development of these network-based monitoring programs requires an investment in planning and design to ensure that monitoring will meet the most critical information needs of each park and produce scientifically credible data that are accessible to managers and researchers in a timely manner. The investment in planning and design also ensures that monitoring will build upon existing information and understanding of park ecosystems and make maximum use of attracting assistance through partnerships with other agencies and academia.

The activities of the first 12 monitoring networks in this first program year focused on defining the high-priority issues and data needs for the parks. This included developing specific, measurable objectives for the monitoring, compiling and summarizing existing information, developing conceptual models that are relevant to the proposed monitoring, and evaluating existing monitoring being conducted by parks and by neighboring agencies. The networks also spent time developing a scientifically credible spatial sampling design, sampling protocols, and a data management system and database to ensure that data are available for analysis and reporting. Finally, network staff determined the types of information needed by managers, educators, and constituents and the type and content of reports to be produced by the monitoring program. The work of the 12 monitoring networks in 2001 is vitally important for the future protection of the national parks; however, 20 networks still require funding in order to extend this critical resource protection function across the entire National Park System.

"… 20 networks still require funding in order to extend this critical resource protection function across the entire National Park System."

Long-term monitoring will provide an early warning of certain abnormal conditions in time to develop effective mitigation measures. Additionally, monitoring will allow the National Park Service to meet certain legal and congressional mandates. It will also provide parks with a means of measuring progress toward performance goals. Monitoring park vital signs gives the National Park Service a way to account for how it is preserving our natural heritage, by evaluating the efficacy of restoration and other management actions and by warning of impending threats

(Opposite) The Natural Resource Challenge provided funding for 12 monitoring networks for park vital signs and water quality in FY 2001 (colored areas). Five networks are proposed for funding in FY 2003 (white areas), and an additional 15 remain unfunded (cross-hatching).

Natural Resource Challenge has its day before Congress

By Abigail Miller

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On March 8, 2001, the National Park Service enjoyed a rare opportunity to testify before the House Subcommittee on Interior Appropriations regarding the role of the Natural Resource Challenge in park natural resource protection. Although the subcommittee normally holds budget hearings, testimony tends to focus on maintenance and construction backlogs and fee collection management. This hearing focused on the Natural Resource Challenge, a commitment made by the House of Representatives in FY 2000 when it expressed its intent "to monitor this initiative very closely."

"We recognize the value to society of using the resources in parks for research."

Nine members of Congress and staff representing other members attended the hearing. Representing the National Park Service were Deputy Director Deny Galvin, Associate Director for Natural Resource Stewardship and Science Mike Soukup, and Point Reyes National Seashore Superintendent Don Neubacher; Doug Morris, superintendent of Shenandoah National Park, was in the audience to answer questions. Deputy Director Galvin submitted formal testimony and summarized his remarks, and Superintendent Neubacher also spoke. Congressman Norman Dicks prefaced the testimony, saying that he thinks the Natural Resource Challenge is a good program and that there is a need to bring science back into the national parks in a significant way.

Courtesy of Jeff Selleck

The U.S. House of Representatives Subcommittee on Interior Appropriations heard testimony from Park Service representatives in March 2001. The hearing focused on the Natural Resource Challenge and engendered positive dialogue on the natural resource preservation role of the National Park Service.

Deputy Director Galvin thanked the subcommittee for its past support and explained that the Natural Resource Challenge is the National Park Service's effort to understand park natural resources without detracting from visitor services. We want, he said, to better explain and document our decisions in court, to the visiting public, and to society at large. We want to make parks friendlier to the scientific community because we recognize the value to society of using the resources in parks for research. He also spoke of the problems the Challenge is designed to address, especially exotic species.

The deputy director assured the subcommittee that the initiative takes advantage of the capabilities of the U.S. Geological Survey (USGS). He also described several other fruitful partnerships and gave examples of efficient and innovative park programs, including the South Florida Exotic Plant Management Team partnership with the State of Florida, the joint USGS/NPS vegetation mapping program, cooperative ecosystem studies units (CESUs), and use of historic buildings for learning centers.

Don Neubacher spoke about the Challenge from a superintendent's perspective. He indicated that superintendents have not had the resource management capabilities and information necessary to make good decisions. This is reflected, Neubacher noted, in 27 park business plans that identified resource management as the area with the biggest gap in funding. He also stressed that NPS field personnel support the Challenge because they developed it—superintendents working with resource managers to come up with the most efficient and effective techniques. The Challenge is effective, Neubacher said, because it is systematic, leverages funds from private sources, and awards project and other funding competitively.

Accountability was the subject of the first question and one to which members kept returning. How, they asked, will the National Park Service ensure that Challenge funding does not get diverted? Galvin repeatedly answered that although 90% of the money goes to the parks, it does not go into park base funding. The group also discussed the relationship between the National Park Service and the USGS Biological Resources Division and the role each plays in the Challenge. Of particular interest were the CESUs, how they work, and the differing roles in them of each bureau. Although concern was raised about whether scientific information will mean more restrictions on visitors, all the witnesses stressed that this is not the intention of the Challenge and provided examples of how more information can *avoid* the need for restrictions. The examples—indeed all the answers to questions—were informative and well received.

Before retiring in December, Deputy Director Galvin remarked that he spent more time discussing resource issues with Congress on March 8 than he had in all his previous congressional appearances put together. Indeed, all who participated in the hearing were delighted that the discussions were positive, held great interest, and told the remarkable story of the Natural Resource Challenge

An American story

Remarks of NPS Deputy Director Deny Galvin on his retirement in December 2001

By Denis Galvin

Editor's note: This year saw the retirement of Deny Galvin whose nearly 40-year career with the National Park Service spanned a wide spectrum of achievement. Deny had the remarkable ability to voraciously absorb new information objectively. He became, after a career as an engineer and construction program expert, one of the most eloquent and avid supporters of the National Park Service's need to enhance its capabilities for protecting the nation's natural heritage—the fauna, flora, and physical resources of national parks. His rapport with Congress was particularly helpful in furthering the Natural Resource Challenge and the concept for learning centers.

It is an American story, and as so many of them, it starts thousands of miles from America. It starts on the quay of Queenstown in County Cork. My father left Ireland in 1914, my mother in 1919. They married in 1922 and lived for the rest of their lives in South Boston, surrounded by other new arrivals. So I grew up with the children and grandchildren of immigrants. Irish mostly. As a child I could distinguish the county in the brogue—Cork, Kerry, Galway. But others too lived there: Italians, Lithuanians, Poles, and Armenians.

A retired cop once characterized the prospects for one growing up in Southie: "It was gas, electric, Gillette, city, cop, crook …" You'll note a career in the National Park Service was not on his list. I'm not sure I knew there were national parks; I certainly had never been to one, nor did I know anyone who worked for the National Park Service.

But life is made of unexpected connections. I joined the Peace Corps. Two years in Tanganyika (now Tanzania) exposed me to the national parks there. I was a surveyor. The work was outdoors, on safari, often enough in national parks. The names have a worldwide magic: Kilimanjaro, Lake Manyara, Serengeti, Ngorongoro. I worked in them, I lived in them. My parents saved my letters. Reading them now, I can call up experiences otherwise forgotten. In May 1963, toward the end of my East African service, I was in Lake Manyara; I wrote: "This afternoon driving up to the camp, I came upon a smallish impala buck with beautifully graceful lyrate horns. He bounded off into the bush with the tremendous leaps characteristic of these animals. I've had one jump over the Land Rover in country north of here. Every day last week I ran into a solitary bull elephant who trumpeted our early morning arrivals. Last Friday he got somewhat curious and ambled along the road toward the Land Rover. A magnificent beast with tusks curving at different angles, trunk stretched forward, and enormous triangulate ears flapping back and forth, each movement enveloping him in a cloud of red dust, which he occasionally sprayed over himself with his trunk. I kept the Land Rover in reverse and he finally got bored and slid off through the bush in the unbelievable, quiet way that … [they move]."

Still, when I returned to the U.S. I had no thought of working for the National Park Service. A chance encounter with an employment brochure yielded the address of the Western Regional Office in San Francisco. The NPS became one of about 75 applications. I needed a job; I wasn't looking for a career.

In the fall of 1963 I arrived in Sequoia. In the first week, Joe Davis, the road foreman, drove me through Giant Forest. The connection with loved landscapes begun in East Africa was being extended. It has become a lifelong affair.

There have been other stops: Mount Rainier, Santa Fe, Grand Canyon, New York, Boston, Denver, and finally Washington. Since arriving here it has been four presidents, four secretaries, five directors, and lots of assistant secretaries.

At the end it's given me lots of stories. But they have accumulated at some price. For that I apologize to my family. That itinerary cost strain and pain. I hope it has come out all right; both kids are gainfully employed, we all love each other, we all have college degrees. There was some benefit: I met the love of my life, Martha, at Mount Rainier. Eileen was born in Santa Fe, Denis at Grand Canyon.

When I joined the National Park Service the system contained 196 units. It has almost doubled during my career. I have been enriched by working on that growth: Gateway, Lowell, Boston,

(Cont'd) —4

"Life is made of unexpected connections."

Denis Galvin at the wheel of a refurbished, vintage bus used for visitor transport in Glacier National Park.

Martin Luther King, Tuskegee, Pecos, Fort Bowie, New Orleans Jazz, the Presidio. And too, I've worked on projects in older units: Yellowstone, Yosemite, Great Smoky, Shenandoah, Everglades. In these last years I've been involved in those programs outside of parks that enrich people's lives in their communities: heritage areas, long distance trails, wild and scenic rivers, national historic landmarks, technical assistance.

Wallace Stegner wrote, "The national park idea, the best idea we ever had, was inevitable as soon as Americans learned to confront the wild continent not with fear and cupidity but with delight, wonder, and awe. Once started, it grew like the backfire it truly was, burning back upwind against the current of claim and grab and raid."

As long as there is an American experience, the System will never be done; the work of the National Park Service will never be finished. For taken collectively, it is the narrative of the nation's experience. It is an American story.

Learning centers connect the public, scientists, and resources in their first year

By Karen Ballentine

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For further information on learning centers, contact **christie_anastasia@nps.gov.**

The Pacific Coast Learning Center at Point Reyes established a program of "Biological Science Aids." In its first summer, the program involved high school students who participated in resource management projects related to water quality, vegetation sampling, and fish restoration.

In March 2001 the National Park Service and several partners gathered at Point Reyes National Seashore to determine how the newly funded learning centers could best meet the vision of connecting the public, scientists, and resources. This group included some of the best leaders the National Park Service has known, along with others who had waited much of their careers to see the Park Service start to merge research and science education. The developers of the Natural Resource Challenge may have done their best work when they decided to create learning centers to make the Challenge objectives come alive. Everyone felt privileged to be at the birth of an idea that will help excite the American public about the significance of national parks.

Deputy Director Deny Galvin and others articulated the ideas that had grown with learning centers out of the Natural Resource Challenge:

- Learning centers facilitate park research to ensure that managers have the information they need to make science-based decisions. The information should also be brought to a larger public that encompasses educators especially.

- Learning centers are the human face of resource management—the interface between science and learners at large.

- They present an exciting context for learning because of hands-on opportunities.

- The focus of programs should be a dynamic combination of natural, cultural, biological, and historical park resources.

- Learning centers are places for conversations that do not usually happen among scientists and educators, biologists and historians, artists and students.

- Learning centers are places to spread excitement and communicate the idea that national parks are among the few places left to show what America is, was, and can be.

The group explored ideas and developed a long list of all the necessary work to make learning centers the institution they deserve to be. These topics included program assessment, accountability to Congress, working within the framework of the inventory and monitoring networks, marketing, developing a national clearinghouse for research opportunities, coordinating among centers, and developing websites and partnerships.

With some trepidation and acknowledgment of hurdles to come, five learning centers emerged and began operating with FY 2001 funding; an additional eight centers were funded in FY 2002. (Altogether, a network of 32 learning centers strategically placed around the country is envisioned to serve parks and the public.) With this start, passion to succeed is high and the momentum will only intensify. By the time the learning centers report went to Congress in November, progress had been made on refurbishing facilities and developing programs and partnerships.

Success stories from the first year of operation in the field illustrate the broad vision and potential of learning centers. For example, 20 scientists at Great Smoky Mountains extended their stay in the national park on account of overnight facilities available at the Appalachian Highlands Science Learning Center. Most of these researchers shared their expertise with education groups or involved them in the collection of research data. The Ocean Alaska Science and Learning Center in Anchorage facilitated the further study of the stellar sea lion, an endangered marine mammal in four national parks in southwestern Alaska. Scientists collected data and shared digital footage of the creatures with schoolchildren by use of remote cameras focused on sea lion colonies. The Atlantic Learning Center at Cape Cod National Seashore sought partnerships in 2001 with Intel Corporation and the National Renewable Energy Laboratory for the donation of equipment and furniture to establish a laboratory and classroom. The Continental Divide Research and Learning Center in Rocky Mountain National Park hosted a one-day conference that brought together scientists and local citizens to learn about research and management of park resources. These first-year successes are but a few examples that demonstrate the potential for linking national parks, people, and science through learning centers.

A natural resource specialist, hired as part of the first-year strategy at the Continental Divide Research and Learning Center, helped attract, coordinate, and support a glacier survey in Rocky Mountain National Park in 2001. Valued at around $33,000, this survey identified more than 120 glacial ice features, compared to the 34 ice and snow masses noted on the current USGS map of the park and vicinity (1990). This suggests that glaciers are more common and active in the park than previously thought.

"Learning centers are … the interface between science and learners at large."

Research permitting system streamlines application process

By Tim Goddard

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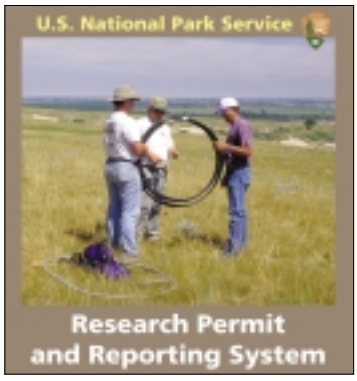
In January 2001 the National Park Service (NPS) introduced the Internet-based Research Permit and Reporting System (RPRS) at http://science.nature.nps.gov/research. The new information system facilitates consistent administration of non-NPS natural resource or social science research activities within units of the National Park System. By year's end, more than 3,000 applications for research permits had been received, more than 2,200 permits approved and generated, and nearly 2,000 annual accomplishment reports completed and documented.

"The system helps match prospective researchers with park-identified research preferences."

The Research Permit and Reporting System enables the public and researchers outside the National Park Service to access information explaining the requirements and procedures for requesting permission to conduct research activities pertaining to natural resources or social science within areas administered by the National Park Service. Additionally, researchers are now able to search and review previously reported research accomplishments before proposing new study activities. Through a search function, the system helps match prospective researchers with park-identified research preferences. These functions cut back on inquiries directed to park staff, reduce redundant studies, attract additional research, and increase the usefulness of research to parks.



Launched in 2001, the Web-based Research Permit and Reporting System facilitates research permitting on-line. The new system provides numerous benefits for researchers and the National Park Service alike.

Applicants prepare and submit applications for scientific research and collecting permits in a consistent format via the Internet. Additionally, researchers are able to prepare and submit consistent annual accomplishment reports, which are required as a condition of conducting research. Thus, park research coordinators are able to process and track research permit applications, issued permits, and annual accomplishment reports. Another benefit is that the number of applications received and research permits issued can be determined quickly.

The National Park Service has learned some lessons from this first year of the new system. While helping to meet the challenge of promoting more scientific research within parks and applying research findings to management decisions, the inauguration of the Research Permit and Reporting System brought to light several potentially troublesome side effects. For example, permit application numbers could double in some parks, adversely affecting staff unaccustomed to this degree of interest. Although this circumstance might indicate that the National Park Service is successfully attracting more science in parks and providing technological tools to help efficiently administer increased workloads, the Internet-based system does not address the extra time required to coordinate peer reviews, assessments of environmental impacts, and other considerations related to analyzing study proposals. Park Service policy coordinators have begun exploring possible solutions to ease burdens placed on park research coordinators. Another side effect is requiring staff to work with yet another information system, perhaps exacerbated by slow or limited access to the Internet. The National Park Service made a strong commitment to provide technical support for both research applicants and NPS field staff. Two training courses were conducted, resulting in hands-on training for nearly 50 park research coordinators in 2001. The continuation of technical support and periodic training courses should help alleviate tensions associated with learning and operating the system.

National Park Service staff and researchers have also made suggestions to improve the system. One idea is to program it so that researchers are automatically notified by e-mail when their permit is approaching expiration. This message could encourage them to apply for permit renewal if their park-based study activities will continue beyond the permit expiration date. Another suggestion is to enable park research coordinators to quickly transmit a single e-mail message to all active permit holders for their park. This could help parks keep researchers informed about special conditions that might affect fieldwork (e.g., area closures and safety notices). Suggestions like these will help ensure that the Research Permit and Reporting System improves the science and management capabilities of the National Park Service, while also providing consistency and simplification of processing and tracking.

Mobile strike forces protect our natural heritage

By Linda Drees

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Control of exotic species is an emerging global problem and one of the most significant land management issues facing the National Park System. The natural heritage of our national parks is threatened by the invasion of exotic plants and animals. Exotic species compete directly with native species for food and space. Natural fire and water processes, and in some cases soil composition, can be altered by exotic plants. Exotic species have been implicated in the decline of 42% of those species listed as threatened or endangered by the U.S. Fish and Wildlife Service. Invasive species cost the U.S. economy an estimated $137 billion annually. Fortunately, the National Park Service made tremendous headway in 2001 toward containing harmful plant species through an innovative resource management tool: Exotic Plant Management Teams (EPMTs).

Modeled after the approach used to fight wildfires, EPMTs are highly trained, mobile strike forces of plant management specialists who assist parks in the control of exotic plants. Each team works with multiple parks across broad geographic areas to identify, conduct, and evaluate exotic plant removal projects and restoration efforts. Four field-based teams are currently in operation: Florida Partnership, National Capital Region, Chihuahuan Desert/Southern Shortgrass Prairie, and Pacific Islands. These teams have developed site-specific strategies for combating exotic plants that reflect the needs and resources of the more than 41 parks they serve.

The Exotic Plant Management Teams marked their first full year of operation in 2001 with a substantial list of accomplishments. They identified, treated, inventoried, or monitored more than 100 high-priority exotic plant species on 17,000 acres and eradicated six species of exotic plants from parklands. Haleakala National Park is now free of damaging silk oak and thatching grass. Loggerhead Key in Dry Tortugas National Park is also free of exotic plants. Strategic monitoring and targeted treatment have helped the National Park Service exceed its Government Performance and Results Act goal for containing exotic species for FY 2001.

Exotic Plant Management Teams are also building the technical capacity to meet the growing demand for information and technical resources to manage exotic plants in natural areas. This effort includes the development and use of a Web-based data system and a corresponding Geographic Information Systems map to track the progress of each project site. Additionally, a website has been created to facilitate access to the teams' activities and quarterly reports. In 2001 the EPMT Operations Handbook was distributed.

Most importantly, the Exotic Plant Management Teams are building partnerships to efficiently prevent invasion by and manage damaging exotic species now and in the future. Because exotic species do not recognize boundaries, cooperative efforts are critical to addressing invasive species and protecting our valuable resources over the long haul. For example, the Pacific Islands Exotic Plant Management Team has partnered with the Hawaii State Emergency Environmental Workforce to augment ongoing efforts to control *Miconia,* a tree species from South America that is poised to overtake Hawaii's forests, and other invasive species. This combined effort will help control the invasion of habitat-modifying exotic plants, contributing to protection of prized Hawaiian resources.

In other partnership efforts, the Florida EPMT is working with more than 136 groups in the Upland Invasive Plant Management Funding Program of the Florida Department of Environmental Protection. It has also initiated other partnership activities, including the South Biscayne Bay Exotic Plant Management Working Group. One-third of the National Capital Region EPMT's work was supported by partners, including The Nature Conservancy, AmeriCorps, the Student Conservation Association, and the Youth Conservation Corps.

As a result of the success of the initial four teams, five new teams and an expansion of the Florida Partnership have been funded and will be on the ground in FY 2002. The new teams will serve parks in California, the Southwest, the Gulf Coast, the Northern Great Plains, and Columbia-Cascades. This expansion will allow for the control of exotic plants in nearly one-third of the nation's parks.

"[The teams] identified, treated, inventoried, or monitored more than 100 high-priority exotic plant species on 17,000 acres."

Chinese wisteria creates a tangle, overwhelming native vegetation at George Washington Memorial Parkway, Virginia. In 2001, an Exotic Plant Management Team in the National Capital Region attacked the problematic plant species.

Other Developments

Award-winner profile

Ambassadors for science

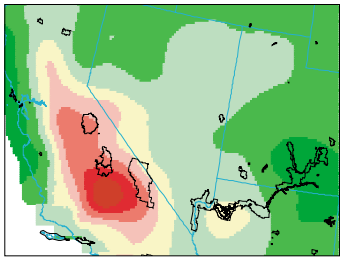
Three National Park Service employees are recipients of the 2001 Ambassadors for Science awards given by the USGS. Gary Williams (holding award), Steve Fancy (center), and Keith Langdon (right) were nominated by their USGS colleagues for their "dedication and energy to the scientific community, and for seeking to integrate scientific information into sound decision making." Williams is the manager of the NPS Inventory and Monitoring Program in Fort Collins, Colorado, which documents the status and trends of natural resources in national parks. Fancy is the national monitoring coordinator, also with the national Inventory and Monitoring Program, and has helped launch vital signs monitoring networks throughout the National Park System (see page 1). Langdon is the inventory and monitoring coordinator at Great Smoky Mountains National Park, Tennessee. In addition to his involvement with the All Taxa Biodiversity Inventory (see page 26), Langdon serves as liaison with the USGS Biological Resources Division and has helped support a variety of work by the USGS in response to their Science in the Parks initiative. The awards were presented by USGS Director Charles Groat (pictured with Williams) in Reston, Virginia, in April 2001.

Air quality

Learning a lot with a little

Learning a lot with a little
When the Natural Resource Challenge was launched in 2000, only 36 of the more than 270 parks with significant natural resources had access to air quality–related information. In anticipation of a budget boost for air quality monitoring in FY 2002, a small amount of money from the Inventory and Monitoring Program was used to review the locations of all air monitoring sites nationwide to see if park information needs could be met with data from nearby sites. Working in cooperation with students at the University of Denver, Air Resources Division staff did a spatial analysis and attempted to interpolate air quality parameters in 2001.

This investment paid off big-time. Based on analyses now available, the Air Resources Division expects to be able to almost double the number of parks where it can report on acidic deposition and triple those where it can report ozone conditions—at little cost to the National Park Service. New monitoring, funded by the Environmental Protection Agency, will also provide visibility data for all the Class I areas and many Class II areas. (Under the 1970 Clean Air Act, Class I areas are more highly protected from air pollution than Class II areas.) The National Park Service can now direct new air quality monitoring to the most pressing needs. Tables and maps summarizing information from the ongoing analysis are available on the natural resources intranet site (http://www2.nrintra.nps.gov/ard/gas/NRC_AQ_mon1.htm).



This map depicts estimated ozone levels in southwestern U.S. national parks (black outlines). Red areas have the highest ozone concentrations, green the lowest. Before this project, estimates of ozone levels were not available for parks where ozone monitoring does not occur.

"NPSpecies" development continues

NPSpecies is the National Park Service database of vertebrates and vascular plants occurring in each unit of the National Park System. Designed for use by park staff to manage lists of species occurring in national parks, the database documents the verifiable evidence for including species in the park lists. NPSpecies represents current knowledge on the biodiversity preserved in the national parks. For example, the system recently documented the discovery and confirmation of a new species of cactus at Biscayne National Park, Florida, the semaphore prickly pear cactus *(Opuntia corallicola)*. It is one component of a larger data management system to integrate natural resource information in the National Park Service.

Development of a science-based species list is one of 12 baseline inventories in the NPS Natural Resource Challenge. When it is complete, experts at the park level will for the first time have control over managing their species lists while simultaneously sharing the information with resource managers, cooperating investigators, decision makers, and the public over the Internet.

The most fundamental capabilities of NPSpecies are the generation of scientifically supported species lists for each park and a list of parks for which any given species may occur. More importantly, NPSpecies has the capability to link each species in each park with multiple references—voucher specimens and observations—that scientifically support the occurrence, past occurrence, or probable occurrence of the species in the park. In the case of references, NPSpecies is linked to the Internet version of NRBib—the Natural Resource Bibliography (see following page). Consequently, information from both databases can be entered, managed, and shared simultaneously.

In 2001, staff of the Inventory and Monitoring Program continued to develop NPSpecies and worked with park staff to enter and verify data on vertebrate and vascular plant species for 270 parks with significant natural resources. However, NPSpecies has the capability to include data for all national parks and all species in all five kingdoms (animals, plants, fungi, protists, and monera). Once fully developed, NPSpecies will be made available to the public over the Internet.

NPS phot by Matt Patterson

EXPERIENCE YOUR virtual AMERICA

Fostering public understanding of the diverse natural resources of the National Park System is one goal shared by the Natural Resource Information Division's (NRID) Synthesis project and the Natural Resource Challenge. Basic national park data are collected, organized, and made available digitally to park managers through the Synthesis Information Management System. In 2001 the Synthesis team in Lakewood, Colorado, began to expand the scope of Synthesis to include the development of educational materials. These materials help shape the unique stories of each unit of the National Park System, highlighting the interactions of natural and cultural resources. This project, Views of the NPS, is a collaborative venture involving NRID and park staff and subject-matter experts. Use of innovative techniques like 360-degree photographs and virtual-reality sequences allow users to interact with the park environment. Views also emphasizes connections between national parks based on natural resource themes such as paleontology, volcanology, and glaciology. Now in development, this new learning tool allows users to experience park features otherwise inaccessible, and brings to life re-created historic or prehistoric landscapes. Further information on Synthesis or Views of the NPS is available from Bruce Nash (303-987-6697 or bruce_nash@nps.gov).

CESUs progress as network grows

Managing complex ecosystem issues requires relevant, timely, and often interdisciplinary scientific expertise. The Cooperative Ecosystem Studies Units (CESU) Network, formed in 1999, brings federal agencies and the nation's universities together in multidisciplinary partnerships to address natural and cultural resource issues affecting federal resource management agencies. CESUs provide research, technical assistance, and education to resource managers; involve and benefit researchers from the nation's universities; and encourage the professional development of federal employees.

In 2001 a third national competition was held, resulting in the selection of two new CESUs (shown in green on the map). The Chesapeake Watershed CESU is hosted by the University of Maryland and includes 10 partners. The Great Basin CESU is hosted by the University of Nevada, Reno, and includes 15 partners. The year also saw the addition of a new federal agency—the National Aeronautics and Space Administration (NASA). By the end of 2001, 10 CESUs had been established, bringing together 10 federal agencies, 60 universities (including 14 minority institutions), and 17 state, tribal, and nongovernmental partners in 30 states and territories. The CESU Network continues to develop and should be complete by 2003.

Information Division branches out

The Natural Resource Challenge identifies public education and improving the usability of scientific data as objectives for improving natural resource management in the national parks. Consequently, FY 2001 Challenge funding enabled the establishment of two new branches within the Natural Resource Information Division of the Natural Resource Program Center. A primary goal of the fledgling Information Services Branch is to improve the public's understanding of the value and importance of natural resource science and stewardship programs and activities in the parks. The branch plans to use several methods to achieve its goals. Upgrading the natural resource publications *Park Science* and *Natural Resource Year in Review*, and continued expansion and improvement of the NatureNet website were major accomplishments during the branch's first year. In addition, several new initiatives were set in motion, including establishing positions for an interpretive liaison, a national natural resource education specialist, a publications development specialist, and a branch manager to oversee the new operation. Armed with an expanded and committed staff of communications specialists, the branch will soon initiate training in natural resource communications for the National Park Service and develop education, public outreach, and other information services.

The Systems Management Branch, also organized in 2001, is working to improve the usability of data in park management. Its first-year activities concentrated on the design and development of data management systems, including the hiring of a database administrator who will help integrate diffuse data. Articles in this report highlight two of the branch's first-year successes: an Internet-based research permit application system (page 6) and Synthesis, an information retrieval interface and education tool (above).

In addition to many other accomplishments for the year, the Inventory and Monitoring Branch produced the Natural Resource Bibliographic Database, known as "NRBib," a tool used primarily for preparing bibliographic reports. A public-access interface is under development and will allow a user to search for natural resource data from NPS sources organized by park. The bibliographic database will contain citation data and links to other databases like NPSpecies (see article, pervious page) to facilitate research.

Science-Based Management

"The Service is beginning to develop a picture of the living things and processes at work inside the parks."

—National Park System Advisory Board

Preservation of the myriad ecosystems in national parks lies substantially in improving the scientific information available for understanding and managing these treasures. Through programs like Inventory and Monitoring and partnership efforts with the U.S. Geological Survey and many other institutions and individuals, the National Park Service acquired valuable data on the distribution, abundance, and condition of park natural resources in 2001. In particular, funding available through the Natural Resource Challenge focused inventory efforts on vascular plants and vertebrates. Many other program- and park-funded studies are also yielding valuable natural and social science information for use in park planning and management. The articles in this chapter emphasize the scientific gains made in 2001 that are helping the Park Service build the baseline information necessary for making scientifically sound management decisions that will secure a vibrant future for the national parks.

Lynx inventories under way in the Intermountain Region

By Laura Hudson

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Management of threatened and endangered species has become a major undertaking in the National Park Service. Starting in 2000, the Natural Resource Challenge funded new positions and expertise in the Biological Resource Management Division (BRMD), expanding the ability of the NPS Threatened and Endangered Species Program to assist parks. For example, the BRMD staff initiated a lynx conservation agreement with the U.S. Fish and Wildlife Service. Management policies revised in 2001 mandate that parks inventory, monitor, restore, and maintain any listed species and their essential habitat. With these policies in mind and with the recent listing by the U.S. Fish and Wildlife Service of the Canada lynx *(Lynx canadensis)* as threatened, parks feel an increased urgency to inventory and monitor these reclusive cats.

Lynx are sensitive indicators of environmental change, as their presence or absence reflects the integrity of northern forest ecosystems. Little is known about the status of lynx populations in parks and much of the scientific technology for detecting lynx presence is relatively new. To determine what scientific information is currently available to parks, the Rocky Mountains Cooperative Ecosystem Studies Unit organized an interagency lynx workshop in 2001. This workshop included an overview of research conducted by federal and state agencies, parks, nonprofits, and universities on techniques for lynx habitat mapping, inventory and monitoring, and genetic sampling.

As an outgrowth of the workshop, the BRMD developed a cooperative agreement with the University of Montana to fund genetic analysis for lynx hairs. Agencies agreed to use National Lynx Detection Protocols to provide data consistency across administrative boundaries. Defined research needs include patterns of lynx movements and home range selection as they relate to population viability, prey resources, and anthropogenic influences. Because of their large home ranges, a collaborative research approach identifies prime potential habitats that are known to support lynx by using a forest matrix that includes a variety of age and structural classes. Parks are working closely with neighboring agencies to survey all potential habitat as completely as possible.

Methods currently used to locate lynx include ground and aerial snow tracking, remote camera stations, substantiated sightings with follow-up tracking, live trapping, and hair snares. Glacier and Yellowstone National Parks used standardized snow tracking procedures in 2001. Grand Teton National Park will be initiating tracking surveys in 2002. All three parks used hair snare sampling in 2001. Hair samples, coupled with genetic analysis, help determine accurate species classification, and sometimes individual and sex identification.

Results include Glacier National Park's confirmation of at least six lynx from 2000 to 2001. Despite numerous historic sightings at both Yellowstone and Grand Teton National Parks, only two potential snow tracks were found in Yellowstone, and using hair snares, no lynx hairs were found in Grand Teton. Since persistence of lynx appears to be closely tied to snowshoe hare *(Lepus americanus)* distribution and density, surveys continue in the state of Montana near Glacier, and the University of Montana is proposing to begin hare surveys in Yellowstone in 2002.

Working together, the National Park Service and adjacent land managers employ an ecosystem approach to inventory lynx in a cost-effective and productive manner. The study of lynx movements and home range selection gained from this collaborative effort will help the Intermountain Region understand the population dynamics of this threatened species and enable it to fulfill its obligation to conserve lynx on federal lands.

"Parks feel an increased urgency to inventory and monitor these reclusive cats."

(Opposite) Relatively large, furry feet ensure efficient travel through snow for the threatened Canada lynx in its northern boreal forest home. In 2001 the National Park Service, working with several partners, launched an ecosystem-based survey for this reclusive species at Glacier, Yellowstone, and Grand Teton National Parks.

A scientist skis into the backcountry of Glacier National Park, Montana, in search of lynx tracks preserved in snow. Hair snares were also employed in 2001 to determine animal presence.

Inventories yield large benefits for Devils Postpile National Monument

By Linda Mutch

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"... 191 plant species and 10 bat species were newly documented as the result of inventories in summer 2001."

At Devils Postpile National Monument, inventory efforts are returning large benefits: 191 plant and 10 bat species were newly documented as the result of inventories in summer 2001. These numbers are even more impressive in light of this monument's small size. At just 800 acres, Devils Postpile is the smallest unit in the Sierra Nevada Network, which also includes Yosemite and Sequoia and Kings Canyon National Parks. The Sierra Nevada Network is one of 32 park networks within the NPS Inventory and Monitoring Program. Networks link parks with similar resources to facilitate collaboration, information sharing, and cost savings during the inventory process.

In undertaking the plant inventory, park staff developed two main objectives. First, they sought to inventory at least 90% of the vascular flora in the monument and document them with vouchered specimens or samples that have been verified by a specialist. Second, the inventory was designed to determine the distribution and abundance of plant species of special management concern, including rare and nonnative species.

Botanist Melanie Arnett, a graduate student, conducted the plant inventory through an innovative educational partnership with the Environmental Careers Organization. Sylvia Haultain, a plant ecologist with Sequoia and Kings Canyon National Parks, supervised the effort. The inventory raised the number of documented plant species for the monument from 169 to 360, an increase of 113%.

In summer 2001 the Sierra Nevada Network conducted vascular plant and bat inventories at Devils Postpile National Monument, a small park unit with limited previous inventory information. During the inventory, botanist Melanie Arnett cut off the seed heads of bull thistle plants and enclosed them in plastic bags before the plants were uprooted to prevent further spread of this invasive plant.

It also documented the abundance and distribution of three rare and eight nonnative species. Of the nonnatives, only bull thistle *(Cirsium vulgare)* appeared to be invasive. Invasive plants are a management concern because they are nonnative species that have or are likely to spread, creating self-sustaining populations that disrupt native plant communities. To prevent the spread of bull thistle into additional areas within the monument, Arnett and other staff undertook control measures on all populations encountered during the inventory.

The inventory yielded important scientific information that benefits institutions and scientists beyond the National Park Service. Arnett collected and prepared complete sets of voucher specimens for a number of collections and research facilities, including Devils Postpile, the Jepson Herbarium at the University of California at Berkeley, and the Rocky Mountain Herbarium in Laramie, Wyoming. The specimens will provide valuable information for future vegetation studies in the monument and surrounding areas. A manuscript describing the results of the study is being prepared.

In addition to the plant inventory, the Sierra Nevada Network contracted bat specialists Elizabeth Pierson and William Rainey to do a preliminary bat survey in Devils Postpile in late August 2001. Through a combination of mist-netting and acoustic sampling over just two days, 10 species of bats were added to the monument's vertebrate list, which included no bats before this study. Of the 10 species found during the preliminary inventory, 5 are listed as federal or state species of special concern.

The information gained from the baseline inventories will assist parks in the Sierra Nevada Network with numerous resource management and planning activities. This information will help NPS staff develop long-term control efforts for nonnative plants in the monument and revise its outdated resource management plan. As park staff work to develop indicators for monitoring the health of the monument's natural systems, inventory information will be critical for identifying and prioritizing vital signs for a network-level, long-term monitoring program. High-quality information about the plants and animals that make their homes in parks also enriches the information available to the public.

Carl Sandburg Home: Biodiversity in a small park

By Anne Ulinski

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Volunteer Naturalist, Carl Sandburg Home National Historic Site, Flat Rock, North Carolina

NatureServe scientists have been working with the Cumberland Piedmont Inventory and Monitoring (I&M) Network to inventory plants and plant communities in the network's smaller parks. Inventory activities at Carl Sandburg Home National Historic Site in western North Carolina prove that good things can come in small packages. An inventory at the historic site in 2001 identified 10 separate plant communities and 124 vascular plant species newly documented on the property, which covers just 262 acres.

Carl Sandburg Home National Historic Site is located in the village of Flat Rock, North Carolina, surrounded by the biologically rich southern Appalachian Mountains. The home, barns, outbuildings, lakes, and pastures occupy about 50 acres of the park, which attracts nearly 150,000 visitors each year. Woodlands and a small old-growth forest take up the remaining acreage. The topography and geology of the site are complex, with globally rare rock outcroppings occurring in nine or more places.

The scientists who visited the park in fall 2001 identified 10 plant communities or associations: a pine woodland, a dry chestnut-oak forest, a mesic chestnut-oak forest, an acidic Appalachian cove forest, an acidic montane oak-hickory forest, a seminatural wooded upland, an herbaceous vegetation meadow, a white waterlily aquatic wetland, a rush marsh, and a "flat rock community" called Appalachian low-elevation granitic dome. This last association is ranked "G2," or globally very rare. These findings suggest that small parks are often sites of tremendous biodiversity.

In September, I&M scientists collected more than 120 vascular plant specimens newly documented at the park. These specimens will be added to the historic park's on-site herbarium. The herbarium is the result of a two-year partnership, 1996 to 1997, between the southeastern office of The Nature Conservancy and the National Park Service. The new additions bring the collection total to at least 540 vascular plant species, an impressive number for a "historic" park.

The Carl Sandburg Home has attracted qualified and dedicated volunteers for many of the park's needs. Volunteers have carried out almost all of the natural resource work, including the first vascular plant inventory in 1992. In fact, two volunteers collected more than half of the herbarium's original specimens. One retired scientist collected 281 specimens of mosses, lichens, and liverworts at the historic site from 1996 to 1998. Today, volunteers continue to enrich the herbarium and assist the park's museum curator in entering the specimen records into the Automated National Catalog System.

Vascular plant inventories with good field notes are invaluable in locating invasive plants. Invasive plants are a management concern because they are nonnative species that can overtake and disrupt native plant communities. Small parks with boundaries close to developed land like this historic site are especially vulnerable to invasions of exotic species. During summer 2001, a forestry technician identified 30 exotic species and prepared a three-year management plan for their removal and future control.

Native plants and habitats are also being destroyed by development. Because the Carl Sandburg Home lies in one of North Carolina's fastest-growing counties, it is a refuge for many native plants of special concern. For example, the historic site is home to the Appalachian fameflower *(Talinum teretifolium),* which is imperiled in North Carolina; the Biltmore carrionflower *(Smilax biltmoreana);* the Piedmont ragwort *(Packera millefolium)*, which is threatened in North Carolina; and the hybrid ragwort *(Packera x memmingeri),* a narrow endemic species known in only a few North Carolina mountain counties. Other species of special concern are roughish witchgrass *(Dichanthelium leucothrix)* and floating bladderwort *(Utricularia radiata),* which are disjunct species—coastal plants whose presence on mountain land is not clearly understood.

Small parks like Carl Sandburg Home National Historic Site are increasingly important repositories for biological diversity, becoming refuges for native plants threatened by exotic species and development. Inventories provide the scientific information needed to preserve the unique natural heritage of this small mountain park.

"... small parks are often sites of tremendous biodiversity."

Carl Sandburg Home NHS, Phil Smith

NPS photo by Tom Ferguson

(Top) Despite its relatively small size, Carl Sandburg Home National Historic Site in western North Carolina preserves remarkable biological diversity with at least 540 documented vascular plant species. An inventory in 2001 documented 120 new species in the 262-acre park.

(Bottom) Beak rush and broom sedge grow in thin soil on a rock outcrop at Carl Sandburg Home. NatureServe scientists and park volunteers identified 10 plant communities, including this one that is globally rare, in the 2001 inventory.

New report on air quality in California Class I national parks

By Annie Esperanza and Judy Rocchio

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Air Resources Specialist, Pacific West Region

"Class I national parks in California experience some of the best and worst air quality found in any park area in the country."

The landscape diversity of California includes remote, pristine views and large, rapidly developing urban areas such as the San Francisco Bay Area, the Los Angeles Basin, and the Central Valley. Its mostly Mediterranean climate helps make California one of the world's most productive agricultural areas. Its population is the highest of all the states, made up of millions of people who drive vehicles. All of these factors contribute to levels of air pollution that adversely affect human health and the natural resources found within airsheds of several California Class I national parks. Class I areas, as defined in the Clean Air Act, include national parks greater than 6,000 acres and national wilderness areas greater than 5,000 acres that were in existence before August 1977. Class I areas are given the most stringent protection under the act.

Class I national parks in California experience some of the best and worst air quality found in any park area in the country. Low levels of air pollutants are more common in coastal area parks, such as Redwood National Park and Point Reyes National Seashore, and parks far from urban areas, like Lava Beds National Monument. In the Sierra Nevada, cleaner air is evident to the north at Lassen Volcanic National Park but then degrades toward Yosemite, with the highest levels of air pollutants in the Sierra found south of Yosemite in Sequoia and Kings Canyon National Parks. Urban areas produce pollutants, which are then transported via air currents to downwind park areas, such as Sequoia and Kings Canyon National Parks, Joshua Tree National Park, and Pinnacles National Monument.

In April 2001, under contract to the Air Resources Division of the National Park Service, Tim Sullivan (E&S Environmental Chemistry, Inc.), Dave Peterson (USGS Biological Resources Division), and Charlie Blanchard (EnvAir) completed the "Assessment of Air Quality and Air Pollutant Impacts in Class I National Parks of California." This report summarizes current and potential air pollution conditions of nine Class I park areas in California, including Joshua Tree National Park, Lassen Volcanic National Park, Lava Beds National Monument, Pinnacles National Monument, Point Reyes National Seashore, Redwood National Park, Sequoia and Kings Canyon National Parks, and Yosemite National Park.

The report uses scientific information provided by research and monitoring of air quality effects in these nine parks to help park managers understand and address the effects of air pollutants on visibility and other components of natural ecosystems. Included in the investigations are terrestrial resource threats such as nitrogen and sulfur deposition and ozone exposure, aquatic resource threats like sulfur and nitrogen deposition, and visibility threats from particulates and aerosols.

This report supports the National Park Service's mandate to protect air quality–related values in Class I areas by providing the following critical information: (1) a summary of terrestrial and aquatic systems for each Class I area; (2) a review of monitoring data for key pollutants; (3) a review of literature on ecological effects of air pollution; (4) an assessment of additional information needed to protect resources from air pollution; and (5) a park-specific assessment of pollution vulnerability. Although the science of monitoring air pollution and assessing associated biological effects is still evolving, park managers can now refer to a single document for the most recent information regarding air pollution impacts on park resources. Copies of the report are available on the Web (www2.nature.nps.gov/ard/pubs/careview/).

This image of Yosemite National Park is a composite of two photographs recorded automatically at the visibility monitoring station in Yosemite Valley. Ninety-nine percent of the time, visibility in the valley is better than that depicted in the right half of the image ("bad" visibility, or less than 10 miles visual range); 1% of the time, visibility is better than that shown in the left half ("excellent" visibility, or greater than 125 miles). Half Dome is circled to show its location.

Assessing potential social consequences of deer management in Cuyahoga Valley

By Kevin L. Skerl

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Ecologist, Cuyahoga Valley National Park, Brecksville, Ohio

Growing white-tailed deer *(Odocoileus virginianus)* populations increasingly threaten vegetation and forest processes in eastern national parks. Park managers often consider lethal control of deer a viable management response; however, significant public controversy can arise over such proposals. Few issues highlight the need to integrate social science into natural resource management more than the proposed lethal control of overabundant wildlife in national parks. In 2001, park managers at Ohio's Cuyahoga Valley National Park gained a better understanding of public perceptions, attitudes, and possible social responses to deer management.

The lethal control of overabundant deer populations at Cuyahoga Valley National Park was first proposed in 1997 when resource managers drafted an environmental assessment and management plan outlining such an action. Amid much public controversy, a group of local and national animal-interest groups filed suit in federal district court to stop the action. The judge issued an injunction partly because of his opinion that the park had not adequately addressed the social consequences of the action. In response, the National Park Service withdrew the plan and continued monitoring and research efforts.

In light of the controversy, land managers were compelled to examine the local social environment with the same scientific rigor usually afforded to biological and ecological issues. In cooperation with the National Park Service, researchers at the University of Minnesota completed the analysis of a mail-back survey of 700 park residents and neighbors in 2001. This comprehensive study not only collected information on public preference for management techniques and emotional reactions to management decisions, but also measured how these decisions might affect park visitation and local attitudes toward the National Park Service.

Somewhat surprisingly, survey results revealed broad public support for lethal control of deer. Approximately two-thirds of respondents found lethal control acceptable, while only one in six felt that taking no action was acceptable. Additionally, the majority of respondents indicated that they would experience no negative emotional effects from lethal control. Respondents showed high general confidence in the Park Service, and 80% indicated that they would not change their use of the park or the opinion of park staff should lethal control be implemented.

However, 20% of respondents found lethal control unacceptable and would be very upset by such actions. A similar number indicated that such a program would keep them from visiting the park or participating in park activities. Though a statistical minority, this group represents the potential for significant controversy over the issue.

The survey also identified key issues and impediments for public outreach and education efforts. Most importantly, survey results revealed a significant disconnect between park management priorities and the reasons why the public would support lethal control of deer populations. Although concern for native impacts to vegetation and ecological processes may motivate the park to manage deer, most respondents supported deer management primarily to maintain a healthy herd, reduce deer-vehicle accidents, and curtail damage to private landscaping and gardens. Helping the public understand how deer overabundance can affect forest ecosystems is clearly a priority. Most respondents also indicated that the deer management issue is important to them personally and is related to their personal values. This high personal connection to the deer issue may indicate potential difficulties in changing public attitudes through education.

The park is now better equipped to assess social impacts, plan mitigation, and design education and outreach programs should lethal deer management be prescribed. Using social science techniques to collect site-specific data on controversial resource management issues characterizes the actual attitudes and needs of the entire local community, not just the most vocal citizens. Integrating such social science information into planning efforts is not only a mandate of the National Environmental Policy Act but is also an act of responsible public stewardship.

"The park is now better equipped to assess social impacts, plan mitigation, and design education and outreach programs should lethal management be prescribed."

Overabundance of white-tailed deer is pervasive in eastern U.S. national parks. In 2001 the National Park Service learned the results of a public survey investigating attitudes toward management of these ungulates.

"Flightlines": Developing partnerships for migratory bird conservation in the North Cascades

By Robert C. Kuntz II

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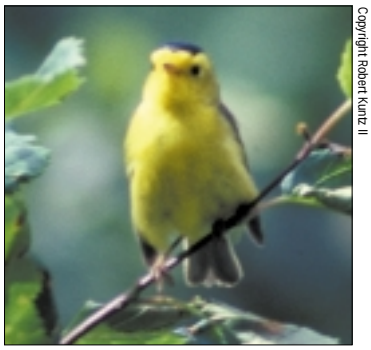
"Quantifying avian habitat relationships will help predict consequences of management decisions within and outside the park."



A Neotropical migrant, Wilson's warbler breeds in North America and winters in Latin America, necessitating coordinated conservation efforts addressed, in part, by the Flightlines program at North Cascades.

North Cascades National Park provides nesting habitat for approximately 70 species of migratory birds. The park Flightlines program seeks improved conservation of migratory birds through partnerships, information sharing, and higher-quality information about their populations in the park.

Reported declines of many migratory birds breeding in North America have stimulated interest in avian population trends and the mechanisms that drive them. Habitat loss or fragmentation, succession, increased nest predation and parasitism, and increased mortality during migration may play a role, and each crosses local, regional, and international boundaries. Developing partnerships with other natural resource management agencies, nongovernmental organizations, and the public is critical if park managers are to succeed in better understanding and protecting migratory birds. In 2001, North Cascades National Park Service complex—which includes North Cascades National Park and neighboring Ross Lake and Lake Chelan National Recreation Areas—initiated a multifaceted program called Flightlines. This conservation program is an effort to improve our knowledge and understanding of migratory bird populations in the North Cascades, develop partnerships to better manage this resource, and promote migratory bird conservation through information sharing.

As one of the National Park Service's 11 prototype national parks for long-term ecological monitoring, North Cascades has spent the last few years planning a monitoring program. In preparation for one element of the program, landbird monitoring, park biologists convened a panel of nationally recognized bird sampling experts to conduct a two-day workshop to help design a landbird monitoring program for the park. In 2001 the park complex took its first step toward implementing the panel's suggested monitoring strategy. Park biologists, the Institute for Bird Populations, and Western Washington University researchers initiated a two-year effort to determine bird-habitat relationships and to field-test and evaluate a sampling method and survey design for monitoring avian populations in areas with diverse habitats and limited access.

This project has several research and management implications for the North Cascades complex and lands beyond its boundaries. First, quantifying avian habitat relationships will help predict consequences of management decisions within and outside the park, including decisions about fire management, visitor use, snag removal, and forest harvest on non-NPS lands. Second, data on avian distributions and population densities will provide a baseline for future comparisons. Third, patterns and trends of concern identified for particular bird species will alert researchers to look for trends in species less conspicuous than birds but using similar resources. In this way, collecting data on many bird species can provide a screen for problems in other animal groups that otherwise would pass undetected.

Funding to develop the program required the help of multiple partners. Research proposals and grant applications were jointly developed by park staff, the Institute for Bird Populations, and Western Washington University. Funds from the NPS Inventory and Monitoring Program were supplemented by Seattle City Light's Wildlife Research Fund, the Northwest Forest Plan Fund, and Western Washington University's Graduate Program.

In 2001 the National Park Service, the American Bird Conservancy, the USDA Forest Service, and the Methow Conservancy were awarded a grant from the National Park Foundation and American Airlines to promote migratory bird conservation through information sharing. The grant will bring three biologists from Central America to north-central Washington in June 2002. The primary objective is to provide the visiting Latin Americans with a wide range of experiences and extensive information exchange relative to bird conservation that can be shared across international borders to further bird conservation efforts on both breeding and wintering grounds. These biologists will spend four weeks participating in bird conservation projects and programs in the park complex and on adjacent national forest and private lands. Project components include monitoring, management, restoration, education, and public outreach.

U.S. Geological Survey

A geologist with the USGS Karst and Geologic Mapping Project collects a water sample from a cave in Ozark National Scenic Riverways, Missouri. Park managers are concerned about lead mining in the area because of potential impacts on park water quality and quantity. In assessing this risk, studies are focusing on the hydrology of the area's extensive aquifer.

USGS science supports NPS in managing park resources

By John Dennis, Sharon Kliwinski, and Lindsay McClelland

The National Park Service and the U.S. Geological Survey extended their solid and productive partnership supporting the goals of "parks for science" and "science for parks." Park managers gained critical tools for improving their understanding, protection, and conservation of park resources through the wide-ranging and valuable scientific research and technical assistance contributions of the USGS. In 2001 the USGS assisted with implementation of the inventory and monitoring components of the Natural Resource Challenge. USGS scientists from a number of science centers, including the Patuxent Wildlife Research Center, helped to design park vital signs monitoring programs and provided substantial assistance with various other activities, including biological research, geologic and other inventories, and a joint effort to provide all parks with vegetation maps. Progress was also made through a multiyear partnership to improve the understanding of park water resources.

In 2001, within the biological discipline, USGS scientists stationed at parks, cooperative ecosystem studies units (CESUs), and USGS science centers drew on USGS, NPS, and cooperator funds to provide valuable research and technical support to national park units and to the NPS national office. For example, a USGS scientist stationed at Glacier National Park developed a methodology for monitoring the park's grizzly bear population that relied on DNA analysis of bear hair snagged on trees and other surfaces, eliminating the need to capture and mark individual bears. With Rocky Mountain Elk Foundation support, a CESU-based USGS scientist monitored elk restored to Great Smoky Mountains National Park, estimated the ultimate size of the restored elk population, and assessed its impacts on park vegetation. An Alaska Science Center scientist studied the mortality rate of Alagnak River rainbow trout resulting from the use of different types of hooks in catch-and-release recreational fishing. At Theodore Roosevelt National Park, a Northern Prairie Wildlife Research Center researcher assessed the impact of abundant exotic plant pollen on the ability of native insect pollinators to carry native plant pollen and successfully pollinate native plant species.

Nationally, the USGS Technology Applications Team at the Midcontinent Ecological Science Center developed the software for, and served, the Internet-based NPS Research Permit and Reporting System. This system offers scientists an automated, on-line mechanism for applying

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"Park managers gained critical tools for improving their understanding, protection, and conservation of park resources through the wide-ranging and valuable scientific research and technical assistance contributions of the USGS."

to parks for scientific research and collecting permits, and for preparing and submitting their required Investigator's Annual Reports (see page 6). Also, USGS scientists at the National Wildlife Health Center worked closely with NPS offices to address several animal disease issues.

Other partnership efforts between the National Park Service and the U.S. Geological Survey range from monitoring volcanoes to geologic mapping. For example, a memorandum of understanding between the National Park Service, U.S. Geological Survey, and University of Utah established the Yellowstone Volcano Observatory in May 2001 (see page 24). The observatory will provide for improved collaborative study and monitoring of active geologic processes and hazards of the Yellowstone National Park region. Communication with land managers and the public will be an important role for the observatory. The USGS Hawaiian Volcano Observatory worked with Hawaii Volcanoes National Park and Hawaii County to identify a safe, road-accessible site for the public to view lava that has flowed from Kilauea's east rift since 1983. The USGS National Landslide Hazard Program is working closely with Yosemite National Park staff to monitor recent rockfall and assess the effects of geologic hazards on park facilities, such as the continued closure of part of Camp Curry after rockfalls in 1999. In Shenandoah National Park, USGS landslide experts are sampling charcoal and pollen from prehistoric landslides to examine the relationship between slope processes and landslide recurrence intervals and climate change.

Mapping has been another productive area of cooperation. The USGS, in cooperation with the National Park Service and the University of New Hampshire, produced a high-resolution, multibeam, bathymetric map of Oregon's Crater Lake, the deepest lake in the United States. Geographic Information Systems analysis was used to study lake evolution and critical fish habitats, winning an ESRI, Inc., award for excellence.

Similarly, USGS geologic mapping of 12 quadrangles around Ozark National Scenic Riverways completed in 2001 is being used to develop a regional geologic framework. Hydrogeologists will use this information to assess the potential of proposed lead-mining activities to contaminate karst aquifers that feed the area's world-class springs. A new USGS 30x60-minute geologic map along the South Rim of the Grand Canyon provides critical structural information for analysis of geologic controls on groundwater movement and spring discharge. The USGS also produced geologic maps of Death Valley that are interpreted for the public on a USGS-NPS website.

Scientists from the USGS headquarters and Northern Rocky Mountains Science Center discuss the contributions of geology to soil development and the diversity of plant and animal communities in Hayden Valley, Yellowstone National Park. The 2001 field trip explored examples of "integrated science," specifically the geo-ecosystem of the greater Yellowstone area.

U.S. Geological Survey

The USGS Mapping Program continued delivering digital mapping products to the National Park Service in 2001. Landsat 7 satellite imagery became available for regional mapping and resource monitoring applications. Another related program, Global Fiducials, provided high-resolution imagery for seven units of the National Park System that are prototype inventory and monitoring parks. Although they focus on small sites, these map resources have adequate resolution for detecting changes in park resources over the long term. Other National Mapping Program products were imagery-derived data for application in Alaska and Hawaii, states where traditional aerial photography is not available.

Water is a major determinant of park resource condition, and understanding park waters, watersheds, and aquatic life is fundamental to the protection of those resources. Through a multiyear partnership, the USGS provides $2.1 million each year for water quality partnership projects with the National Park Service. These projects, conducted by USGS scientists, address the highest-priority water quality issues

identified by parks. To date, 76 partnership projects have been implemented in 56 park units. For example, the USGS is studying nitrogen cycling in forested streams and nutrient loading in estuaries at Acadia National Park. In Glen Canyon National Recreation Area, the U.S. Geological Survey is evaluating water quality impacts from visitation and recreational use within side canyons in Lake Powell.

In addition to its utility in managing water resources, good scientific information that can be used in legal and administrative proceedings is critical to the protection of water and water-related park resources. The USGS Midcontinent Ecological Science Center developed information describing the dependence of riparian vegetation on water all across the western United States, including Black Canyon of the Gunnison and Capitol Reef National Parks. The USGS Water Resources Division provided substantial help in developing a groundwater monitoring and management plan that protects Mojave National Preserve resources from nearby water development. The USGS Water Resources and Geologic Divisions are developing hydrologic, geologic, and geophysical information that describes surface and groundwater flow systems in and around Death Valley National Park, Lake Mead National Recreation Area, and Great Basin National Park.

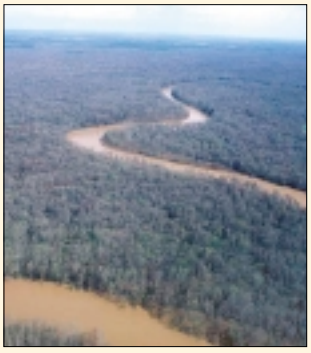
Both agencies receive benefits from their partnership efforts. Information from the various projects is used by the National Park Service to meet specific park management needs, including issues of regional and national scope. The USGS views the partnership as an integral part of its mission to provide high-quality science to partners and a successful means of directing their scientific expertise toward solving real-world problems. The partnership between the National Park Service and the USGS demonstrates how collaboration on biologic, geologic, and water resource studies in national parks benefits both parks and science.

U.S. Geological Survey

The USGS is instrumental in helping the public understand the geology of the national parks. For example, the USGS Flagstaff Field Center sponsors an annual field trip for elementary, middle, and high school science teachers to learn about the area's geology, and often includes units of the National Park System. Recent outings have focused on the Grand Canyon and Lake Mead (shown), Canyonlands, and Chiricahua.

Other Developments

USGS science helps protect Congaree Swamp

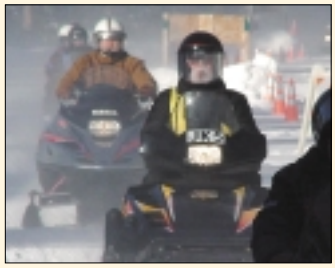


In 1999, a massive $1 billion development was proposed on 4,600 acres along the Congaree River near Columbia, South Carolina. To permit building on the site, the developer proposed to the Federal Emergency Management Agency (FEMA) a redesignation of floodplain zones. FEMA flood maps predict where the highest and fastest floodwater is expected to flow during a 100-year flood and generally do not allow development in a floodway. The National Park Service was concerned about the proposal because Congaree Swamp National Monument is located on the river about 30 miles downstream and hydrology is the most important factor integrating the natural, physical, and biological components of the monument. The National Park Service, along with the South Carolina Department of Natural Resources and others, was concerned that the proposed flood map was not based on credible, scientific information. The National Park Service asked the USGS to review the hydrologic and hydraulic modeling components of the flood map proposal for technical adequacy. The USGS review of these complex modeling efforts greatly contributed to scientifically defensible information required to manage the Congaree River floodplain.

In August 2001, after a long process, FEMA released its final flood maps for the Congaree River. The final map located about 70% of the development property in the floodway, where development is severely restricted. This put the fate of the development in the hands of local governments because they must approve any request to improve existing levees to prevent flooding of new development.

Effects of snowmobiles on wildlife

Snowmobiles are a popular and controversial means of winter transportation in many units of the National Park System. A concern is that increasing numbers of snowmobiles in the parks might be affecting wildlife, from large ungulates and carnivores to small mammals that burrow under the snow. Of particular interest are changes in animal behavior, mortality, susceptibility to disease, and population that might be related to snowmobile use. Experts disagree on the type and severity of this winter stress. In order to assess the state of scientific knowledge and the efficacy of snowmobile monitoring protocols to relate snowmobile use to changes in wildlife, the NPS Biological Resource Management Division and the Rocky Mountain Cooperative Ecosystem Studies Unit (RM-CESU) convened an expert workshop in April 2001. Biologists from the Universities of Montana and Idaho worked with an interagency steering committee to organize the three-day workshop. Participants included university scientists and experts from federal and state agencies, including the National Park Service, USDA Forest Service, Bureau of Land Management, and States of Alaska, Colorado, and Idaho. The experts determined where monitoring protocols currently exist and recommended research to develop additional protocols that will address the multitude of resource management questions. Few studies link wildlife stress responses directly to snowmobiles. This research area needs considerable attention before managers will have the necessary monitoring tools. Results of these discussions are included in a proceedings volume, available from Kathy Tonnessen (kat@forestry.umt.edu) of the RM-CESU.



MGM2: Economic analysis for park-community planning

What if park managers and local stakeholders could easily understand the dollars-and-cents impact of park visitors on the economy of nearby communities? The NPS Money Generation Model, version 2 (MGM2), developed by Daniel Stynes and Dennis Propst of Michigan State University, estimates the spending of visitors at the national parks and their contributions to gateway economies in sales, income, and jobs. The data help clarify roles that the community, local businesses, and national parks play in regional tourism, community development, and quality of life.

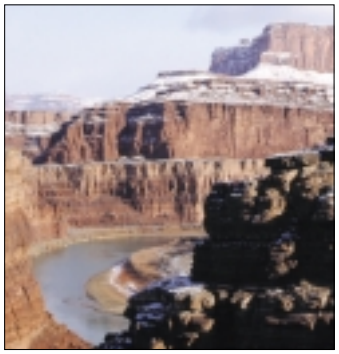
For example, MGM2 tracks spending patterns for different types of visitors—local visitors vs. tourists, campers vs. hotel guests, day visitors vs. overnight guests. Park managers and community partners can then explore economic impacts of alternative management, development, and marketing strategies (such as adding 10 rooms to a park lodge or undertaking a marketing strategy to increase day trips).

The model is available in short form and long form. In 2001, MGM2 provided selected analysis data for 34 parks and more complete economic analysis for 5 other parks. In 2002, analysis assistance will be available for 50 additional parks. Further information is available at www.prr.msu.edu/mgm2/.

Process emerges for park vital signs water quality monitoring

The advent of inventory and monitoring (I&M) networks presents many opportunities for improving natural resource management across the National Park System. For example, they offer an efficient new approach for integrating water quality monitoring into the park vital signs monitoring program the networks carry out. The overall objectives for the water quality component of vital signs monitoring are to improve the quality of impaired waters and to maintain the quality of pristine waters in the national parks. In 2001 the National Park Service began developing a network-based water quality monitoring program for the Northern Colorado Plateau I&M Network with funding from the Natural Resource Challenge and assistance from the NPS Water Resources Division (WRD).

From a national perspective, the Water Resources Division wanted to develop a planning approach that can serve all I&M networks. Therefore, WRD staff formulated a concept paper identifying existing park-specific information and water-related data sources and presenting a synthesis process using this information. The synthesis will identify those park water bodies where water quality monitoring is adequate and expose those that need to be monitored or that warrant modification to existing monitoring. The concept paper provides the foundation for design and implementation of a network-based monitoring program. The Water Resources Division will continue to evaluate and modify the concept for other networks as needed.



Award-winner profiles

Weber and Finley honored for science-based management efforts

Samantha E. Weber and Mike Finley were honored in 2001 with Director's Awards for their outstanding efforts to improve the management of park resources through the application of science. Weber was the recipient of the Trish Patterson–Student Conservation Association Award for Resource Management in a Small Park. At Cabrillo National Monument, California, she initiated the Division of Natural Resource Science and implemented a GIS program. Lacking professional and support staff for her new division, she developed a network of resource managers and scientists in and outside the National Park Service to assist the monument. She also worked closely with scientists who wished to do research in the monument to ensure that their projects meet the monument's information needs. Through her hard work and determination, Weber acquired and managed the scientific information necessary for the proper care of park natural and cultural resources. Like many of the winners, she felt that the award is more reflective of the dedicated people she works with. Upon receiving the award in October, she said, "It's a little like winning the Academy Award for Best Picture, when all you really did was bring a bunch of talented, dedicated people together to get things done."

Mike Finley, the immediate past superintendent of Yellowstone National Park, was the recipient of the Director's Award for Superintendent of the Year for Natural Resource Stewardship. Finley was recognized for his instrumental leadership in several complex and controversial areas of resource management, including the restoration of the gray wolf, management of bison, winter use in Yellowstone, and conservation of the Yellowstone cutthroat trout. He has championed the protection of park resources, showing strong support for scientific research and professional resource management. He has recognized the importance of good information in decision making, insisting that management decisions be based on science.

Ungulate management

Tule elk at Point Reyes

Since 2000, staff of Point Reyes National Seashore, California, have administered contraceptives to more than 40 tule elk in the Tomales Point elk reserve in the national seashore. Initially developed as a research project by endocrinologists at the University of California, Davis, contraception was explored by managers at the national seashore because of growing concern that an expanding elk population would negatively impact vegetation and rare plant and butterfly populations in the fenced 2,600-acre range. The vaccine, porcine Zona Pellucida (pZP), is effective in preventing pregnancy in over 70% of inoculated animals for one year. Boosters, delivered by dart with a dart rifle, must be administered yearly before the onset of mating season. Treated animals, identifiable by radio-transmitter collars, are stalked by the darter on foot, who uses a horse and rider as a screen to approach within 130 feet of the elk. Far from being the easy procedure portrayed by the media, remote contraceptive inoculation is an arduous, time-intensive process for the darter and can occasionally cause injury to elk. The fall 2001 elk census indicated a population of more than 400 animals with 13 calves prevented last year. The results of a year-round elk monitoring program will allow managers to determine whether immuno-contraception of tule elk at Point Reyes National Seashore is indeed the most practical and effective method to control the size of this free-ranging ungulate population.

In addition to managing elk in the reserve, park staff monitor the progress of a free-ranging herd of tule elk in the national seashore. The release of 28 elk in June 1999—the first free-ranging elk at Point Reyes National Seashore in 130 years—marked the restoration of a dominant herbivore to the coastal ecosystem. Founders of this new herd were relocated from the Tomales Point elk reserve, quarantined before their release, and rigorously tested for Johne's disease, a chronic and fatal disease of livestock. Two years after their release, the population hovers at 25 animals, with six calves born in 2001. Seashore managers will continue to monitor the new herd for disease and population growth over the next few years. The release has enjoyed widespread support from the visiting public and local community alike.

Technology in monitoring

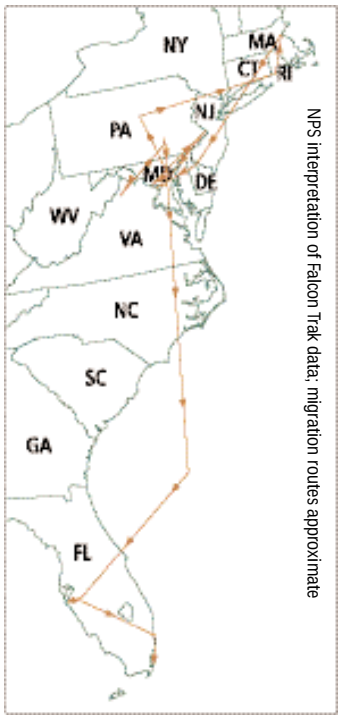
Knowing where the falcons go

Courtesy of Dominion

Listed as federally endangered in 1970, the American peregrine falcon has been reintroduced to the eastern United States over the last three decades. Although the species was delisted in 1999, scientists are monitoring the population for five years to determine whether the species is reproducing in sufficient numbers to ensure their survival. Knowing where the reintroduced peregrines are migrating or dispersing, where they are exposed to contaminants, and how long they stay in various areas would enable researchers to do more to improve their survival rate. Fortunately, innovative, solar-powered technology for transmitting signals to satellites has recently become available. Just as important, concerned representatives from the public and private sectors have funded a three-year study dedicated to using this technology to map the flight of the falcons in a project called FalconTrak.

The project was initiated by the Center for Conservation Biology at the College of William and Mary in late 2000. The center worked with the Virginia Department of Game and Inland Fisheries, Dominion (a power company headquartered in Richmond, Virginia), and Shenandoah National Park to plan and fund the tracking of 8 peregrines in Virginia. In 2001, six additional partners, including another national park unit, dedicated enough funds to track 18 birds. Of this total, Harpers Ferry National Historical Park sponsored 2 birds and Shenandoah sponsored 1. Dominion was the largest contributor, sponsoring 9 birds.

This sophisticated attempt to help the falcons begins with locating nests built in a high-risk location (e.g., on a bridge across water) and moving them to a special rooftop or mountaintop nest (hack box) until the young are ready to fledge. Before their first flight, the young birds are fitted with lightweight vests that contain solar-powered transmitters. The signals from the transmitters are received by satellites and transformed into data that reveal the location of the "fitted" falcons. Information about the falcon's flight paths is updated every three days on the Internet (www.dom.com). The well-planned use of advanced technology is clearly focusing the interest of the public, as well as representatives of government, business, and education, on efforts to restore the peregrine falcon to its original habitat.



NPS interpretation of Falcon Trak data; migration routes approximate

National Parks as Laboratories

"Parks are places to demonstrate the principles of biology, … to engage formal and informal learners throughout their lifetime, … in exciting and motivating settings."

—National Park System Advisory Board

Rock Creek Park. Bill Yeaman

The National Park Service made great strides in 2001 to ensure that the nation's parks fulfill their role as unmatched living laboratories. National parks are increasingly recognized for their ability to provide scientists with the opportunity to study natural processes and systems that are relatively undisturbed by human activity. Our parks are shedding light on a wide range of scientific questions, from volcanic activity to the ecological role of fire to the discovery of unknown species. In addition to facilitating scientific discovery that benefits society, the Park Service expanded its efforts in 2001 to enlist the skills and talents of research partners able to develop the scientific information needed to improve management decisions. The articles in this chapter underscore the value of national parks as places of discovery, collectively telling the story of the nation's natural and cultural history.

Urban refuge for rare amphipods in the National Capital Region

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Rock Creek Park is not only an oasis for visitors within the concrete and asphalt sprawl of the nation's capital but it is also a refuge for freshwater crustaceans called amphipods (in the genus *Stygobromus*). Given its urban location, it was surprising to discover in 2001 that Rock Creek Park, a natural area of 1,754 acres (701.6 hectares), has one of the most diverse *Stygobromus* assemblages in perched, small-basin habitats anywhere in the United States. Two species in the park are federally endangered and rare: Hay's Spring *(Stygobromus hayi)* and Kenk's amphipods *(S. kenki)*, respectively. Hay's Spring amphipod is known from five sites and Kenk's amphipod from four sites, all within the District of Columbia. Rock Creek Park, established in 1890 as the third national park, protects many miles of Rock Creek tributaries within the D.C. area. However, outside of park boundaries, large portions of the tributaries in the Rock Creek watershed have been converted to covered sewers or filled in with rocks and soil. Discoveries made in 2001 about the unique *Stygobromus* fauna in Rock Creek Park emphasize both the importance of urban parks as significant biological refuges and the value of parks as natural laboratories.

American University scientist Dr. David Culver is completing an amphipod species inventory at multiple springs in Rock Creek Park. He used chemical and physical analyses of the water and sediment to describe the spring and seep sites where amphipods live and to investigate current threats to their habitats. Dr. Culver will provide management and protection recommendations to the National Park Service based on the results of his study.

Typically, exclusively subterranean aquatic species such as *Stygobromus* occur in caves or permanent groundwater habitats where shallow fissures or cavities are isolated in the bedrock and have low levels of organic matter. However, Dr. Culver found that three of the *Stygobromus* species in the Rock Creek valley live in habitat that is shallow, subsurface, high in organic matter, and possibly seasonally dry. That *Stygobromus* could be found in these conditions was not suspected before this year's work in the park. The habitat is called hypotelminorheic and is created when groundwater seeps to the surface from underlying bedrock to flow up through sediments and vegetative litter. In Rock Creek Park, thick layers of clay lie beneath these seeps, stopping the water and creating perched pockets of subterranean habitat for the *Stygobromus*.

Ascertaining the security of the amphipod populations and mitigating any identified threats is important. Correlations between habitat characteristics and presence or absence of amphipods may help explain species distributions in the park. Preliminary results from the chemical analyses of sediment at three of the spring sites revealed elevated levels of some heavy metals. One seep where Kenk's amphipods occur had significantly lower levels of selenium compared to a seep where the amphipods do not occur. Further analyses of the data are ongoing. Currently, the extent of the aquifers that feed the springs and seeps is unknown and a hydrogeologic study is needed to fully understand protection at the watershed level. Beyond the park's borders, the Maryland Department of Natural Resources is currently searching for Kenk's amphipod within that state. Partnerships with other agencies and universities are essential to fully describe the distribution and habitat of these rare subterranean amphipods.

Exploring the conservation capacity of small parks has proven important for enhancing the scientific understanding of species like amphipods. In turn, science makes it increasingly clear that small natural areas like Rock Creek Park are ecological remnants that protect a range of habitats and species that may no longer exist in the surrounding urban environment.

"Discoveries made in 2001 about the unique Stygobromus *fauna in Rock Creek Park emphasize both the importance of urban parks as significant biological refuges and the value of parks as natural laboratories."*

American University, Irena Sereg

Searching for rare crustaceans called amphipods (opposite page), scientists with American University pour springwater through a fine mesh. The survey, conducted in 2001, revealed a big surprise: Rock Creek Park in Washington, D.C., hosts a diverse group of the tiny animals, including Kenk's amphipod, left. Information from the survey will also help the National Park Service protect the unusual park habitat.

Monitoring volcanic and earthquake unrest in Yellowstone

By Tom Olliff

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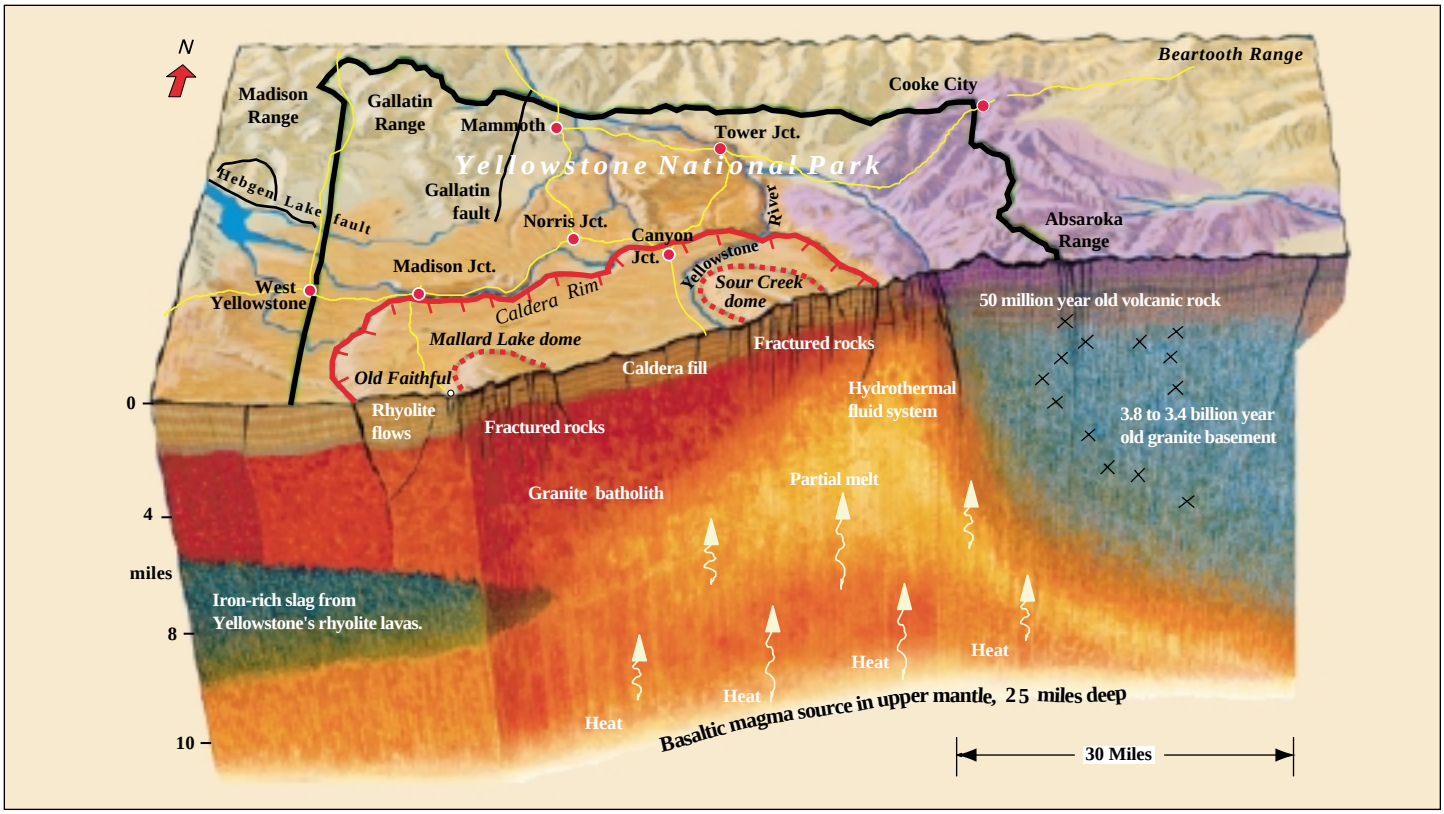
The spectacular geysers, boiling hot springs, and mud pots that have made Yellowstone National Park famous owe their existence to volcanic activity that has affected the region during the past 2 million years. Cataclysmic explosive eruptions 2.0, 1.3, and 0.6 million years ago ejected huge volumes of molten rock and formed large, overlapping, elliptical depressions called calderas. This energy also created the mountains and canyons, and generates the unique ecosystems that support Yellowstone's diverse wildlife today. With a little help from interpreters, park visitors do not have to look very hard to understand that Yellowstone and the surrounding area encompass the largest active magmatic system in North America.

To strengthen the long-term monitoring of volcanic and earthquake unrest in the Yellowstone National Park region, the USGS, Yellowstone National Park, and the University of Utah agreed in 2001 to establish the Yellowstone Volcano Observatory. The new partnership will improve collaborative study and monitoring of active geologic processes and hazards of the Yellowstone volcanic field and its caldera, site of the largest and most diverse collection of natural thermal features in the world. It will also facilitate better interpretation of geologic events because park staff can access real-time data on-line.

"The new observatory will improve our efforts to monitor Yellowstone's extraordinarily large and long-lived volcanic system," said Dr. Robert L. Christiansen, USGS scientist-in-charge of the new observatory. "This agreement is a natural evolution of our collective work over the years to track and study Yellowstone's unrest."

The new observatory is modeled after the other USGS volcano observatories in Alaska, California, the Pacific Northwest, and Hawaii. Together, they monitor 43 of the 70 or so potentially hazardous volcanoes in the United States. The observatories are operated under the auspices of the USGS Volcano Hazards Program. Operations for the Yellowstone Volcano



A cross section of the earth beneath Yellowstone reveals molten rock under a large caldera at depths of about 3–5 miles. Heat emitted by the magma powers Yellowstone's famous geysers and hot springs.

Fumaroles, or steam vents, scattered across the slope of Roaring Mountain give testimony to Yellowstone's volcanic past and serve as a constant reminder of the heat that lies just beneath the park's surface.

"Yellowstone and the surrounding area encompass the largest active magmatic system in North America."

Observatory will be based at existing facilities at the University of Utah and Yellowstone National Park. Ground-based instruments and satellite data are used for real-time monitoring of active and restless volcanoes, including a modern digital seismic and global positioning system (GPS) network, operated for many years by the University of Utah Seismograph Stations under a cooperative funding agreement with the USGS and with additional support from the National Park Service. The partners also monitor ground deformation using portable leveling stations and a continuously recording GPS network.

"The extensive thermal features of Yellowstone are fueled by heat from magma beneath the caldera that in turn is fed from a magma reservoir in the Earth's deep interior called a hotspot, a significant feature in plate tectonics," said Dr. Robert B. Smith, University of Utah coordinating scientist of the observatory. "In the past we've measured the rise of the ground by as much as 3 feet and fall by a foot across the youngest caldera. This active deformation was accompanied by thousands of small earthquakes, marking the park as a living geologic system."

The Yellowstone region also is seismically active today. The 1959 magnitude-7.5 Hebgen Lake earthquake, centered just outside the park's northwestern boundary, was the largest earthquake in the western interior in U.S. history and caused 28 fatalities. Hydrothermal eruptions are also a concern. Since deglaciation almost 14,000 years ago, scientists estimate that 6 to 10 large hydrothermal eruptions have occurred in Yellowstone, blowing tons of debris into the air and forming such modern-day features as Indian Pond and Turbid Lake.

Christiansen emphasizes: "There is no increased threat of eruptive activity at Yellowstone to cause concern at this time. We hope to use the observatory to share even more of what we are learning with the public … and to be in a better position to provide warning of any future hazardous activity." Additional information about the Yellowstone Volcano Observatory is available on the Web (http://volcanoes.usgs.gov/yvo).

Finding our hidden biodiversity

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By Becky Nichols and Keith Langdon

The fourth year of the All Taxa Biodiversity Inventory (ATBI) in Great Smoky Mountains National Park was very successful. Accomplishments include scientific and educational advancements, facility expansion, and increased volunteer involvement, all being realized under the park's partnership with Discover Life in America, the nonprofit organization leading the project.

From a scientific viewpoint, a tremendous amount of information is being collected regarding species' ranges, habitats, and relationships. An amazing number of new species has been found in just four years since the project began. At the end of 2001, the tally of newly discovered, undescribed species was 228, and the number of new records for the park was 1,613. The majority of new discoveries are arthropods, although other groups are also represented, such as algae, fungi, slime molds, and worms. Some of the more notable finds in 2001 are a new species of leaf litter flea beetle, a group previously unknown in North America, and a new species of moth that represents a new North American record for its genus and tribe (one taxonomic level above genus); one of the many new species of *Collembola* (springtails) discovered represents not only an undescribed species but also an undescribed genus.

The Biological Resources Division of the U.S. Geological Survey has funded a study to determine the specifics of conducting an ATBI using passive invertebrate collecting devices in a plot system. Information about seasonal occurrence, relative abundance, and species distribution and diversity is being gathered. This information will help determine the most efficient and lowest-impact sampling methods. The study is also leading to the development of protocols that can be used for the remainder of the ATBI in the Smokies and in many other parks and reserves. (Point Reyes National Seashore began planning in 2001 for a marine species ATBI.)

One method for collecting data and creating enthusiasm for the project is the "bio-blitz." This series of events brings together amateur and professional biologists to document park species in a short time period, and has been held in the past for butterflies and moths, algae, and flies. In 2001, several world-class coleopterists were here to participate in a beetle bio-blitz, resulting in many new records for the park. Also, as part of this event, a large number of Upward Bound high school students (minority and disadvantaged science and math students) collected species, learned basic identification skills, and interacted with the scientists. Volunteer Training Days were also held, involving orientation and skills training for anyone interested in participating in ATBI activities. Sorting, collecting, distribution mapping, photography, scientist hosting, and Web page development are all skills and services in need of public involvement in the ATBI.

In addition to scientific advancements, 2001 was a good year for many other aspects of the ATBI. The Purchase Knob Science Learning Center was further developed to facilitate science-education programs for the Appalachian Highlands Inventory and Monitoring Network. The facility is now open to accommodate ATBI scientists and others. The annual ATBI conference was held in November in Gatlinburg, and approximately 150 scientists attended. Since 1999, Discover Life in America has distributed $150,000 in grants to researchers, and to help increase this level of funding, it hired a full-time fund-raiser in 2001. With this type of staff expertise, Discover Life in America will be better able to seek the levels of funding necessary to build on the work completed so far.

Both: University of Tennessee, Dr. Ernie Bernard

In 2001 scientists continued their discovery and documentation of species not only new to Great Smoky Mountains National Park but also new to science. The two insects shown here (genus *Hypogastrura*, top, and *Agrenia*, bottom) are among the 228 species that have never been described before the comprehensive survey of all life occurring in the national park.

Kemp Davis Jr.

(Right) The All Taxa Biodiversity Inventory of Great Smoky Mountains National Park relies on the energy and dedication of hundreds of scientists and volunteers. The group gathered in November 2001 for the annual ATBI conference, held in the park, to review their progress.

Rest from grazing at Chaco

By James M. Ramakka

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The scenic canyons of northwestern New Mexico hold prehistoric ruins from the Chaco Culture. In 1907 those ruins came under the protection of the National Park Service at Chaco Canyon National Monument. The Park Service began fencing monument boundaries in 1933 to protect the resource from erosion and damage by domestic livestock. By 1948, approximately 21,000 acres were enclosed by fences. In 1980 the National Park Service acquired an additional 12,000 acres and Chaco Canyon National Monument became known as Chaco Culture National Historical Park. As funds became available, these lands were also fenced. Thus, the park now contains plant communities that have been protected from livestock grazing for both long and relatively short periods of time. These protected parcels make Chaco Culture National Historical Park one of the largest living laboratories on the Colorado Plateau.

The impact of livestock grazing on rangelands has long been a controversial topic. Antigrazing proponents state that livestock cause long-term damage to plant communities and soils and adversely affect biodiversity. Grazing advocates believe that livestock are a substitute for native grazers, such as bison, that are no longer present and therefore, grazing is essential to maintain rangeland health. Often, both sides rely on anecdotal evidence to support their arguments, and at least one grazing consultant has stated, without data, that the protected area of Chaco is a classic example of the detrimental effects of prolonged rest from grazing. The contrast in ground cover between the park and surrounding multiple-use lands shows clearly in aerial photographs and satellite imagery. However, other than one study in the mid-1980s, which examined the effects of grazing on soil and vegetation, the park had no quantitative data to evaluate the contention that rest from grazing was causing a decline in health of plant communities and biodiversity within the park.

In 1998 the park partnered with the Environmental Studies Program of Prescott College, Arizona, to study the effects of historic livestock grazing on vegetation. The study examined differences in plant species richness, capacity for nutrient cycling, and vegetation structure and composition between three grazing treatments: long-term protection (50-plus years), recent protection (5 years or less), and currently grazed. The park accepted the final report of the researchers in early 2001.

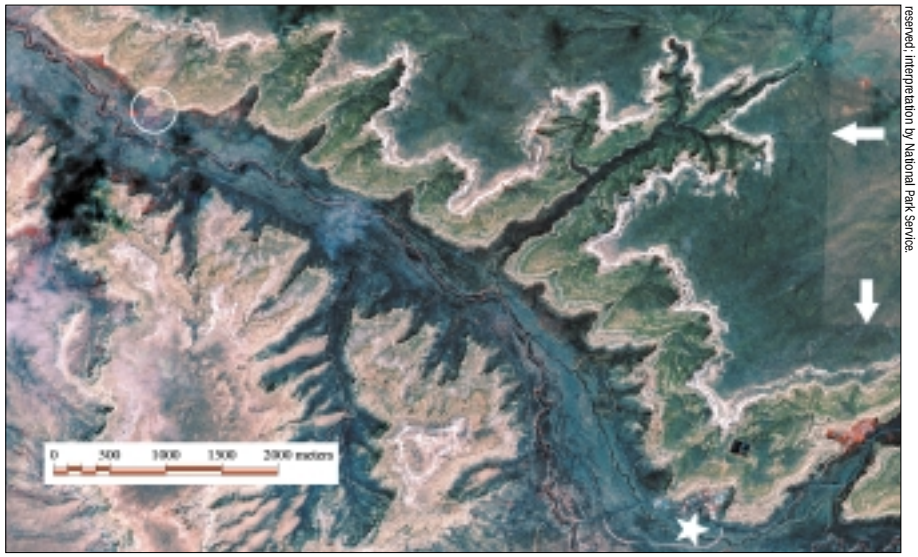
The results of the study contradict the assertion that long-term protection from grazing has been detrimental to park plant communities. Researchers found significantly greater plant species richness in areas protected from grazing. Although shrub cover and grass cover were also greater in the majority of protected areas, there was enough variation between sample sites to indicate that physical characteristics, such as soil type and water infiltration capacity, can affect the trajectory of plant succession after the removal of grazing.

In addition to the park making land management agencies aware of this study, the researchers will publish their results in a peer-reviewed journal. Prescott College began a new study in 2001 that will analyze historic changes in riparian plant communities using the 12-mile Chaco Wash as their study site.

Conservation biologists advocate the establishment of large reserves to conserve community and species diversity, while land management agencies occasionally cite the lack of control areas as one problem affecting their analysis of long-term planning efforts. To help address these issues, park personnel are conducting outreach efforts with other agencies and universities to make them aware of the potential use of the park as an ecological reference site for regional biodiversity assessments and planning efforts.

"The results of the study contradict the assertion that long-term protection from grazing has been detrimental to park plant communities."

Little Bluestem *(Schizachyrium scoparium)* is one of several plant species rarely seen on grazed lands adjacent to Chaco Culture Park. A recent study looked at the relationship of park plants to protection from grazing.



Visible from Earth's orbit, the boundary of Chaco Culture National Historical Park (arrows) reveals a distinct difference in vegetation growing inside and outside the park. The park harbors plant communities that are protected from livestock grazing by fencing on the park perimeter. The star shows the location of park facilities, while the circle indicates the nearly semicircular ruin of Pueblo Bonito.

Lessons from the 1988 Yellowstone fires

By Tami Blackford and Mary Ann Franke

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In summer 1988 a combination of conditions never before seen in Yellowstone National Park led to the burning of nearly 800,000 acres. Many dire predictions were made about the park's future—wildlife would be reduced, forests would have to be replanted, increased erosion would cause downstream flooding, visitation would decline—none of which turned out to be true.

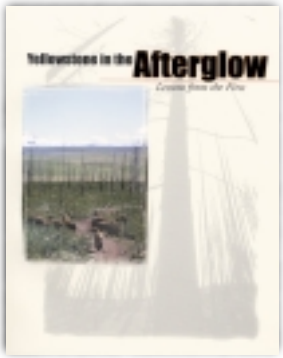
The fires created unparalleled opportunities for scientific research. Most of the previous research on fire impacts in wildland areas had been done in relatively small areas and after the fires were out. After the 1988 fires, the Greater Yellowstone Coordinating Committee (GYCC), representing Yellowstone and Grand Teton National Parks and six national forests, assembled 15 interagency teams to collect data and make initial assessments on topics ranging from air quality to recreational use. The GYCC selected a panel of scientists to prepare an independent evaluation of "the apparent ecological impacts and implications of the 1988 fires as they related to the area's watersheds, fisheries, wildlife, forests, soils, ranges, and biological diversity" and to develop a list of postfire research needs. The National Park Service provided more than $6 million to support 32 projects involving scientists from 70 institutions; some of this funding came from a special congressional appropriation for a postfire research program and the remainder was diverted from other programs at Yellowstone and other national parks.

More than a decade after the fires, Yellowstone Center for Resources staff compiled the results of the more than 250 research projects initiated in the greater Yellowstone area since 1988. Distributed in 2001, the 118-page report, *Yellowstone in the Afterglow: Lessons from the Fires*, summarizes the research findings of dozens of academic and government scientists in a broad range of disciplines. The research largely documents the resilience of the Yellowstone ecosystem in response to large fires.

Prefire records compiled by government agencies and academic researchers made it possible to answer many questions about how the 1988 fires affected various components of the ecosystem. In 1988, fire-behavior experts and managers had underestimated the influence of the weather—a threshold exists between a very dry year and an extraordinarily dry year—and overestimated the effect that multiage forest stands would have in limiting the spread of fire. But for the most part, the fires did not affect the abundance, distribution, or diversity of the park's plant and animal communities. A few exceptions stand out. Research suggests that the moose population on Yellowstone's northern range has declined in part because of the loss of old-growth forests due to the fires, and aspen seedlings are growing in burned areas where they had not previously grown. Thousands of acres of forest have been replaced with millions of lodgepole pine. The fires also increased public understanding and acceptance of the role of fire in wildland areas.

This information will assist land managers as they begin to look for signs of ecological change on millions of acres of western forest and grassland hit by the record-breaking fire season of 2000. Once again, drought conditions meant that some fires remained out of control for weeks despite the best efforts of firefighters using the best that modern technology has to offer. While large fires are incompatible with the human communities that now cover much of the United States, research has shown that they are not only consistent with the mission of Yellowstone National Park but are also essential for Yellowstone to continue to be Yellowstone.

Copies of *Yellowstone in the Afterglow* can be obtained through the park website at http://www.nps.gov/yell/publications/pdfs/fire/afterglow.htm or by writing the Yellowstone Center for Resources, Publications, P.O. Box 168, Yellowstone National Park, WY 82190.



Now in its second printing, *Yellowstone in the Afterglow* has proven to be a popular and valuable resource for researchers, managers, interpreters, resource educators, and anyone interested in learning more about the events of 1988 and the research efforts that have taken place during the postfire recovery period.

This aerial view near the Madison River shows how the fires, driven by strong and shifting winds, skipped across the landscape, creating a mosaic pattern of burns, and with it, new forest edges.

Other Developments

Parks for science

The National Park System offers unique laboratories for scientific research. Three innovative NPS programs support outstanding scholars—graduate students, postdoctoral researchers, and university faculty—to conduct scientific research in units of the National Park System, often on issues critical to natural and cultural resource management.

Since 1997 the Canon National Parks Science Scholars Program has provided dissertation scholarships for research in the biological, physical, social, and cultural sciences. Program partners are the National Park Service, Canon U.S.A., Inc., and the American Association for the Advancement of Science. In 2001 three Canon Scholars graduated with Ph.D.s and eight new scholars initiated their research, bringing the total number of Canon Scholars to 29.

The National Parks Ecological Research Fellowship Program offers postdoctoral fellowships for basic ecological research on the flora of national parks. Funded through the Andrew W. Mellon Foundation, program partners are the National Park Service, the National Park Foundation, and the Ecological Society of America. In 2001 three Fellows began their research in national parks.

The Sabbatical in the Parks Program arranges faculty sabbaticals for scholarly activity that provides usable knowledge for NPS managers or advances science and human understanding. In 2001 the program launched its website (www.nature.nps.gov/sabbaticals) to assist in matching faculty interests and park needs. The first sabbaticals were arranged in Yosemite, Glacier, and Theodore Roosevelt National Parks. Additional information on these programs is available from Dr. Gary Machlis, visiting chief social scientist, National Park Service (208-885-7129 or gary_machlis@nps.gov).

John Burcham, courtesy of Mac Gillivray Freeman Films

Journey into Amazing Caves premieres

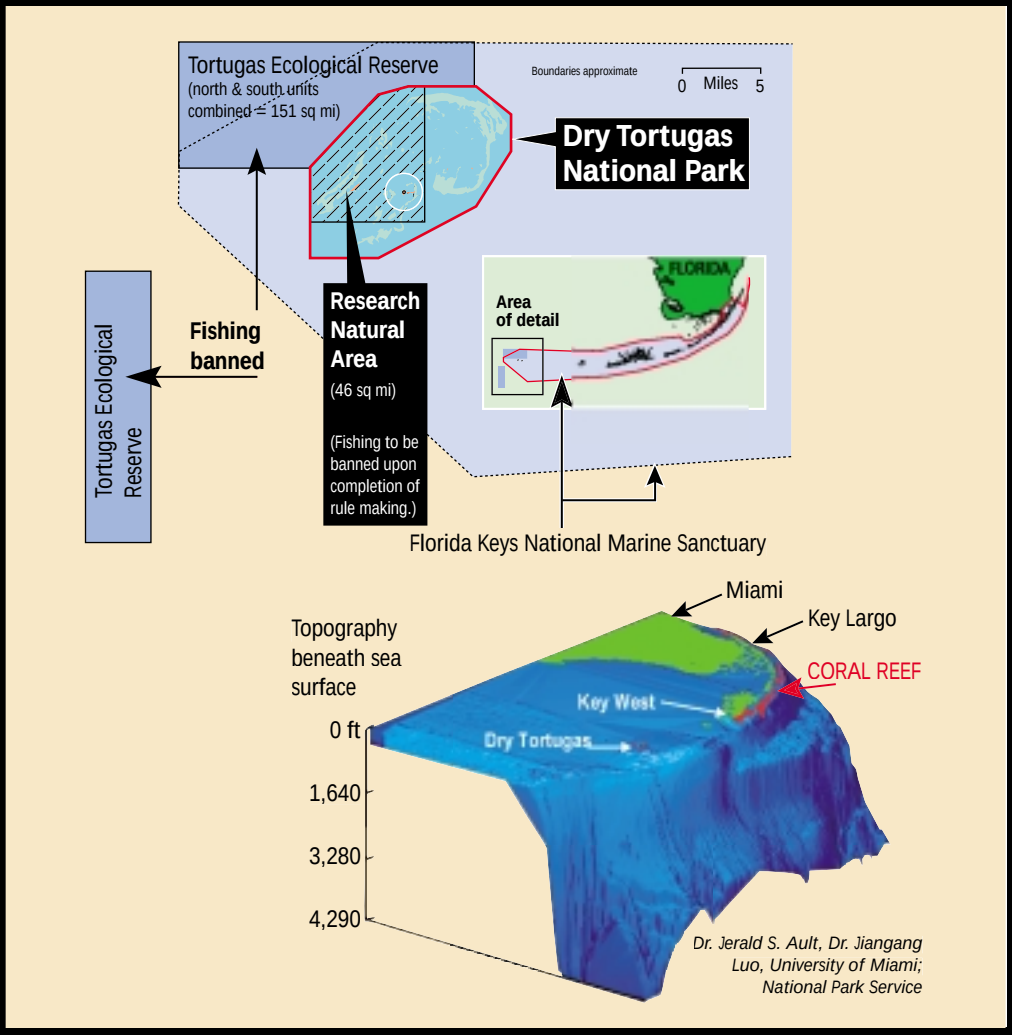
Caves: Exploring Hidden Realms, a new book by Michael Ray Taylor, was written in conjunction with the release of a new IMAX film, *Journey into Amazing Caves*. The book and film follow two experienced cavers, Hazel Barton and Nancy Aulenbach, as they explore caves in Iceland, Mexico, and Grand Canyon. The National Park Service has been involved with the production of the film and book since their inception. Author Michael Taylor has caved extensively in Lechuguilla Cave in Carlsbad Caverns National Park, and in his book *Dark Life* writes about the advances science has made in understanding extremophiles—lifeforms living under extreme conditions—found in various units of the National Park System from the hot springs of Yellowstone National Park to the wall coatings of Lechuguilla Cave. Dr. Hazel Barton has been very active in the survey and exploration of Wind Cave in Wind Cave National Park. She is also a microbiologist, and her work with microorganisms is featured in the IMAX film.

The book and film rely heavily on the scientific aspects of speleology. The foreword for Taylor's book—published by the National Geographic Society—was written by NPS Cave Specialist Ron Kerbo, who also presented a series of talks for the premiere of the IMAX film on March 8 and 9, 2001, at the Duluth, Minnesota, Omnimax Theater. The audiences for the Duluth premiere ranged from newspaper writers and staffs attending a special preview to groups of more than 400 schoolchildren on an "Educational Day." The final talk was for television and radio reporters. Kerbo was interviewed for television about the film and book. He, Dr. Michael Soukup (NPS Associate Director for Natural Resource Stewardship and Science), and Lindsay McClelland (geologist with the NPS Geologic Resources Division) also attended the Washington, D.C., premiere of the film at the Smithsonian's National Museum of Natural History.

Marine and Coastal Resource Protection

"Networks of no-take marine reserves–areas where extractive use is prohibited–are one of our only tools for ensuring that future generations will be able to continue to enjoy sustainable use of marine resources."

—National Park System Advisory Board



Many Americans do not realize that the National Park Service manages 7,300 miles of the nation's shorelines, encompassing a tremendous diversity of coastal ecosystems and cultural resources. When the United Nations declared 1998 the international "Year of the Ocean," attention was focused on global preservation of marine resources. The following year, the National Park Service was called to action to undertake a leadership role on this issue. Proudly, in 2001 the Park Service significantly advanced marine protection efforts through a number of initiatives. This chapter examines these efforts, including the precedent-setting creation of a research natural area in Dry Tortugas National Park, an important model for improved conservation of marine ecosystems. The articles focus on efforts to improve the scientific understanding of marine and coastal resources, which is ultimately the key to the sustainable future of our coastal and island-based national parks

Cover article

A new era for marine resource protection at Dry Tortugas and the Florida Keys

By Brien Culhane, AICP

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The largest fully protected marine reserve in the United States became a reality in July 2001 with the completion of the new general management plan for Dry Tortugas National Park, Florida. This plan establishes a 46-square-mile research natural area where extractive activities, including fishing, will be prohibited. Fifty-four square miles of the park will remain open to recreational fishing. The research natural area complements the adjacent 151-square-mile Tortugas Ecological Reserve in the waters of the Florida Keys National Marine Sanctuary, established in April 2001. The success of the park and sanctuary planning efforts resulted from extensive stakeholder participation, strong public support, interagency cooperation, advances in national policy for marine protected areas, and, most importantly, the use of the best available science.

Located 70 miles west of Key West, Dry Tortugas National Park encompasses seven small islands and 100 square miles of the Gulf of Mexico. The park's enabling legislation explicitly directs that fish and wildlife are to be protected and the ecosystem is to remain intact and unimpaired. In 1990, much of the surrounding waters gained protection with the establishment of the Florida Keys National Marine Sanctuary, managed jointly by the National Oceanographic and Atmospheric Administration (NOAA) and the State of Florida. In addition to its clear waters, lush coral reefs, and stunning array of marine and bird life, the Dry Tortugas region plays a critical role in the dynamics of the larger Florida Keys coral reef ecosystem. Larvae spawned in this region are dispersed by currents throughout the Keys and up the southeastern coast, helping to replenish depleted fisheries in Florida and beyond.

Although the park is isolated, its visitation quadrupled from 23,000 in 1994 to more than 95,000 in 2000. The rapid increase in popularity resulted in crowding, noise, strained facilities and a decline in the quality of the visitor experience. Coral reefs and water quality also began to show the effects of concentrated use. During this period, scientists from the University of Miami; NOAA's Florida Keys National Marine Sanctuary, National Undersea Research Center, and National Marine Fisheries Service; and the Florida Fish and Wildlife Conservation Commission documented impacts from recreational and commercial fishing in the Tortugas region. Reef fish populations were significantly depleted, threatening the integrity and natural dynamics of the ecosystem. Increases in the size and number of vessels on the water and improvements in navigation and fishing gear contributed to these trends. To ensure that resources and quality visitor experiences are protected, park management initiated the general management planning process in 1998. At the same time, the Florida Keys National Marine Sanctuary was initiating a plan to establish the Tortugas Ecological Reserve, also a no-take area, adjacent to the park. Although the National Park Service and NOAA have different missions, they share common goals for Tortugas ecosystem health. By coordinating science, planning, and public involvement, and through collaboration with state agencies, park and sanctuary managers sought to minimize public confusion and maximize participation in the planning process.

On a global scale, 1998 was declared the "Year of the Ocean" by the United Nations, drawing attention to the worldwide collapse of fisheries and the associated socioeconomic impacts. In June of that year, President Clinton issued Executive Order 13089, calling for greater understanding of coral reefs through mapping, inventories, and research. This action also mandated greater reef protection, anticipating the possible closure of some reefs to commercial and recreational fishing. A March 2000 report of the U.S. Coral Reef Task Force, created by this executive order, called for the protection of at least 20% of all U.S. coral reefs and their associated habitats in no-take ecological reserves by 2010. This evolution in policy, concurrent with the burgeoning visitor pressures on Dry Tortugas National Park, boosted the planning process by broadening public and agency support for establishing no-take zones in the Tortugas ecosystem.

Yet, most critical to gaining support for the Dry Tortugas Research Natural Area and the national marine sanctuary's Tortugas Ecological Reserve was a commitment to using the best available science. In 1998 the park and sanctuary commissioned a *Site Characterization for the Dry Tortugas Region* that synthesized current knowledge of physical oceanography, benthic (bottom-dwelling) communities, and fisheries. These scientific analyses were used in developing a range of alternatives for the

"The Dry Tortugas Research Natural Area will be the largest, fully protected marine area in the National Park System."

(Opposite) Adopted in 2001, the Dry Tortugas General Management Plan designated the 46-square-mile research natural area to help meet park preservation goals. The plan also addresses expanding high-quality opportunities for experiencing the park. The complex planning project recently won the 2002 award for Outstanding Collaborative Planning Project from the American Planning Association's federal planning division.

Dr. Jiangang Luo, University of Miami

A research team diver and expedition leader, Dr. Jerald Ault of the University of Miami takes a census of marine life in the Dry Tortugas region. From 1999 to 2000, the team made more than 3,000 dives of this type and documented overfishing.

research natural area and the Tortugas Ecological Reserve. Boundaries of the research natural area were based on regional fisheries surveys, physical oceanographic and larval dispersal pathways, benthic habitat investigations, and enforcement and socioeconomic considerations. Research on existing no-take reserves indicated that for the research natural area and the ecological reserve to be biologically effective, the full range of land and marine habitats and their associated communities had to be included in these areas. The national marine sanctuary's reserve, with its deep reefs and habitats, provides spawning areas for fish while the national park's research natural area, with its shallow reefs and sea grass beds, provides nurseries for commercially important fish and a multitude of other marine species.

To gain additional information, in 1999 the Department of the Interior and NOAA asked the National Research Council of the National Academy of Sciences to examine the utility of marine reserves and protected areas for conserving fisheries, habitats, and biological diversity. The council's report, *Marine Protected Areas: Tools for Sustaining Ocean Ecosystems,* endorses the increased use of no-take marine reserves, in concert with conventional management approaches, as tools for managing ocean resources.

"Most critical … was a commitment to using the best available science."

In June 2000 the national park and national marine sanctuary released their draft plans for public review. The goal of the general management plan is to protect natural and cultural resources while providing for visitor use and enjoyment consistent with the purposes of the park. This would be accomplished through management zoning, establishing visitor carrying capacity, and using commercial services to structure and direct visitor use. Comments on the draft general management plan were overwhelmingly supportive of establishing the research natural area. Out of 6,000 comments received, 97% favored the prohibition of extractive activities in this area. Some sports fishing groups, who maintain that properly regulated recreational fishing has no negative impacts on fish populations, expressed strong opposition to the area's creation. Environmental groups supported the proposal, as did the Florida Fish and Wildlife Conservation Commission, NOAA, and the Gulf of Mexico Fisheries Management Council.

In January 2001 the final Dry Tortugas General Management Plan was made available to the public. In June, following months of review, additional public input, and a change in administrations, President Bush and Governor Jeb Bush visited Everglades National Park and expressed their support for implementing the plan. On July 27, Secretary Norton approved it and the record of decision was signed. In announcing approval of the plan, the secretary stated, "This plan has been developed with broad public outreach and a great deal of participation with the State of Florida, fishing organizations, and interest groups…. My goal for this plan in the future," she elaborated, "is that recreational and commercial fishermen will see more and bigger fish, more conch and lobster in Florida Bay and the Straits of Florida, as a result of the critical spawning and marine nurseries we are protecting in the park."

Upon completion of a rulemaking process to change the park's fishing regulations, the Dry Tortugas Research Natural Area will be the largest fully protected marine area in the National Park System and, with the Tortugas Ecological Reserve, the third largest coral reef protected area in the world. Combined, the two areas will constitute the largest no-take reserve in the United States. With the creation of the research natural area, Dry Tortugas National Park hopes to realize the area's full potential and offer outstanding opportunities for visitor education and appreciation of an intact marine ecosystem. The research natural area will provide tangible long-term benefits for protection of marine resources in the national park and the national marine sanctuary, and for recreational and commercial fishers. It also will advance science, serving as a reference site for distinguishing between natural and human-induced changes to the Florida Keys ecosystem. Effective implementation and enforcement will require coordination among federal and state agencies and active input from community, commercial, and recreational interests.

In August the National Park System Advisory Board called upon the National Park Service to be a leader in developing and implementing a strategically designed system of no-take marine reserves, covering a broad range of marine habitats. This call to leadership, and the lessons learned during the Tortugas planning effort, will be valuable for parks and sanctuaries working to protect vital marine resources.

A bottom-dwelling fish, the 8-inch-long bigeye *(Priacanthus arenatus)* prefers coral or rocky reefs and the deep waters of the continental shelf and slope. The species is relatively common in the Dry Tortugas region.

Dr. Jiangang Luo, University of Miami

NPS photo by Chris Stein

Jagged volcanic peaks (Left) overlook submerged coral reefs (below) accessible from Ofu Beach at National Park of American Samoa. In 2001, resource managers identified practical strategies for monitoring the remote national park's coral reef resources within the capability of the park's small staff.

Coral reefs in American Samoa: A practical approach to monitoring

By Peter Craig

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The National Park of American Samoa may be small, but it is blessed with an abundance of coral reefs in its 2,550 marine acres on three South Pacific islands. These biologically diverse reefs support more than 200 coral species, 890 fish species, and countless invertebrates. Although the reefs are recovering well from the severe hurricane damage of 10 years ago, poaching has impacted fish populations and sea turtles are "rapidly approaching extinction," according to a U.S. Fish and Wildlife Service–National Marine Fisheries Service Recovery Plan. In 2001 the National Park of American Samoa began developing a monitoring program to evaluate the health of the ecosystem and implement management actions when warranted.

Given the worldwide interest in monitoring coral reefs, several manuals are available that describe methodology for large-scale projects, but the realities of this small park make it necessary to focus on practical applications. To help identify appropriate strategies, a vital signs workshop convened in 2001 to view coral reef monitoring from a small-park perspective, where local resources are far fewer than in more developed states or countries with numerous management agencies and academic institutions. The challenge was to determine what information will be needed for practical management of coral reefs and what tasks can realistically be accomplished by managers of small and often remote marine protected areas.

The workshop first identified on-site managers as the primary users of the monitoring program and then examined what information the managers needed and why. That information required knowledge of natural environmental changes and threats to the park's reefs, which currently include factors such as local fishing pressure and natural forces (e.g., hurricanes and potentially increased mortalities due to global warming). Monitoring questions related to these threats and natural changes were formulated, followed by a listing of indicators, or "vital signs," that would provide the desired information by tracking changes in reef condition over time.

The vital signs selected for monitoring were human uses of the park and selected parameters for corals, other invertebrates, fish, algae, and water quality. A schedule for measuring vital signs was established, specifying those that should be measured annually or less frequently to document baseline conditions for possible future comparisons.

This approach provided a convenient way to identify, organize, and prioritize the variables that should be included in a monitoring plan for a relatively small area like the National Park of American Samoa. It also identified some needs that exceed current park capabilities. The continuing development of the program will lead to appropriate sampling methods that will allow the park to monitor and manage the condition of its coral reefs.

"A vital signs workshop convened in 2001 to view coral reef monitoring from a small-park perspective."

Evolution of coral reef monitoring at Virgin Islands

By Jeff Miller

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In 1992 the National Park Service began an Inventory and Monitoring Program to gather baseline information and develop monitoring methods to better understand natural resources in the national parks. The focus of this program initially was in-depth, scientifically rigorous, long-term ecological monitoring in 10 biogeographic regions of the National Park System. As a result, Dr. Caroline Rogers, marine ecologist and director of the U.S. Geological Survey (USGS), Caribbean Field Station in St. John, U.S. Virgin Islands, and other scientists worked with NPS resource managers to develop protocols to monitor coral reefs, reef fish, nesting and juvenile sea turtles, sea grass beds, and water quality (see "Movies for managers: An advance in coral reef monitoring" in *Natural Resource Year in Review—1999*). This investment of NPS funding and USGS time and expertise in the development of protocols is paying off for Virgin Islands National Park and many other marine reserves around the globe as they begin to use the protocols in resource monitoring.

"These protocols have … elevated the quality and scientific defensibility of monitoring."

In 2001 the Inventory and Monitoring Division of Virgin Islands National Park began to implement the USGS monitoring protocols. A close working relationship between the USGS and the National Park Service facilitated the protocol "handoff." In fact, many of the same individuals who were involved in the protocol development are now NPS employees using the protocols to monitor coral reef and sea grass communities in Virgin Islands National Park and Buck Island Reef National Monument. These parks have a history of successful resource monitoring, and these latest protocols are being used to build upon a wealth of data spanning decades. For example, the random sampling protocol using a sonar mapping system ensures statistical rigor for independent sampling during sea grass and video (coral) monitoring. Water quality protocols provide quality assurance and control during sampling, preservation, shipping, and analysis. The sea turtle monitoring protocol ensures essential information on threatened and endangered species for park managers.

The protocols were specifically designed to extend beyond the Virgin Islands and be useful in many units of the National Park System or other natural areas with coral reef resources. For instance, the video protocol for monitoring coral reefs is being used by the governments of several Caribbean countries, including the Bahamas, Jamaica, Belize, Puerto Rico, and British and U.S. Virgin Islands. The fish monitoring protocol is consistent with methods used throughout the Caribbean and Hawaii, and the water quality monitoring protocol complements the U.S.Virgin Islands territorial monitoring, thus allowing for large spatial coverage. Biscayne and Dry Tortugas National Parks use the coral reef video monitoring protocol, and resource managers have expressed interest in applying this technique in the Pacific Ocean and the Red Sea. Additionally, the video, reef fish, and sea grass protocols will be used to establish valuable baseline data for resources in two of the most recently designated national park units: Virgin Islands Coral Reef National Monument (including 12,708 acres of submerged lands adjacent to Virgin Islands National Park) and the 18,135-acre expansion of Buck Island Reef National Monument.

These protocols have not only elevated the quality and scientific defensibility of monitoring but have also been the subject of more than 25 scientific publications. Protocol methods and data are regularly presented at numerous international scientific and general public meetings, and are taught in workshops and training seminars to scientists and resource managers around the world. What started out as a way to improve upon existing monitoring has developed into the creation of statistically rigorous, scientifically sound, peer-reviewed protocols that are benefiting not only national parks but also resource managers of critical marine habitats worldwide.

USGS, Rob Waara

Using a digital video camera, a diver monitors the relative abundance of coral, sponges,algae, and other organisms at Virgin Islands National Park. The USGS developed several protocols that are now being used by the National Parks Service to monitor coral reefs, fish, nesting and juvenile sea turtles, sea grass beds, and water quality.

USGS, Rob Waara

(Right) Coral reefs in the Caribbean are susceptible to coral bleaching, diseases, and storm damage. The video monitoring protocol helps park resource managers detect and address these problems.

USGS science for coastal national parks

By Rebecca L. Beavers

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Shoreline erosion, lower water levels in the Great Lakes, saltwater intrusion in groundwater supplies, and inundated wetlands and estuaries are serious concerns along more than 7,000 miles of shoreline managed by the National Park Service. Potential climate change–induced impacts such as these confront more than 80 coastal park units. To obtain the information needed to address these challenges, the U.S. Geological Survey National Assessment of Coastal Change Hazards project (USGS project) continued efforts to quantify coastal change and created map products in 2001. These USGS products will help park managers understand and predict emerging threats to fragile coastal resources and develop appropriate management responses.

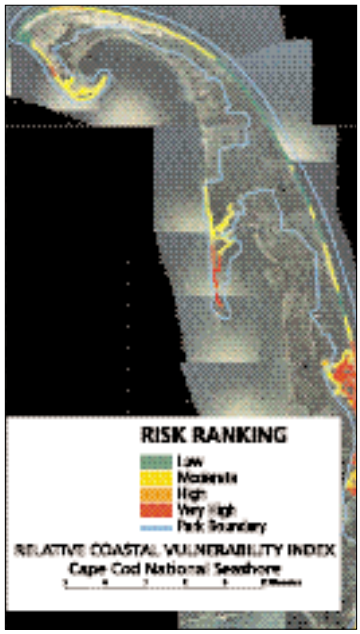
The USGS project has implemented new technologies that have vastly improved the quantity and quality of coastal change data. For example, emergent lidar technology, a laser version of radar, makes cost-effective data available nationally. The acquisition of shoreline position data is feasible for numerous parks; however, the analysis of large, complex raw lidar data is not practical at parks with small natural resource management staffs and competing priorities. Through the USGS project, coastal parks like Assateague Island National Seashore, a pilot park for the project, are receiving assistance with analyzing lidar data and developing maps. In 2001 the USGS project worked with Assateague Island National Seashore to develop high-resolution GIS topographic layers and digital aerial photomosaics for landscape monitoring and habitat mapping. Impacts of feral horse grazing on dune vegetation and the extent of piping plover brood habitat were quantified and used to make resource management decisions.

Lidar baseline information is also used to evaluate historic shoreline changes. Accurate rates of historic change are critical to defining human vs. natural changes along NPS-managed shorelines and developing appropriate management responses. For example, managers at Assateague have used the information developed through the project to evaluate previous shoreline engineering projects and critically evaluate plans for an island restoration project. "Lidar data enhances our ability to manage a changing island and make intelligent decisions," according to Carl Zimmerman of the national seashore.

Defining the physical response of shorelines to sea-level rise is another challenge facing NPS managers as they try to protect complex coastal systems. Global sea level has risen 4–8 inches (10–20 cm) in the past century and current models suggest this rise is likely to accelerate. For example, the level of the Great Lakes is projected to decline by 3–10 feet (1–3 m) in the next 50 years. Implementing protection or retreat strategies for vulnerable coastal resources requires consideration in areas where beaches and wetlands migrate inland to survive elevated sea levels and increased storm surges. To improve understanding of sea level change, the USGS project will continue to assess the spatial distribution of specific risk types, including erosion, shoreline retreat, and inundation. The project will produce park-specific vulnerability maps and GIS data layers.

During 2001, the USGS used information on coastal geomorphology, shoreline erosion rates, sea level rise rates, storm surge, wave height, tide range, and regional coastal slope to develop the Coastal Vulnerability Index for shorelines at Cape Cod National Seashore (see map), Olympic National Park, and Gulf Islands National Seashore. Olympic National Park used USGS project products to identify vulnerable infrastructure and implement plans to relocate the Kalaloch Lodge. In 2002, this cooperative project will map the Coastal Vulnerability Index at 10 additional parks with Fee Demonstration Program funding.

The lidar technology used to define coastal change and climate change–induced impacts has been developed in the last decade. New technologies are increasingly able to provide the types of detailed information park managers will need to protect fragile coastal resources as the USGS project has begun to demonstrate. In the future, partnership efforts like the USGS project will yield important information that will allow the National Park Service to protect natural shoreline conditions, recreation opportunities, cultural and historic resources, and park infrastructure.



U.S. Geological Survey

Shoreline vulnerability is depicted in this illustration of Cape Cod National Seashore, Massachusetts, produced by the USGS project in 2001. Erosion rates, sea level rise rates, storm surge, and other factors were evaluated to determine the susceptibility of the park shoreline to inundation and change.

Kalaloch Lodge at Olympic National Park, Washington, will be relocated to a site further inland and away from a cliff, affording greater safety from coastal erosion.

Shifting sands: The challenges of managing NPS coastal resources

By Julia Brunner and Rebecca Beavers

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Citizen demands regarding the coastlines of the United States are both extensive and contradictory. Americans want miles of undeveloped shoreline for walking, bird-watching, and spiritual renewal, in addition to wide beaches to protect coastal homes and cities from hurricanes and the rising sea. These goals require naturally functioning ecosystems, including the natural movement of sand. Yet, citizens also want the benefits of engineered coastlines, such as reliable navigation channels, fiber-optic cables, and oceanside roads. As the manager of more than 7,300 miles of shoreline and one of the largest federal land managers of coastal areas, the National Park Service strives to protect park resources despite these competing demands. In 2001 the newly formed coastal team within the NPS Geologic Resources Division addressed these issues, providing individual parks and centralized offices with scientific information, technical expertise, and policy analysis.

"By applying a higher level of technical and policy expertise to coastal issues in 2001, the National Park Service furthered its fundamental purpose of preserving … the natural resources in its care."

Many of these modern-day challenges beset Cape Hatteras National Seashore, North Carolina. In 2001 the national seashore continued to steadfastly oppose a U.S. Army Corps of Engineers plan to build mile-long jetties on either side of Oregon Inlet, a major navigation channel within the seashore. Intended to enhance the local commercial fishery by restricting sand flows into the inlet, the jetties, at a cost of $100 million, would harm wildlife such as piping plovers and sea turtles, diminish public recreation, and cause massive erosion at the seashore.

Along with the U.S. Fish and Wildlife Service, fishery experts, geologists, and economists, the National Park Service has long opposed this proposal. In 2001 the Corps of Engineers released the final supplement to the environmental impact statement on this project. With the assistance of the Geologic Resources Division and the NPS Southeast Region, the national seashore persistently and persuasively voiced its concerns throughout the year to the Council on Environmental Quality, the General Accounting Office, the Corps of Engineers, and the Department of the Interior. The fate of the project is unresolved, but the seashore's unflagging resistance may play a crucial role in the final decision.

Meanwhile, the Geologic Resources Division examined mechanisms for decreasing damage to park resources and values caused by non-NPS dredging and disposal activities in coastal parks. To date, the National Park Service has not fully supervised or, in some cases, even known about these activities. In 2001 the Park Service began to significantly increase its role in planning and execution of such operations to better protect park resources.

Occasionally, parks may consider dredging to maintain navigation channels, provide access to cultural resources, and improve water quality. At Dry Tortugas National Park, for example, a channel dredged during construction of Fort Jefferson filled with sand and closed in December 2000. Division staff evaluated this site in 2001 and recommended that the park allow the channel to remain closed rather than fight natural processes through an intensive dredging operation.

In the past year, division staff also researched the National Park Service's ability to protect coastal resources from the negative impacts of laying fiber-optic cable across park coral reefs. Digging of trenches and drilling of tubes for the cables increase siltation, which deprives living coral of light and oxygen. Improperly secured cables can also damage coral.

Despite these problems, telecommunication companies are laying thousands of miles of cable around the world and have applied to coastal parks for right-of-way permits. In the course of assisting War in the Pacific National Historical Park in addressing such an inquiry, the Geologic Resources Division found that the National Park Service's statutory, regulatory, and policy mandates give the bureau the undisputed authority to protect park coral reefs from such activities.

From urban coastal parks such as Golden Gate National Recreation Area to rural units like San Juan Island National Historic Park, coastal areas face an increasing array of challenges. By applying a higher level of technical and policy expertise to coastal issues in 2001, the National Park Service furthered its fundamental purpose of preserving for future generations the natural resources in its care.

After the channel between two islands in Dry Tortugas National Park closed because of natural sediment movement, NPS Geologic Resources Division staff evaluated possible management alternatives. Analysis resulted in a decision to leave the natural sand isthmus in place.

Other Developments

Award-winner Profile

Dr. Charles Roman honored

In October 2001, Dr. Charles Roman received the Director's Award for Natural Resource Research. A research scientist in the Biological Resources Division of the USGS, Dr. Roman has been studying the ecology of coastal ecosystems on behalf of the NPS Northeast Region's coastal parks for more than 15 years. His research has been essential to the protection of coastal barrier national seashores in four major areas: evaluating effects of hydrology on freshwater wetland ecosystems; restoring salt marshes and small estuaries; quantifying changes in coastal ecosystem structure, function, and process; and evaluating relationships between sea-level rise and salt marsh habitat structure.

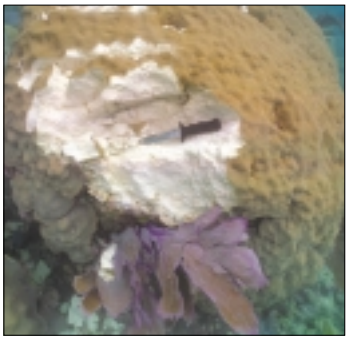
"His innovative approaches to predicting and quantifying ecological restoration responses have benefited park resources," according to Mary Foley, chief scientist for the NPS Northeast Region. "In addition, he has been instrumental in uniting the strengths of the academic community with the strengths of the resource management professionals."

"Our coastal national parks are very special places," said Roman, "and I am fortunate to have the opportunity to study these areas. It is especially rewarding to know that the National Park Service applies much of my research toward understanding, protecting, and restoring their coastal habitats." In early 2002, Roman transferred to the National Park Service as research coordinator of the North Atlantic Coast Cooperative Ecosystem Studies Unit, hosted by the University of Rhode Island at Narragansett.

Damage assessment process bears fruit

The year 2001 was a busy one for the Environmental Response, Planning, and Assessment unit (ERPA) of the NPS Environmental Quality Division. The unit helps parks respond to oil spills and other environmental disturbances. It also conducts damage assessments and prepares claims that help parks recover funds from responsible parties for restoration of impacted resources. In 2001 ERPA settled 8 of 110 pending cases in criminal and civil court, involving 7 parks and damage to sea grass and coral reef habitats (photos), coastal forest, chaparral, battlefield resources, and earthworks. The unit also helped restore a breakwater at San Juan National Historic Site, Puerto Rico, and began drafting an NPS Director's Order and other internal guidance on resource damage assessment and restoration.

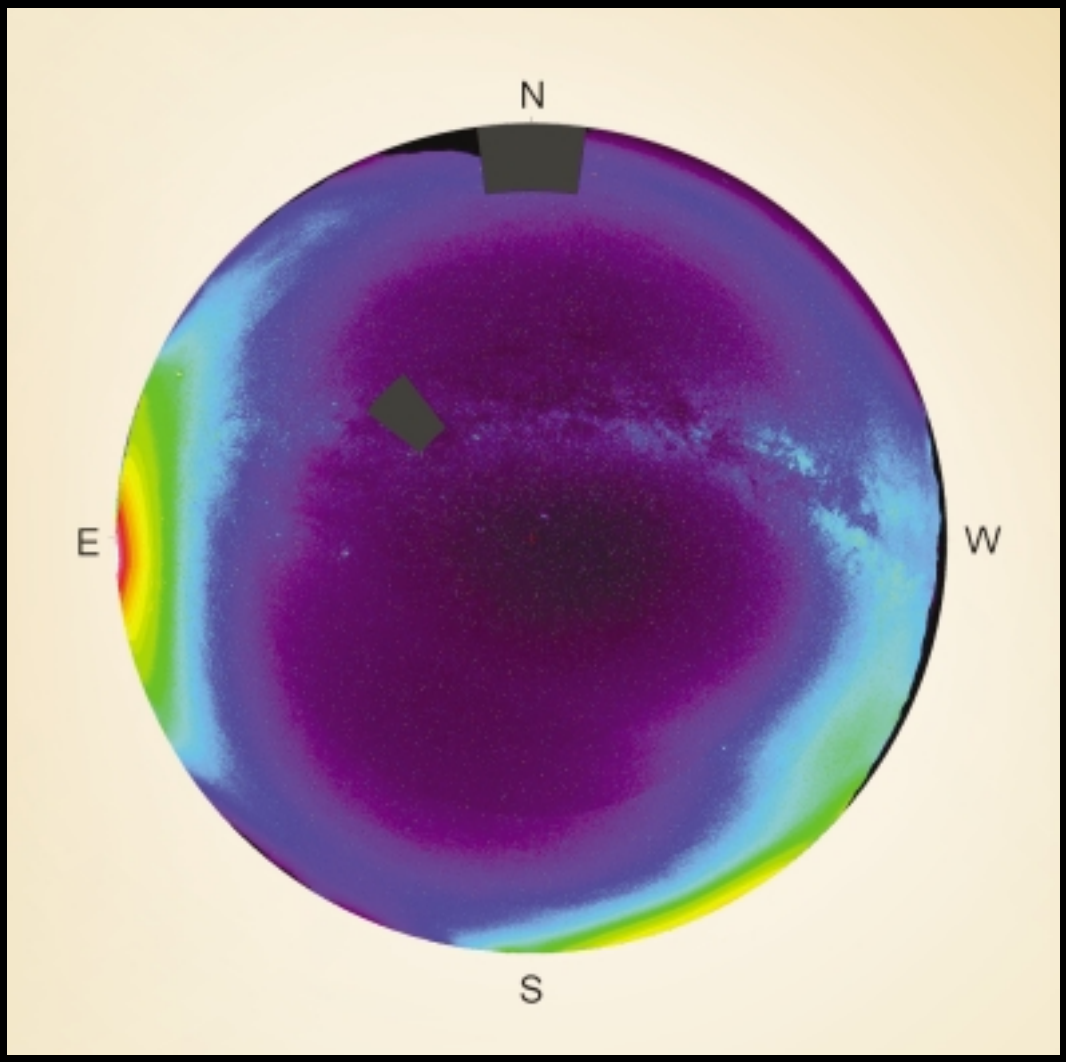
The cases remaining on the docket range from assessment to final restoration and address damage to park facilities, natural and cultural resources, and the loss of public enjoyment of these resources. These cases are predominantly vessel groundings, although encroachment on park resources such as illegal timber harvest is an emerging trend.



Managing Risks

"We are a species whose influence on natural systems is profound, yet the consequences of this influence remain only dimly understood."

—National Park System Advisory Board



Preserving the grandeur and unimpaired natural function of national parks for the enjoyment of future generations is the fundamental purpose of the National Park Service. In 2001 the Park Service advanced risk management strategies to protect park resources from a number of hazards, including poaching, exotic plants and animals, light pollution, diseases in wildlife, and air and water pollution. Some of the risks facing park resources in 2001, including exotic species eradication and foot-and-mouth disease, were issues of national and international concern. The articles in this chapter demonstrate the role of NPS professional staff and science in managing potential risks to the air, water, landscapes, and living things found in our national parks. The articles in many instances explore the management activities park managers are using to successfully meet the challenges facing the natural resources in their care.

Light pollution

Preserving endangered night skies

By Dan Duriscoe and Chadwick A. Moore

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The national parks, especially the wilderness parks of the West, have traditionally been thought of as places where pristine views of the night sky abound. Yet, over the last three or four decades, this resource has been rapidly degraded in many parks by the widespread growth of light pollution—an unintended by-product of human population and land development. As light scatters in the atmosphere, it diminishes the view of the night sky, including the stars and planets, an important and inspirational part of the national park experience for many.

The progression of increased night lighting in the United States has been tracked by military satellite images that have been used to model the effects of wasted light reflecting off the atmosphere. One of these models, developed by a group of Italian scientists, demonstrates the potential for the growing loss of night sky views in the future. This model projects that in 2025, precious few places will be left in the lower 48 states where people can experience dark night skies. Although models are valuable in assessing threats, they still require real-world observations to verify predictions.

A central problem in protecting night skies is the widespread lack of data about impacts on this resource. Although hundreds of national park areas suffer from the effects of light pollution, only a handful have any data whatsoever to assess their situation. Moreover, not all park managers are aware of the significance and necessity of a dark night sky and the rapidity at which it is being lost. Although other park managers are genuinely concerned about the problem, they lack the tools to inventory, monitor, and protect this resource.

To address these issues, a small group of resource managers working in two parks formed the Night Sky Team in January 2000. Assisted by the Air Resources Division, the team's task was to implement a multifaceted night sky protection plan, beginning with increasing awareness of the problem through the development of educational materials and outlining methods for monitoring and protecting night skies. The plan also directed them to research, develop, and test various methods for measuring night sky quality. Finally, the team would assist the parks in reducing wasted light inside and outside park boundaries.

By the end of 2001 the Night Sky Team had accomplished many tasks that move a dozen parks in the Pacific West and Intermountain Regions closer to achieving their objectives. For example, the team assisted the National Parks and Conservation Association in publishing a *Handbook for Protecting Night Skies*, and reviewed facility lighting in numerous national parks in the West. A meeting with astronomers and engineers of the U.S. Naval Observatory in Flagstaff and the nonprofit International Dark Sky Association led to the development of protocols for employing techniques in national parks to measure night sky brightness and estimate visual degradation. The team tested and refined the use of a research-grade CCD (digital) camera, a photoelectric photometer, and visual estimation methods for making sky brightness measurements, and analyzed the results. Foremost in these methods, All-Sky CCD Photometry provides the most complete information and produces a graphic depiction of sky quality that can easily be interpreted.

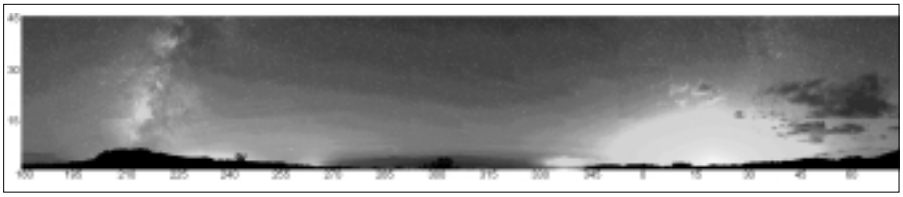
Site visits to 12 parks directly address the need for data by capturing night sky images that can be analyzed for brightness, identifying sources of light pollution, and establishing scientific monitoring strategies. Sky brightness measurements establish a baseline from which future resource degradation or improvement can be accurately determined. Not only do the data stand as a benchmark, but the photographs and visual estimation methods are also powerful tools for interpreting and communicating the issue. Another valuable aspect of the team's work has been to incorporate reviews of facility lighting and consultation with park staff into site visits.

We stand on the verge of losing our view of the universe from our national parks. Yet, unlike losing a species to extinction, topsoil to erosion, or virgin lands to development, the night sky is 100% recoverable. Perhaps the momentum of the Night Sky Team and many individual parks can lead to a broader based national effort to protect this fleeting resource.

"We stand on the verge of losing our view of the universe from our national parks."

(Opposite) The Night Sky Team tested various methods for evaluating night sky darkness including the "all-sky" CCD photometric method shown here. This image combines 114 precise brightness measurements above Death Valley National Park, ranging from the darkest (purple) to the lightest (red). Ninety miles to the east, Las Vegas completely drowns out a portion of the sky. The glow of Los Angeles is visible on the southern horizon.

This panoramic view of Mojave National Preserve clearly shows light pollution from Las Vegas in contrast with the darker, "natural" night sky. The river of light on the left is the Milky Way. Altitude and azimuth in degrees are indicated along the margin. Although somewhat degraded, the night sky above the southwestern desert national parks still harbors a valuable resource.



Poaching

Protecting American ginseng

By Janet Rock

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"As populations of the plant are depleted outside the national park, poaching pressure in the Smokies intensifies."

Great Smoky Mountains National Park, North Carolina and Tennessee, is the largest protected area in the southern Appalachians and probably the largest protected reserve for American ginseng *(Panax quinquefolius)* in the United States. This plant has been collected illegally in the Smokies for its medicinal value since the park was established in 1934. Harvesting of wild populations of American ginseng is likely increasing throughout the plant's range of eastern North America. According to buyers, the roots of ginseng found in naturally occurring populations are more valuable than cultivated roots, making the Smokies an ideal place to collect. The USDA Forest Service reports that collecting of wild ginseng roots may be escalating; in only three years the number of legal collecting permits issued for the harvest of wild roots on Forest Service lands has increased by about 300%. Great Smoky Mountains National Park is flanked by three national forests where ginseng collecting is permitted. As populations of the plant are depleted outside the national park, poaching pressure in the Smokies intensifies.

A pile of confiscated ginseng roots is testimony to the threat posed by illegal collecting of this medicinal plant in Great Smoky Mountains National Park. Through use of a root-marking technique, park staff are able to identify the source of certain illegally collected plants, potentially resulting in criminal convictions.

Ginseng plant populations are vulnerable to impact through illegal collection because the plants do not usually mature and produce seeds (shown here) until they are five years of age or older.

In the last 10 years, park law enforcement rangers have seized nearly 11,000 illegally harvested ginseng roots in the national park. Park staff believe that only a small percentage of the roots actually poached from the park are detected, despite routine ranger patrols. In an effort to track the health of ginseng populations throughout the park, staff of the Resource Management and Science Division have weighed and dated more than 9,000 of the confiscated roots. Undamaged roots are then replanted for monitoring. Confiscated roots as young as one to three years have been processed. Sadly, plants younger than five years of age are usually not mature and have not had the opportunity to contribute seeds to the population (the only method of reproduction for this species).

Ginseng was listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora in 1977. For 1999–2001, the Office of Scientific Authority issued findings on the export of ginseng based, in part, on data from Great Smoky Mountains National Park. The authority stated that collection of ginseng roots five years and older was not detrimental to the species, emphasizing that exported roots must be of reproductive age and produce seeds.

An integral part of the park's protection efforts has been the marking of wild and replanted ginseng roots to deter poaching in the park. For several years, resource managers have worked with law enforcement rangers and the North Carolina Department of Agriculture to mark roots. In 2000 the partners uniquely marked 3,500 roots in situ in the park. When law enforcement rangers recently seized roots at the park boundary, they were able to determine that the roots came from the park, as 4 of about 500 of the poached roots were distinctly marked. In 2001 the two defendants pled guilty and each paid a $200 fine. Additionally, they were banned from the park for one year and paid $5-per-root restitution to cover the cost of aging, weighing, and replanting the roots.

The park monitors wild and replanted ginseng populations, which provides solid data on the effectiveness of law enforcement measures. The root-marking methodology developed in the Smokies is now being used to protect ginseng in Shenandoah and Mammoth Cave National Parks and Blue Ridge Parkway. Overall, this technique is helping protect American ginseng.

Incident management team develops foot-and-mouth disease plans

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When 10 million farm animals were slaughtered in the United Kingdom in 2001 to control foot-and-mouth disease (FMD), an outbreak in North America looked imminent. Although the disease occurs in hoofed animals in many parts of the world and is not usually fatal, what concerned U.S. officials about the outbreak that began in England and spread to mainland Europe was the potential economic impact. Federal departments, from the USDA to the FBI, met in Washington, D.C., to plan how the United States would manage an outbreak of the disease. The focus of the National Park Service during the crisis was the threat to hoofed wildlife such as deer and elk, and the outcome was a unique approach that drew praise from around the country.

Craig Axtell, chief of the NPS Biological Resource Management Division, requested that the NPS director delegate authority to the NPS National Incident Management Team to develop plans for dealing with foot-and-mouth disease. There were compelling reasons for using the Incident Command System to respond to a disease that was not yet even in the country. Timeliness was critical: if foot-and-mouth disease arrived in North America, a plan needed to be in place. The disease spreads so rapidly that NPS managers would be under intense pressure to make critical decisions affecting park resources and visitors. "I also saw it as an opportunity," Axtell said, "to integrate emergency operations specialists from the NPS Incident Management Team with scientists from the Natural Resource Program Center to pull together on a big problem with a short deadline." Also, if there were an FMD outbreak near a national park, an Incident Management Team would probably be called to respond.

As the team assembled in April 2001 in Fort Collins, Colorado, the city's newspaper, The Coloradoan, carried a story on how foot-and-mouth disease would be an ideal agent for terrorists. The delegation of authority given to Incident Commander Greg Stiles made the time frame clear: 16 days, including travel, to develop and distribute a plan that would provide pertinent information and guidelines if the disease occurred in or near a national park unit.

Biological Resource Management Division staff and NPS personnel from around the country began the assignment, using planning methods previously employed on incidents such as Hurricane Andrew in 1992 and the Yosemite flood in 1996. It soon became clear that dealing with the threat of foot-and-mouth disease far from a national park required a different approach from an occurrence of the disease in a park or on its boundary. Two documents would be needed: a prevention plan and a response plan.

The Interim Prevention Plan recommended that national park units designate a coordinator to communicate with other agencies in the area, provide pertinent information to employees and the public, and evaluate the potential threat to park resources. The Interim Response Plan focused on securing the area in accordance with the recommendation of disease experts, conducting a situation analysis that included the risk to wildlife from infected livestock, and preventing panic by communicating clearly to the public that the disease is not fatal to humans.

Throughout the process the team was in close contact with representatives from the USDA Animal and Plant Health Inspection Service and the U.S. Department of the Interior National Wildlife Health Center. Drafts of the plans were sent for review by subject-matter experts, including federal and state officials, veterinarians, and NPS personnel from both the operations and natural resources directorates. In light of the comments, significant changes were made to both plans. An executive summary was included in each plan to provide park superintendents with clear guidance on how to evaluate the FMD risk and the appropriate response.

The interim plans were submitted to Craig Axtell on May 9, 2001. The following week, the incident commander provided a briefing on the FMD plans to U.S. Department of the Interior staff in Washington, D.C. The threat of foot-and-mouth disease from an accidental exposure or a bioterrorist act remains, but with the distribution of these plans the National Park Service is in a proactive position to protect its resources.

"The distribution of these plans [puts] the National Park Service … in a proactive position to protect its resources [from foot-and-mouth disease]."

When an outbreak of foot-and-mouth disease in North America appeared imminent in 2001, NPS emergency operations staff worked with other divisions to quickly develop plans to protect park ungulates, including deer and elk, such as tule elk at Point Reyes National Seashore. Although the immediate threat passed, the planning process was a unique approach that drew praise from around the country.

An overview of invasive exotic plant management strategies in the Northeast

By Kathleen Kodish Reeder

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National Park Service managers nationwide are aware that invasive vegetation cannot be ignored without endangering the biodiversity of our national parks and, indeed, of whole geographical regions. They also realize that they may never eradicate all of the "invaders." However, during 2001, managers in the National Park Service's Northeast Region developed and refined several strategies for suppressing exotic plants enough to greatly reduce the risk they pose.

The most prevalent strategy has been collaboration among parks or with conservation organizations, whether they are within the same geographic area or share the same concern about a specific invasive species. One of these team efforts in the Northeast was formally funded in Virginia where eight national parks cooperated to address high-priority, invasive vegetation issues. None of them had sufficient funding to provide the required expertise, staffing, equipment, or supplies on their own. Their proposal to form the Virginia Invasive Vegetation Management Team was funded by the Natural Resource Preservation Program (NRPP) for a two-year period (2000–2001).

Drapes of invasive kudzu envelop native trees at Colonial National Historical Park (below). Staff of the National Park Service collaborated with the Colonial Williamsburg Foundation in 2001 and treated two jointly managed areas with herbicide (above). Once the kudzu is eradicated, crews will work to restore the site's biodiversity.

In the first year, the parks designed strategic plans to reduce targeted species to manageable levels, and trained their team's field staff to recognize and control invasive exotics, restore native habitat, and install monitoring plots. During 2001, in addition to creating public information pamphlets and setting up tool caches at each park to continue the fieldwork, the Virginia team established the infrastructure for practical support and sustainability after the NRPP funding expires. Essentially, the latter entailed forming collaborative partnerships not only among themselves, but also with other agencies that share their concern about controlling invasives.

According to James Åkerson, forest ecologist at Shenandoah National Park, an excellent example of this collaborative approach occurred when the Virginia team joined the Colonial Williamsburg Foundation (a private, nonprofit organization) to eradicate kudzu (*Pueraria montana* var. lobata) in an area that is mutually overseen and operated by the National Park Service and the foundation at Colonial National Historical Park. The treated parcel occupies two acres along a parkway that is heavily used by the public. In 2001, preplanning occurred in April and May and an herbicide was applied during July; follow-up treatments were applied in the fall. Additional monitoring and treatment are scheduled for 2002. Once they have eradicated the kudzu, the crews will work to restore the biodiversity of the site's pond and stream, as well as their respective banks.

A different type of collaboration was illustrated at the Johnstown Flood National Memorial and Allegheny Portage Railroad National Historic Site in Pennsylvania where Japanese knotweed *(Polygonum cuspidatum* Siebold and Zucc) and giant knotweed *(Polygonum sachalinense* F.W. Schmidt ex Maxim) have threatened natural resources. Before 2001, these parks had funded two research projects designed to identify the most effective treatment against both species of knotweed and reveal their reproductive ecology. Knowing that suppressing knotweed within the two parks was not sufficient to eliminate the threat when knotweed was also growing on neighboring land, NPS staff began persuading those who were developing the Kiski-Conemaugh Rivers Conservation Plan, as well as members of the Conemaugh Valley Conservancy and the Southern Alleghenies Conservancy, to target knotweed in their regional control plans.

After receiving a grant in October 2000 from the U.S. Department of Agriculture, these parks were

Staff at Assateague Island recognized the importance of early suppression of an invasive exotic, dune-building plant called Asiatic sand sedge. Their quick efforts will help protect native beach grasses and the threatened seabeach amaranth.

able to greatly expand control measures of knotweed and other noxious plants within their borders; to increase their support of control efforts by other groups; and to develop more public outreach activities, including a formal education program about invasive plants. By continuing to facilitate the education of landowners and the public throughout the watershed, the National Park Service leveraged its resources in 2001 to preserve or restore the native habitat of an area far larger than the land encompassed by the parks themselves.

Several best management practices were also illustrated at Assateague Island National Seashore, Maryland, where park staff showed ingenuity in procuring funds, conducting their own research, and developing outreach activities to share vital information resulting from that research. When park personnel realized that an invasive exotic, the dune-building plant called Asiatic sand sedge *(Carex kobomugi),* seemed capable of overwhelming two more beneficial, native beach plants, they also learned that little information was available about how to suppress the invasive species. The park staff were able to conduct their own research by combining funding from several sources, including the Natural Resource Preservation Program and the Endangered Species Conservation Fund, because their investigation proposed satisfying two interrelated goals: suppressing an invasive exotic plant and protecting a plant on the federal list of threatened species, seabeach amaranth *(Amaranthus pumilus),* one of the native plants. The work done by Chris Lea, ecologist at the national seashore, revealed the practicality of suppressing the invasive plant during the early stages of its incursion. Lea notes that, although suppressing Asiatic sand sedge after the plant has become abundant in an area is probably possible, the cost and effort to do so would be prohibitive for most parks.

Knowing that this information was not widely available and learning that dunes formed by Asiatic sand sedge in other parks also exist, Lea began collaborating with the Office of Natural Lands Management in the New Jersey Division of Parks and Forestry to develop a fact sheet. The information source explains that Asiatic sand sedge is an impending threat to native beach grasses, and describes effective control or eradication treatments (depending on the extent of the "invasion" by the sand sedge). Assateague Island's extensive educational efforts culminated in the submission of the newly developed fact sheet to the "Weeds Gone Wild" Web page, which is maintained by the Alien Plant Working Group of the Plant Conservation Alliance, a national consortium of 10 federal agencies and 145 other organizations interested in ecology and conservation.

As this overview reveals, during 2001, national parks in the Northeast Region formed partnerships at many levels and used several tactics to raise awareness and fund research that will protect the native plants and natural resources under their stewardship. Whether they have collaborated with others to develop a treatment strategy or developed their own and then shared their discoveries, NPS staff members have been pooling all available resources to control exotic vegetation.

"The National Park Service leveraged its resources in 2001 to preserve or restore the native habitat of an area far larger than the land encompassed by the parks themselves."

Eradicating rats from Anacapa Island

By Kate Faulkner, Gregg Howald, and Steve Ortega

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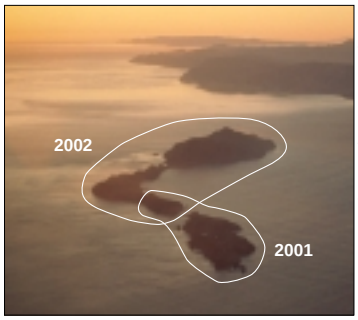
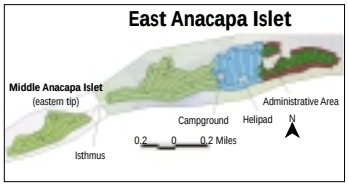


Courtesy of Tim Hauf; interpretation by National Park Service

Anacapa Island, 12 miles from the southern California mainland, is one of five islands in Channel Islands National Park and is just over 700 acres in size. Segmented into three islets, east Anacapa was treated with aerially applied rodenticide in fall 2001; the same rat eradication measures will be used on middle and west Anacapa in 2002.



Real-time mapping enhanced aerial application of the rodent bait on Anacapa. Each time the helicopter bucket was opened to drop bait, the Global Positioning System recorded the location of the drop. This technique, accompanied by ground surveys, ensured full coverage of the treatment area.

Located off the southern California coast and part of Channel Islands National Park, Anacapa Island provides critical habitat for seabirds, pinnipeds such as California sea lions, and endemic plants and animals. The island's steep, lava rock cliffs incorporate numerous caves and crevices that are particularly important for the increasingly rare seabird species, Xantus's murrelet and ashy storm-petrel. The largest breeding colony of the California brown pelican in the United States also occurs on Anacapa Island, and a unique subspecies of deer mouse *(Peromyscus maniculatus anacapae)* occurs only on this island. Unfortunately, the Anacapa ecosystem has been degraded by the nonnative black rat *(Rattus rattus)* that preys on birds, reptiles, amphibians, and invertebrates.

In the mid-1990s, staff of the national park met with biologists of the Island Conservation and Ecology Group to discuss black rats and investigate solutions to the problems they pose. The Island Conservation and Ecology Group was very active internationally in the restoration of island ecosystems through the eradication of nonnative species. They described how rats had been successfully eradicated from various islands, particularly in New Zealand. Thereafter, the former Western Region of the National Park Service funded a research proposal to determine if and how rats could be eradicated from Anacapa and through a cooperative agreement partnered with the conservation group to do the work.

But Anacapa Island presented special challenges. Its extensive steep cliffs would complicate placing rodenticide bait into the territory of every rat. The endemic deer mice would feed on any bait that was attractive to the rats. Additionally, the endangered California brown pelican, extremely sensitive to disturbance, breeds and nests on a large portion of Anacapa Island eight months of the year. Following extensive consultation with experts, Channel Islands National Park and Island Conservation and Ecology Group determined that rats could be eliminated through the distribution of bait pellets containing brodifacoum, the anticoagulant used in the majority of successful rat eradications, from a hopper suspended under a helicopter. The bait application would need to happen in the fall, the end of the dry season, when rats are very hungry and numbers of human visitors and birds are relatively low. Protection of the native deer mouse would be achieved through two measures. First, a small population of the mice would be held in captivity, preventing exposure to the bait and allowing for their restoration. Second, only the eastern portion of Anacapa Island would be treated in the first year, ensuring survival of wild deer mice on middle and western Anacapa, which would be treated the following year. Extensive ecological monitoring before and after the rat eradication operation would be needed to determine the environmental impacts of the project.

Fortuitously, the American Trader Trustee Council, consisting of the California Department of Fish and Game, National Oceanic and Atmospheric Administration, and the U.S. Fish and Wildlife Service, had court settlement monies resulting from a southern California oil spill in 1990. In part, the purpose of the settlement monies was to restore seabird populations injured by the spill. The trustees supported eradication of the black rat from Anacapa Island because it is one of the most significant islands for breeding seabirds in southern California. They expect to spend approximately $1 million for rat eradication and another $1 million for pre- and post-eradication monitoring, education programs, and efforts to prevent future introductions of rodents to the island.

Following public input and application for a permit to aerially apply the bait, the first phase of the operation was completed in December 2001 when east Anacapa Island was treated. Channel Islands National Park and its partners are currently monitoring the site to determine whether all rats were eradicated, and the results look promising so far. The park is also monitoring impacts to non-target species and the recovery of species impacted by rats. Phase II, treatment of middle and west Anacapa, is planned for fall 2002.

Other Developments

Focus on toxic airborne pollutants

In 2001 the National Park Service began a concerted effort to determine if toxic airborne pollutants are affecting park resources in the western United States. Pollutants of concern are "persistent organic pollutants" such as DDT, PCBs, and furans, and metals such as mercury. These pollutants can travel long distances (in some cases from Europe and Asia), persist in the environment for a long time, and tend to accumulate at higher levels of the food chain, causing toxic effects in fish, mammals, and humans who consume them. The NPS air toxics monitoring effort is a five-year process that began in 2001 with strategic planning and a pilot study. The next three years will focus on monitoring snow, lake sediments, plants, and fish or mammal tissue at six selected parks in Alaska and the western United States. The final year of the effort will focus on data analysis and reporting. Dixon Landers, a scientist with the Environmental Protection Agency, is on loan to the NPS Air Resources Division to lead the project. The effort will involve coordination with a variety of groups, including the six focus parks, the NPS Inventory and Monitoring Program, the Water Resources Division, the U.S. Fish and Wildlife Service, USGS, and others.

Courtesy of Karen Selleck

Mosquito surveillance in the National Capital Region

In 2001 the National Park Service stepped up efforts to monitor mosquitoes, carriers of West Nile Virus, in the nation's capital. West Nile Virus can result in fatal swelling of the brain in humans and wildlife, and is a particular threat to wild birds, especially crows. During the year, the National Capital Region hired three biological science technicians to sample mosquitoes at parks in the region for viral analysis. Extended wet periods and the invasion of a mosquito species new to the area had likely led to an unprecedented number of public complaints about the biting pests in 2000 and 2001. These complaints and increasing concern over the spread of the virus led managers to establish the program. Surveillance was based on a regional West Nile Virus Management Plan, prepared with the help of Dr. Howard Ginsberg of the USGS Biological Resources Division at the University of Rhode Island and staff of the Natural Resource Program Center.

The mosquito catch was greater at some of the developed collection sites, like the Old Stone House, than in natural areas. This may be due to the many small breeding sites, such as backed-up gutters, clogged storm drains, and dumped tires that are often found in the city, and the lack of natural checks and balances. Two mosquito genera in the region are known vectors of West Nile Virus: *Culex* and *Aedes*. The mosquito catch from field sampling was submitted to the Fort Meade Center for Public Health and Preventive Medicine for viral analysis. All results from the region were negative. The National Park Service is using the information in public education programs and will continue to monitor for the virus.

Battling alien fish in Yellowstone Lake

The war against the nonnative lake trout in Yellowstone Lake escalated in 2001 when the fishery staff of Yellowstone National Park launched a new boat that more than doubles their gillnetting potential. The boat pays out 6,000 feet of net each trip. The results in 2001 were notable as operations yielded 15,496 lake trout from Yellowstone Lake. But in a body of water that covers 139 square miles and is up to 390 feet deep, reducing the lake trout population still poses a daunting challenge. Each mature lake trout can consume 50 to 90 native cutthroat trout a year, and cutthroat trout numbers have been lower in recent years than at any time during the park's 25-year monitoring effort. This could ultimately affect 42 species of mammals and birds that feed on the cutthroat trout. Although the lake trout may have been illegally planted in Yellowstone Lake as much as 20 years ago, their presence was not confirmed until 1994, by which time they had become well established. Since 1995, gillnetting has removed more than 43,400 lake trout. Anglers also have contributed substantially in the removal, taking more than 10,000 lake trout from 1995 to 2000.

In their efforts to continually improve on a strategy that will remove as many lake trout as possible while minimizing the unwanted catch of cutthroat trout, the fishery staff have had to apply the results of ongoing research on where the lake trout reside and spawn. With threats also posed by other nonnative organisms—the parasite that causes whirling disease and the New Zealand mud snail—in 2001 all of Yellowstone's native fish species throughout the park were placed under the catch-and-release angling policy for the first time.

Award-winner Profile

Hawaii Volcanoes resource manager honored

The Director's Award for Natural Resource Management was presented in October 2001 to Tim Tunison, Resource Management Specialist at Hawaii Volcanoes National Park. As early as 1986, Tunison led and documented experiments to remove exotic plants in very small areas called special ecological areas (SEAs), and focused on methods that encourage native species to reestablish. He collaborated with scientists to use SEAs as living laboratories, formulating and testing hypotheses about native ecosystems and their vulnerability to exotic plant invasions, and devising practical techniques to restore and protect native systems. As a result, Tunison and his resource management crew have effectively restored native ecosystems ravaged by exotic plant infestations in the park—a task some thought was hopeless. His successes over the long term have encouraged all the NPS land managers of the Pacific Islands to reconsider their techniques for managing exotic species.

"The problem with exotics in Hawaii is a big one, which has led some people to say it is impossible. Sure, it is a big job, but there is hope because we have made a lot of progress in restoring native ecosystems. What we learn here is important because parks in the mainland will be confronted with similar problems over time," says Tunison. "As for the award, it was fun to get my 15 minutes of fame, but creating a model that other park managers can use is what's important. Other than that, my kids really loved the sculpture of the buffalo that was presented as the award. The Park Service really got that right."

Restoration

"In the face of ever diminishing biodiversity throughout the world, our national parks should be models of healthy, natural, sustainable ecosystems."

—National Park System Advisory Board

Rachel Mazur

The National Park Service is pursuing not only groundbreaking ecological restoration efforts to return individual species to their former ranges but also complex initiatives to revitalize entire natural communities. Many of these efforts reached significant benchmarks in 2001 through the dedication and expertise of NPS biologists, hydrologists, geologists, soil scientists, veterinarians, engineers, facility managers, and many valued partners. Over time, it has become increasingly clear that successful restoration activities require a sophisticated knowledge of how species interrelate with their habitats, which makes ongoing scientific research in the parks all the more critical. The projects featured in this chapter range from a remarkably successful effort to return the gray wolf to Yellowstone after a 60-year absence to restoration of the entrance to world-renowned Lechuguilla Cave, the first project of its kind in the world.

Restoration of mountain yellow-legged frogs in Kings Canyon

By Harold Werner

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The mountain yellow-legged frog, *Rana muscosa*, is endemic to the Sierra Nevada and some mountains in southern California. It is the only large frog in the high Sierra and an important part of the alpine and subalpine environment where lakes are naturally free of fish. Historically, backcountry visitors could see hundreds of these frogs along the shores of individual lakes, and thousands of their large tadpoles could be seen swimming in the clear water. Today they are rarely observed.

The mountain yellow-legged frog is a rapidly declining species in the Sierra Nevada. The U.S. Fish and Wildlife Service has found sufficient evidence to warrant its designation as a federally endangered species. Science has shown that introduced fish are a primary cause of their decline in some portions of their range, and that frogs will repopulate areas after fish have been removed if adjacent donor populations exist.

Other stressors also threaten the species' survival. Diseases, particularly chrytrid fungus infections, kill large numbers of frogs. Growing evidence suggests that airborne pesticide drift from the San Joaquin Valley may be a serious cause of decline in large portions of their range. Science is attempting to understand these threats but is still far from providing effective tools for species management.

The seriousness of the decline prompted the park to explore options for meaningful recovery where sufficient information supported by research was available. The park lacked the scientific information needed to develop a comprehensive long-term program, but wanted to take some immediate actions toward restoration. Four alternative recovery prescriptions were developed, and an environmental assessment was prepared. In developing the alternatives, staff focused on proven methods and avoided actions that were most likely to generate controversy, such as the use of fish poison. Though labor-intensive, much of the public support came from park staff's willingness to use gill nets to eradicate introduced fish from lakes. This approach effectively eliminated social and biological concerns associated with the use of fish poison. Professional herpetologists identified sites with a high probability for success. The park received 167 comments with 80% support for the preferred alternative, clearing the way for removal of fish from 11 lakes and associated stream segments.

A crew began removing fish from lakes using gill nets on June 26, 2001. By the end of the field season, they had removed 1,665 fish from 6 of the 11 lakes. The effort involved 14,479 net-hours (1 net hour = 1 gill net used for one hour). The crew removed 81 additional fish from adjacent streams using an electrofisher, a device that electronically stuns the fish. Other fish were herded downstream into the lakes, where they could be captured in gill nets. Removed fish included 937 eastern brook trout and 728 hybridized golden trout. Gill nets consisted of six panels with mesh sizes from 10 to 38 mm, allowing capture of all sizes of fish except for that year's young. The target was to remove all fish of breeding age from lakes where fish were not native. During the next one to two years, the remaining young fish can be removed from the lakes as they grow.

In conjunction with fish removals, the crew is monitoring frog populations at targeted sites to document recovery. The restoration team found mountain yellow-legged frogs in the vicinity of all restoration sites. Based on previous research, recolonization is expected to begin even before all fish have been removed. In the meantime, information is being collected for a programmatic environmental document that will examine alternatives for managing all human-related threats to frogs in the park.

"Much of the public support came from park staff's willingness to use gill nets to eradicate introduced fish."

Roland Knapp

Rachel Mazur

A resource manager (facing page) sets a gill net in a high-elevation lake in Kings Canyon National Park in an effort to restore the mountain yellow-legged frog (above). Nonnative fish are removed from lake and stream habitat by gillnetting and electrofishing (left), reducing competition with the rapidly declining frog species.

Restoration of the Lechuguilla Cave entrance entailed lowering sections of stainless-steel culvert into the cave (Left), backfilling around them, and sealing the top with an airlock (middle). The first of its kind, the new entrance prevents air exchange through the artificial cave opening and allows safe access for researchers (right).

(Left and middle) NPS photo by Mark Bremer; (Right) NPS photo by Stan Allison

Breathing space at Lechuguilla Cave

By Jason M. Richards

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With the 2001 completion of a new airlock and culvert at its entry, Lechuguilla Cave can finally breathe a sigh of relief. In 1914, Lechuguilla Cave was mined for guano. By 1986, cavers recognized the possibility of an extensive cave system and excavated an opening into the depths of the cave. The need for safe access for scientists and exploration teams through the breakdown rubble of the excavation site led to the installation of a 24-inch-diameter, galvanized road culvert with an interior ladder. Although the culvert solved the problem of safe access, it had a problem of its own.

"Constant changes in barometric pressure eventually caused the culvert access to deteriorate."

Constant changes in barometric pressure eventually caused the culvert access to deteriorate. In periods of high barometric pressure the interior of the culvert was usually dry owing to the cave inhaling outside desert air. During times of low barometric pressure the cave would exhale the moist air from its interior, creating a very wet environment on the culvert's interior walls. The extensive size of the cave, which includes 107 miles of mapped passageways, allowed air exchange through the culvert at a rate that sometimes exceeded 60 miles per hour depending upon the outside barometric pressure. Cave Resource Office staff, explorers, and scientists agreed that this substantial air exchange was drying out the upper passages. Although no baseline humidity data were collected before the 1986 excavation, the water level at Lake Lechuguilla in the upper passage was relatively high in the first years of exploration, and now it is almost dry. It is not known whether these drying conditions would have occurred naturally or would have been induced by changes in the rubble pile.

The need to resolve the air exchange problem coincided with the need to replace the deteriorating culvert. Adding an airlock to a new stainless-steel culvert seemed to address both problems. This solution also allowed safe access to continue for world-class scientists conducting significant research and secured the cave from unauthorized entry. An environmental assessment was prepared and sent out for review in February 1999. A year later, the process of removing the old culvert began, followed immediately by construction of the new stainless-steel airlock and culvert. Stabilization of the 30-foot-deep, 60-degree-angle shaft created a problem that was solved by the same plastic netting used to stabilize roadsides during construction. The airlock's two doors, one for entry into the airlock and one that seals the culvert, have virtually eliminated barometric air exchange through the access structure.

The significance of Lechuguilla Cave research was another factor in the airlock and culvert installation. Lechuguilla Cave's microbial ecosystems are in the forefront of cave microbiology. Important studies include Dr. Larry Mallory's discovery of microbes that may aid in the cure of certain cancers. Dr. Penny Boston and Dr. Diana Northup have discovered sulfur-reducing bacteria and microbes from the archaea family. Speleothems or cave features have been found in Lechuguilla that are found in no other known cave in the world.

The construction of the airlock and culvert was a tremendous undertaking that required a little over two years and $79,000 from the Recreational Fee Demonstration Program to complete. Thanks to the efforts of many volunteers and a dedicated staff, the project was a total success.

National Park Service to share science role in Everglades restoration

By Thomas Van Lent

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With the passage of the Water Resources Development Act in December 2000, restoration of the Florida Everglades moved from concept to implementation. Incorporated within this legislation was the "Restoring the Everglades: An American Legacy Act" that envisions the largest ecosystem restoration program ever undertaken in the world. This conceptual plan is estimated to cost $7.8 billion and require 36 years to complete. One half of the funds are to come from the federal government, the other half from the State of Florida. The plan is authorized in its conceptual form as "a framework for modifications and operational changes to the Central and Southern Florida Project that are needed to restore, preserve, and protect the South Florida ecosystem while providing for other water-related needs of the region, including water supply and flood protection." The legislation authorizes the Comprehensive Everglades Restoration Plan, which is conceived as perhaps our last best chance to save what is left of the Everglades and to restore it to a healthier, naturally functioning system.

Congress accorded the Department of the Interior a significant role in the implementation of the plan. Interior manages more than 3.5 million acres of wetlands and submerged lands and resources. According to the senate report accompanying the bill, the protection and restoration of these departmental lands and waters is the primary federal interest in the plan. The secretary of the interior was given a concurrence role on the regulations that guide implementation, and along with the secretary of the army, is charged with reporting to Congress at least every five years on progress toward restoration.

Three units of the National Park System are directly affected by the restoration effort: Everglades National Park, Big Cypress National Preserve, and Biscayne National Park. All three units were active participants in the development of the Comprehensive Everglades Restoration Plan. Maureen Finnerty, Superintendent of Everglades National Park, sees a critical role for the National Park Service: "The National Park Service will continue to be an advocate for environmental restoration, not just for the parks, but for the entire ecosystem." The South Florida Natural Resources Center at Everglades National Park has received a $5.5 million funding increase to support its participation. The National Park Service will focus its efforts on those projects that most directly affect its lands and waters in south Florida.

The Comprehensive Everglades Restoration Plan relies heavily on "adaptive management." The historical characteristics and operation of the Everglades are not completely known to science. Adaptive management will provide necessary flexibility so that if restoration actions do not achieve the desired or highest levels of natural system recovery, projects can be refined to try a different approach or technology. This process is also continuously monitored by an independent scientific peer review process established in the legislation. Robert Johnson, director of the South Florida Natural Resources Center, envisions the National Park Service bringing its considerable scientific expertise into the implementation process to guide restoration. According to Johnson, "success will require an interdisciplinary effort among ecologists, hydrologists, researchers, engineers, and planners. The Park Service's long experience with interdisciplinary teams, in monitoring ecosystems, and scientific investigations of trends will prove invaluable in the adaptive management process."

The National Park Service is currently working with its sister Interior bureaus, the U.S. Fish and Wildlife Service and the U.S. Geological Survey, on a coordinated effort to evaluate and improve the components of the plan, as well as to guide scientific investigations to ensure the Comprehensive Everglades Restoration Plan is based on sound science. The individual bureaus will work in the implementation process, which is led by the Corps of Engineers and the South Florida Water Management District, to make the Everglades restoration a reality.

Courtesy of Jeff Sellack

(Top) Competition for water and flood control measures led to the decline of the Everglades ecosystem over the past several decades. Recent legislation commits the federal government and the State of Florida to a series of projects over the next 36 years to restore seasonal variations in water flow through the vast and once vibrant marsh system.

(Bottom) An indicator of Everglades health, the endangered snail kite relies on a steady diet of apple snails from the Everglades marsh. In January 2002, the president and Florida Governor agreed to joint funding of the planned restoration and ensured adequate water availability to restore the natural system.

California condors return to the Colorado Plateau

By Elaine Leslie

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Numbering 30 in the wild in Arizona, California condors are commonly seen along the North and South Rims of Grand Canyon National Park. Restoration of the species in Arizona began in 1996, and in 2001 a condor laid an egg in the park, which later broke (below). In February 2002, two condor pairs nested below the South Rim, again raising hopes for successful reproduction of the species.

"For the first time in more than 100 years, a California condor laid an egg in the wilds of Arizona."

Spring 2001 brought a significant event to the hidden ledges and caves within Grand Canyon National Park. For the first time in more than 100 years, a California condor laid an egg in the wilds of Arizona. Although the condors promptly broke the egg, the event still raised hope for the restoration of an extirpated species in the skies over the Colorado Plateau.

The discovery of the egg came at an opportune moment for the condor restoration program, which was about to enter into a five-year review of reintroduction efforts. The program has been under fire lately by scientists who argue that too many of the released birds are dying. In spite of aversive training and conditioning to keep condors away from humans and human structures, condors continue to be killed by collisions with power lines, consumption of antifreeze, and lead poisoning. These dangers create a quandary for biologists trying to restore the species in both Arizona and California. How can they release these endangered creatures back into a world where such threats still await them?

At Grand Canyon National Park, staff biologists take a proactive approach. Power lines and poles throughout the developed zone have been fitted with devices to deter collisions. Human structures where condors are tempted to perch or roost have an aluminum wire deterrent called Nixalite temporarily affixed to the rooftops to prevent landing. A condor biologist constantly roves areas of high visitor use in hopes of reducing human and condor encounters.

Despite these efforts, lead poisoning remains a problem for scavenging condors. Many biologists hypothesize that ingestion of lead bullets found in animal carcasses may have been a primary factor in the decline of condors. To address this concern, rangers in the park use copper slugs to dispatch animals wounded by vehicles. The park plans to switch to a "green" bullet developed by the U.S. Army that is made of tungsten combined with tin or nylon when it becomes available in summer 2002. Additionally, the park is concerned about other forms of lead in the environment, such as paint, and has applied for funding under the Natural Resource Preservation Program to identify and mitigate their sources.

The existing release and monitoring program is an important aspect of the recovery efforts, but more scientific data collection is being encouraged to analyze habitat use by the birds. The park will use the data in park planning, preparing National Environmental Policy Act documents, and analyzing potential impacts of recreation. Park staff, the U.S. Fish and Wildlife Service, and the Peregrine Fund continue to work closely with adjacent land management agencies, such as the Bureau of Land Management; USDA Forest Service; and Navajo, Hualapai, and Havasupai Tribal Nations, to prepare for challenges in the upcoming breeding season.

To meet those challenges, the ecological aspects of recovery efforts must be given high priority. Preserving the species is not enough. Data on distribution, abundance, and ecological relationships of the California condor must be collected and examined to ensure that suitable habitat for survival and reproduction is available, inside and outside park boundaries, to reach the long-term goal of a viable yet unmanaged population of condors in the wild.

Wolf restoration in Yellowstone successful beyond expectations

By Douglas W. Smith, Roger J. Anderson, and Julie Mao

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Reintroduction of 31 gray wolves into Yellowstone National Park in 1995 and 1996, after a 60-year absence, has proved to be a remarkable success story for the National Park Service, ushering in a new ecological era for the greater Yellowstone area. Approximately 216 wolves now reside in this area, comprising 24 packs with 14 breeding pairs that produced 77 surviving puppies. Ten of the packs make their home in Yellowstone National Park.

The goal of the wolf restoration program is to maintain 30 breeding pairs throughout the three Rocky Mountain recovery areas—greater Yellowstone, central Idaho, and northwest Montana. Once 30 pairs reproduce for three successive years, the gray wolf can be removed from the endangered species list in Idaho, Montana, and Wyoming.

The restoration program reached several important milestones in 2001. Biologists determined that the number of breeding pairs in the recovery areas had reached 30 late in 2000, meeting the population criteria necessary for delisting the wolf for the first time. These gains were solidified in 2001 when the number of reproducing pairs increased to 35, further ensuring the population's recovery. Wolves could be recommended for delisting as early as 2003 if the population criteria are met for the third year.

Congressionally decreed public land policy had mandated predator removal, especially of wolves, and by 1926 Yellowstone's top carnivore was gone. Missing, too, was the critical role wolves played in the ecosystem. Animals that can affect a broad array of other animal and plant species, like wolves, are called "keystone species" and often enhance the biodiversity of a natural system.

Now that wolves have returned to the greater Yellowstone area, will they fulfill their role as top carnivores? So far, wolves have not impacted the elk population, although elk make up 87% of their diet. Prey populations fluctuate for many complex reasons with weather and predators being the two most important factors. A catastrophically severe winter from 1996 to 1997 lowered the elk population by several thousand; however, a series of mild winters helped the population bounce back, even with a restored wolf population. In addition to wolves, five other species, including humans, prey on elk; yet, the elk population has increased in recent years.

If the elk population has not changed, have wolves had an indirect effect on elk? Fortunately, data are available on elk before wolf reintroduction. These data also precede the 1988 Yellowstone fires, another major ecological jolt to Yellowstone and a factor that complicates analysis. To date, researchers using radio collars have found little change in elk habitat use before and after wolf reintroduction. The only significant change detected was that elk have been summering at higher elevations since the wolves were reestablished. This could also be due to other factors, such as the drought conditions that have prevailed since the reintroduction effort began. Elk might venture to higher elevations in search of forage less affected by drought.

It is still too early to know what the ultimate influence of wolves will be on the Yellowstone ecosystem. Other studies have revealed increases in biological diversity with carnivore restoration. Already, wolves have dramatically lowered the coyote population, which will likely influence other species. Other findings indicate that improved aspen growth occurs in areas with high wolf activity, but low elk use. Besides aspen and elk, many other plant and animal species stand to gain from the restoration of this long-absent, keystone carnivore. What is clear is that wolf restoration in Yellowstone has been successful beyond all expectations. The greatest victory of the effort to restore wolves to the greater Yellowstone area may be a philosophical one: An attempt has been made to restore all of the parts and processes of a natural ecosystem.

"Reintroduction of 31 gray wolves into Yellowstone National Park … has proved to be a remarkable success story for the National Park Service."

Wolf recovery in the greater Yellowstone area has exceeded all expectations. The species reached the minimum required population size for delisting of at least 30 breeding pairs in the three recovery areas (Yellowstone ecosystem, central Idaho, northwest Montana) in 2000 and 2001. Once wolves maintain these population levels and state management plans are approved, they will be delisted under the Endangered Species Act.

Completed restoration.

After excavation.

Excavation in progress.

Before restoration.

Wetland and stream restoration at Elk Meadow in Redwood National Park

By James H. Popenoe

Dedication ceremonies were held May 5, 2001, at Redwood National and State Parks to celebrate the opening to the public of the Elk Meadow Day Use Area. The new facility provides parking, rest rooms, picnic areas, visitor information, and a network of trails. The dedication ceremonies cap a complex and remarkable effort that involved not only the construction of a major public facility but also a major restoration to enhance wildlife habitat and natural values that had been seriously degraded.

Before they were acquired in 1996, a lumber mill and a log storage area or "deck" occupied the Elk Meadow site. The mill owner had built the deck in 1967 on fill placed in a wetland below the mill, diverting the mountain stream that fed the wetland through a small culvert beneath the deck. Amazingly, park biologists found salmon species still in the creek above the culvert. The site offered tremendous potential to restore essential habitat for sensitive species.

The restoration geologist used old aerial photographs to estimate the creek's likely route before construction of the deck. Excavation exposed native soils and confirmed the creek's original location. Through this process other original landforms gradually came into view. Park Service restoration activities included removing and recycling 8 acres of asphalt and excavating approximately 30,000 cubic yards of fill to restore 3 acres of wetland and 650 feet of stream channel buried under the former log deck. Most of the fill was relocated to the slope from which it had originally been taken to construct the deck; the balance was used as the base for the new parking lot and picnic area.

Moved earth was shaped and sloped to provide appropriate drainage, then covered with woody

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debris and mulch to control surface erosion. Elevation surveys were completed to provide a baseline against which to measure potential future landform changes. The new wetland was 2 feet lower than the surrounding terrain, which park staff surmise occurred when the ground settled under the immense weight of the deck.

For the revegetation phase of the project, the restoration ecologist chose species from reference sites in the immediate area, specifying a well-dispersed, local collection of plants to preserve genetic integrity and maximize genetic diversity. Monitoring results indicate that natural recruitment probably influenced vegetation development more than did planting efforts. Flooding carried the seeds of invasive plants from nearby pastures into the site, which required extensive weeding to control. Fortunately, reexposing the wetland's topsoil brought buried seeds of native wetland plants to the surface, where they germinated. Additionally, the wind carried a rain of native alder and willow seeds to the site. These tree species eventually outnumbered planted trees by 10 to 1.

When monitored in summer 2000, native plants had achieved a slight edge over exotics. By summer 2001, natives had increased their lead and were generally the taller plants. Although not dominated by exotics, the species composition of the new wetland differed from the reference sites because of the impacts of a large local population of Roosevelt elk *(Cervus elaphus)* that depleted accessible young woody plants.

One goal of the restoration was to restore in-stream coho salmon *(Oncorhynchus kisutch)* juvenile rearing habitat, but it was predicted that restoration would also benefit other species of fish over time. This prediction came true. Park fish biologists monitoring the Elk Meadow site for two seasons have found a wide variety of aquatic species using the area, including red-legged frogs, Pacific giant salamanders, rough-skinned newts, juvenile steelhead, cutthroat trout, and juvenile coho salmon.

Ecological recovery is under way at Elk Meadow, but the story remains incomplete. Over time, landforms will adjust and native plants and animals will be at home on the newly restored site.

"The dedication ceremonies cap … a major restoration to enhance wildlife habitat and natural values that had been seriously degraded."

Restoration of the three-acre Elk Meadow (opposite, series of four photos) took two years and involved the technical expertise of NPS geologists, hydrologists, ecologists, soil scientists, botanists, and crews responsible for moving earth and planting vegetation (opposite, bottom). What once a sawmill and log storage area (below) was transformed into a visitor day-use area and habitat for elk, salmon, and many other species in 2001.

Award-winner Profile

Botanist honored with first professional excellence award

Tamara S. Naumann, botanist at Dinosaur National Monument, Colorado-Utah, was the first recipient of the Director's Award for Professional Excellence in Natural Resources. The new award recognizes subject-matter specialists in various natural resource fields who foster creative and innovative resource management practices with the ability to convey this knowledge to the broader resource management community.

Despite limited funds and staff, Naumann designed and developed a vegetation management program that addresses control of weeds, restoration of native species and communities, and rare-plant research and monitoring. Each of these components has applicability to other parks and agencies on the Colorado Plateau, with strong educational elements ranging from public speaking to development of a rare-plant coloring book for youngsters. Naumann takes great pride not only in her expertise in controlling exotic plant species but also in working to build community awareness of the weed problem through a hands-on volunteer program begun in 1996. "Very few people understand that invasive plants threaten the special places we preserve in our parks," notes Naumann, who is working to change this situation.

In receiving the award, Naumann gives credit to having had a great mentor in Steve Petersburg. "It is important to recognize how significant mentors are to people like me. When people do well it's often because the people who supervise them make it possible for them to do well."

Preservation of the Fort Dupont stream

Fort Dupont Park, part of National Capital Parks-East, is one of the Civil War defenses of Washington, D.C. In addition to the historic earthen remains of the actual Civil War fort and some NPS facilities, the 376-acre park contains significant expanses of mature forests, scrub-shrub areas and meadows, and streams that connect to the nearby Anacostia River. As national park land, Fort Dupont protects this unusual urban stream system and watershed in a landscape that is largely developed.

Funded by the Natural Resource Preservation Program, the National Park Service and the USGS Biological Resources Division have been working with the District of Columbia government, the U.S. Army Corps of Engineers, and the Metropolitan Washington Council of Governments to develop means for protecting the steep, forested slopes in the park from the erosive impacts of uncontrolled stormwater flows draining from nearby residential areas. Additionally, numerous other enhancements to the stream were implemented in 2001, or were being studied. These include the reintroduction of black-nosed dace *(Rhinichthys atratulus)* and creek chub *(Semotilus atromaculatus),* pool habitat restoration, removal of failing culverts and obstacles that block fish passage, and "daylighting" a 200-meter stream reach contained in a large pipe. The restored fish survived over the winter and the presence of the year's young observed in August indicated they reproduced successfully.

Coastal dune restoration at Point Reyes

Over summer 2001, Point Reyes National Seashore initiated the first stages of a three-year coastal dune restoration project. The dunes along the Point Reyes peninsula, north of San Francisco, support 11 federally listed species, including the threatened western snowy plover and the endangered plants Tidestrom's lupine *(Lupinus tidestromii)* and beach layia *(Layia carnosa)*. These rare species and their habitat are imminently threatened by the invasive nonnative plants European beachgrass *(Ammophila arenaria)* and iceplant *(Carpobrotus edulis)*. These nonnatives form a thick mat that excludes native plants and animals. For example, western snowy plovers require open habitat for nesting. Large stands of iceplant and European beachgrass prevent these birds from nesting in the dunes, forcing them to the open beach where they are vulnerable to disturbance from park visitors and dogs. Restoration targets 30 acres near Abbotts Lagoon, a site that harbors the largest dune remnants in the park and is one of the prime attractions for park visitors.

In 2001, park staff monitored vegetation plots and nest locations and also removed target nonnative plant species. Pre-restoration monitoring enables staff to determine where and in what quantity the native species return. Native dune plants, adapted to quick colonization of open sand, have already begun spreading into some treatment areas. The restoration is part of the process to recover and delist the rare species. The undertaking is funded by the Natural Resource Preservation Program, a competitive source for resource management projects that is supported by the Natural Resource Challenge.

Bonytail restoration continues

Courtesy of John Wullschleger

In 2001 the National Park Service continued to contribute to the recovery of four species of endangered fish in the Upper Colorado River Basin. This bureau has been an active participant in the Upper Colorado River Recovery Implementation Program (UCRRIP) since its application for program membership was accepted in September 2000. Staff from Dinosaur National Monument assisted other agencies in stocking 13,000 bonytail *(Gila elegans)* in the Green and Yampa Rivers immediately upstream of the national monument. The stocked fish were implanted with passive transponder "tags" that will allow them to be recognized if they are subsequently captured in other river reaches.

As a UCRRIP member, the National Park Service has reviewed and provided input on a variety of documents with implications for endangered fishes and aquatic habitat in several units of the National Park System. These include recovery goals for the four listed fishes, stocking plans, and numerous scientific reports. In addition, staff from the NPS Water Resources Division have been participating in the development of the Flaming Gorge Environmental Impact Statement and are working with the Bureau of Reclamation and environmental groups to develop dam operations alternatives that will provide for the recovery of the endangered fishes and sustain river processes within Dinosaur National Monument (photo) and Canyonlands National Park.

Maintenance staff help restore native fish at Point Reyes

For years, failing culverts and a sediment control structure in Point Reyes National Seashore have hindered the passage of threatened coho salmon and steelhead trout in their annual spawning runs in this coastal California park. Following assessment by the Coho and Steelhead Restoration Project and funding by the Natural Resource Preservation Program, staff were able to leverage funding for restoration at two problem sites. Park maintenance and resource management staff collaborated on projects to remove fish passage barriers and restore habitat on streams supporting these anadromous species. Maintenance staff used their skills in operating heavy equipment to construct weirs, creating step-pool systems that facilitate fish passage and maintain streambed stability.

This work has been a success from a biological and organizational point of view. Monitoring has shown that the restoration sites function as planned. The number of adult salmon successfully passing beyond the former barrier at the first restoration site increased from 14% to 75%. Just as important, these projects facilitated on-the-job interaction between resource and facility managers and helped build a sense of ownership of these restoration sites. Enthusiasm among staff remains high with constant requests to start another restoration project.

Collaboration and Public Participation

"A sophisticated knowledge of resources and their condition is essential. The Service must gain this knowledge through extensive collaboration with other agencies and academia, and its findings must be communicated to the public. For it is the broader public that will decide the fate of these resources."

—National Park System Advisory Board

The National Park Service is increasingly working with neighboring communities and other partners to enhance park resource conservation and improve the visitor experience. Partners bring a tremendous array of skills, financial resources, and passion to park management issues. In 2001 the Park Service combined its talents with those of local, national, and international cooperators to benefit both the parks and their partners. Beyond the national parks, international partnerships hold great promise for building trust and peace, as cooperative efforts with Russian scientists to develop a brucellosis vaccine exemplify. The articles in this chapter showcase progress made through cooperation to advance scientific understanding, develop sound park management plans, and protect park natural resources. Cooperative activities and public involvement offer a fundamental and meaningful tool to secure the health and vitality of our national parks for the future.

Public involvement at Blue Ridge Parkway

By Bambi Teague and Chris Ulrey

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Locals know the Devil's Courthouse as the must-see view along the Blue Ridge Parkway. For 30 years solo rock climbers and groups from youth camps within a 300-mile radius have seen this unusual formation as a challenge to their climbing skills. Biologists recognize it as a fragile habitat, home to four rare plant communities and 13 rare plants. With its ever-increasing popularity, the Devil's Courthouse is in trouble. As visitor use has increased, the natural resources have deteriorated. Much of the vegetation has been trampled, leaving soil to erode.

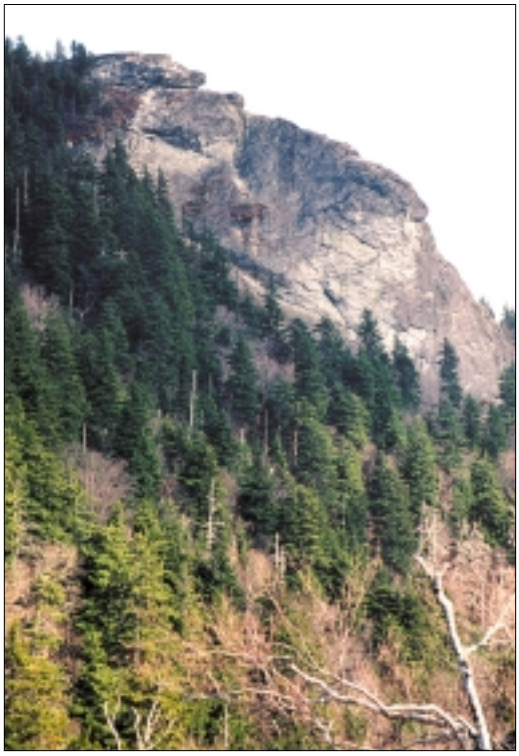
To avoid permanent damage to the site, a decision on how to manage Devil's Courthouse was greatly needed. Involving the public in the decision-making process was critical to its success, so 2001 was dedicated to a lengthy but productive effort to include the public as partners in resource management. The first, and perhaps most important, step was to rove the site to talk to users about their concerns. Working on a personal level, the park was able to establish a trusting relationship between park managers and users.

The park's next step was to hold a public meeting. The purpose of the public meeting was twofold: to inform the public of the site's significance and alert them about declining conditions and to gather input on options for reducing impacts to the site. During the first meeting, park staff made a brief presentation on the overall significance and current condition of the site and quoted comments solicited from local scientists before the meeting. After the presentation, all meeting participants acknowledged the importance and urgency of the site. The park received many comments and options for reducing impacts to the site during the meeting and later by mail.

After reviewing all sources of input, the park held a second meeting to present the pros and cons of all alternatives, including the park's preferred alternative of maintaining the existing trail to the summit while closing all use beyond the summit. The data alone confirmed that no other alternative could provide the necessary protection of the site. An attendee at the second meeting, a member of the rock-climbing community, stated that though he was not pleased with the preferred option, he did not see any other way to protect the site. He thanked the National Park Service for allowing him to voice his concerns. Another walked away shaking his head: "I am really going to have to reflect on why I can accept closing the site if peregrine falcons were to nest there, but not if rare plants occur there. I never thought I would come out of this meeting needing to reflect on my own flaw."

This process was extremely productive because the final decision was based upon all available information and the users understood the critical decision to be made. One USDA Forest Service employee commented that his agency could learn a lot from the National Park Service. Indeed, staff of the Blue Ridge Parkway hope that the National Park Service and others will find utility in the approach of engaging the public in reaching management decisions.

"… 2001 was dedicated to a lengthy but productive effort to include the public as partners in resource management."



A combination of public involvement and scientific information recently led to a decision, endorsed by the public, to halt off-trail use—including rock climbing—of Devil's Courthouse (Left) in Blue Ridge Parkway, North Carolina. The decision protects mountain or spreading avens (*Geum radiatum*—opposite page), a federally listed endangered plant species, but continues to allow trail access to the summit.

Located 56 miles south of Moscow, Priosko-Terssny State Nature Preserve is the Russian home of the European bison and will be participating in the cooperative research.

Russian scientists help seek brucellosis solutions for Yellowstone

By Glenn Plumb, Wayne Brewster, and Margaret Wild

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State and federal records of decision were signed to implement a new long-term bison management plan for Yellowstone National Park and Montana in 2000. The plan focuses on preserving free-ranging bison *(Bison bison)* and reducing the risk of transmission of brucellosis from bison to cattle that graze on lands adjacent to the park (see following article). An important component of brucellosis risk management at Yellowstone National Park is the eventual use of a safe and effective brucellosis vaccine for bison. In 2001, through an innovative partnership, park resource management staff from Yellowstone National Park participated in the development and implementation of new Russian research to supplement U.S. research in brucellosis vaccine development.

During the Cold War, a great deal of research was done on brucellosis in the former Soviet Union. *Brucella abortus,* the bacterium that causes the disease, was identified as an important pathogen with potential use as a biological weapon. Soviet scientists were given extensive resources to study the disease and vaccines to prevent it. Collaborating with Russian scientists on brucellosis research presented an opportunity to speed the development of an improved vaccine for Yellowstone bison.

National Park Service participation in the research effort was made possible through an innovative partnership sponsored by the U.S. Defense Threat Reduction Agency, the World Foundation for Environment and Development, and the Nuclear Threat Initiative. Investigations will be conducted primarily by three Russian research institutes, including the Research Center of Toxicology and Hygienic Regulation of Biopreparations, the State Research Center for Applied Microbiology, and the All-Russian

Research Veterinarian Institute. The Russian home of European bison *(Bison bonasus)* is the Priosko-Terssny State Nature Preserve, which will also participate in the project.

With support from the private sector and the U.S. Defense Threat Reduction Agency, NPS staff from Yellowstone National Park and the Biological Resource Management Division in Fort Collins, Colorado, traveled to Russia to discuss the status of Russian brucellosis vaccine development. Park Service staff also sought to impart a better understanding of Yellowstone's brucellosis risk management needs to inform the development of collaborative investigations. In September 2001 a Russian scientific delegation traveled to the United States to meet with cooperating experts and visit Yellowstone National Park to view America's wild bison. A leading Russian brucellosis scientist, Dr. Roman Borovick, summed up the Russian team's reaction to the park by recalling that, as a boy, he had been amazed to see "a large green spot on a U.S. map." He added that he could not imagine that in his lifetime he would ever visit such a natural wonder in the heart of America.

Although project success is not guaranteed, the National Park Service is very proud to participate in efforts to strengthen cooperation between the United States and Russia in connection with development of valuable nonmilitary uses of former Soviet bioweapons science, a perspective applauded by all sides.

Russian hospitality is evident in discussions of a safe and effective vaccination for free-ranging bison that might have application in Yellowstone. Pictured from left to right are Dr. Calvin Carpenter, U.S. Army; Chris Robinson, U.S. Civilian Research and Development Foundation; Dr. Alexander Denisov, Russian Research Center of Toxicology and Hygienic Regulation of Biopreparations (RCT&HRB); Dr. Jim Wolfram, U.S. Defense Threat Reduction Agency; and Dr. Roman Borovick, RCT&HRB.

"Collaborating with Russian scientists on brucellosis research presented an opportunity to speed the development of an improved vaccine for Yellowstone bison."

Long-term bison management plan for Yellowstone and Montana

During the 1980s and 1990s, when bison that left Yellowstone National Park were killed as a control measure, a national debate began over the objectives that should guide stewardship of this treasured resource. In December 2000 the National Park Service, the U.S. Department of Agriculture's Animal and Plant Health Inspection Service, and the USDA Forest Service completed the Record of Decision on the Joint Management Plan for Bison in Yellowstone National Park and Montana. The plan is designed to preserve the largest wild, free-ranging population of bison in the United States while minimizing the risk of brucellosis disease transmission between bison and cattle.

The plan reflects a commitment on the part of federal and state agencies to limit the killing of bison outside Yellowstone National Park by allowing some bison to use some winter range on public lands adjacent to the park. Through adaptive management, the plan progresses to management steps during the next several years that will eventually allow limited numbers of untested bison on public land outside the park during the winter when cattle are not present. Key management elements include monitoring and hazing bison, capture of bison at or outside the park boundary when hazing is unsuccessful, shipment to slaughter of captured bison that test positive for the disease, and holding or releasing healthy bison in management zones outside the park during the early stages of the plan. Another important element is the eventual vaccination of free-ranging bison in the park with a safe and effective brucellosis vaccine (see accompanying article).

Park Flight Program protects migratory birds beyond the United States

By Carol Beidleman

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"The National Park Service is broadening its involvement with other national and international bird conservation initiatives."

The National Park System provides critical habitat for many species of migratory birds, from raptors and shorebirds to songbirds. Continental and local declines in these bird populations have led to concern for their future. Because these species use national parks on a seasonal basis, their protection cannot be ensured without conservation efforts occurring in the habitats the birds use throughout the year. This requires collaborative, coordinated programs between the United States and Latin America, such as the Park Flight Program, to protect breeding, migration, and wintering habitats, as well as a proactive migratory bird conservation program within the National Park Service.

The Park Flight Migratory Bird Program works to protect shared migratory bird species and their habitats in both U.S. and Central American national parks and protected areas. The program develops bird conservation and education projects and creates opportunities for technical exchange and cooperation. The assistance is integrated and focuses on two areas of migratory bird conservation: (1) species assessment, protection, and management; and (2) park interpretation, environmental education, and outreach.

Park Flight is an innovative partnership between the National Park Service, National Park Foundation, and National Fish and Wildlife Foundation/USAID, and is made possible through the NPS Natural Resource Challenge and the generous support of American Airlines. Technical direction is provided through the University of Arizona Desert Southwest Cooperative Ecosystem Studies Unit and the NPS Biological Resource Management Division.

Calendar year 2001 was a banner one for the Park Flight Program, with many accomplishments. In collaboration with the National Park Foundation, Park Flight funded bird conservation and education projects in 13 U.S. national park units, including Sequoia and Kings Canyon, North Cascades, Bandelier, Pecos, Aztec Ruins, Capulin Volcano, Fort Union, New Jersey Coastal Heritage Trail, Cuyahoga Valley, Great Smoky Mountains, Golden Gate, and Point Reyes.

An agreement with the National Fish and Wildlife Foundation facilitated funding of migratory bird conservation and education projects in Central American national parks and protected areas in 2001, including Guatemala, El Salvador, Nicaragua, Honduras, Panama, and Mexico. This is the first time the National Park Service, National Park Foundation, and National Fish and Wildlife Foundation have partnered on a program of this scope. The National Fish and Wildlife Foundation is an important partner because of its long-standing presence in Central America and success in assisting with projects in the region.

In addition to initiating these bird conservation and education projects, the Park Flight Program implemented a program of technical assistance, including workshops, personnel exchanges, and participation of Central American professionals in U.S. national parks through the NPS Office of International Affairs. A workshop for Park Flight grantees from U.S. and Central American national parks and protected areas was held at the Grand Canyon Albright Training Center. Staff of the Chocoyero El Brujo Wildlife Refuge in Nicaragua received assistance from an NPS landscape architect who designed a boardwalk and viewing platform at an important site for resident and migratory birds. An NPS wildlife biologist from Sequoia and Kings Canyon National Parks provided instruction to biologists and park guards in bird monitoring techniques at the Cerro Azul Meambar Protected Area, Honduras. Interns from Nicaragua and Mexico assisted with Park Flight bird monitoring and education efforts at Sequoia, Kings Canyon, Point Reyes, and Golden Gate.

The National Park Service is broadening its involvement with other national and international bird conservation initiatives, such as the North American Bird Conservation Initiative and Partners in Flight, and collaborating with other agencies and partners on migratory bird conservation. In March 2002, the Park Flight Program won the Director's Award as part of the National Park Partnership Awards.

(Top) Panamanian schoolchildren dress in Harpy eagle costumes as part of the environmental education component of the Park Flight project in Panama. Also focusing on migratory shorebirds, the project's goal is to engage rural communities in the conservation of both important migratory and resident species.

Nicaraguan biologist Salvadora Morales holds a Wilson's warbler, captured at a banding station in Kings Canyon National Park, California. As an international intern with the Park Flight Program, Morales worked with park staff banding and interpreting Neotropical migratory birds, like this warbler.

Technology and collaboration improve interagency fire planning

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The Southern Sierra Geographic Information Cooperative (SSGIC) was established in 2000 to develop and test collaborative approaches to landscape-scale fire management planning. The scope and complexity of fire management are increasing with more emphasis on the wildland-urban interface, integrating the role of fire in ecosystem management, and reducing hazardous fuels. Disastrous fires in the wildland-urban interface are increasing in frequency and intensity with large economic losses and increasing threat to public and firefighter safety. Effectively managing fuels in fire-dependent ecosystems such as the Sierra Nevada is growing in importance as plant communities continue to depart from their historic fire regimes and ecosystem health deteriorates. This interagency initiative focuses on technologies, including the Internet and Geographic Information Systems (GIS) to support different agencies' missions, enhance resource protection, improve public safety, protect property values, and reduce long-term costs to taxpayers.

The SSGIC project area includes six major watersheds in the Southern Sierra Nevada encompassing 4.7 million acres. Member agencies include the Bureau of Land Management, USDA Forest Service, California Department of Forestry and Fire Protection, Kern County Fire Department, and National Park Service.

The traditional approach to fire management planning has been agency-centric, which discouraged landscape analysis and planning. The Southern Sierra Nevada has highly fragmented ownership and experiences substantial and increasing human encroachment on native ecosystems. Increased fuel loads after nearly 100 years of fire suppression have made cooperative planning an important goal. A significant impediment to successful collaboration has been technical issues associated with assembling interagency data sets and developing analyses that meet the goals of all agency missions. Additionally, each agency has its own business processes and standards for developing and managing its own data.

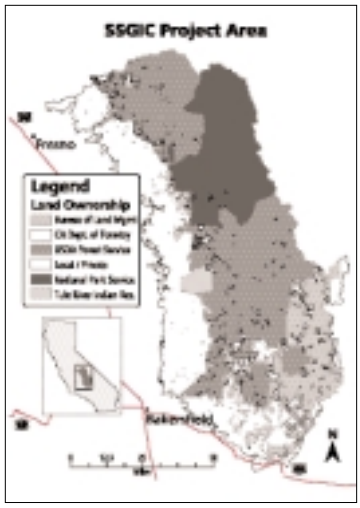
The process of assembling "best available data" from the source agencies is a daunting and continuous task. Data related to fire, for example fuels, are dynamic and should be updated annually to improve the reliability of analyses and other applications. These problems reinforce the nationally recognized need for common fire data standards and business practices. Therefore, the SSGIC project is analyzing interagency differences between current data and business processes and developing strategies for improving long-term collaboration.

To provide effective analytical tools, the local fire and GIS community continued a series of workshops in 2001 to develop analysis models and an implementation process. The process combines the "risk" of an ignition with a "hazard" value describing the potential fire behavior and a "value" factor that considers both the values at risk of loss due to fire as well as the benefits of fire to ecosystems. The individual analyses will be integrated and maps produced to provide fire managers with previously unavailable information for collaborative planning. To date, analyses are complete for risk, hazard, and positive ecosystem values. By April 2002 the values at risk of loss will be completed.

The Southern Sierra Geographic Information Cooperative is working with the USGS to develop a website (http://ssgic.cr.usgs.gov). It uses ArcIMS software that allows users to display data and analysis results as a map that can be printed from a Web browser. On-line mapping ensures access to the best available data and allows customization of maps to meet specific user needs. Additionally, source data and analysis outputs can be downloaded by individual watersheds and employed with the user's GIS software.

The Southern Sierra Geographic Information Cooperative is a prototype model of interagency collaboration consistent with National Fire Plan policy and focused on issues representative of those facing fire managers across the country. Experience gained from analyzing agency business practices and developing analytical models will contribute to the current nationwide initiative to develop a comprehensive, interagency fire planning and analysis tool.

"Increased fuel loads after nearly 100 years of fire suppression have made cooperative planning an important goal."



Fire planning is traditionally agency-centric, discouraging landscape or ecosystem considerations. The Southern Sierra Geographic Information Cooperative is deploying technical information management solutions to the Southern Sierra Nevada ecosystem for improved coordination in fire planning across landowner boundaries.

Work group initiated by National Park Service gains permanent support from county government

By Kathleen Kodish Reeder

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Since 1970, continuous population growth in the coastal counties of Maryland and Virginia has created an escalating threat to the habitats and quality of aquatic resources in those counties. By 1996 the increased development throughout coastal bays and associated land areas had prompted the formation of the Maryland Coastal Bays Program, a component of the Environmental Protection Agency's National Estuary Program. The strain on land and water resources has been especially evident in Worcester County, where the resident population has grown at an annual rate of 3% throughout the last decade, more than two-and-a-half times faster than the state average.

"The purpose of the GIS work group has been to support conservation planning and land use management."

Within the watershed that encompasses Worcester County is Assateague Island National Seashore, in which oceanic and estuarine waters comprise 31,000 of the park's 49,000 acres. Concern about identifying threatened habitats and restoring water resources grew as commercial and recreational fishing increased, development consumed more wetlands, and changing land use altered natural coastal processes. According to Carl Zimmerman, resource management specialist at the national seashore, in 1997 this concern prompted the park to initiate what has since become known as the Worcester Regional GIS Program to provide state and local governments the data they need to make day-to-day management decisions and implement long-range planning, such as the Comprehensive Conservation and Management Plan of the Maryland Coastal Bays Program.

The regional GIS partnership among Assateague Island National Seashore, Worcester County, and the Maryland Coastal Bays Program (Maryland Department of Natural Resources) plays a key role in promoting watershed conservation measures, such as the Rural Legacy program, that lead to park resource protection.

During the first three years of the program, the National Park Service and the State of Maryland have funded the program. The activities of the GIS analyst and technician, both employees of Worcester County, have been coordinated by a work group with representatives of the four partners: the National Park Service, the Maryland Department of Natural Resources, the Maryland Coastal Bays Foundation, and Worcester County. The GIS facility is located on Assateague Island, where the National Park Service provides GIS hardware, software, and associated equipment, materials, and supplies, in addition to supervision of the two GIS staff members. Like the National Park Service, the state and county have contributed in-kind services, such as administrative and technical support and access to relevant, nonproprietary analog and digital data.

The purpose of the GIS work group has been to support conservation planning and land use management by developing, managing, and distributing spatial information in the formats required by the partner organizations. The variety of its accomplishments has been impressive. For example, it has processed the survey data needed to identify patterns of recreational boating to guide permit activities and developed a tracking system that improves compliance with regulations, monitors waste treatment and storm water management, and supports long-range planning and rezoning efforts. In addition, they have provided data that describe the location of sensitive aquatic resources and habitats and identify critical areas for requiring naturally vegetated shoreline buffers. In fact, their analyses and supportive documentation have been instrumental in recommending alternative growth areas and supporting grant applications to secure new funding for watershed conservation initiatives by several entities in addition to the regional partners.

The Regional GIS Partnership in Worcester County has succeeded so well that Zimmerman reports, "In 2001, support for the program was affirmed by local governments with the institutionalization of base funding to support permanent staffing of the Regional GIS Program by Worcester County employees." With stable funding, the GIS staff will be able to continue developing the customized information each partner agency needs to ensure preservation of the coastal ecosystems that have made this national seashore a popular choice for visitors and residents alike.

Partners in plant protection at Capitol Reef National Park

By Tom O. Clark

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At first glance, this landscape looks barren, stretched and folded into colorful canyons that seem home to nothing but stone. Look closer and the landscape begins to share its secrets. Scattered among the sandstone, tenacious plants are tucked in rocky pockets. South-central Utah's Capitol Reef National Park and surrounding lands contain populations of more than 40 rare and endemic plant species. New plant species and varieties continue to be found in these underexplored landscapes. Capitol Reef's eight federally listed plants and one candidate for listing as threatened or endangered, representing almost half of the listed plants in Utah, make it the unit with the most in the National Park System outside Hawaii and California.

Capitol Reef shares management responsibilities for these species under the Endangered Species Act with the Bureau of Land Management and two national forests. In 1999 the agencies agreed to hire an interagency botany technician. In the past, each agency addressed rare plant work on its land as funds became available, resulting in a piecemeal approach to species management. Since the agencies share the burden of protecting these species, surveying and monitoring across agency boundaries provide essential information necessary for proper management. Each agency understands that information from another agency's land is just as valuable as information from its own land. This realization has been the key to generating support for the program by agency managers.

Opportunities for leveraging federal dollars with nonfederal partners have also been increased through establishment of this agreement. Each agency can use funds provided by another agency to leverage funding within its agency or through matching funds from nongovernmental organizations. By pooling scarce funds for threatened and endangered plant species, each agency obtains more complete information and increases personnel services for each individual agency dollar spent. The partners in this agreement are Capitol Reef National Park, the Richfield Field Office of Bureau of Land Management, and the Fishlake and Dixie National Forests.

In 2000, Capitol Reef successfully competed for Natural Resource Challenge funds that established a nucleus of nonrecurring funds for inventory of listed and rare species. This funding was the catalyst that brought the partnership to a higher level of involvement from all agencies. In 2001, Capitol Reef National Park received $53,000 of Natural Resource Challenge funds from the Natural Resource Preservation Program supplemented by donations of $4,000 from Capitol Reef Natural History Association and $1,000 from the Utah Native Plant Society. Through the agreement, the Bureau of Land Management and USDA Forest Service were able to cost-share these funds and pool $40,000 to extend surveys for the plant species onto lands adjacent to Capitol Reef. In addition to the funds provided in 2001, the Fishlake and Dixie National Forests had three biological technicians assist with survey work during peak blooming times.

Each agency is proud of the accomplishments this partnership has generated and believes this program embodies Congress's intent for rare species management as articulated in the Endangered Species Act. Information gathered from inventories will allow agencies to focus future funding and management on protection of rare species and, because of that protection, avoid the necessity of listing them in the future.

Winkler's cactus *(Pediocactus winkleri)* is listed federally as a threatened species and occurs in and around Capitol Reef National Park. A recent partnership between land management agencies near the park has increased surveys in the area for rare plants.

Tolerating dizzying heights, a field crew inventories endemic plant species in the Navajo sandstone of Capitol Reef National Park, Utah. The park's rugged topography creates habitat for rare and endemic plant species that continue to be discovered in these hard-to-reach locales.

Mountain of partnerships elevates North Cascades' monitoring capabilities

By Bruce L. Freet

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First-year funding (FY 2001) of the North Coast and Cascades Monitoring Network brought about several important enhancements to long-term ecological monitoring in North Cascades National Park and adjacent Ross Lake and Lake Chelan National Recreation Areas. Managed by the National Park Service as a group or complex, these areas were able to parlay $400,000 of monitoring funds into $890,000 to advance their park vital signs monitoring program. Collaboration within and outside the National Park Service was key to this success. First, the complex added $141,000 of its own base funding to allow its career employees to focus specifically on park and network monitoring needs. Second, inventory funds paid for surveys worth $88,000. The Northwest Forest Plan fund, the NPS Water Resources Division, and the NPS Air Resources Division applied $64,000 to a variety of park monitoring projects. The USGS Biological Resources Division contributed $150,000 for research and development of protocols for lakes and streams monitoring. Seattle City Light (SCL, a public utility), the USDA Forest Service (USFS), and Western Washington University also gave funds or in-kind services totaling $47,000. The first-year funding also paid for research, inventory, and monitoring assistance from 18 universities, agencies, businesses, and nongovernmental organizations.

The North Coast and Cascades Monitoring Network consists of seven parks in the Pacific Northwest that collaborate in order to deliver inventory and monitoring capabilities efficiently to all member parks. The North Cascades complex is a leader in the network because it began focusing on long-term ecological monitoring around 10 years ago. At that time, North Cascades was selected as a prototype park, one of 11 in the National Park System, concentrating on lakes and streams. Since then, the scope of monitoring has broadened to include all natural resources, but the primary focus remains freshwater resources—the lifeblood of this ecosystem.

The aquatic ecology emphasis is apparent in the development of inventory and monitoring protocols for the complex: glacial mass balance, surficial geology and land type assessment and mapping, watershed assessments, water quality monitoring, lake and stream biomonitoring, and stream habitat monitoring. These areas are relevant to NPS and USFS management issues, especially with the regional emphasis on salmon recovery. This focus on freshwater resources links the complex with potential partners in the Skagit Watershed Council, a collaborative group of 38 federal and state agencies, Native American tribes, companies, and nongovernmental organizations. It also facilitates leveraging of funds. Together these groups protect and restore salmon habitat on the Skagit River, a 3,300-square-mile watershed that includes much of the complex and extends into Canada. Working with the council, the complex

Stream biomonitoring at North Cascades focuses on identifying changes in the number and distribution of aquatic invertebrates like the mayfly species *Epeorus deceptivus*.

Monitoring of the freshwater ecosystem in North Cascades National Park focuses on early-warning signs of ecological change, or vital signs. As part of this program, a scientist evaluates the Chilliwack River for large woody debris, an indicator of disturbance.

persuaded Earthwatch Institute to designate the Skagit River watershed as its North American Conservation Research Center. The institute has a $5 million grant to establish five of these centers throughout the world.

In a related cooperative effort, the park has worked with the Mount Baker–Snoqualmie National Forest and North Cascades Institute since 1997 to coordinate the Skagit River Stewards program, a citizen-based, water quality monitoring program on the Skagit Wild and Scenic River. The partnership has grown to include the Skagit Fisheries Enhancement Group, a local nonprofit stream restoration organization and member of the Skagit Watershed Council. The stewards collect information on water quality and stream habitat variables at 42 watershed sites.

Seattle City Light operates three hydroelectric dams on the upper Skagit River within the national park complex, providing Seattle with 25 percent of its electricity. Under its current license from the Federal Energy Regulatory Commission, the utility funds several mitigation projects that support natural resource inventory and monitoring. The public utility recently remodeled and furnished the North Cascades Research Station—a historic house in Newhalem—with a laboratory, office, library, and bunkhouse for eight people. (It is available to visiting researchers by reservation.) Construction will soon begin on the SCL-funded, $11 million North Cascades Environmental Learning Center, built on the site of a former NPS concession facility. Another park partner, the North Cascades Institute, will operate the center. Additionally, Seattle City Light provides $25,000 annually for wildlife inventory and monitoring in the national park complex. These funds have been used for surveys of aquatic macroinvertebrates, amphibians, bats, and harlequin ducks. The complex has also successfully competed for money from the SCL Wildlife Research Fund. Awarded $60,000, this is the single largest funding source for the complex's research on breeding landbird abundance and distribution. Seattle City Light also conducts radio telemetry research on bull trout in Ross Lake in cooperation with Skagit Watershed Council members and their Canadian counterparts. These research projects will lead to the development of additional park monitoring protocols.

The park staff is presently exploring a monitoring concept in which five of the seven network parks would partner with the Mount Baker–Snoqualmie and Olympic National Forests to provide the terrestrial and freshwater component for the Puget Sound Basin watershed. This landscape-level strategy connects over 3.4 million acres of national parks and forests or about 34% of the total land area draining into the Puget Sound. This collaborative approach will place federal land managers in a better position to use environmental laws such as the Clean Air Act, Clean Water Act, and Wilderness Act in protecting the area's mountain ranges. The watershed-basin concept crosses administrative boundaries in an ecosystem approach that connects the National Park Service and USFS to numerous federal and state agencies, Native American tribes, and nongovernmental organizations on the cooperative Puget Sound Water Quality Action Team. Additionally, British Columbia is applying this watershed-basin concept to their lands and waters surrounding the Georgia Straits, immediately north of the Puget Sound.

"First-year funding (FY 2001) of the North Coast and Cascades Monitoring Network brought about several important enhancements to long-term ecological monitoring in North Cascades National Park and adjacent Ross Lake and Lake Chelan National Recreation Areas."

Other Developments

A photographic mushroom survey

Robert Morgan, a photographer and park volunteer, obtained a $14,500 grant from the Skagit Environmental Endowment Commission to conduct a photographic survey of fungi in North Cascades National Park and neighboring Ross Lake National Recreation Area. Although 600–800 mushroom species were estimated to exist in the parks, few had been documented before this effort. In two years of photographing that culminated in 2001, Morgan produced 340 color slides documenting 125 mushroom species. The University of Washington provided expert assistance with species identification, and one rare species was discovered. Twenty-four specimens could not be identified by photographs alone and may include new species. Morgan recorded the date, time, weather, location, and soil temperature for each photograph, and the original color slides and related data were accessioned into the park's museum collection. Work has begun to convert information from the standard NPS format for museum collections (ANCS+) to the NPSpecies database format, which includes geo-referenced locations of each record for use with GIS applications. The slides have been copied and assembled in three reference notebooks for use by NPS interpreters, the North Cascades Institute, and British Columbia Parks. The photographs have also been placed on CD-ROMs for museum loan, website use, and further investigation by researchers. Although Morgan's survey covered less than 5% of the parks, it provided valuable information for their management and interpretation.

NPS photo by Robert Morgan

Conical waxy cap *(Hygrophorus conicus)*

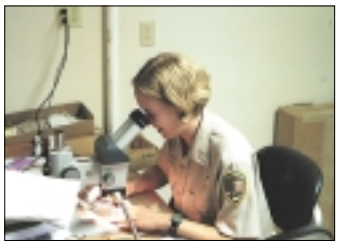
Joint conservation plan for the Potomac Gorge

Despite its location in the Washington, D.C., area, the Potomac Gorge is one of the most significant natural areas in the eastern United States. The site harbors more than 400 occurrences of 200 rare species and communities, a major river system with numerous tributaries, noteworthy stands of upland forest, seeps and springs that contain rare groundwater organisms, and abundant wetlands. The National Park Service is the primary landowner (Chesapeake and Ohio Canal National Historical Park and the George Washington Memorial Parkway), while the Nature Conservancy has a long-standing interest in the site's extraordinary biological diversity. Working collaboratively, the two organizations completed the Potomac Gorge Site Conservation Plan in November 2001.

The site conservation plan is organized around a group of conservation targets representing the site's biodiversity—riparian and terrace communities, upland forest blocks, tributary stream systems, rare groundwater invertebrates, anadromous and semianadromous fish, and wetlands. The plan analyzes threats to these targets and presents strategies that will help ensure their conservation, and thus conservation of the gorge's overall biodiversity. The National Park Service, The Nature Conservancy, and other stakeholders are currently exploring ways to implement the plan strategies.

This site conservation planning process has many parallels to the NPS process for identifying park vital signs, and elements of the process will be incorporated into park inventory and monitoring plans. As one of the first site-based planning efforts between the National Park Service and The Nature Conservancy, this project serves as a model for the many other locations around the country where the organizations' interests overlap.

Geologists-in-the-Parks program expands in scope



The Geologists-In-the-Parks program (GIP), managed by the NPS Geologic Resources Division, began as an idea over six years ago. In its first year the program placed a handful of volunteers in national parks to provide badly needed geologic expertise. Over the years, the program grew, filling more than 50 positions per year. In 2001 other division chiefs at the Natural Resource Program Center took a closer look at the program's success. They decided to expand the realm of the GIP program, prompting a change in the name to GeoScientists-In-the-Parks. The program continues to address geologic issues (such as geomorphology, cave and karst, stratigraphy, and paleontology), and it now accepts proposals to address soils, water, air, Geographic Information Systems, and other physical science issues. Of particular interest to many of the outside funding partners are projects that examine the relationship of physical resources and processes to biotic resources. The positions—a combination of professional volunteer and stipend-supported positions—continue to be a mix of interpretation, resource management, research, operations, and law enforcement. Parks can still share GIP positions among several divisions. All work is predicated on park one-page proposals. Further information about the GIP program is available on the Internet at www2.nature.nps.gov/grd/geojob/ and the NPS intranet at www2.nrintra.nps.gov/grd/.

Public participation and personal watercraft

In 2000 the National Park Service promulgated a regulation that closed all but 21 units of the National Park System to personal watercraft use. The regulation dictates that the Park Service must declare special regulations and support them with findings in environmental analyses required by the National Environmental Policy Act in order to allow continued personal watercraft use in 21 park units beyond specified grace periods. As a result, the National Park Service is drafting 13 environmental analyses to determine whether to allow personal watercraft use beyond the grace periods.

To afford the public an opportunity to participate in their decisions on whether to continue personal watercraft use, Glen Canyon National Recreation Area and Fire Island National Seashore held public meetings in 2001. The public's affirmation, rejection, or refinement of resource issues, management objectives, and proposed alternatives continues to help these park managers make informed decisions regarding personal watercraft management. Other parks, including Lake Mead, Chickasaw, Curecanti, and Gateway National Recreation Areas, plan to hold similar meetings in 2002.

Facility Manager Chris Case recognized with award

Chris V. Case, facility manager at Pictured Rocks National Lakeshore, Michigan, was presented with the Director's Award for Excellence in Natural Resource Stewardship through Maintenance. Case has led the Maintenance Division and park staff in the application of "green" technologies at the park. He has researched, developed, and introduced a comprehensive program encompassing sustainable energy, parkwide recycling, "biofluids" conversion, and product inventory and standardization. His efforts resulted in the conversion of hand-operated campground water pumps to solar, chlorinated well-pump systems; development of a solar power grid system for seasonal employee housing; and conversion of diesel additives and hydraulic fluid to soy-based biofluids in vehicles. The park program won the Department of the Interior's Award for Environmental Leadership. Case has worked closely with Sandia National Laboratory, the U.S. Department of Energy, solar contractors, and the Michigan Soybean Promotion Council in applying these technologies in the park.

Like other award recipients, Case believes that the innovations for which he and the park have been recognized are the result of the work of a team of committed people. "The enthusiasm of the staff is what has made the difference," according to Case. "Three-fourths of our green program success was accomplished without additional cost. It was human energy."

Superfund cleanup at Grant Kohrs Ranch

Nestled in the scenic Deer Lodge Valley of western Montana, Grant Kohrs Ranch National Historic Site typifies the early ranching history of the West. But it is also plagued by a history of mining and ore processing in the Butte-Anaconda area. The Clark Fork River, running through the national park unit, was designated a Superfund site—the largest in the United States—by the Environmental Protection Agency in 1983. This status requires remediation to clean up the heavy metals and acids resulting from the deposition of tailings from large-scale copper mining upstream. Within the park, areas adjacent to the Clark Fork are denuded from acid conditions and high metals concentrations. In 2001 the national historic site staff coordinated a major field effort with researchers from member universities of the Rocky Mountains Cooperative + (RM-CESU) to collect data for an assessment of the resource damage and restoration options at the park site. Scientists from the University of Montana and Montana State University collected information on metals concentrations in the environment and the toxicity of those metals, such as arsenic and copper. These researchers are the leading experts on the effects of mining activity on natural ecosystems in Montana. The RM-CESU cooperative agreement allowed the park staff to tap this expertise in an effort to restore the site to its "unimpaired" condition.

Progress developing the National Cave and Karst Research Institute

The pace of activities to establish the National Cave and Karst Research Institute accelerated in 2001. The organizational structure and staffing plan were formulated so that staff recruitment can begin. The institute received its first federal appropriation for fiscal year 2002. The appropriation matches funding that New Mexico Technological University received from the State of New Mexico for activities in support of the institute. One important focus in 2001 was forming partnerships with all types of cave and karst interest groups, agencies, and organizations, which are critical to the success and useful function of the institute. The goal of the institute is to focus attention on and foster cave and karst research and education for improved resource management. This goal can best be accomplished by broad coalitions—a banding together of scientists to advance knowledge of cave and karst systems. A website (http://www2.nature.nps.gov/nckri) facilitates communication with partners and the public on progress in establishing the institute.

International fisheries management plan for the Amistad Reservoir

In September 2000, 18 resource managers from Amistad National Recreation Area (Texas); the NPS Water Resources Division; Texas Parks and Wildlife; and the Mexican Secretary of Environment, Natural Resources, and Fisheries met in Ciudad Acuña, Coahuila, Mexico, to begin planning how to cooperatively manage the shared international fishery resources in the Amistad Reservoir. One of the main goals to come out of the first meeting was an agreement to develop a Binational Fisheries Management Plan to "improve the management of Amistad Reservoir fisheries through interagency and international cooperation."

In 2001, three meetings between U.S. and Mexican agency counterparts helped to develop the fisheries management plan. The latest meeting occurred in November, in Ciudad Acuña, to review the working draft plan. Initiated in 2001, the plan sets goals for the monitoring of sport and commercial fishery resources and the completion of an economic analysis of these resources. The plan calls for a Binational Fisheries Management Team to meet once a year to coordinate work projects and share information. The final Binational Fisheries Management Plan document is scheduled for completion in spring 2002.

Looking Ahead

"The parks should reach broader segments of society in ways that make them more meaningful in the life of the nation."

—National Park System Advisory Board

Courtesy of Jeff Selleck

Visitors to Hawaii Volcanoes National Park are dazzled by lava flowing out to sea below the safe haven of a cliff overlook.

Implications for natural resource preservation in parks

By John G. Dennis

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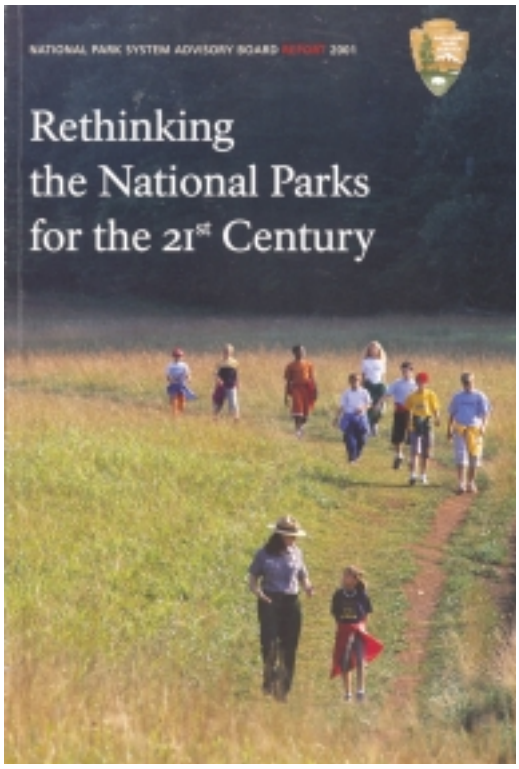
In 2001 the National Park System Advisory Board completed a review broadly focused on "the purposes and prospects for the National Park System for the next 25 years." The Advisory Board collaborated with the National Geographic Society to publish a report of this review that incorporates findings gathered through a series of internal discussions and consultations with NPS employees and partners, including organizational representatives and academics. Titled *Rethinking the National Parks for the 21st Century,* the report highlights challenges facing the National Park Service and opportunities for parks to contribute to conservation, science, education, and outdoor recreation.

The report offers principles that are important to the natural resources point of view. Parks represent a "pact between generations" where creation of a system of parks and programs today benefits a new generation of citizens tomorrow. Parks are precious places, which increasing environmental pressures exerted by growing human populations will make even more precious in the future. They contribute to education, history, biodiversity, sustainability, cross-cultural connections, outdoor recreation, and creating a workforce that reflects these roles. To help realize the full potential of these benefits, the report suggest five initiatives.

First, the National Park Service will need to better integrate science into management decision making and education programs. This will depend on greater understanding of how natural resource systems and their components function in a changing and complex world. To develop this understanding will require more intensive and comprehensive scientific knowledge and capability than the Park Service now has. Park managers will need a great deal of site-specific, scientific, and traditional natural resource knowledge provided by a diversity of physical, biological, and social science disciplines. To most effectively use its scientifically trained personnel, the Park Service will need to recruit management-oriented, broadly trained scientist-scholars with advanced degrees who possess three key attributes: skill in combining general process knowledge drawn from the scientific literature with park-specific knowledge gained through traditional knowledge and scientific work conducted specifically in parks; comfort with and proficiency in overseeing, coordinating, and integrating a wide array of scientific information—from inventory, monitoring, research, and assessment to adaptive management—developed by many government, university, and other scientists; and finally the ability to be active partners in cooperative efforts to bring imaginative, forward-looking, and scientifically based knowledge and techniques into NPS educational programs.

Second, the National Park Service will need to encourage use of parks as natural laboratories for both research and education. As lands surrounding parks become more intensively developed, the relatively intact ecosystems found in parks will make them ever more valuable as natural laboratories. These park laboratories will be sites for scientific research that advances specific understanding of park resources and general scientific knowledge; relatively undisturbed comparison sites for



"The report is available on the Internet at www.nps.gov/policy/futurereport.htm."

"[The national parks are] 'chapters in the ever-expanding story of America.'"

research that investigates the influences on natural systems of the many human uses of lands surrounding parks; and monitoring sites where scientists can track conditions of park resources, landscapes containing parks, and regional environments. They will be field laboratory sites for partnership-conducted, hands-on environmental education programs.

Third, the National Park Service will need to strengthen management and education programs for preserving park biodiversity. "Parks should be models of healthy, natural, sustainable ecosystems" and "conservation of biodiversity should become a core purpose" of parks, according to the Advisory Board report. Sustainably conserving biodiversity, the variety of life at genetic, species, biological community, and ecosystem levels of organization, will require that the Park Service increase its conservation and education focus. One focus should be aquatic and marine ecosystems and involve the National Park Service in national and international partnerships. A second focus should be North American partnership efforts to restore landscape-, regional-, and continental-scale habitat corridors to provide biological linkages for wild animals. A third focus should emphasize preserving biodiversity as one determinant for establishing new parks or modifying existing park boundaries. A fourth focus should be supporting park biological reference collections and the taxonomists who identify and curate the biological specimens that scientifically document park resources. Finally, a fifth focus should be increasing human consciousness about resource preservation needs, sustainable uses of parks, and making sustainable the ecosystems that contain parks and their adjacent communities. To achieve its role in preserving biodiversity, the Park Service will need to increase its application of scientific information in decision making and emphasize conservation of biodiversity in education programs for both park visitors and partners.

Fourth, the National Park Service will need to increase emphasis on the sciences and park natural resources in its place-based learning programs. Park natural systems and their components represent a large portion of the nation's natural history. Using in-park interpretation and hands-on activities, outside programs conducted in partnership with many organizations, and imaginative application of new technologies, the Park Service will bring its greater scientific understanding of park natural resources to educating an increasingly diverse population of people of all ages about park natural systems and related natural and social sciences. Thus, the National Park Service will implement the Advisory Board's idea of using parks to help people from all walks of life understand humanity's relationship to the natural world.

Fifth, the National Park Service will need to involve the creative skills of a greater diversity of energized employees and partners. *Rethinking the National Parks for the 21st Century* envisions parks as "key institutions" for improving "understanding of the forces that shape our lives and future," serving as "chapters in the ever-expanding story of America." They are part of "a national network of parks, preserves, open spaces, greenways, and recreation areas" — "an American System of Parks." The essence of this system and of the expanding story of America is diversity—diversity in resources being preserved, in history of human attitudes toward those resources, in human cultures and their differing relationships to those resources through time, and in forces that determine the existence and very survival of those resources across many human generations. The report illuminates the evolution that the National Park Service will need to undergo if it is to bring this vision with its inherent diversity forward to future generations, to "the broader public that will decide the fate of" parks, park resources, and park programs. The National Park Service will need to broaden the diversity of human cultures and origins represented in its employees and volunteers and increase the breadth and depth of their skills. This workforce will need to reach across park boundaries to work with private and public landowners, local governments, academics, and many others who live in or care about the landscapes containing the parks. Finally, to fully develop this American System of Parks, the Park Service will need to integrate its site-focused park management and visitor education responsibilities with its local, state, national, and international conservation assistance responsibilities.

Through these actions, the National Park Service will stimulate a science- and scholarship-based partnership focused on restoring and nurturing the American System of Parks and the scientific, educational, recreational, and inspirational benefits this system provides to the American people. Thus, in the Advisory Board's vision, the National Park Service will help us—the American people—to "care for ourselves and act on behalf of the future" by conserving [our] heritage and [our] home on earth."

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