Natural Resource Year in Review 2000

Summarizing and analyzing the year
in natural resource stewardship and science
in the national park system

2000

United States Department of the Interior • National Park Service

Natural Resource Year in Review—2000

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Cover Photo
A ribbon of water in an arid landscape, the Green River sustains endangered fish and other aquatic and riparian species in Dinosaur National Monument (Colorado and Utah). However, Flaming Gorge Dam has altered conditions in the river and negatively impacted many river-dependent species; dams elsewhere in the Colorado River basin have had similar effects on other river reaches, including those within a number of units of the national park system. The National Park Service is becoming increasingly engaged in efforts to reestablish flow, restore habitat, and recover endangered fishes in the upper Colorado River basin (see related stories on pages 23, 34, 35, and 39).
John Wullschleger

When the National Park Service began [in 1916], the appearance of nature—of simple beauty—was mistaken for nature itself. Today we know that scenic beauty can mask dying species and disappearing ecosystems.

—Robert Stanton

15th Director of the National Park Service

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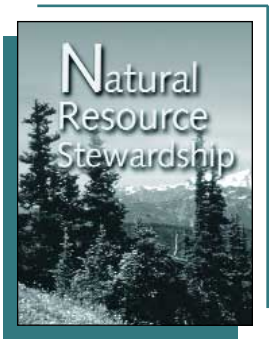

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Year at a Glance

January

Thanks to a $3.4 million appropriation under the Natural Resource Challenge, a new program dedicated to the management of native and exotic species becomes functional; the new capability is managed by the Biological Resource Management Division of the Natural Resource Program Center.

The Department of Energy announces a plan to reclaim uranium mill tailings near Arches and Canyonlands National Parks, Utah, lessening the potential for surface and groundwater contamination and negative effects on endangered fish.

February

Occurring in at least seven units of the national park system, the black-tailed prairie dog is designated a candidate species for listing as threatened under the Endangered Species Act.

The NPS Air Resources Division publishes a scientific report on air pollution from snowmobiles in the national park system, with an emphasis on Yellowstone National Park.

Ownership of the Glines Canyon Dam in Olympic National Park, Washington, and the Elwha Dam outside the park is transferred from private to public, paving the way for the restoration of the salmon and steelhead fisheries in the park.

March

The Canada lynx is listed as threatened under the Endangered Species Act, with implications for park management in as many as 18 units of the national park system in the northern United States.

The NPS Water and Air Resources Divisions participate in a workshop to discuss methodologies for sampling snow and water for chemical pollutants from snowmobile emissions in national parks.

Exotic Plant Management Teams are selected for the control of exotic plant species in four areas of the national park system: Hawaii, Florida, National Capital Region, and the Chihuahuan Desert/shortgrass prairie.

Five pilot learning centers are selected across the national park system to facilitate public-private research on park resources and the accumulation, synthesis, and delivery of the information to the public.

April

The Department of the Interior holds a press conference to announce that the National Park Service will enforce regulations related to snowmobile use in the national park system, significantly reducing their use in parks.

The Director's Awards for Natural Resource Stewardship are announced for calendar year 1999 and include a park superintendent, resource manager, research scientist, facility manager, and resource manager in a small park. The award is redesigned this year and includes a bison sculpture by western wildlife sculptor Chris Schiller.

A U.S. District Court rules that the National Park Service acted properly in entering into a cooperative research and development agreement governing biological diversity prospecting by the Diversa Corporation in Yellowstone National Park. However, based on an earlier court ruling the agreement is suspended until NEPA evaluation is completed.

May

The National Park Service ignites a prescribed fire to reduce brush in Bandelier National Monument that escapes control and burns 47,000 acres and destroys or damages 380 structures in the vicinity of Los Alamos, New Mexico.

Zion National Park initiates its new bus transportation system, which promises to reduce traffic, noise, and associated resource impacts on air and vegetation in the park.

A special edition of *Park Science* is published that focuses on the contributions of the social sciences to park management.

Year at a Glance

June

In conjunction with the meeting of the Society for Conservation Biology, the Rocky Mountains Cooperative Ecosystem Studies Unit (CESU) hosts the annual meeting of regional and national NPS resource managers in Missoula, Montana. Discussions focus on the function of the CESUs, the Natural Resource Challenge, improving the use of the National Environmental Policy Act, revisions in NPS management policies, and several other topics.

July

Ten thousand bonytail, the rarest of four endangered Colorado River fishes, are released in the Green and Yampa Rivers in and near Dinosaur National Monument (Utah and Colorado) as part of the species' recovery.

Resource managers start a second population of rare Bonneville cutthroat trout in Great Basin National Park when they transplant 60 individuals from a genetically pure source stock, recently discovered in the park, to a different park watershed.

As part of Great Smoky Mountains National Park's All Taxa Biodiversity Inventory, more than 20 entomologists take part in a butterfly and moth "bio-blitz," identifying an astounding 706 lepidopteran species in a 24-hour period.

The NPS Intermountain Region staffs its third CESU in a year to assist parks in meeting their research needs and to help plan the operation of the new inventory and monitoring networks.

August

Using multibeam sonar technology, the U.S. Geological Survey completes its bathymetric survey of Crater Lake, recording a maximum depth of 1,958 feet and rendering the most detailed map of the lake floor to date.

Groundwater tests in the New World Mining District near Yellowstone National Park indicate the need to line a proposed waste repository with an impervious layer and leachate collection system to protect Soda Butte Creek in the park from potential acid mine drainage.

September

More than 1,200 participants gather for *Discovery 2000*, the National Park Service general conference, in St. Louis, Missouri, to develop a vision for the future of natural and cultural resource stewardship, leadership, and education in the National Park Service.

The NPS Sabbatical in the Parks program launches a website (www.nature.nps.gov/sabbaticals) to help arrange faculty sabbaticals in parks that focus research on park management and advance science and human understanding.

The National Park Service and the Society for Conservation Biology sign an agreement affirming their partnership and the participation of Associate Director Soukup on the editorial advisory board of *Conservation Biology in Practice.*

October

Congress approves $15.3 million in budget requests tied to the Natural Resource Challenge. The funds speed up park inventories and vegetation mapping, enhance resource monitoring and the management of exotic and native species, and support many other natural resource programs.

November

The National Park System Advisory Board votes unanimously to create a standing science committee to advise the National Park Service on its programs and overall management of park resources.

December

The National Park Service proposes a rule in the *Federal Register* to phase out snowmobile use in Yellowstone National Park, on the John D. Rockefeller, Jr., Memorial Parkway, and, with some exceptions, in Grand Teton National Park by winter 2003–2004; snow coach use will continue to be allowed.

The National Park Service and the U.S. Geological Survey install a sulfur dioxide–monitoring system at Hawaii Volcanoes National Park that facilitates early warning of unhealthy concentrations of the respiratory irritant.

2000 Year in Review

▲ **Natural resource inventories in the national park system** received a significant boost in FY 2000 when Congress appropriated $7.3 million under the Natural Resource Challenge for this pur pose, particularly vascular plant and vertebrate inventories. Water quality inventories, now completed or under way in 31 parks with inadequate water quality baselines, are also supported by this funding increase. Natural resource monitoring, like the long-term water quality monitoring shown here in Shenandoah National Park, will benefit from Challenge funding increases in 2001.

The year 2000 in review

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If the year 2000 is any indication and as many scientists suggest, this may well be the century of the environment. In 2000, the National Park Service focused on its resources to a greater extent than it has in a long time.

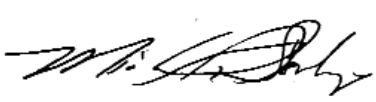
The cornerstone of success this year was significant support from Congress for the second year of the proposed five-year Natural Resource Challenge program. This enabled the Service to make major strides in natural resource management. Details are highlighted herein, but include our participation in 10 cooperative ecosystem studies units on university campuses, the selection of five learning centers (to support researchers logistically and provide interpretation of science to visitors), and the establishment of four exotic plant management teams and a Sabbatical in the Parks program. The effort to provide inventories of vascular plants and vertebrate animals in parks took a giant leap forward with the funds provided by Congress. The U.S. Geological Survey, including its Biological Resources Division, also had a significant budget increase this year. We made great progress in promoting "parks for science" and "science for parks" under the Natural Resource Challenge.

The Discovery 2000 conference in September—a dialogue focused on the future of the national park system, and our vision for it—was also a major achievement for the Service. We were particularly honored by the participation of Professors E. O. Wilson and Peter Raven, both of whom see important future roles for the Service in the stewardship of the nation's biodiversity. This role is largely a logical restatement of the original language of the NPS Organic Act of 1916, which charges the Service with conserving the "scenery and the natural and historic objects and the wildlife therein." Each national park is a complex manifestation of processes and players. Plant and animal species are the players responding to physical processes of the place, and to each other. Conservation of the plants and animals in over 380 units with 83 million acres makes the National Park Service, inescapably, a factor in the preservation of much of our nation's biodiversity.

Revision of NPS *Management Policies* in 2000 included a clear statement that ends the misconception that we, in managing parks, must balance equally the protection of resources and the provision of visitor services. Both must be served, but cannot receive equal weight in every decision without gradual erosion of the resources that visitors come to enjoy. This does not mean that visitor access must be curtailed, but it does mean that we must know enough to be able to provide services and accommodations without compromising park resources to the point of impairment. As Wallace Stegner put it, resources are "first in logic, first in law," and recent court decisions have borne this out for the National Park Service. Parks can be better hosts for present and increasing future publics if we become better accumulators and synthesizers of information. Along these lines, this year also saw the development of the companion Cultural Resource Challenge. These events were all extremely positive for the future of national parks.

In the *Year in Review*, we also document the setbacks and new issues of the year. Without doubt the Cerro Grande fire was the low point of this year. In May, the National Park Service set a prescribed fire that escaped control and caused enormous damage to the local communities around Bandelier National Monument (including Los Alamos, New Mexico, and others). Needless to say, we felt genuine anguish in the park, the region, and the national park system over the error and apologized for our role in it. There was also a prompt review of fire policies and operational procedures but the damage had been done. Although Cerro Grande was extremely unfortunate, the fire management program of the National Park Service should not be judged by this one event. Since 1968 we have applied nearly 3,800 prescribed fires with success. Prescribed fire is critical to meeting resource management objectives and reducing hazardous fuel loads. Indeed, the prevalence of wildfires across the West this year was a harsh reminder for many agencies and citizens that years of misguided suppression of forest fires bears a price. One legacy of failing to recognize the role of fire in natural systems is its strong testament to the necessity of understanding the dynamics of natural systems before management policies and decisions are made. Herein you will find a summary of the extraordinary 2000 fire season.

In both advancement toward understanding the natural systems we manage and stark evidence of the need for better information and higher levels of professional support for our parks, the first year of the 21st century has more than lived up to our expectations.



2000 Confluence

▲ **Chinese wisteria (*Wisteria sinensis*),** an invasive exotic vine, grows along the George Washington Memorial Parkway, overwhelming trees and other native vegetation. The fast-growing and highly competitive species will be the target of future invasive plant control measures by the National Capital Region Exotic Plant Management Team. Rosa Wilson

The challenge that lies ahead will be to learn how to preserve parks for future generations. In a changing world, what will keep these parks natural and healthy?

—Excerpt from the Natural Resource Challenge:
the National Park Service's action plan for preserving natural resources

In 1999 the National Park Service articulated its commitment to natural resource preservation in the Natural Resource Challenge. This five-year national program identifies numerous actions needed to sustain park natural resources in the 21st century and has resulted in two substantial budget increases for natural resource programs: $14.3 million in FY 2000 and $15.3 million in FY 2001. Through the strategies outlined in the Challenge and with the increased funding provided by Congress, the National Park Service is stepping up to a new level of resource management and applying the best science to high-priority natural resource management issues affecting parks. As events in 2000 indicate, the Park Service is increasing its capabilities to control invasive vegetation, to maximize scientific collaboration and education opportunities with partners, and to expand and speed up natural resource inventories, among other efforts. This effective program continues to build momentum and rally enthusiasm and support for worthy conservation goals. Through the Challenge the National Park Service is moving forward in protecting the country's natural heritage for the American people.

Invasive Vegetation

Natural Resource Challenge funds Exotic Plant Management Teams

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After habitat loss, invasive or exotic species are considered the greatest threat to the preservation of natural resources throughout the national park system. They are implicated in the listing of 42 percent of all species protected by the Endangered Species Act. Additionally, more than 2 million acres of national parklands are infested by exotic invasive plant species.

A new weapon to combat exotic plant species was launched by the National Park Service in 2000. Called the Exotic Plant Management Team or EPMT, the new capability was modeled after the coordinated rapid response approach used in wildland fire fighting because it is also effective in controlling exotic plants. The first test of the EPMT concept was made in 1997 at Lake Mead National Recreation Area (Nevada and Arizona) and served park units throughout the Southwest. Its success led to a request to fund the establishment of four EPMTs through the Natural Resource Challenge (the Challenge). As a result, four teams were established in FY 2000 with approximately $1.2 million in Challenge funding: (1) Florida EPMT (based at International University in Miami); (2) National Capital Region EPMT (based at Rock Creek Park, Washington, D.C.); (3) Chihuahuan Desert/Southern Shortgrass Prairie EPMT (based at Carlsbad Caverns National Park, New Mexico); and (4) Pacific Islands EPMT (based at Haleakala National Park, Hawaii). Each will serve parks over a broad geographic area.

"[EPMTs are] a new weapon to combat exotic plant species."

The success of the EPMT derives from its ability to adapt to local conditions and needs. Each team employs the expertise of local experts and the capabilities of local agencies. Each sets its own work priorities based on the following factors: severity of threat to high-quality natural areas and rare species; extent of targeted infestation; probability of successful control and potential for restoration; opportunities for public involvement; and park commitment to follow-up monitoring and treatment. Thus, each EPMT provides a highly trained, mobile *strike force* of invasive plant management specialists to assist parks with limited resources and expertise in the control of exotic plants.

The EPMTs of Florida and the National Capital Region provide excellent yet contrasting illustrations of regional adaptability. The Florida EPMT formed a partnership with the Upland Invasive Plant Management Program of the Florida Department of Environmental Protection and approximately 136 other groups in the program to control invasive plants. Furthermore, it augments existing exotic plant control efforts in Big Cypress National Preserve and Everglades National Park. With one-to-one matching funds provided by the State of Florida, the partners pay for removal of exotics in 11 units of the national park system in Florida. The EPMT of the National Capital Region takes another approach. This team serves 10 regional parks directly by assisting in the control of exotic plants. It also trains park personnel to manage infestations within the limited fiscal resources available to the park.

▲ **Workers with the National Capital Region EPMT** employ a chainsaw in the removal of Chinese wisteria at Prince William Forest Park, Virginia. The EPMTs are part of a strategy for long-term control of invasive plants set by the Natural Resource Challenge. Actions by the teams also address the Government Performance and Results Act goal Ia1B: containing exotic plant disturbances. Furthermore, these actions meet the requirements of Executive Order 13112 on invasive species, which includes provisions of the Invasive Species Council National Management Plan.

The teams and the NPS Biological Resource Management Division are developing a database for the monitoring evaluation of EPMT effectiveness. The system will also track information about each project such as work site, date, species removed, management technique, number of person-hours, and extent of eradicated plants.

In less than a year, the four EPMTs have been staffed, equipped, and readied for on-the-ground management of invasive plant species. Ultimately, 10 teams are planned to be deployed full-time throughout the national park system to reduce the impacts of invasive plants on natural and cultural resources.

NPS

Inventory and Monitoring Program benefits from the Natural Resource Challenge

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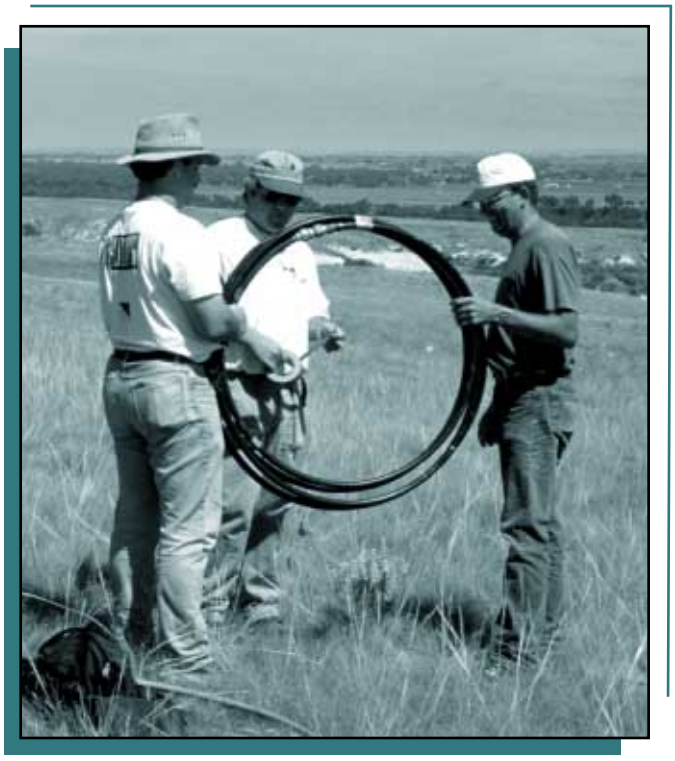
In FY 2000 the NPS Inventory and Monitoring (I&M) Program received a base increase of $7.3 million for accelerating 11 of the 12 basic inventories initiated by the program in 1992. In particular, the increase is for vertebrate and vascular plant inventories, which had received little funding since the program began. The funding will allow the National Park Service to complete all of the basic resource inventories in about seven to eight years.

Most of the nonbiological inventories have been conducted by staff of the I&M Program; the biological inventories, on the other hand, will be managed primarily by NPS regional and park personnel. The inventories will be conducted in collaboration with local universities and state and federal agencies to establish partnerships and agreements to share costs and avoid duplication of effort. For that reason, a small portion of the increased funding was given to the regional offices to hire inventory coordinators to carry out those functions. The Park Service also designed and adopted a national strategy for organizing the biological inventories and implementing the park vital signs monitoring called for in the Natural Resource Challenge. Under this strategy, all of the units in the national park system that have significant natural resources ("natural resource parks") have been assigned to one of 32 separate networks of parks that share similar ecological characteristics. The regional I&M coordinators worked with the networks in FY 2000 to develop inventories and to begin implementing them.

Five million dollars of the FY 2000 increase was allocated to vertebrate and vascular plant inventories, including approximately $1 million for special inventories of amphibian populations in 12 parks. These particular parks will be incorporated into a larger amphibian research and monitoring effort of the U.S. Geological Survey. The amphibian inventories acquired much of the baseline information needed to support future research in these parks and also yield information that park managers can use to address a variety of resource management and protection issues. For example, preliminary research at Sequoia and Kings Canyon National Parks has suggested that introductions of sport fish into previously fishless lakes may have led to the extirpation of amphibians in some of those areas.

Inventories of park, local, regional, and university museums and herbaria were undertaken to acquire and verify as much information as possible on species occurrence in the parks. More than 239,000 species records for parks were verified, obtained, and incorporated into a new national database that includes information on more than 68,000 voucher specimens (i.e., those that document the occurrence of a species in a particular park). This represents the first time that the National Park Service has so comprehensively verified a database on park vertebrates and vascular plants. In addition to compiling and verifying existing species information, another focus of the vertebrate and vascular plant inventory has been to fund the most acute resource inventory needs in parks that are most capable of implementing new, integrated inventory methods. One recipient of such funding was the Pacific Island Network. Nesting Tahiti petrels were discovered on the summit of Mt. Lata, on Ta'u in the National Park of American Samoa. This seabird was not previously known to breed in American Samoa. The inventories also documented the recent arrival of an introduced finch and several plant species in Hawaii Volcanoes National Park. Early identification is important for rapid control of exotic species.



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

The FY 2000 funding also sped up nonbiological inventories. For example, more than 6,000 base maps and related data products were acquired for 230 parks, increasing to 248 (96 percent) the number of parks for which this inventory has been completed. Additionally, data on several air quality parameters were assembled from existing national data sets for use in statistically estimating air quality in parks that do not have air quality–monitoring stations. This approach is cheaper than measuring air quality in each park and will provide for the first time comprehensive air quality information for all natural resource parks. These baseline data will be critical in determining where future monitoring is needed to measure changes in park air quality, both locally and regionally, throughout the national park system.

Maximizing Scientific Collaboration

CESUs and the inventory and monitoring networks: A case of good timing

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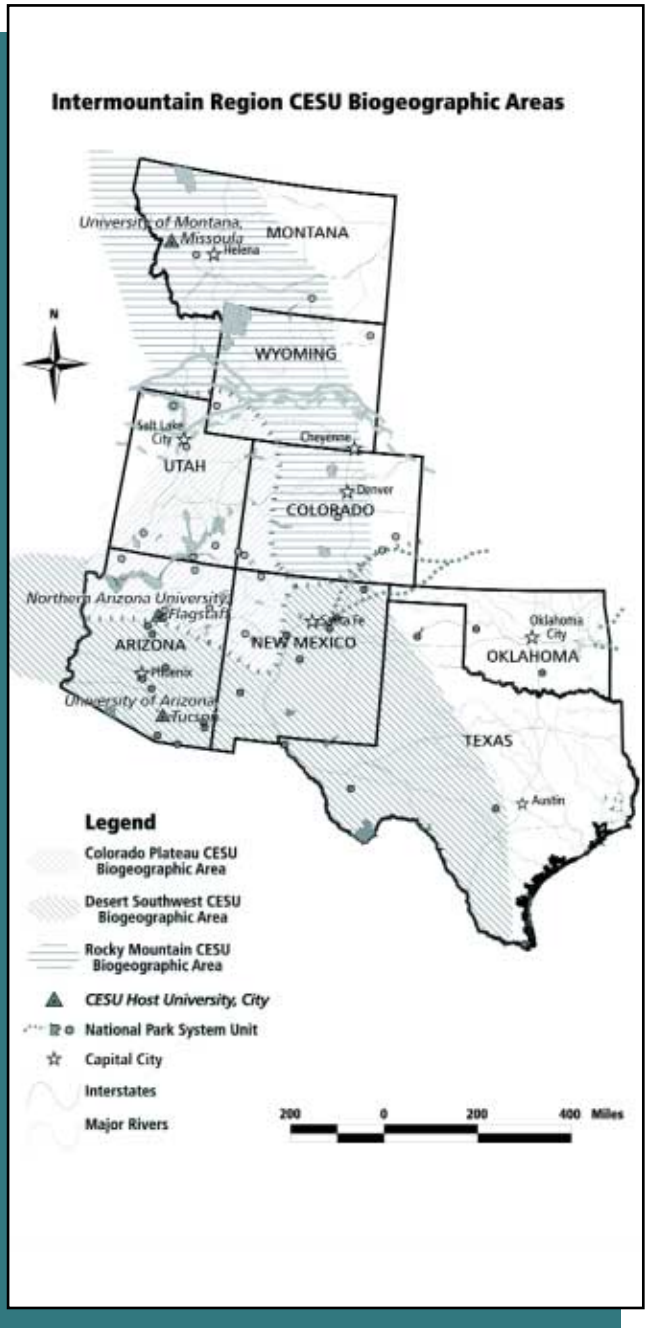
In 2000 three research coordinators with the NPS Intermountain Support office moved to their posts at host universities of three cooperative ecosystem studies units (CESUs): Kathy Tonnessen at the University of Montana, Missoula (Rocky Mountains CESU); Ron Hiebert at Northern Arizona University, Flagstaff (Colorado Plateau CESU); and Larry Norris at the University of Arizona, Tucson (Desert Southwest CESU). These moves coincided with a flurry of activity in the inventory and monitoring (I&M) networks and included the hiring of network coordinators, the holding of expert workshops, and the writing of inventory proposals for funding in FY 2001.

Established in 1999, the I&M networks were created to implement inventory and monitoring across the national park system. Their role is to track the most critical ecological variables or indicators of ecosystem health in the parks, commonly called "park vital signs." In 2000, the I&M networks began planning for the inventory of vascular plants and vertebrates, the first major initiative of the Natural Resource Challenge. A number of options were available to get the scientific expertise and leadership needed for this biological inventory planning, and within the Intermountain Region several networks called upon the CESU research coordinators, CESU partner universities, and the cooperating CESU agencies for assistance.

"Science coordination in the National Park Service was available through the CESU network...."

Within the Rocky Mountains CESU, Kathy Tonnessen served as the chair of the Greater Yellowstone Network in organizing the inventory. She worked with a technical committee with representatives from several member parks to organize the workshop, write the biotic inventory proposal, and hire an inventory coordinator. In 2000 the network also began the planning phase of park vital signs monitoring, and Kathy will serve on the board of directors for that long-term monitoring project. Kathy also assisted the Rocky Mountain Network in organizing their expert workshop and writing the inventory proposal. She will be part of the network steering committee in charge of carrying out the recommended inventory projects. More importantly the Rocky Mountains CESU partner universities and agencies (such as the USDA Forest Service and USGS) were active players in outlining the



▲ **Organized around biogeographic areas,** the three cooperative ecosystem studies units in the NPS Intermountain Region provide research, technical assistance, and education services to parks. In 2000, several NPS inventory and monitoring networks requested CESU assistance in planning for the inventory of vascular plants and vertebrates. NPS Intermountain GIS Office and Natural Information Division, Denver, Colorado; January 2001

Continued on page 4 ▶

inventory needs and providing the scientific content for these two proposals. Both networks are making use of CESU member scientists from academia and agencies as both principal investigators and science advisers to this effort.

"Coincidence brought the CESUs into operation at the same time as the funding for inventory and monitoring networks...."

Ron Hiebert of the Colorado Plateau CESU served as the lead for the Southern Colorado Plateau Network and as liaison between it and the Northern Colorado Plateau Network (NCP) to ensure consistency in applying inventory techniques and compatibility of data. He worked with the two network steering committees to organize a joint expert workshop and to form partnerships with taxonomic experts from the USGS Colorado Plateau Field Station and other CESU partner institutions. Coordinators for both networks were hired and joined the team in 2000 to prepare the two top-rated biotic inventory proposals. Ron will continue his role as liaison between these two networks and will work closely with the NCP as it begins its park vital signs monitoring program and initiates a five-park monitoring prototype.

Desert Southwest CESU Research Coordinator Larry Norris has responsibilities for a vast area of ecosystems and is involved with five I&M network plans. He was the lead author on the Southern Plains Network study plan proposal and he also provided information and advice to the Chihuahuan Desert Network on inventory priorities and on the use of cooperative agreements, interagency agreements, and contracts. Larry has agreed to be an ex-officio member on the board of directors for the Sonoran Desert Network, and he is ready to assist as a technical adviser to the Mojave Desert and Gulf Coast Networks. Throughout the Southwest Cluster, Larry is looking for research projects that complement the I&M inventories by creating knowledge for use by management and by sharing resources and equipment.

Coincidence brought the CESUs into operation at the same time as the funding for inventory and monitoring networks under the Natural Resource Challenge. The timing was fortuitous in that science coordination in the National Park Service was available through the CESU network to assist parks with their natural resource inventory needs. The CESUs are likely to provide more service and scientific expertise as the I&M networks begin their work on the complicated task of defining their park vital signs that will be tracked over the long term.

NPS

Four new cooperative ecosystem studies units established

The Natural Resource Challenge allocated $1.6 million in FY 2001 to establish four new cooperative ecosystem studies units (CESUs). The new units cover the Pacific Northwest (including Southeast Alaska), Desert Southwest, Great Plains, and South Florida/Caribbean. They join four CESUs that were established in 1999, covering the Colorado Plateau, Rocky Mountains, Southern Appalachian Mountains, and North Atlantic Coast. CESUs provide research, technical assistance, and education to national parks and other federal land management, environmental, and research agencies and their partners. They also provide support in biological, physical, social, and cultural sciences needed to address resource issues in an ecosystem context. Thirty-eight universities and other institutions are involved in the four new CESUs. Nine federal agencies and 61 host and partner institutions are currently included in the CESU network.

Coral reefs at Dry Tortugas National Park, Florida, are among the many regional park resources that will benefit in the coming years from the research, technical assistance, and education services available through the South Florida/Caribbean CESU, established in 2000. NPS Submerged Resources Center

Natural resource project funding increased

The Natural Resource Challenge FY 2000 budget provided a big boost to critical park resource management programs. One of the programs that benefited was the Natural Resource Preservation Program (NRPP), an important funding source for park resource management projects administered under the Disturbed Lands and Threatened and Endangered Species Programs. NRPP funds are allocated to regions for park projects based on a priority ranking process. Of the $2.875 million increase allocated to NRPP in FY 2000, nearly $1 million was provided for additional park preservation projects, another $1 million for disturbed lands restoration projects, and about $500,000 each for small park projects and threatened and endangered species projects.

The Ute ladies'-tresses orchid occurs along the Green River in Dinosaur National Monument (Colorado and Utah). This federally threatened plant species is the subject of ecological studies, funded through NRPP during 2000, that will aid resource managers in evaluating potential effects of future water releases from the Flaming Gorge Dam.

The Challenge funds native and exotic species management

In FY 2000 the Challenge dedicated $3.449 million to establishing and operating the Biological Resource Management Division. The division—a new part of the Natural Resource Program Center—is responsible for policy formulation, planning, training, coordination, and implementation of biological resource management activities and programs of broad national importance. It focuses on nonnative species management and ecosystem restoration, threatened and endangered species, and wildlife management. In addition to funding the four EPMTs, the Natural Resource Challenge funds were spent in support of the Department of Interior's Invasive Species Council, to obtain technical assistance from CESUs, and to implement exotic plant management projects in parks. The division now includes a division chief, a liaison with the Washington, D.C. staff, a chief of the Exotic Species and Restoration Branch, two integrated pest management coordinators, two endangered species specialists, an ecosystem restoration specialist, a wildlife biologist who assists parks in capturing and moving large animals, and a wildlife veterinarian who addresses wildlife diseases in parks. These biologists are augmenting the Park Service's efforts to preserve, protect, and manage biological resources and related ecosystem processes in the national park system.

A nonnative African oryx (gemsbok) is readied for helicopter removal from White Sands National Monument to neighboring White Sands Missile Range, New Mexico. The new NPS Biological Resource Management Division provided a wildlife capture specialist and a veterinarian, on staff, and through a new task agreement with the Colorado State University College of Veterinary Medicine, a veterinary resident (shown here), and a veterinary medicine technician. Eighty-two oryx were removed from the monument in 2000 using nonlethal methods.

Connecting the public, scientists, and resources through learning centers

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Imagine a network of cooperating scientists and educators, NPS staff, and park facilities that are combined to preserve and protect vast areas of national significance. From the information generated through this collaboration superintendents are able to make critical resource decisions based on scientific knowledge and ecological principles. Public support coalesces around these management decisions because they are defensible and preserve ecological integrity. Finally, the network consists of individual centers of activity throughout the country and nurtures the next generation of scientists and educators who will guide future management of our planet through the 21st century. This vision progressed toward reality in 2000 when the National Park Service created the first learning centers in the national park system.

To help realize this future, the Natural Resource Challenge includes a commitment to establishing 32 learning centers around the country. Strategically placed in inventory and monitoring networks and unified in concept and function, they will facilitate park research and educate the American public about the health of park resources and the regions they live in.

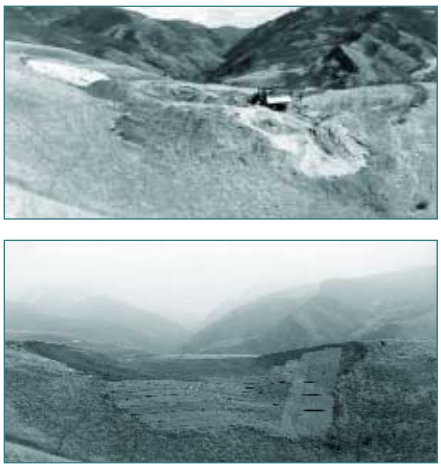
After a national competition in 2000, five pilot centers were selected and subsequently funded as part of the FY 2001 appropriation for the Natural Resource Challenge. These centers are currently being developed at parks across the country that are located in different inventory and monitoring networks. The five centers are the Pacific Coast Learning Center at Point Reyes National Seashore (California), the Atlantic Learning Center at Cape Cod National Seashore (Massachusetts), the McGraw Ranch Learning Center at Rocky Mountain National Park (Colorado), the Rim of Fire Marine Science Center at Kenai Fjords National Park (Alaska), and the Purchase Knob Learning Center at Great Smoky Mountains National Park (Tennessee and North Carolina). Another eight centers have been selected for possible funding in FY 2002; by 2005 the hope is for a nationwide system of 32 learning centers to be formed.

Conceived as public-private partnerships, learning centers will support research activities, the accumulation and synthesis of information, and the direct transmission of information to the public. Each center will provide computer access and laboratory, office, and dormitory facilities. They will only have a small core staff, paid for by appropriation, and will rely heavily on partnerships for both start-up and operational expenses.

Equally important, the centers will promote education and outreach through an education specialist who will work with area park interpreters and partners. Building upon and expanding the National Park Service's environmental education effort, the centers will help transfer information learned about park resources to park visitors and the broader public through diverse educational programs. The centers will help to carry a nationwide message to the public about the health of the national park system and the importance of parks as biological reserves. Although developed as a part of the Natural Resource Challenge, the centers are not meant to focus on natural resources only, but on opportunities for parks to become laboratories, libraries for research, and learning centers for and about *all* park resources. Imagine the potential.

A former U.S. Air Force station in Truro, Massachusetts, now the Highlands Center for the Arts and the Environment, is the site of the Atlantic Learning Center within Cape Cod National Seashore. The Air Force transferred the locale to the seashore in 1994; the National Park Service and several partners are currently adapting the facilities for use as the first learning center to serve the Northeast.

Geologic Resources Division expands expertise



Resource managers across the national park system have identified the critical need for geologic expertise to protect park features and manage resources such as fossils, caves, and shorelines. Park staffs also recognize that effective restoration requires an understanding of the natural geologic setting. In recognition of this need, the FY 2000 budget for the Natural Resource Challenge devoted an additional $696,000 to expand the professional staff of the Geologic Resources Division. The division used these funds to hire specialists in cave and geologic inventories, coastal geology, paleontology, and restoration geomorphology, in addition to a director for the National Cave and Karst Research Institute. These geoscientists will assist in implementing resource protection projects in the 200-plus parks with significant geologic resources.

◀ **White Bird Battlefield,** where the Nez Perce defeated the U.S. Army in 1877, is altered by a modern, abandoned sand and gravel mine (top). In 2000, newly hired restoration geomorphologists with the Geologic Resources Division assisted staff of Nez Perce National Historical Park, Idaho, in restoring the site (bottom).

Award-Winner Profile

Gary Machlis receives Conservation Service Award

▲ **Gary Machlis** (second from right) receives the Conservation Service Award from Secretary of the Interior Bruce Babbitt (second from left). Also present at the awards ceremony in October were Machlis's colleagues Jean McKendry, Research Scientist with the University of Idaho Cooperative Park Studies Unit and NPS Social Science Program, and Charles Hatch, Vice President for Research and Dean of the College of Natural Resources at the University of Idaho.

In October, University of Idaho Forestry Professor and NPS Visiting Chief Social Scientist Gary Machlis received the Department of the Interior Conservation Service Award, one of the Department's highest honors granted to private citizens. Machlis was recognized for his major contribution to the Department in providing extraordinary leadership as coordinator of the multiagency Cooperative Ecosystem Studies Unit (CESU) Council. Secretary of the Interior Bruce Babbitt presented the award as part of the Department of the Interior's 60th Honor Awards Convocation.

Begun in 1998, the CESU network now includes nine federal agencies and 62 universities and other partners. The citation from Secretary Babbitt reads, "The CESU concept has been called a compelling future model for advancing partnerships between government, academe, and others. Dr. Machlis' efforts have made this concept tangible, powerful, and effective."

Gary takes pride in the honor, but quickly remarks that "this award was not just for me. It recognized hard work by many creative people—Mike Soukup, Jean McKendry, Mark Shaefer, the CESU Council, and the agency and university individuals that have turned the CESU concept into a powerful tool for 21st-century resource management and science." He said, "Receiving it at the awards ceremony reminded me that the 'joys of construction'—building something useful—are some of the best benefits of public service."

2000 NPS Science

▲ **A National Park Service snorkeler** and U.S. Geological Survey data recorder survey freshwater mussels in the Upper Delaware River. The initial phase of the mussel study has revealed the presence of dwarf wedgemussel in Pennsylvania where it was thought to be extirpated. Monitoring changes in the populations and distribution of species found in the survey will provide valuable information about the health of the river ecosystem.

We will lose the wildness, the very nature of our parks, if we don't understand them. If we don't truly understand them, we won't be able to speak authoritatively for them, and we won't know how to restore them. We will ultimately lose them if we can't educate people about what parks require for survival.

—Mike Soukup
Associate Director, Natural Resource Stewardship and Science

A fundamental and critical role of the National Park Service is acquiring and considering scientific information to preserve park natural resources for the American public. The Inventory and Monitoring (I&M) Program has been at work since the early 1990s gathering baseline resource information and monitoring conditions over time. New information may suggest the need for more sophisticated studies to examine why conditions have changed and how those changes are affecting ecological processes. The Park Service relies on its own resource managers and an expanding network of partners to gather and focus such information on park management questions. Certainly much more information is needed to thoroughly understand the natural systems in the national parks. Nevertheless, as the articles for 2000 indicate, the knowledge being developed through science is providing valuable insights for the long-term care of park natural resources.

Gathering Usable Data

Inventories benefit resource management efforts in the Northeast Region

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The value of scientific inventories as a resource management tool in national parks is that they create baseline data for future planning and reflect the health of ecosystems. With information yielded by a systematic sampling of a park's plants and animals, resource managers know they will have convincing evidence when they evaluate the effects of proposed construction, land use changes, or other developments within or near their borders. In fact, as microcosms of their respective regions, national parks can use their surveys and monitoring to provide an early-warning system that benefits the inhabitants of entire watersheds. During 2000 the breadth of these inventories improved as a result of the Natural Resource Challenge, which provided $7 million to the Servicewide Inventory and Monitoring Program. By combining these funds with regional and park funds, several of the national parks in the Allegheny and Chesapeake Clusters of the Northeast Region implemented or began developing policies to protect rare, threatened, or endangered species that had been identified in previous inventories. Moreover, some studies that were initiated in 2000 have already yielded surprises.

"Scientific inventories ... in national parks ... create baseline data for future planning and reflect the health of ecosystems."

Among the species in the Northeast that will benefit from investigative surveys is the bog turtle (*Clemmys muhlenbergii*). A study conducted in 1998 and 1999 identified likely habitat for this federally endangered species in the Delaware Water Gap National Recreation Area and confirmed its presence in the park. However, researchers observed that the open marshland needed by the turtle was being invaded by purple loosestrife (*Lythrum salicaria*), a common exotic whose high canopy crowds out lower-growing native plants. In 2000 the park began implementing a long-term strategy designed to reverse this trend. Two kinds of beetles (leaf-eaters and root-borers) that are biological enemies of the loosestrife were released. Ongoing monitoring of both the bog turtle population and the loosestrife will enable resource managers to evaluate the effectiveness of their strategy and to modify it if needed.

Additional opportunities to provide or protect habitat for rare species are being revealed by inventories in West Virginia. Although the species have not yet been identified, researchers have verified that bats are using the cavelike habitat of the abandoned coal mines found in the New River Gorge National River/Gauley River National Recreation Area. Three federally endangered species of bats occur in West Virginia, two of which (gray myotis [*Myotis grisescens*] and Indiana myotis [*Myotis sodalis*]), have previously been found in abandoned deep mines. The third, the Virginia big-eared bat (*Plecotus townsendii virginianus*), is typically found in caves and uses rock shelters in other parts of its range. At least two other rare species, the eastern small-footed bat (*Myotis leibii*) and Rafinesque's big-eared bat (*Corynorhinus rafinesquii*), are occasionally or regularly associated with abandoned underground mines. When the study is completed, resource managers hope to identify specific portals that are being used by one or more of these at-risk species. Gating these portals will reduce hazards to the public, continue to make mines accessible to bats, and reduce disturbances to bat colonies due to recreational entry.

The value of combining information gathered from several surveys was shown in Colonial National Historical Park near Williamsburg, Virginia. During 2000, a small community of a threatened wetland plant, sensitive joint-vetch (*Aeschynomene virginica*), was rediscovered in the park during a survey by the Virginia Division of Natural Heritage of the Department of Conservation and Recreation; the presence of this species had not been documented in that area since 1939. Fortunately a two-year, parkwide inventory of invasive flora had disclosed that common reed (*Phragmites australis*) was growing nearby. Knowing the relative location and density of these two species has prompted park management to target that area for treatment in 2001 to help ensure that the rare plant survives.

Continued on page 10

▲ **Capable of siphoning and straining** up to 5 gallons of water a day, freshwater mussels contribute to water quality and clarity by filtering algae, bacteria, and particulate matter from the water. These five mussels, representing four species, were documented during a survey along 73 miles of the Upper Delaware River. They are valuable indicators of ecosystem health.

Of course, because they are so recent many inventories begun or conducted in 2000 have not yet affected management policies or monitoring strategies—but they will. Perhaps most dramatic are surveys that yield discoveries reflecting the health of ecosystems. Knowing that freshwater mussels are the most rapidly declining animal group in the United States and that they serve as useful barometers of environmental health, the National Park Service and the U.S. Geological Survey began a two-year study in July 2000 to determine the diversity, abundance, and distribution of freshwater mussels in the Upper Delaware Scenic and Recreational River. The researchers are using geographic information system technology to create maps of mussel species distribution and abundance that incorporate data from each 200-meter snorkel survey section along 73 miles of river. Among the eight species found so far, three are listed as endangered, threatened, or proposed endangered at the state or federal level. These three (all indicators of good water quality) are the dwarf wedgemussel (*Alasmidonta heterodon*), thought to have been extirpated in Pennsylvania; the brook floater (*Alasmidonta varicosa*); and the eastern pearlshell (*Margaritifera margaritifera*), which had not been documented in the Delaware River basin in Pennsylvania since 1919. As part of the study, researchers will establish permanent monitoring transects to allow for long-term assessment of trends in mussel populations. This ongoing monitoring will give park personnel an additional indicator of water quality and better enable them to detect changes in ecosystem health in a river upon which millions of people rely for drinking water.

Surveys in 2000 have also revealed species that are intriguing because they are being found in some parks for the first time. Examples include a crayfish (*Cambarus acuminatus*) in Valley Forge National Historical Park, the mountain dusky salamander (*Desmognathus ochrophaeus*) in Delaware Water Gap National Recreation Area, and the northern leopard frog (*Rana pipiens*) in Gettysburg National Military Park (NMP). While conducting an inventory in 1999 and 2000 at both Gettysburg NMP and Eisenhower National Historic Site, researchers also documented four new species of bat for those areas: northern or long-eared myotis (*Myotis septentrionalis*), eastern pipistrelle (*Pipistrellus subflavus*), red bat (*Lasiurus borealis*), and hoary bat (*Lasiurus cinereus*). These preliminary findings suggest the need to conduct a population assessment and to continue monitoring those sites where these animals are being found.

Because factors such as urban sprawl, changing land and water use, and encroachment by dominant plants (both native and exotic) will continue to affect each region's biodiversity, the role of the National Park Service as a protector of natural resources has never been more critical. As researchers analyze and monitor the newfound species in the coming months, their insights will enhance the ability of managers throughout the Northeast Region to plan proactively and to educate the public about the delicate ecosystems in the parks.

Dan Foster honored for resource monitoring

Award-Winner Profile

The Trish Patterson/Student Conservation Association Award for Resource Management in a Small Park went to Dan Foster, Chief of Resource Management of Nez Perce National Historical Park and Big Hole National Battlefield. Dan was recognized for his exemplary work in developing an effective, practical, and sensible natural resource management program for the 38 widely dispersed park units in Washington, Oregon, Idaho, and Montana. The natural and cultural resources in the units are closely intertwined in the stories of the Nez Perce War, the Lewis and Clark Expedition, western missionary history, and the fur trade, and face problems related to encroachment, habitat loss, exotic species, water quality, and lack of knowledge.

"In looking at the problems we faced in widespread park sites, limited [staff], and long intervals of return," Dan explained, "we decided that the best monitoring of park resources was through the use of digital photography." With the help of Lewis and Clark College, Clearwater National Forest, the Nez Perce Tribe of Idaho, the National Park Foundation, and Canon U.S.A., Dan established a three-year project to document change to park resources. The project compares historical photographs with current conditions through digital videography and computer technology. He also acquired funding for and coordinated high-resolution aerial photography of Bear Paw Battlefield to help create detailed digital maps for the park geographic information system. Along with the Nez Perce Tribe and the U.S. Geological Survey, he secured funds and coordinated a baseline water quality study on five of the park units.

Dan relies heavily on partners and park neighbors to address many park resource management issues. He does not consider himself a "genius or outstanding manager," but is thankful for working with highly committed coworkers who care deeply about resource preservation. Winning the award encourages Dan that the work he and his staff and partners are doing "is recognized and important in other people's minds and hearts. We will keep going."

▲ **Dan Foster,** accompanied by his wife, receives the Trish Patterson/Student Conservation Association Award for Resource Management in a Small Park from Mike Soukup, Associate Director for Natural Resource Stewardship and Science. The award included a $2,000 cash prize and a bronze sculpture of a bison.

Amphibians and abandoned mines spawn collaboration of scientific disciplines

✎ By Carol A. Pollio

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The critical decline of amphibian populations has gained worldwide attention. Frequently, units of the national park system have little if any baseline data on amphibians and their habitat. Prince William Forest Park (Virginia) was no exception until a partnership evolved between park staff and geologists with the U.S. Geological Survey (USGS).

In 1995 the Cabin Branch Pyrite Mine was reclaimed after years of coordination between the Virginia Department of Mines, Minerals, and Energy and the Geologic Resources Division, Water Resources Division, and other natural resource staff of the National Park Service. After the reclamation, the amphibians gained the attention of the geologists by using numerous pools of surface water designed to minimize acid mine drainage. By 1998 the geologists had teamed up with the resource management staff of the park to initiate monitoring of the amphibians.

"The data … will be invaluable in protecting amphibian communities…."

Monitoring of the amphibians comprises (1) anuran calling surveys, (2) community structure and breeding surveys, (3) identification and digitization of amphibian breeding sites with geographic information systems, (4) development of educational materials, and (5) development of an interactive Web-based training program. With information from the literature, resource management staff developed a monitoring protocol in 1997 and began water sampling in 1998. The protocol prescribes the recording of anuran calls, visual encounter surveys, dipnetting and identification of larvae, and use of egg bags to enumerate hatch success. Monthly grab water samples are analyzed for 67 parameters, including aluminum, copper, lead, and zinc. The USGS conducts soil-pH and geoelectrical surveys, solid material characterization, and radiogenic isotope studies. The data are used for in-depth analyses of site conditions, levels of inorganic constituents, and characterization of surface and groundwater, which will be used to determine the relationship between habitat condition and community structure.

The amphibian monitoring program also includes a dynamic educational component. In 2000, park staff and volunteers developed an amphibian brochure, an intranet page, an interactive CD-ROM, and a detailed training manual. Interpretive staff at the park developed amphibian programs and worked with the resource management staff to expand the programs to local schools.

The park first sought funding for the program from the Science Division of the National Capital Region in 1999 and matched the funds with money from the base funds of the park and funds from the Volunteers-in-Parks Program. From 1997 to 2000, the USGS donated expertise and laboratory analyses valued at approximately $50,000 per year. In 2000, park staff expanded the surveys of anuran calling and amphibian habitat by conducting them throughout the park.

An NPS resource manager and USGS scientist at Prince William Forest Park identify amphibian larvae as part of an extensive baseline survey of park amphibians. Expanded in 2000, the surveys have enabled the park to develop lasting partnerships with scientists, educators, and the public, and to gather substantial data for use in monitoring changes to amphibian populations and habitat.

The success of this partnership is already evident. The park now has unparalleled baseline data on amphibian breeding success, characterization and identification of critical amphibian habitat, and corresponding water chemistry data. The monitoring of amphibians has become an integral part of the park's Inventory and Monitoring Program and has park support for its continuation. Finally, the park developed long-lasting partnerships with scientists, educators, and members of the public who provide continuous feedback for the program as new issues and technologies emerge.

The data, collected by scientists from diverse disciplines, will be invaluable in protecting amphibian communities because they will allow resource managers to monitor changes in these populations and their habitat. As trends are identified, efforts can be focused on particular species or threatened habitats to ensure the highest level of protection for them.

Barred owl displaces northern spotted owl at Olympic

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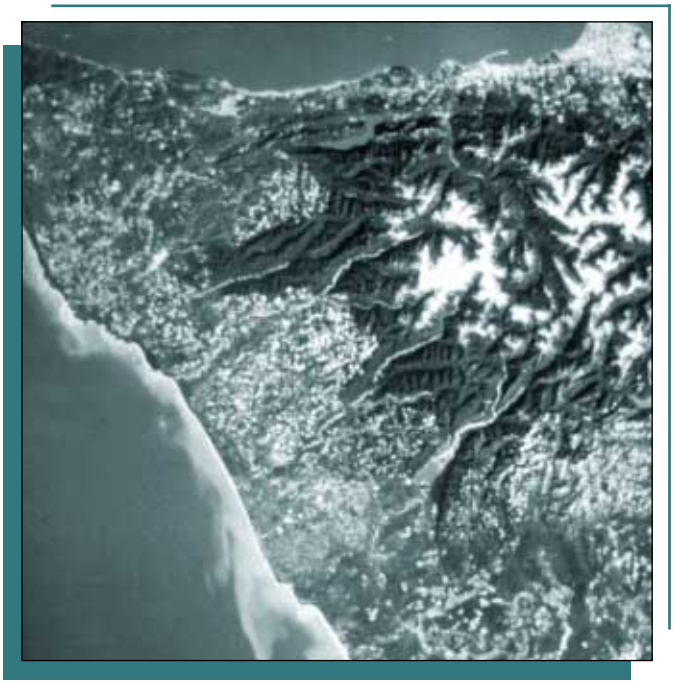
Native to eastern forests, the barred owl (*Strix varia*) has moved into the Pacific Northwest over the last several decades, likely as a result of human-caused changes in the landscape. The barred owl is closely related to the threatened northern spotted owl (*Strix occidentalis caurina*, the subspecies found in Olympic National Park, Washington), but is larger, more aggressive, and better adapted to a range of habitats. As recently as 10 years ago, the barred owl was rare in Olympic, found mostly adjacent to logged areas along the park boundary and in broad, naturally disturbed river floodplains at lower elevations. During monitoring activities in 2000, crews documented barred owls at 18 sites, many of which formerly supported northern spotted owls. More than 10 of the 53 currently monitored northern spotted owl sites are now unoccupied, or the northern spotted owls were displaced 750 meters or more following the first documented use of the site by the barred owl. This biological invasion may prove to be the primary threat to the northern spotted owl in otherwise protected landscapes such as national parks.

As with many of the more subtle ecological changes occurring in parks, the extent of this problem was revealed by a long-term monitoring program, in this case one focused primarily on another question. In 1993, President Clinton released the Northwest Forest Plan to address disagreements about the management of federal forestlands in the Pacific Northwest. The plan mandates "effectiveness monitoring" to measure whether the various federal entities are achieving the goal of protecting enough habitat to support viable populations of

species that are dependent upon late-successional forest. Northern spotted owl monitoring sites within the park, together with those monitored by the USDA Forest Service on the Olympic Peninsula, constitute the Olympic Demographic Study Area. This is one of eight study areas where rates of reproduction and survival are being



▲ **Human-caused changes in the landscape** surrounding Olympic National Park, Washington, may be facilitating a park invasion of barred owls, a competitor of the federally threatened northern spotted owl.
◀ **Owl monitoring in the park** in 2000 documented the highest number of locales supporting the barred owl since monitoring began over 10 years ago. The satellite image above reveals forest clear-cuts as light areas surrounding the park.

investigated throughout the range of the northern spotted owl through 2002. In 2002, planners hope to replace this intensive and costly monitoring with a model that would predict trends in northern spotted owl populations by tracking changes in habitat. The barred owl complicates these efforts by increasing the uncertainty surrounding estimates of northern spotted owl numbers in protected forests. Future monitoring at Olympic will address factors that predict which northern spotted owl sites are most vulnerable to displacement. This will allow barred owl competition to be incorporated into future habitat models.

Although designed to monitor demographic rates, this long-term study also offers insight into the natural history of the northern spotted owl. Olympic National Park contains the largest unfragmented area of suitable habitat within the range of this species. As such, it provides an exceptional control area against which to compare more highly managed forests and to test hypotheses about the effects of barred owl competition.

Return of the muskox to Gates of the Arctic

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They are solid creatures with a slight hump at the shoulders. Their necks, legs, and tails are short. Their dark brown, coarse guard hairs hang almost to the ground, shedding rain and snow. Neither cold nor frost can penetrate their dense inner coat of fine, soft, light brown hair. They stand approximately 4 to 5 feet tall at the shoulders and weigh from 440 to 900 pounds. Both sexes have broad horns that curve down and outward. They are muskoxen (*Ovibos moschatus*), creatures of bitterly cold and often forbidding environments, and they are beginning to occupy new habitat in Gates of the Arctic National Park and Preserve, Alaska.

One of the mandates of the National Park Service is the maintenance of a full complement of native species in national parks. But by the middle of the 19th century, muskoxen were extirpated from northern Alaska, including the park and preserve. Anecdotal information indicates that small numbers of muskoxen in the mountains and foothills of the Brooks Range were the last to disappear from the state. The species was reintroduced into northeastern Alaska in 1969 and 1970, and the released population expanded rapidly; today the animals generally occur in arctic coastal regions in the state. Since 1989, however, muskoxen have been observed with increasing frequency in Gates of the Arctic National Park and Preserve.

The reestablishment of muskox populations has been controversial in northern Alaska. Many people perceive the return of this species to historical ranges as an exciting event that affords visitors and residents the opportunity to observe this distinctive animal. Many local residents regard the muskox as a traditionally hunted resource. At the same time, many residents have expressed concern that the presence of the muskox will have a detrimental effect on caribou (*Rangifer tarandus*) populations and caribou hunting.

The natural reestablishment and harmonious integration of the muskox in Gates of the Arctic National Park and Preserve require baseline information for park managers. However, information on habitat use by muskoxen on the arctic coastal plain, with its low snow levels, may not be applicable in the alpine environment of Gates of the Arctic with higher snow levels. Information on the species' occupancy of alpine areas is limited to one study in Norway.

"The natural reestablishment and harmonious integration of the muskox in ... the park ... require baseline information for park managers."

Muskox habitat use in the park is being investigated using a geographic information system. In 2000 the locations of animals observed by park biologists and park visitors were mapped. Land cover, elevation, slope, and aspect were quantified. Initial data suggest that muskoxen occupy mountain drainages when snow is shallow and that they likely move up onto windswept mountain shoulders as snow accumulates in the drainages. The next task for park staff is mapping all muskox habitat in the park. All of the information will be used to evaluate the potential for a viable muskox population in the park, to guide management, to set future harvest levels, and to allow the National Park Service's informed participation in meetings with local, state, and federal wildlife agencies.

The National Park Service is a member of interagency and international working groups that formed to synchronize management of muskox in northern Alaska and the northern Yukon. Baseline information on habitat and distribution of the species is essential for establishing common goals of cooperative management and for addressing all concerns.

▲ **A large herd of muskox** forms a defensive circle along the coastal plain in Bering Land Bridge National Preserve, Alaska, providing a degree of safety from predators. Fewer in number in the mountainous Gates of the Arctic National Park and Preserve, the species is just beginning to occupy mountain drainages and windswept mountain shoulders in this park, prompting habitat use surveys coordinated by the National Park Service.

Paleontological inventories unearth the remains of ancient life in parks

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From the badlands near the U.S.–Mexico border to the coastline of Alaska, park staff, scientists, students, and others conducted paleontological resource inventories in 32 units of the national park system in 2000. Working in teams, the partners collected information that has advanced the knowledge of park managers regarding these nonrenewable resources and their protection. The surveys were funded by the Inventory and Monitoring Program, the Geologists-in-the-Parks Program, and the Alaska Regional Office.

Preliminary paleontological resource surveys were completed in all of the national park units in Colorado and Utah. Intensive fossil inventories initiated at Arches National Park, Glen Canyon National Recreation Area, and Zion National Park yielded some exciting new discoveries. Dozens of dinosaur track sites, containing new track types, were documented in remote canyons at both Arches and Zion.

"In Texas the largest and most complete skeleton of the sauropod dinosaur Alamosaurus *was discovered in late Cretaceous sediments at Big Bend National Park."*

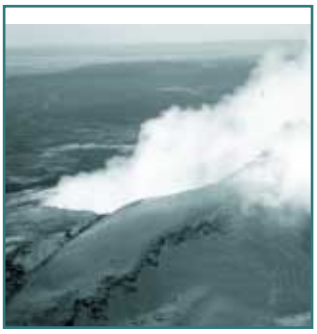
A small team of paleontologists in Alaska overcame the limitations of weather, bears, and transportation to remote locations, and initiated field surveys by foot, car, boat, and plane in four parks. Among the many new discoveries is a fossil leaf locality at Katmai National Park and a rich concentration of marine invertebrates and plants along the coastline of Aniakchak National Monument and Preserve.

In Texas the largest and most complete skeleton of the sauropod dinosaur *Alamosaurus* was discovered in late Cretaceous sediments at Big Bend National Park. Additionally, paleontological resource surveys were undertaken at Lake Meredith National Recreation Area and Alibates Flint Quarries National Monument as part of the oil and gas management planning for both areas. This is the first time that the National Park Service has incorporated paleontological resources into oil and gas management planning and an environmental impact statement.

In addition to the surveys completed in the national park system, NPS staff assisted other federal land management agencies. The NPS approach to inventorying paleontological resources, as piloted at Yellowstone National Park in 1998 and continued with great productivity in other parks in 2000, has been recognized as a highly effective way of documenting the fossil record preserved on public lands. During 2000 the Bureau of Reclamation partnered with the National Park Service to complete paleontological surveys at Red Fleet and Steinaker Reservoirs near Vernal, Utah.

▲ **Vertebrae of a brontosaurus-like dinosaur** (i.e., sauropod) were among the discoveries at Arches National Park, Utah, during a recent paleontological resource survey by the National Park Service. This survey and similar ones conducted at Big Bend and several Utah, Colorado, and Alaska parks in 2000 have significantly advanced the knowledge of these resources and the need for their protection.

Sulfur dioxide advisory system installed at Hawaii Volcanoes



▲ **The Pu'u 'O'o vent on the east rift** zone of Kilauea Volcano currently emits approximately 1,500 tons of sulfur dioxide (SO_2) gas each day. In 2000 the Park Service and the U.S. Geological Survey began developing an SO_2 advisory system at Hawaii Volcanoes National Park to warn staff and visitors of unhealthy levels of the toxic gas.

U.S. Geological Survey

Hawaii Volcanoes National Park is unique in the national park system because it periodically has extremely high concentrations of sulfur dioxide (SO_2)—far higher than any other national park or even most urban areas. Sulfur dioxide is a poisonous gas that irritates the skin and mucous membranes of the eyes, nose, throat, and lungs. The SO_2 gas is emitted by the Kilauea Volcano, which has produced a steady flow of lava and gas since 1986. During the winter months when tradewinds are absent, high concentrations of SO_2 often occur at Kilauea's summit, impacting the popular Kilauea Visitor Center and Jaggar Museum.

To help protect the health and safety of park visitors and employees, in 2000 an SO_2 monitoring station was installed in the highly visited summit area of the park, and a notification and response plan was developed. The project was a cooperative venture among the NPS Air Resources Division, the NPS Pacific West Region Air Quality Coordinator, Hawaii Volcanoes National Park, and the U.S. Geological Survey's Hawaiian Volcano Observatory. The sulfur dioxide response plan identifies a list of actions to take when SO_2 concentrations reach defined levels for specified lengths of time. The primary intent of the response plan is to advise people about the SO_2 hazard and to recommend measures for limiting or avoiding exposure. The response plan is currently in a trial period with changes and refinements to be made as needed. The new advisory system allows the Park Service to be proactive in efforts to protect visitor and employee health and safety during periods of volcanic air pollution.

Beaver, river otter, and muskrat inventoried in Grand Canyon

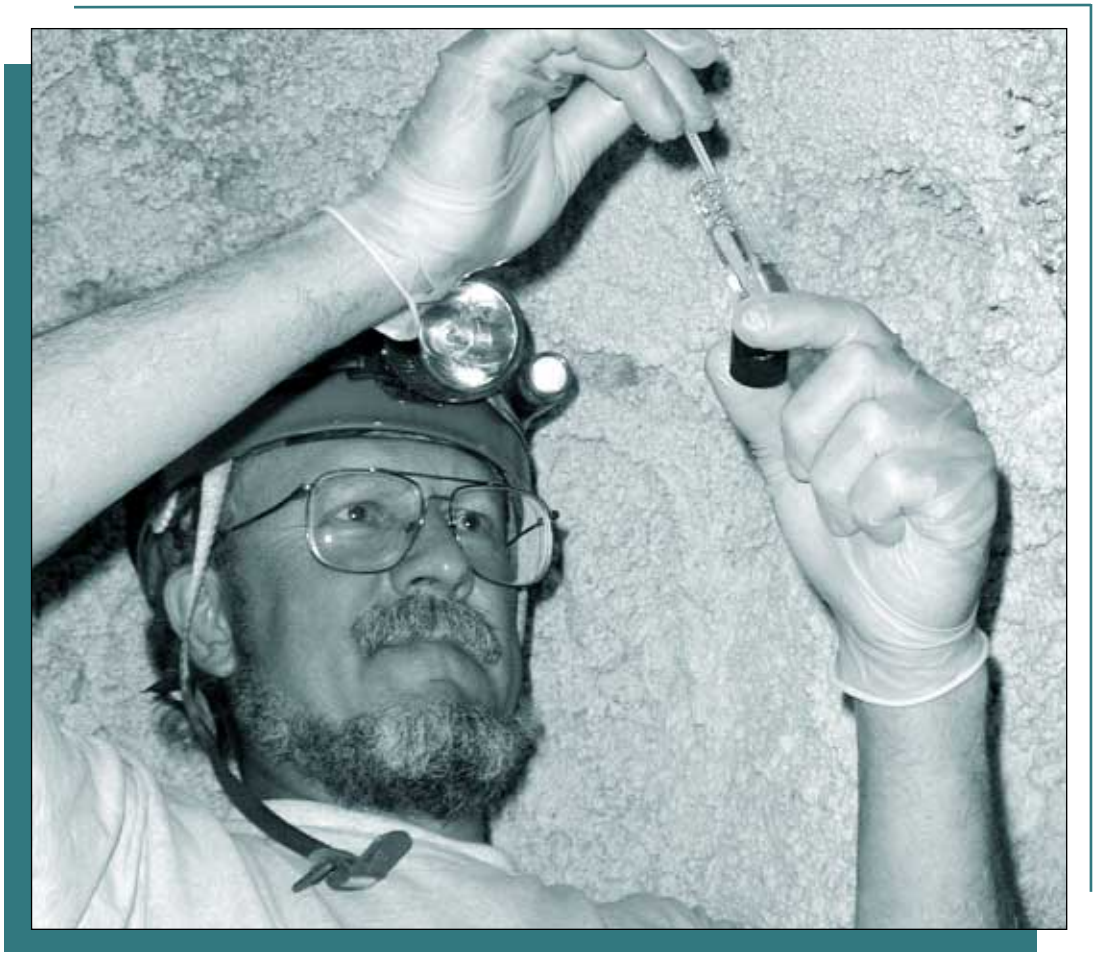
Relatively little has been published about the distribution and abundance of beaver *(Castor canadensis),* river otter *(Lutra canadensis),* and muskrat *(Ondatra zibethicus)* in the Grand Canyon and their relationships with the riparian habitats along the Colorado River. This lack of information has made it difficult for wildlife managers to know how these species are faring in the park.

In spring 2000, Grand Canyon wildlife biologists took advantage of a scheduled decrease in the river's flow to conduct the first furbearer survey along the Colorado River from Lee's Ferry to Pearce Ferry. Nearly 300 miles of riverine habitat was inventoried by park biologists and more than 20 interagency volunteers from as far away as Washington, D.C., and Yellowstone National Park. With flow rates below 8,000 cubic feet per second, bank dens, slides, and tracks belonging to riparian mammals were well exposed, offering clear and accurate observations of active and inactive furbearer dens. Nearly 300 beaver dens were recorded, muskrat and otter tracks were identified, and bank vegetation was identified and mapped. All of this information was entered into a geographic information system database. The resulting data are being compiled for inclusion in a feasibility study for reintroduction of the river otter into Grand Canyon National Park, which the park hopes to complete by 2002.

Although one pair of otter tracks was observed in the survey, a viable population of the species no longer exists in the Colorado River below Glen Canyon Dam. The park staff plan to work cooperatively with local tribes, adjacent land management agencies, and local environmental groups to restore this important carnivore to the river ecosystem.

▲ **A beaver at Tapeats Creek** was one of the furbearing mammals inventoried along the Colorado River in Grand Canyon National Park in 2000.

2000 Parks as Laboratories



▲ **Cave scientist Michael Spilde** of the University of New Mexico prepares a sample of limestone corrosion residue taken from the wall of Spider Cave in Carlsbad Caverns National Park for examination in the laboratory. Like nearby Lechuguilla Cave, Spider Cave harbors diverse microbial life. Both caves are being studied for insights into the evolution of life in these subterranean environments where nutrient levels are extremely low.

The parks themselves are wonderful natural laboratories, relatively well controlled, where species can be investigated in depth [and] where the whole constellation of species found in individual areas can be explored … on a large scale.

—Peter Raven
President-elect, American Association for the Advancement of Science

Featuring some of the best-preserved ecosystems on earth, the many units of the national park system are great repositories of biological and geological diversity. The scientific knowledge and applications that are being discovered in these strongholds have the great potential to improve society and enhance the protection of the parks themselves. To bring such discoveries to light, the National Park Service relies on its research partners to design and conduct experiments that yield useful information. Conversely, scientists look to the National Park Service for access to parks and for leadership in research on biodiversity, ecology, and conservation. As the following articles suggest, this relationship is growing and must continue to grow. Recent research and scientific advances are adding to our knowledge of parks and improving their management, and national parks are increasingly fulfilling a vital role in the quest for knowledge and understanding of our world.

Social Benefits of Park Research

Survival in extreme environments

✎ By Paul Burger

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The discovery of a small rock—Martian meteorite ALH84001—on an Antarctic ice field in 1984 and the discovery of possible Martian fossil bacteria on the rock in 1994 sparked a search for life in extreme environments where organisms subsist with few organic nutrients. Such extreme environments include caves, and caves are preserved in many units of the national park system.

In 2000, scientists from the University of New Mexico continued their six-year search for life in caves of Carlsbad Caverns National Park, New Mexico. They braved pits that are more than 200 feet (60 meters) deep and mazes of tight, dirty crawls. With the help of cave specialists of the National Park Service, the scientists discovered previously unknown bacteria on the walls and in the pools of several caves.

Some bacteria are hidden in mats of red, black, and orange corrosion residues on the cave walls where they obtain energy from tiny amounts of iron and manganese in the limestone bedrock. These bacteria may be analogs for life beneath the stony, barren surface of Mars where satellite imagery and samples revealed large amounts of iron in rock.

In Lechuguilla Cave, only 1 mile (1.6 kilometers) from the world-famous Carlsbad Cavern, pools are also teeming with life. According to Dr. Larry Mallory, a microbiologist with Biomes, Inc., "There is more biodiversity in some of the pools of Lechuguilla than in the Amazon jungle." By releasing enzymes that kill competitors, the bacteria in these pools compete fiercely with each other for the few available nutrients. Testing in the laboratory revealed that some of these enzymes attack leukemia cells and may someday become instrumental in cures of human diseases.

Unfortunately, foreign bacteria shed from human skin, hair, and clothes harm the native microbes by outcompeting them for food. Additionally, food particles, flakes of dead skin, hair lint, and dirt left behind by people can overwhelm portions of the cave's nutrient-poor ecosystem, altering it in favor of exotic surface microbes. Only a few contacts with cave explorers have already decimated native microbe populations in some of the pools of Lechuguilla Cave. Explorers and scientists, who often camp in the cave for several days, are now required to eat and sleep on drop cloths that catch food, skin, and hair. Furthermore the explorers are restricted from approaching pools they discover and are required to report their discoveries to the Cave Resources Office of the park and to the investigators of the University of New Mexico. Scientists approach the pools in Tyvek clean suits and set up clean glass slides that remain in the cave for as many as five years. After the slides are collected, scientists culture the bacteria in a laboratory and attempt to isolate important enzymes to gain an understanding of life in extreme environments.

Continuing research will further an understanding of the complex ecosystems and life-forms in the caves of Carlsbad Caverns National Park. Already the studies reveal the delicacy of these organisms and the importance of appropriate management of the caves.

▲ **Rich in bacteria and fungi,** cave wall corrosion residue may form as a result of microbial metabolism of inorganic elements such as iron and manganese. Geobiologists studying this phenomenon in several near-pristine caves in Carlsbad Caverns National Park hypothesize that these microbial life processes hold clues to the potential for subterranean life on Mars.

National Cave and Karst Research Institute begins organizational phase

In 1998, Congress directed the National Park Service, in cooperation with other federal and nonfederal partners, to establish the National Cave and Karst Research Institute in the area of Carlsbad, New Mexico. The institute's emphasis is on partnerships, research, and education for the improved management of cave and karst resources.

In July 2000 an interim director, Zelda Chapman Bailey, was hired to define the institute's purview and scope of operation, design the organizational structure, find funding sources, form partnerships, locate a facility, and identify specific research needs and priorities. Bailey has more than 20 years of experience as project chief and manager with the USGS Water Resources Division, working in several states. She also has expertise in developing partnerships with other agencies in managing challenging organizational situations.

◀ **Improving the understanding** of delicate cave formations such as these "snake dancer" helictites in the Guadalupe Mountains of New Mexico (and cave resources throughout the country) is a fundamental goal of the National Cave and Karst Research Institute.
Ronal Kerbo

Mapping the floor of America's deepest lake with sonar

✎ By William M. Brock

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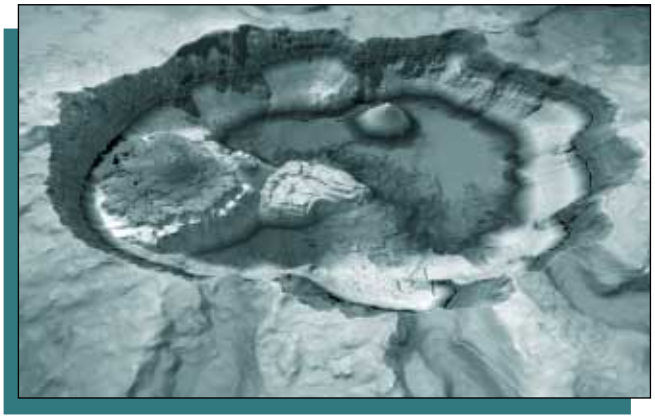
In 1886, scientists of the U.S. Geological Survey took the first-ever measurements of the depth of Crater Lake (Oregon) in various locations. From a rowboat lowered by ropes to the lake surface, they used a spool of piano wire with lead weight and leather tabs to record depths. They took about 100 measurements and recorded a maximum depth of 1,996 feet (609 meters). In 1959 other scientists provided another glimpse of the lake floor and a new official depth of 1,932 feet (589 meters). Their methods, although sophisticated for the day, could provide only a crude understanding of the lake floor.

One hundred fourteen years after the first depth recording, the staff of Crater Lake National Park repeated the measurements. In cooperation with the U.S. Geological Survey, in 2000 they completed a comprehensive survey of the floor of Crater Lake with state-of-the-art, multibeam sonar technology. This time an 11,200-pound (4,178-kilogram), 26-foot (8-meter) research vessel, *Surf Surveyor*, was used for the mapping. It was trucked from Louisiana and then transported by a U.S. Army Reserve Chinook helicopter 1,000 feet (305 meters) from the rim of the caldera to the lake surface.

Scientists mapped the lake floor with the most advanced multibeam sonar equipment. Only six equivalent units are in service worldwide. The scientists took more than 16 million soundings and recorded, among other things, a maximum lake depth of 1,958 feet (597 meters), which is 26 feet (8 meters) greater than previously thought. The crew completed the survey in five days and the military retrieved the vessel from the lake surface.

Like the early explorers, scientists from the U.S. Geological Survey and managers from the National Park Service are exuberant about the results of the mapping. The new images of the geologic features are very precise and reveal amazing details of ancient lava flows, huge landslide debris fields, distinct submerged shorelines, and previously unknown drainage patterns formed before the lake filled. Information from these new data will launch geologists and volcanologists onto a new plateau of scientific investigations of the lake and its volcanic origins. The data may also provide clues to the evolution of volcanoes throughout the Cascade Range.

Mapping Crater Lake developed from an unusual compact begun in 1995 among attorneys, corporate executives, insurance adjusters, government officials, research scientists, and the military in a civil settlement under the Resource Protection Act (16 USC 19jj). Although the survey phase of the research on the lake is now complete, the park and the scientific community will continue to reap its benefits and build upon the results for years, if not decades, to come.



▲ **This computer-generated map** of Crater Lake, Oregon, is the result of recent surveys using state-of-the-art, multibeam sonar for the acquisition of soundings. The new depiction is the most detailed to date and reveals submerged shorelines, lava flows, landslide debris fields, and a maximum depth of 1,958 feet.
U.S. Geological Survey

New moth and butterfly species identified in the Smokies

As part of Great Smoky Mountains National Park's All Taxa Biodiversity Inventory, in the summer of 2000 a lepidoptera "bio-blitz" inventory sparked great interest. This effort involved more than 20 professional and amateur lepidopterists collecting (if necessary) and identifying as many moth and butterfly species as possible during a 24-hour period. A one-day inventory like the lepidoptera bio-blitz has never been done on this scale before. The results amazed even the scientists involved with the finding of 706 species, including 327 new distributional records. The number of lepidopteran species known to occur in the park, is now up to 1,100; however, experts believe that the actual total is closer to 3,500.

The All Taxa Biodiversity Inventory is a 10- to 15-year effort intended to comprehensively document all life-forms in Great Smoky Mountains National Park (North Carolina and Tennessee). The current tally of all species new to science recorded during the inventory, which is in its fourth year of operation, is 80; the total number of new park records, not counting the 80 new species, is 620. The park staff hopes to hold more of these bio-blitz events in the future.

The luna moth (*Actias luna*), common in the eastern United States, was one of many lepidopteran species inventoried during a 24-hour "bio-blitz" in summer 2000 at Great Smoky Mountains National Park. ▶

Award-Winner Profile — Dr. Howard Ginsberg honored

▲ **Dr. Howard Ginsberg** in his laboratory at the University of Rhode Island. Michael Salerno, University of Rhode Island

Michael Soukup, Associate Director, Natural Resource Stewardship and Science, presented the annual Director's Award for Natural Resource Research to Dr. Howard Ginsberg at the annual natural resources meeting in Missoula, Montana, in June 2000. Dr. Ginsberg is a research ecologist with the USGS Biological Resources Division, stationed at the University of Rhode Island. He was honored for research and technical assistance he provided in 1999 to national park units on the west Nile virus, and for his research on the tick *Ixodes scapularis*, the primary vector of Lyme disease in North America.

The west Nile virus, native to southern Europe, the Middle East, and Africa, is a mosquito-borne disease that is deadly to wildlife and people. The virus can result in fatal encephalitis (inflammation of the brain) in humans and horses, as well as kill certain domestic and wild birds (particularly crows) and mammals. It is believed to have been introduced into the United States in 1999, when it made 62 people seriously ill and killed 7 people in New York City. The virus is spreading through the New England and Mid-Atlantic states and could become a nationwide problem.

Dr. Ginsberg provided critical support to Fire Island National Seashore and Gateway National Recreation Area, the two park sites nearest the 1999 outbreak, as well as other Northeast Region coastal parks, in assessing the disease risk of the virus during the 1999 breeding season. He wrote detailed surveillance and management protocols for the two parks, which established comprehensive monitoring programs and tied management actions to the surveillance data. He also helped other parks in the area, including Assateague Island National Seashore and Delaware Water Gap National Recreation Area, to set up similar but less detailed programs. In addition, Dr. Ginsberg's research and knowledge of mosquito ecology prevented the local Suffolk County (New York) Vector Control Agency from spraying saltmarsh mosquitoes with malathion, a chemical pesticide, in the Fire Island National Seashore Wilderness Area.

The west Nile virus can adversely affect park resources by directly impacting wildlife populations. Efforts to control the disease, such as pesticide applications, can also adversely affect parks. In an interview after winning the award Dr. Ginsberg observed, "The best way to minimize these negative effects is to monitor vector and wildlife populations to determine the level of risk, and to target interventions as efficiently as possible. If interventions are not needed, based on surveillance data, do not intervene. If interventions are needed, use interventions that will work (to minimize the need for future interventions), and target them carefully to minimize effects on park resources."

Dr. Ginsberg deeply appreciates being recognized by the National Park Service. "I have always felt a strong connection to the national parks, and I hold the people I have worked with in very high regard…. To be recognized by these fine and dedicated people is a high honor indeed."

"New" waterfalls discovered in Yellowstone

A book published in 2000 amazingly documented for the first time more than 240 "new" waterfalls in Yellowstone National Park. *The Guide to Yellowstone Waterfalls and Their Discovery* was based on seven years of research and off-trail exploration by its three disciplined and adventurous authors. The discovery of these waterfalls has increased the understanding of Yellowstone's geography and has added new, albeit in most cases remote, attractions for visitors. The waterfalls are also barriers to fish, including the Yellowstone cutthroat trout (*Oncorhynchus clarki*), a species that historically occurred throughout the park but now has been reduced to isolated populations. Park staff used the information on the waterfall locations to create a digital fish barrier layer in their geographic information system. This information will assist them in determining the distribution of the trout and in developing future strategies for conserving and restoring this species.

◀ **Citadel of Asgard Falls,** documented for the first time in 2000 in Yellowstone National Park, Wyoming. Copyright Paul Rubinstein

Forging Partnerships

What does NASA have to do with the National Park Service?

✎ By Anita Davis

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Liaison to NASA Goddard Space Flight Center, NPS Division of Interpretation, Greenbelt, Maryland

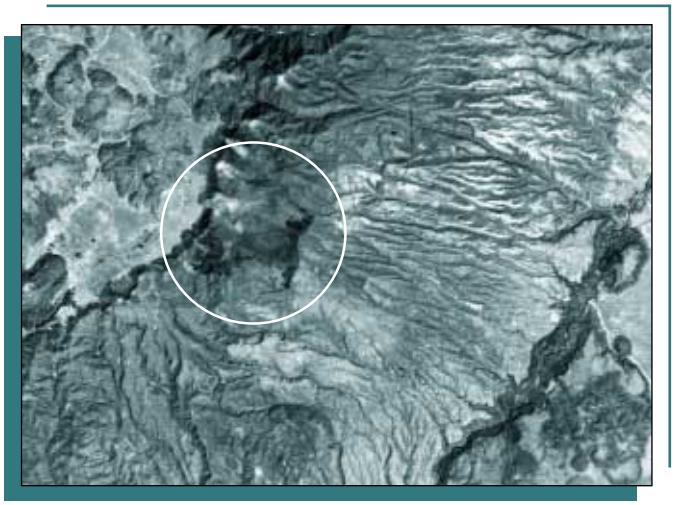
A lot! In 1998, at the request of Goddard Space Flight Center in Greenbelt, Maryland, a partnership between the two agencies began with the filling of the first one-year detail assignment of an NPS liaison to NASA. The incumbent is on staff of the NPS Division of Interpretation in Washington, D.C.; the position is funded by NASA.

The space program offers many products and services that can support the Park Service's Natural Resource Challenge, in particular the call for increased collaboration with scientists and the expanded use of parks as research locales. Goddard Space Flight Center is NASA's lead center for the Earth Science Enterprise, whose scientists study deforestation, wildfires, volcanism, air quality, urban growth, plankton distribution, decline of coral reefs, and glacial retreat—topics of obvious relevance to NPS resource preservation efforts. Because of this emphasis at Goddard, the liaison position offers a perfect opportunity to explore possible connections between NASA's earth scientists and national park research needs, thus supporting the goals of the Challenge.

In 2000 the partnership provided information about the Earth Science Enterprise's work and possible applications for resource management posted to NPS bulletin boards. Ongoing research produced satellite images of fires in summer 2000 that were posted on the NPS website and internal bulletin boards for staff use. Also, some NASA programs, most notably Landsat 7, gave technical assistance to parks. Dialogues with NASA personnel studying uses of hyperspectral data led to new remote sensing data and imagery for selected parks in Florida.

Collaboration with the Park Service is not entirely new to NASA. In recent years, research on LIDAR technology (a laser version of radar) produced detailed mapping and monitoring of beach erosion for Assateague Island National Seashore, Maryland. But the partnership has also helped other Goddard scientists become aware of NPS interests. Some inquired about desirable research and offered to help parks in data acquisition. For example the Landsat 7 team helped Delaware Water Gap National Recreation Area, Pennsylvania, acquire and process data to analyze land use change in the Delaware River watershed. The satellite images provide information over the entire watershed that is not obtainable from maps.

New technologies can and do support preservation of park resources. Land managers and researchers are already using data from the new MODIS instrument (*Mod*erate-resolution *I*maging *S*pectroradiometer) aboard the satellite Terra for studying effects of wildfires. Instruments providing better land-imaging data are being tested in the recently launched EO-1 satellite, and the satellite Aura (launching in 2003) will allow analysis of air quality with unprecedented accuracy. Some NASA scientists are interested in working in national parks to "ground-truth" such new instruments, which would yield valuable data and information for both agencies.



▲ **A combination thermal and visible spectrum image** of the Cerro Grande fire in Bandelier National Monument, New Mexico (circled), was captured on 9 May 2000 by the Landsat 7 satellite 427 miles in space. It is a good example of the remote sensing imagery available to parks that has application in resource management. Although difficult to see in this reproduction, the full-color image readily reveals the fire perimeter and levels of fire intensity. When compared with subsequent views of the area, this information is useful in determining site recovery or indicating the need for rehabilitation. The full-color image can be viewed at http://visibleearth.nasa.gov/cgi-bin/viewrecord?588. Parks wishing to purchase Landsat data may do so through the EROS Data Center (http://edcwww.cr.usgs.gov/index.html) for $600 per data set. The data are not copyrighted and may be shared without restriction.

NASA Earth Observatory; http://earthobservatory.nasa.gov

The agencies' partnership also spawned Introduction to Remote Sensing for Park Rangers, a course to be offered jointly by the Park Service and the U.S. Fish and Wildlife Service at the National Conservation Training Center in Shepherdstown, West Virginia, in May 2001, and funded with a grant from NASA. It is open to anyone from the sponsoring agencies.

As natural resource managers and scientists of the National Park Service increasingly use NASA technologies, collaboration between the two agencies will soon be common. The NPS liaison in the NASA Public Affairs Office welcomes questions, requests, and ideas for the partnership. The agencies' partnership will continue in 2001.

Further information on NASA's earth science research is available at http://earthobservatory.nasa.gov.

Satellite imagery used for long-term park monitoring

In 2000 the National Park Service joined the Multi-Resolution Land Cover Consortium, which provides access to Landsat 7 satellite data (33-yard or 30-meter resolution) and land-cover mapping products for free or at a reduced price. Satellite imagery is a method for taking a snapshot of a park's resources in their regional context. Landsat 7 and higher-resolution imagery offers an excellent opportunity for mapping, monitoring, and discovering ecosystem patterns and processes. Further information on the use of imagery is available at http://edc.usgs.gov/earthshots/slow/tableofcontents.

Leslie Armstrong (leslie_armstrong@nps.gov) and Mike Story (mike_story@nps.gov) of the National Park Service are available to assist parks in purchasing Landsat or other types of satellite imagery. The NPS Inventory and Monitoring Program maintains a long-term archive of imagery that includes all new purchases by parks. To help park staff learn what imagery is available from federal and commercial sources, a Microsoft Access database called the Imagery Database was assembled and posted at www.nps.gov/gis/national_data.htm.

This map of unplanned "social" trails (short, dark lines) at Cape Cod National Seashore, Massachusetts, was derived from high-resolution imagery. It serves as a baseline for monitoring the effectiveness of management strategies to reduce the development and natural resource impacts of such trails.

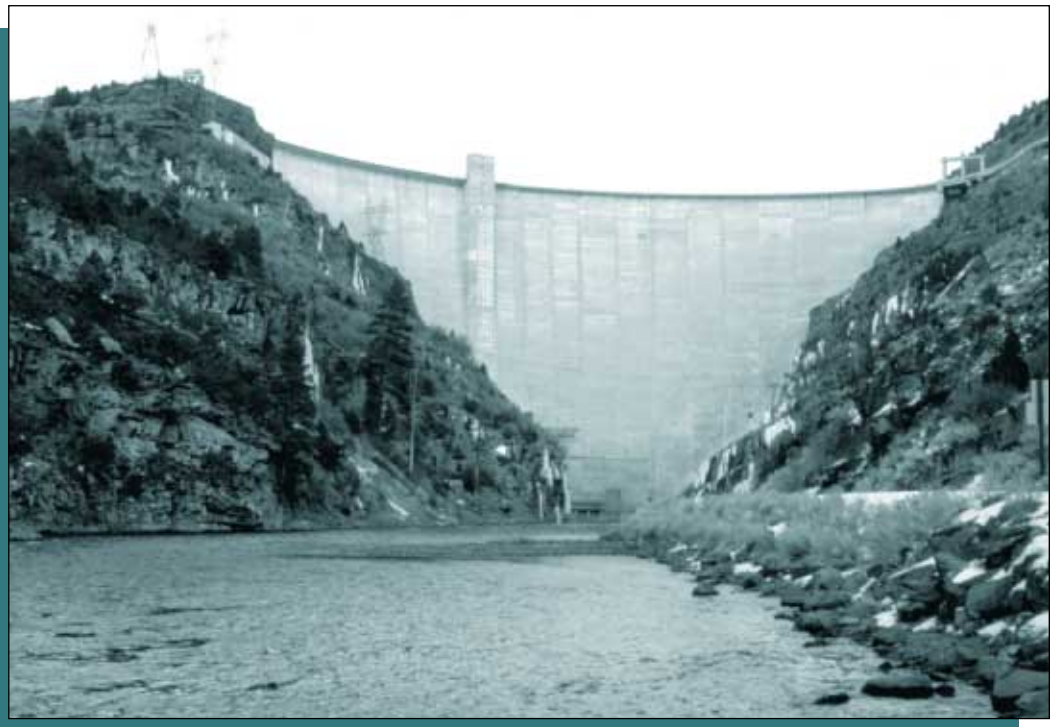
First Canon National Parks Science Scholars retreat

Eleven of 13 National Parks Science Scholars attended the Canon retreat outside Yellowstone National Park on 11–14 May 2000. The retreat focused on the relationship among science, the media, and the public. Pulitzer Prize–winning journalist William Dietrich gave a speech on communicating science to the public. Seven new 2000 Canon Scholars were announced and 1997 scholars Andy Suarez and Ilene Grossman-Bailey were recognized for completing their doctorates. Andy earned his degree in biology at the University of California, San Diego. His dissertation was titled "Measuring the Impact of Exotic Species in Natural Systems." Much of his research was conducted in Cabrillo National Monument. Ilene earned her degree at Temple University, Philadelphia. Her dissertation was titled "Native American Resource Use in the New Jersey Outer Coastal Plain." Ilene's fieldwork was conducted at sites in the Pinelands National Reserve and along the New Jersey Coastal Heritage Trail Route.

The Canon National Parks Science Scholars Program was established in 1997 with the purpose of developing the next generation of scientists working in the fields of conservation, environmental science, and park management. It is the first and only program of its kind to encourage doctoral students to conduct research on problems critical to the national park system. The program is underwritten and supported by Canon U.S.A., Inc.

Recent Canon Scholar graduates Andy Suarez (top) and Ilene Grossman-Bailey

2000 Resource Risks



▲ **The Flaming Gorge Dam** in northeastern Utah regulates the flow of the Green River, affecting endangered fish and other riparian species in Dinosaur National Monument and Canyonlands National Park. The National Park Service has been providing input on new flow recommendations to stimulate recovery of endangered fish species and to restore riparian habitat.

Homo sapiens *has become a geophysical force, the first species to obtain that dubious distinction. We have driven carbon dioxide to the highest levels in the last 200,000 years, unbalanced the nitrogen cycle, and contributed to global warming that will ... [create] severe pressure on the national parks, probably within a matter of just decades.*

—E. O. Wilson
Harvard biology professor, naturalist, and author

Environmental histories identify the late 20th century as the period in which human beings recognized that no place on earth is safe from environmental degradation, regardless of its remoteness. Despite appearances, units of the national park system are no exception. Undeterred by park boundaries or the distance of their sources, air and water pollution commonly diminishes park values. Habitat loss and fragmentation reduce populations of plants and animals and influence the spread of exotic species. Other threats arise from within parks and include erosion, vandalism, and overuse of some areas. This reality compels the National Park Service as caretakers of beloved treasures to be vigilant about changes in park natural resources and to intervene as a sophisticated, scientific force for their preservation. The actions of the National Park Service today—some of which are documented here for 2000—to maintain the health of park ecosystems will determine the quality of parks it passes on for the enjoyment of future generations.

Competition for Water

River management and the Upper Colorado River Recovery Implementation Program

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The Colorado River may be the world's most managed, legislated, and litigated river system. The river and its tributaries sustain cities, industry, and agriculture in an arid region. More than 49 dams store water conveyed by canals and aqueducts to locations inside and outside the basin. Overallocation of basin water yield has fueled conflicts among competing interests, making the river ecosystem the major casualty of battles over water to meet human demands. Modification of flow regimes by dams has contributed to the decline of river-dependent species, including those in six units of the national park system. Affected species include the endemic, federally listed endangered Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), humpback chub (*Gila cypha*), and bonytail (*G. elegans*). Proposed actions for the recovery of the species include the reoperation of dams to provide flows that meet life history requirements. Although establishing more natural flow patterns is probably the most important tool for recovery, it is controversial because of its potential impacts on human use.

"The river ecosystem [is] the major casualty of battles over water to meet human demands."

While the impairment of rivers in the Colorado River basin by dams affects many species, the most significant river restoration projects are being driven by efforts to recover the four endangered fishes. The U.S. Fish and Wildlife Service is ultimately responsible for recovery, but other agencies and various interest groups are jointly implementing recovery actions within the subbasins. The Upper Colorado River Recovery Implementation Program (hereafter "the program") was formed in 1988 with the goal of recovering the endangered fishes while allowing the continuation of water development in compliance with existing laws. The program initially comprised the Upper Basin Water Users; the U.S. Fish and Wildlife Service; the U.S. Bureau of Reclamation; Western Area Power Administration; the States of Colorado, Utah, and Wyoming; and the environmental community represented by The Nature Conservancy and Environmental Defense. The Colorado River Energy Distribution Association and the National Park Service acquired voting membership in 2000.

In 2000 the program reviewed reports with flow recommendations for the Green River below the Flaming Gorge Dam and the Gunnison River below the Aspinall Project. These rivers are the two largest tributaries to the Colorado River upstream of Lake Powell. Their flows affect natural river functions in Canyonlands (Utah) and Black Canyon of the Gunnison National Parks (Colorado) and in Dinosaur National Monument (Colorado and Utah).

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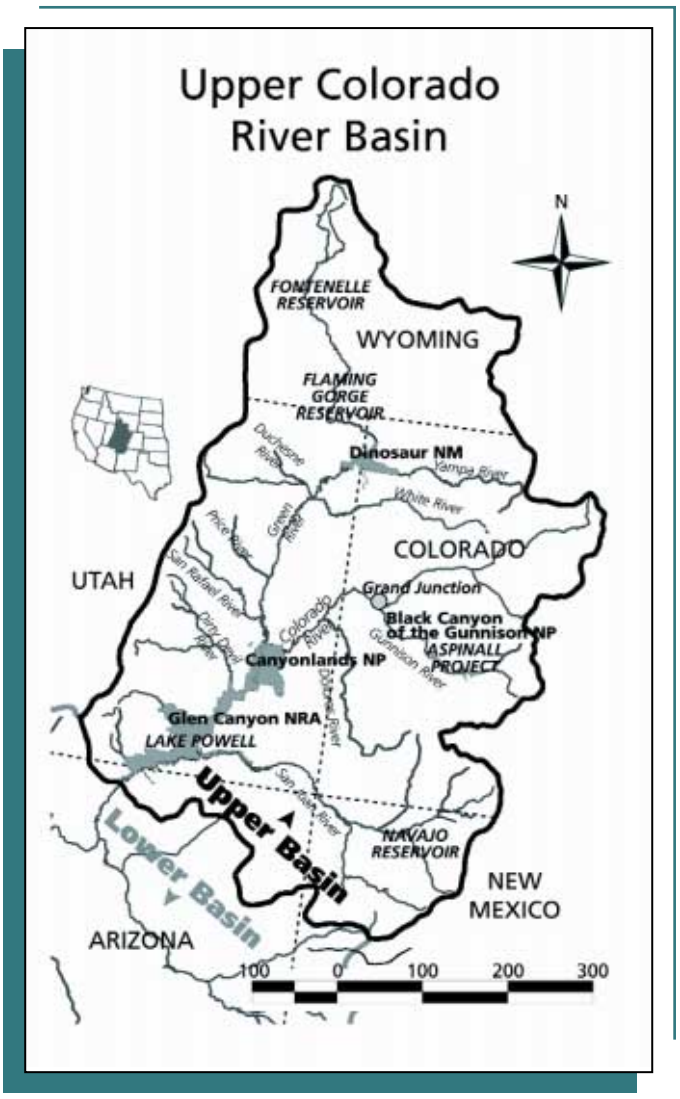

▲ **Major rivers and reservoirs** of the Upper Colorado River basin and the national park system units they affect. NPS Intermountain GIS Office and Natural Resource Information Division

In June, the program adopted flow recommendations for the Green River. In its comments, the National Park Service indicated that these flow recommendations were inadequate to restore riverine processes or meet the needs of the listed species in Dinosaur and Canyonlands. The Park Service was not a voting member at that time. The recommendations were specifically intended to provide benefits in the river between Dinosaur and Canyonlands, where it is believed that fish requirements can be met with lower releases from the dam. The National Park Service is now providing input into the Flaming Gorge Dam Environmental Impact Statement, which will determine how the dam is operated to implement the recommended flows. In addition the NPS Water Resources Division is supporting research on river and riparian species and refining a model to identify flow needs for the purpose of quantifying a federal reserve water right within the monument.

In 2000 the program also considered flow recommendations for the Gunnison River. The National Park Service voted to adopt these recommendations because they represented a legitimate attempt to emulate the natural flow patterns and because the habitat maintenance benefits were well supported by hydrologic data. In addition the recommended flows were consistent with those needed to maintain natural river functions upstream in Black Canyon of the Gunnison National Park. However, the program has yet to resolve differences in the views of its members. Continued opposition by dissenting members could block approval or effect substantial changes of the recommendations.

Flows needed for the recovery of the endangered fishes have yet to be determined for other tributaries, including the Yampa and White Rivers. In addition to containing occupied habitat for the listed species, both rivers contribute to the maintenance of flow and habitat in the Green River in Dinosaur National Monument and Canyonlands National Park. Although it is unclear how tributary flows will be determined, the program will probably affect the decisions.

Riverine habitat managed by the National Park Service is critical for the recovery of the endangered fishes. However, the program's attempts to strike a balance between recovery and water development can constrain the ability of the Service to meet its other resource management responsibilities. Participation in the program challenges the National Park Service to contribute to endangered species recovery in a manner that is consistent with its broader responsibilities of restoring and protecting the river ecosystem in the national parks.

NPS

Change in status of lynx and black-tailed prairie dog

Two rare mammals are affecting the management of several units in the national park system from Maine to Washington. The U.S. Fish and Wildlife Service listed the Canada lynx *(Lynx canadensis)* as a threatened species in the 48 conterminous United States on 24 March 2000. Eighteen national park units are currently believed to have lynx. The National Park Service and other federal agencies have been working with the Fish and Wildlife Service to improve recovery of the species. The USDA Forest Service has already signed a lynx conservation agreement and both the Park Service and the Bureau of Land Management are attempting to sign similar agreements. These will help the agencies coordinate management efforts until other recovery guidance is in place. In addition to the conservation agreements, a science report and a lynx conservation assessment/strategy are available to help manage this species.

The black-tailed prairie dog *(Cynomys ludovicianus)* was designated a candidate species for listing as threatened under the Endangered Species Act on 4 February 2000. The species is known to occur in at least seven national park units, including Badlands, Wind Cave, and Theodore Roosevelt National Parks; Devils Tower and Scotts Bluff National Monuments; and Ft. Larned and Bents Old Fort National Historic Sites. Several other parks historically supported the prairie dog but do not currently have prairie dogs. The National Park Service is a participant in a federal working group on black-tailed prairie dog conservation, is working with states and Native American tribes on managing the species, and is sponsoring or conducting research on prairie dog ecology in several parks.

▲ **Canada lynx** (top) and black-tailed prairie dog (bottom). (2) Copyright Daniel S. Licht

Water Pollution

Mysterious tadpole die-off in Whiskeytown

✎ By Jennifer Gibson

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Declines in amphibian populations were perhaps one of the most urgent and enigmatic worldwide environmental problems of the late 20th century. Scientists are currently investigating amphibian die-offs in several locations across the United States. Multiple species of frogs, toads, and salamanders and one species of newt are dying off on private, state, and federal lands, including several national parks. Possible causes of the decline include the introduction of nonnative species, increased ultraviolet (UV-B) radiation, acid precipitation, rising global temperatures, pollution, infectious disease, and a combination of factors.

In June 2000, hundreds of dead bullfrog (*Rana catesbeiana*) tadpoles were found in the lake of Whiskeytown National Recreation Area, California. Although the bullfrogs are a nonnative, invasive species in the recreation area, the dead tadpoles alarmed park staff. Amphibians are sentinels of water quality and environmental degradation because of their different life stages (an aquatic larval stage and a terrestrial adult stage), highly specialized physiological adaptations, and specific microhabitat requirements. Because amphibians have been identified as indicator species for the aquatic and terrestrial ecosystems in Whiskeytown National Recreation Area, several explanations for the die-off were investigated.

Iridoviruses and a newly recognized, yeastlike fungus are the only known infectious diseases that cause large die-offs in tadpoles. A histological examination of the dead tadpoles by the USGS National Wildlife Health Center revealed abnormalities in the gills, skin, and oral disks but no sign of known infectious disease. Thus, what was thought to be an amphibian disease outbreak became a water quality issue.

> *"What was thought to be an amphibian disease outbreak became a water quality issue."*

Whiskeytown Lake lies at the confluence of seven major streams that comprise one of the largest watersheds of the Sacramento River. Land use outside the park boundary was considered a potential source of pollution in the arm of the lake in which the die-off occurred. A bioassessment of the watershed revealed a previously unknown abandoned mine that is associated with the Iron Mountain Mine Superfund site, which is well known for having the most acidic waters (pH –3.6) in the world. However, tadpole samples revealed no sign of the heavy metals that are typically associated with acid mine drainage.

The National Park Service now suspects that the most probable cause of the die-off is the introduction of a low-molecular-weight, rapidly metabolized, organic compound. This includes some herbicides and rodenticides, fertilizers, petroleum-based compounds, and several solvents that are associated with the manufacture of illegal substances, such as methamphetamine. Drops of fire retardant, which were numerous in summer 1999, are also suspect because retardants containing sodium ferrocyanide release pure, deadly cyanide when exposed to sunlight. Although the effects of the chemicals associated with retardants are thought to be short-lived, their persistence in the environment is unknown.

▲ **Dead bullfrog tadpoles** float in Whiskeytown Lake, alerting staff to a potential environmental hazard. Investigations during 2000 did not identify infectious disease and heavy metals poisoning as causes and shifted suspicion to chemical contamination of the water as the source of the problem.

Pollutants associated with two-stroke engines (MTBE and PAHs) have also been considered, because even at low concentrations, these compounds can harm aquatic organisms through phototoxicity.

The cause of the tadpole die-off in Whiskeytown Lake has yet to be determined. The tissue abnormalities and deaths of the tadpoles emphasize the pressing need for long-term ecological monitoring. Although monitoring in the Klamath Network of the Inventory and Monitoring Program is not funded yet, Whiskeytown National Recreation Area's future participation in this program may provide critical information about the status of its amphibians and clues to the tadpole die-off.

Water quality–monitoring partnership on the Pedernales

✎ By John Tiff and Brian Carey

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In December 1996, Lyndon B. Johnson National Historical Park inaugurated a partnership with the Colorado River Watch Network (CRWN) of the Lower Colorado River Authority to assess and monitor the water quality of the upper Pedernales River. The partnership between CRWN and the park was born of a mutual need to gather basic water quality data from the Pedernales, a tributary of the Colorado River. Approximately one mile of the river forms the southern boundary of the park's LBJ Ranch District, the setting for the Texas White House located near Stonewall, Texas.

▲ **Ranger Cynthia Dorminey** calibrates a pH meter that is used biweekly to sample water at two locations on the Pedernales River in Lyndon B. Johnson National Historical Park. She is one of five certified water quality monitors at the park who participate in the cooperative program.

Training, equipment, and support from CRWN have enabled the park to conduct a low-cost, carefully targeted water quality–monitoring program. Two sites in the park are monitored by park staff on a biweekly schedule for temperature, pH, total dissolved solids, dissolved oxygen, nitrate nitrogen, and *E. coli* bacteria. These water quality–monitoring sites are the only ones on the upper Pedernales; only one additional monitoring site exists on the entire river. The data are provided to CRWN staff, who also make periodic site visits to audit the data collection and verify that the methodology used complies with their standards.

Monitors have found consistently high fecal coliform and *E. coli* bacteria counts since the initiation of the monitoring program. Likely sources of water quality degradation include agricultural runoff and failing septic systems in the unincorporated areas of Gillespie County. Based on the high quality and consistency of park observations, the Texas Natural Resource Conservation Commission added this section of the Pedernales River to the Environmental Protection Agency's 303(d) list of impaired surface waters. Monitoring data have also been used in the development of the park's 1999 General Management Plan. In that year, CRWN presented the park with an "Outstanding Partner" award "for exceptional dedication and leadership through superb quality and consistent environmental monitoring."

Late in 2000 the park began a biomonitoring program to gain further information about the river and its health. Twice a year, park staff will collect and identify a sample of the benthic invertebrate fauna. Comparing the samples over time will provide additional indications of changes in water quality in the Pedernales River.

Park management originally entered into this partnership in order to gather baseline data and to ensure that agricultural activities associated with the maintenance of the cultural landscapes at the LBJ Ranch would not further impact the already impaired water quality of the Pedernales River. Along with an increase in the park's standing in the scientific community due to this exemplary partnership have come additional opportunities to develop relationships with new people and organizations in the local community. These relationships will serve as catalysts for the improvement of the overall water quality of the Pedernales River in years to come.

Virus responsible for amphibian deaths in parks

Researchers and land managers worldwide are concerned about severe and mostly unexplained declines of amphibian populations worldwide, including remote and pristine areas. Die-offs of large numbers of frogs, toads, and salamanders occurred in 1999 and 2000 throughout the United States, including national park units. In late June 2000, hundreds of juvenile spring peepers (*Pseudacris crucifer*) were found dead or dying at several known breeding ponds in Acadia National Park, Maine. The discovery came as a result of an inventory component of a research project funded by the Natural Resource Preservation Program. For the second consecutive year, frogs and salamanders also died in the springtime at Great Smoky Mountains National Park, Tennessee. A partner in the All Taxa Biodiversity Inventory program made the initial discovery; the situation is now being closely monitored by the U.S. Geological Survey.

In both these cases USGS scientists at the National Wildlife Health Center in Madison, Wisconsin, have identified iridoviruses as the probable culprit for the die-offs. Since 1996, when USGS scientists began investigating amphibian mortality, iridoviruses have been associated with numerous tiger salamander (*Ambystoma tigrinum*) die-offs in the western United States and Canada. Little is known about the origin of iridoviral disease, its link with amphibian populations, and how it spreads. When the disease was discovered at Acadia, researchers, park staff, and others using or accessing multiple water bodies in one day were asked to clean field equipment and footwear with a mild bleach disinfectant at each site to prevent transmission of the virus to other wetlands. Researchers going into the field are being asked to look for symptoms and report anything suspicious.

▲ **Spring peeper.**
Copyright J. Harding

Vandalism and Theft

Calling for stronger fossil resource protection: A report to Congress

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The U.S. Senate report accompanying the 1999 Department of the Interior Appropriations Act directed the Secretary of the Interior to develop a report assessing the need for a unified federal policy on the collection, storage, and preservation of fossils on federal lands. Congress further directed the Secretary to consider whether current federal policies adequately prevent deterioration and loss of fossils and maximize their availability for scientific study. Eight federal agencies (National Park Service, Bureau of Land Management, Bureau of Reclamation, Bureau of Indian Affairs, U.S. Fish and Wildlife Service, U.S. Geological Survey, USDA Forest Service, and Smithsonian Institution) went to work on the task.

Despite their contrasting missions, the agencies worked closely to develop a report that explains many of the problems and weaknesses of federal fossil management and proposes a long list of practical solutions. They prepared a background paper and conducted a public hearing in June 1999. Building on this public input, they developed a draft report, which was circulated for public review in November 1999. They then analyzed the public comments and developed the final report, which Secretary Babbitt sent to Congress on 15 May 2000.

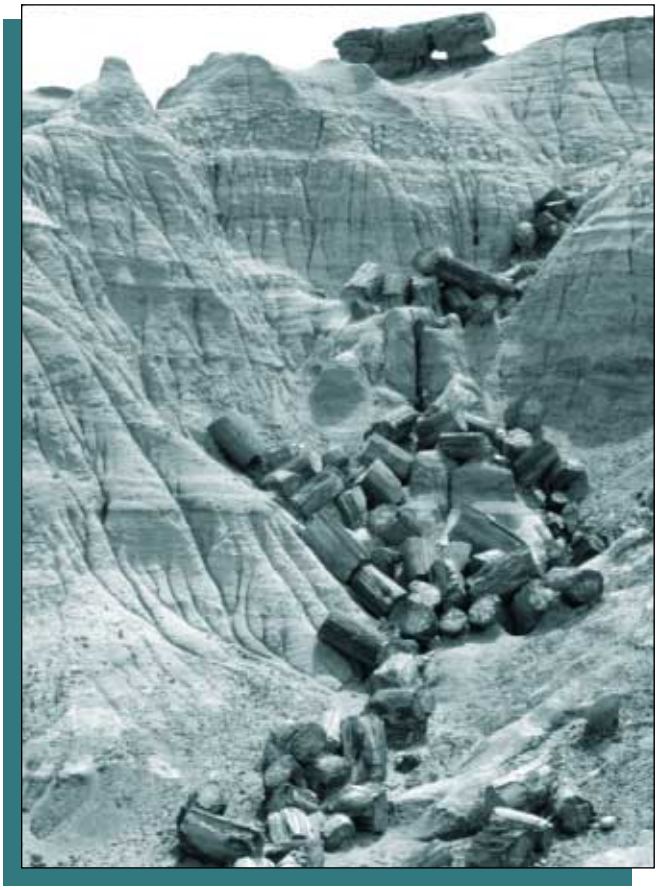
In his transmittal letter, the Secretary recommended that Congress enact legislation to strengthen federal fossil management. The report advocates improving fossil assessment, management, and protection through the development of a coordinated approach that addresses seven basic principles.

First, the report states that any fossil collection on federal lands for purposes other than science, education, or (at appropriate sites) recreation is incompatible with the public interest. Citing the overwhelming majority of public comments, the report opposes opening federal lands to commercial collection.

Next, the report acknowledges that fossils on federal lands often deteriorate or are lost through theft, vandalism, and other causes, primarily because of lack of personnel and fiscal resources dedicated to their protection. To combat these problems the report advocates increasing the penalties for fossil theft and damage; improving the education of federal land managers, prosecutors, law enforcement personnel, and the judiciary; and increasing the number of field personnel.

Noting that paleontological inventories are a vital component of effective management, the report calls for increased emphasis on fossil inventorying, using modern technology and regional approaches across agency lines. It further advocates the use of modern technology to improve curation and access to fossils by the public and amateur and professional paleontologists alike. Finally, the report emphasizes the need for public involvement in the appreciation and stewardship of fossils.

The National Park Service had a large role in shaping the content of the fossil report. It did so through an effective, interdisciplinary NPS team comprising policy and technical staff from the Geologic Resources Division, several parks, the Ranger Activities Division, and the Museum Management Program. Members of the NPS team participated in all of the agencies' meetings, developed two rough drafts of the report, researched applicable law, contributed significantly to several sections of the final report, and drafted the report's executive summary and Secretary Babbitt's transmittal letter.



▲ **An estimated 9,600 pieces** (12 tons or 10.9 metric tons) of fossil wood are stolen annually from Petrified Forest National Park, Arizona, a statistic that represents a general problem in national parks and on other federal lands. A 2000 report to Congress detailed numerous suggestions for increasing the protection and appreciation of fossils on federal lands. Copyright Jeff Selleck

Although it is not yet known how Congress will react to the final report, the fact that the November draft received an overwhelmingly positive response from the public suggests that the National Park Service's time and effort in this project were well spent. The report can be viewed on-line at www.doi.gov/fossil/fossilreport.htm.

Off-road vehicles in Big Cypress to be managed in consideration of natural resources

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In 2000, Big Cypress National Preserve, Florida, took a big step toward managing off-road vehicles (ORVs) for the preservation of natural resources. During the year, the National Park Service published its new plan for the management of ORVs, coinciding with growing concerns about the suitability of ORVs throughout the national park system, including snowmobiles in Yellowstone National Park, dune buggies in Mohave National Preserve, and most recently swamp buggies and airboats in Big Cypress.

The 729,000-acre (294,840-hectare) Big Cypress National Preserve comprises the eastern third of the Big Cypress Swamp in southern Florida. The preserve was established in 1974 to protect the upstream watershed that is vital to western Everglades National Park and to prevent development in the fragile Big Cypress Swamp. Use of ORVs in Big Cypress National Preserve predates its establishment; the enabling legislation permits the use of ORVs in the preserve.

The Big Cypress Swamp has historically been a remote environment without roads that loggers, hunters, and trappers have accessed via custom-built vehicles such as swamp buggies and airboats since the 1940s. Today recreationists, hunters, and backcountry camp owners use ORVs to traverse the mosaic of semiflooded sawgrass prairies, cypress forest, and pinelands.

"Trail accretion … signifies that natural soil recovery is not keeping pace with the rate of impact."

Nearly three decades after the establishment of the preserve, the Florida Biodiversity Project, an environmental advocacy group, raised concerns about the management of ORVs in the preserve. In its subsequent review the National Park Service noted that ORVs were harming the environment. Aerial and ground-level photography highlighted soil disturbances, vegetation loss, and surface-water inundation and flow. Aerial photographs from 1940, 1953, 1973, and 1988 revealed that the total length of ORV trails had increased since establishment of the preserve. Trail accretion over time signifies that natural soil recovery is not keeping pace with the rate of impact. Hydrologic data indicated that the preserve was significantly wetter in the 1990s than during the 1970s and 1980s when hardened soil conditions prevailed. Soils that are subjected to inundation or prolonged presence of water near the surface are more prone to disturbance from vehicle overpass.

Technological developments since the inception of the preserve have raised new concerns about the ease of ORV access. Manufactured all-terrain vehicles now offer a low-maintenance, high-speed alternative to swamp buggies and airboats. More recently the proliferation of cell phones and global positioning systems has expanded the operators' abilities to navigate through remote backcountry regions.

▲ **Muddy off-road vehicle tracks** crisscross Big Cypress National Preserve, signaling disturbed vegetation, compacted soils, and altered hydrology. In 2000 the national preserve published a management plan for off-road vehicles that extends greater protection to natural resources while providing for ORV recreational use.

In response to the findings, Big Cypress National Preserve drafted a new Off-road Vehicle Management Plan and began its implementation in 2000. The plan is expected to meet the challenge of protecting the fragile natural resources of the preserve for public enjoyment while still providing access. Establishment of a designated trail system will end the era of unrestricted ORV access throughout the preserve. The plan also stipulates closures of heavily disturbed areas, the habitat of the Cape Sable seaside sparrow, and pristine areas. In addition it establishes a new three-pronged permit system requiring ORV operators to obtain a vehicle permit, an ORV operator's permit, and a backcountry permit. Finally the plan calls for initiation of monitoring, research, and restoration of natural resources that are affected by ORVs.

NPS

Award-Winner Profile — Maintenance Chief Merry Petrossian recognized with award

▲ **Merry Petrossian** (top left) and her staff at the USS Arizona Memorial, Honolulu, Hawaii.

Merry Petrossian, Facility Manager, USS Arizona Memorial, Hawaii, received the 1999 Director's Award for Excellence in Natural Resource Stewardship Through Maintenance. Merry has ensured that the memorial's Maintenance Division develops designs with resource stewardship as the primary outcome. Among the projects completed under her leadership were replacement of the worn visitor center teak deck with recycled material and installation of solar-powered lights in the parking lots. Merry also was instrumental in finding a solution to a major shoreline erosion issue and in developing an oil spill contingency plan for the park.

In 1996, Chevron spilled 40,000 gallons (151,400 liters) of oil into Pearl Harbor. The cleanup involved the placement of absorbent but abrasive booms and repeated high-pressure washing of the shoreline to remove the oil. This activity accelerated shoreline erosion at the park visitor center and also resulted in loss of the native naupaka *(Scaevola sericea)* shrubbery that protected the shoreline. High tides and heavy rainfall also destabilized and eroded shoreline soils. Merry acted quickly and designed a temporary sandbag system to stop the erosion; later she developed a new riprap system to prevent future erosion. The new system, funded through a 1999 settlement with Chevron under the damage assessment procedures of the Oil Pollution Act, was based on her input and knowledge of Pearl Harbor tides and currents. It incorporated the remaining concrete pilings and slabs and used naupaka and bougainvillea plants at the upper edge of the riprap to keep visitors away from the drop-off. The plantings require little maintenance and thrive in saltwater areas. The erosion prevention system is successful and the U.S. Navy now uses this design along its shorefront area adjacent to the USS Arizona Memorial property.

Merry believes that resource management is an important part of her job. "I never think when I'm undertaking a task ... 'How can I protect the natural or cultural aspects?...' In this cultural park I do alot of natural resource management... I'm natural, cultural, and a little bit rock-and-roll maintence."

Exotic invertebrates spread

Two exotic aquatic species with potential to seriously harm native wildlife are spreading in St. Croix National Scenic Riverway (Minnesota and Wisconsin) and Yellowstone National Park (Wyoming, Montana, and Idaho). In summer 2000, reproducing zebra mussels (*Dreissena polymorpha*) were found within the lower 16 miles of the St. Croix River as far as Hudson, Wisconsin. The estimated density of the mussels at one location at Prescott, Wisconsin, was 9.3 per square foot (100 per square meter). The zebra mussel, a black-and-white-striped bivalve mollusk, came to North America from Europe. Since it was first discovered in Lake St. Clair in June 1988, it has spread rapidly and is expected to continue to do so throughout North America. The mussel disrupts aquatic ecosystems throughout its range and fouls beaches, clogs water intakes, and damages boat motors. Under the St. Croix River Zebra Mussel Action Plan, adopted in May 2000, the National Park Service and other federal and state agencies are continuing to inform the public about the problems associated with the zebra mussel. The agencies are also inspecting boats and trailers, restricting access to slow the spread of the mussel, and monitoring the spread of the infestation.

▲ **Zebra mussels** (cluster) threaten freshwater mussels native to St. Croix National Scenic Riverway by blocking their feeding, respiration, and reproductive structures.
St. Croix National Scenic Riverway

The New Zealand mud snail (*Potamopyrgus antipodarum*) was first discovered in Yellowstone National Park in the Madison River in 1974. Localized infestations in the river approached a density of greater than 28,000 individuals per square foot (2,604 per square meter) in 1997. Subsequent investigations by independent researchers documented a rapid spread of this exotic species to the Firehole and lower Gibbon Rivers. Although scientific studies of the snail's distribution have not been completed, park staff and researchers have observed that this nonnative, invasive species is continuing to spread into the park's interior. The long-term effects of this exotic species are unknown, but indications are that the snail is impacting the invertebrate community in the rivers it inhabits. Reductions in aquatic insect species diversity or abundance could in turn affect the famous recreational fisheries found in the park. It is not known how the New Zealand mud snail was introduced into the park, but human transport is strongly suspected. The park staff is continuing to monitor the spread of the snail and is conducting a public information campaign to control its expansion.

2000 Restoration

▲ **Once believed to be extinct,** the Sonoma spineflower occurs today only on the coastal prairie of Point Reyes National Seashore. In 2000, NPS resource managers and the Point Reyes National Seashore Association established a second population of the species from seed.

When a species goes extinct locally you can do a great deal, still. You may have lost some of the genetic diversity, but there is still the option of transplanting, of reintroducing species, and rebuilding local populations.

—E. O. Wilson
Harvard biology professor, naturalist, and author

Like human beings, park ecosystems in modern landscapes occasionally require "medical" attention to maintain their health. Information on park vital signs is being developed through the NPS Inventory and Monitoring Program to help park managers recognize when changes in certain key species or natural processes in parks are cause for action. For example, a rapid population decline in a species may signal the need for intervention to stop it; the information may also indicate the need for further study to understand cause-and-effect relationships and to guide ultimate restoration. As the following articles indicate, in 2000 the National Park Service sought to restore several plant and animal species and natural processes that were in decline. They also illustrate the increasing awareness among park managers of the benefits of working with adjacent landowners and other partners to restore park ecosystems to health.

Vegetation

Restoring the abundance of the endangered Sonoma spineflower

✎ By Michelle Coppoletta and Barbara Moritsch

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Perhaps restoring diversity is most of all about restoring hope.

—Reed F. Noss
Restoring Diversity:
Strategies for Reintroduction of Endangered Plants

Hope was restored in 2000 for the long-term protection of the federally listed, endangered Sonoma spineflower (*Chorizanthe valida*). The plant, which had last been recorded in 1903, was presumed to be extinct until botanist Wilma Follette discovered specimens in a grazed pasture on Point Reyes National Seashore, California, in 1980. Until now this population was the only known in the world. By combining efforts, however, the Point Reyes National Seashore Association and NPS vegetation managers established a second population on the seashore in 2000.

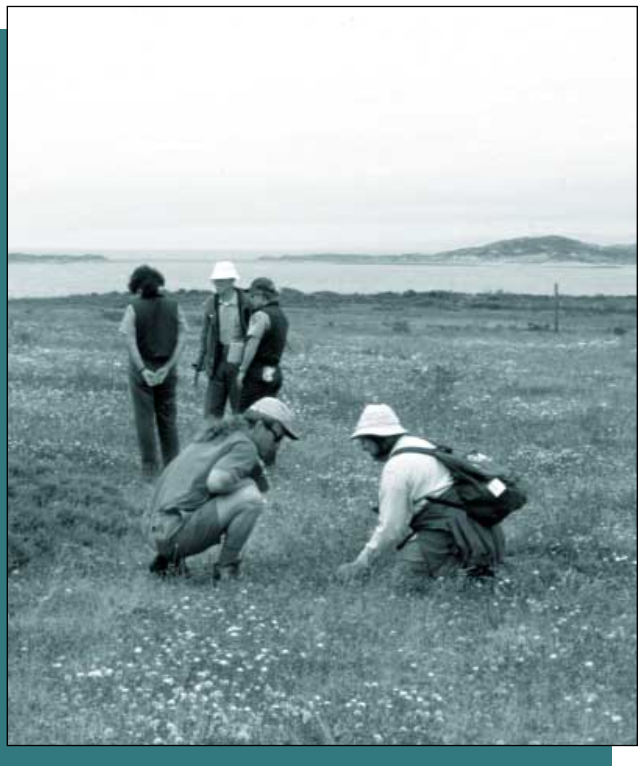
The original Sonoma spineflower population on the Point Reyes peninsula occurs on 2.5 acres (1 hectare) of coastal prairie. However, plant collections from the 1800s indicate that the flower formerly had a much broader range in Marin and Sonoma Counties. Intensive agriculture and urbanization since the early 1900s have significantly altered the habitat. Information from research suggests that today the species is limited by its dependence on grazing by cattle or wildlife, which reduces competition with nonnative plants, and its restriction to well-drained, disturbed, sandy soils. These ecological requirements, in addition to narrow endemism, render the plant particularly vulnerable to events such as disease outbreak, fire, flood, and other circumstances that could eliminate the population and cause extinction.

"The Point Reyes National Seashore Association and NPS vegetation managers established a second population [of the endangered Sonoma spineflower]."

In 1999 the Point Reyes National Seashore Association provided the vegetation management program of the national seashore with funds for monitoring, evaluating, and expanding the existing population of the Sonoma spineflower and for developing management in accordance with the recovery plan of the U.S. Fish and Wildlife Service. According to the recovery plan, the species cannot be delisted until two additional populations are established and sustained.

By consulting historical records, soil maps, and local plant taxonomists, and by conducting field searches to identify potentially suitable habitat, the vegetation managers of the national seashore identified suitable sites for trial plantings with seeds from the existing population. Seeds were also placed in long-term storage in the seed bank facility of the Rancho Santa Ana Botanical Garden. A trial site was selected in similar habitat at another location on the national seashore, and in fall 1999, cattle troughs were removed, the soil was lightly disturbed with a rake, and 1,000 seeds were planted.

In 2000, seeds on the trial plot yielded 34 plants, all of which produced flowers and many of which later set seed. With additional funds from the association in 2000, the natural resource managers of the national seashore established two more plots within 565 feet (200 meters) of the first trial plot and planted them with seed from the first population.



▲ **Natural resource managers** and California Native Plant Society volunteers census the main population of the Sonoma spineflower each year. In the past the main population has exceeded 20,000 individuals, making the task of counting these small annuals a challenge.

Whether the new populations will persist over time cannot be predicted now. Nevertheless, the establishment of a second population is significant because it reduces the probability of extinction due to catastrophe and moves the Point Reyes National Seashore one step closer to the long-term conservation of the Sonoma spineflower.

NPS

Restoring a mixed-grass prairie and a cultural landscape

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When a visitor stands at the overlook at Washita Battlefield National Historic Site in Oklahoma, he or she should gain a sense of the area as it appeared 132 years ago. In 1868 the U.S. Cavalry under Lieutenant Colonel George A. Custer attacked and decimated a Southern Cheyenne Indian village on the windswept plains along the Washita River. In the intervening years the former battle site has been ranched and farmed, but the rural character of the land has kept its integrity. Since acquiring the site in 1997, the National Park Service has sought to restore this cultural landscape by converting a 20th-century farm into a 320-acre (130-hectare) patch of mixed-grass, native prairie. The recent Natural Resource Challenge, with its emphasis on restoring native plant and animal species, gave the park added incentive to begin the restoration. During 2000 several projects undertaken at the park have led to progress in achieving this goal.

In order to restore natural conditions to this habitat, resource managers must first understand its current state. Toward that end, the park has entered into a contract with the University of Oklahoma to perform biological inventories of mammals, birds, reptiles, and amphibians currently on-site, and the first field sessions took place in summer 2000. Inventories of other major taxa, such as vascular plants and fish, will begin within three years as a result of the park's participation in the Inventory and Monitoring Program's park networks created through the Challenge. Information derived from these inventories will help determine which species should be restored to the landscape. In the meantime the first geographic information system maps of the park's native and exotic vegetation were produced this year with the assistance of specialists from the regional office.

The exotic vegetation documented by the mapping teams poses the most serious impediment to fully restoring the site. At least 15 aggressive weed species occur on-site and together occupy upwards of one quarter of the park's acreage. To gain a foothold in stemming the invasive tide, the park used its neighbors and the newly formed Chihuahuan Desert/Shortgrass Prairie Exotic Plant Management Team (EPMT) to great avail during the year. With the assistance of the USDA Forest Service, the park eradicated 4 acres (1.6 hectares) of black locust trees, and by combining the efforts of the EPMT and a tamarisk control crew from Lake Meredith National Recreation Area (Texas), removed over a mile (1.6 kilometers) of tamarisk from the south bank of the Washita River and elsewhere in the park.

At another location on this former battleground, the park is going beyond the removal of Old World bluestem, an introduced crop species. In a 57-acre (23-hectare) former pasture, a contracted farmer is repeatedly plowing under the nonnative forage grass to exhaust the seed source while annually planting winter wheat as a cover crop to reduce erosion. This is being accomplished in accordance with a plan drawn up under the guidance of the USDA Natural Resources Conservation Service. When this three-year process winds up in 2001, sorghum will be sown along with a mixture of native grasses that will mature into a replicate prairie grassland.

All of these restoration activities help contribute to Washita Battlefield's GPRA (Government Performance and Results Act) goal of protecting, restoring, and maintaining the natural and cultural resources of the site. More important, they help fulfill the Challenge's mandate to focus attention on the ecological integrity of parks and the restoration of native plant and animal life in the national park system.

▲ **Acquired by the National Park Service in 1997,** Washita Battlefield National Historic Site is being converted from a modern farm into a mixed-grass, native prairie. The restoration entails conducting biological inventories, exotic species control, and temporary planting of winter wheat (shown here). In 2001, native prairie grass species and sorghum will be planted to complete the process.

Whitebark and limber pine restoration under way in Glacier

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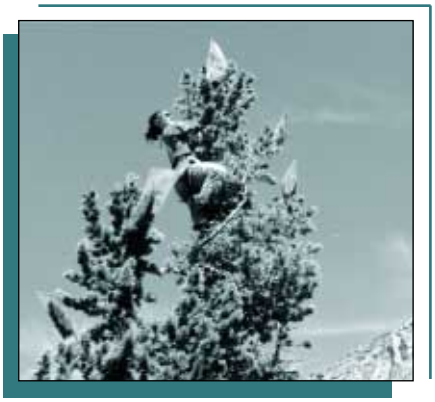
✎ By Tara Williams

Historically, whitebark (*Pinus albicaulis*) and limber pine (*P. flexilis*) communities were significant components on 15–20 percent of forested lands in Glacier National Park, Montana. However, due to the exotic white pine blister rust—a Eurasian fungus—and fire exclusion, whitebark and limber pine stands in the Northwest have been decimated over the last 90 years. Based on research conducted by the USGS Glacier Field Station, almost half of all whitebark pines in Glacier are dead. Of the remaining trees, 90 percent are lethally infected and will likely die in the next 5 to 15 years. One-third of their cone-bearing crowns are already dead. Scientists and park managers agree that whitebark and limber pine will be functionally lost in Glacier without active management intervention. In 2000 the first trees were planted in an effort to begin restoration of these communities.

Whitebark and limber pine are important to many wildlife species. The grizzly bear (threatened under the Endangered Species Act) raids middens of cones stored by red squirrels. During good cone-crop years, whitebark seeds are among the most important food sources for bears, encouraging them to keep to higher elevations and away from developed areas. Clark's nutcrackers deposit whitebark seed in caches; these caches, particularly those deposited in recently burned areas, provide ideal germination conditions for the conifer. Whitebark are able to germinate at higher elevations and under harsher conditions than other conifers, thus establishing tree line. Their spreading branches catch and retain snow, and their shelter provides suitable conditions for subalpine fir germination. Restoration of whitebark and limber pine communities will preserve a number of significant ecological processes.

Over the past three years, Glacier has received funding through the Intermountain Region Natural Resource Fund for whitebark and limber pine restoration. Resource managers have collected seed from healthy trees in otherwise blister rust–decimated stands. Preliminary research by the USDA Forest Service (USFS) indicates that these healthy trees have natural genetic resistance to the rust. This year more than 17,000 limber pine seeds were collected. From collected seeds, stock has been raised in Glacier's native plant nursery, a cooperative nursery at the Blackfeet Tribe's Blackfeet Community College, and in the USFS Coeur d'Alene Nursery. In 2000 more than 3,800 trees were produced by the nurseries and are ready for planting. Appropriate planting locations are selected by overlaying geographic information system layers of recent wildland fires for resource benefit with a map of whitebark pine habitat.

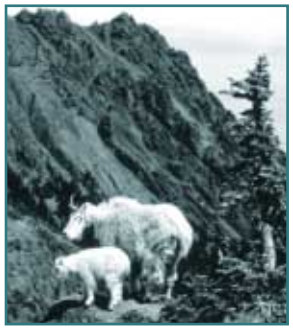


A biological technician in Glacier National Park places wire mesh cages over whitebark pinecones, protecting them from predation by Clark's nutcrackers. Seeds are extracted from the mature cones once they are collected; they are planted and raised in the greenhouse until the disease-resistant seedlings are ready for transplanting in the park.

As the disease travels south, more districts and agencies have become concerned. Whitebark is considered one of four major food sources for grizzlies in the greater Yellowstone area (GYA), and the health of this species is one of the factors that will affect decisions regarding delisting grizzlies in the northern Continental Divide ecosystem. The Coeur d'Alene Nursery began raising whitebark for a few USFS districts and Glacier. They currently have orders to produce 100,000 trees for the GYA. They are beginning work with limber pine, which has received less attention but appears to be following the same path.

In September 2000 the first on-the-ground restoration work was completed in Glacier. One hundred trees were planted shortly after a burn that occurred in whitebark habitat. Planted trees are mapped and marked for future monitoring. The extreme fire season of 2000 precluded additional planting of trees this season, but they will be overwintered and planted as soon as snowmelt allows. Through this project there is hope that whitebark and limber pine ecosystems will persist for the benefit and enjoyment of future generations of humans, Clark's nutcrackers, and grizzly bears.

Scientific review of research on mountain goats in Olympic



On 21 July 2000 the National Park Service announced the availability of an independent report titled "Review of Scientific Material Relevant to the Occurrence, Ecosystem Role, and Tested Management Options for Mountain Goats in Olympic National Park." This review, conducted by the Conservation Biology Institute of Corvallis, Oregon, under contract to the Department of the Interior, is available on the Internet at www.consbio.org. The report found that the available evidence supports the view that the mountain goat (*Oreamnos americanus*) has never been native to the Olympic Peninsula in Washington. The probability that the mountain goat naturally colonized the peninsula in the past is relatively low. The review team noted that although mountain goats are certainly having some effect, substantial and harmful impacts at the population, community, and ecosystem levels have not been established. The team indicated that this does not mean that significant impacts have not occurred, but only that the studies fail to distinguish goat-caused impacts from effects of natural physical factors such as wind, freeze-thaw cycles, or water erosion. The team also stated that control of mountain goats within the park would be both prudent and feasible.

Endangered bonytail returns to the wild

✎ By Stephen Petersburg

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On 13 July 2000, one of the West's rarest fish species was returned to the Green and Yampa Rivers. Five thousand hatchery-reared juveniles of the endangered bonytail (*Gila elegans*) were released in the lower Yampa near Echo Park in Dinosaur National Monument, and another 5,000 were released in lower portions of Browns Park in the Browns Park National Wildlife Refuge and in the national monument. These releases will be augmented by additional future releases in an attempt to reestablish wild populations of bonytails.

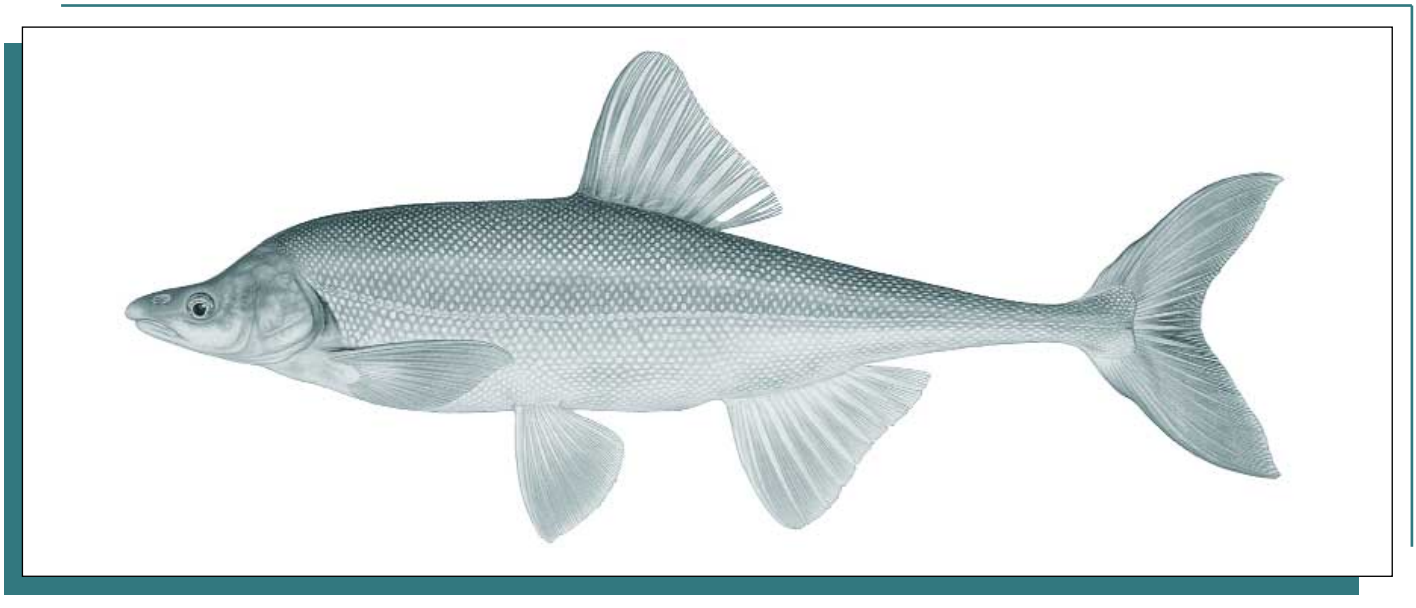
One of four endangered large-river fishes in the Colorado River system, the bonytail had been virtually extirpated from wild riverine habitats. The other three endangered species are the Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), and humpback chub (*G. cypha*). The State of Utah listed the bonytail as protected in 1974, while Colorado listed it as endangered in 1976. In 1980 the bonytail was federally listed as endangered under the Endangered Species Act of 1973.

"Stocking the rivers with bonytail is a cooperative undertaking...."

The bonytail is a member of the minnow family Cyprinidae. It has a streamlined body that narrows markedly toward the tail. Its back is gray or olive, its sides are silvery, and its belly is white. Its large fins are also characteristic of the species. Bonytails may reach lengths of greater than 24 inches (61 centimeters) and may live nearly 50 years. They are closely related to other chub species in the Colorado River system, and intergrades with the humpback chub and the roundtail chub (*G. robusta*) have frustrated geneticists for many years.

Dams in major river channels, such as the Flaming Gorge and Glen Canyon Dams, are the proximate cause of the decline of endangered Colorado River fishes. Dams alter many characteristics of riverine habitats, and the new habitats favor nonnative fish species, many of which compete with or prey on the endangered species. The bonytail was once common from the lower reaches of the Colorado River to well upstream of Dinosaur National Monument. One of the last riverine areas that wild bonytails occupied into the late 1960s was around Echo Park. Remnant populations have persisted in reservoirs in the lower Colorado River basin and in hatcheries.

Stocking the rivers with bonytail is a cooperative undertaking by the U.S. Fish and Wildlife Service, National Park Service, Colorado Division of Wildlife, and Utah Division of Wildlife Resources. The bonytails were raised in the Wahweap Fish Hatchery of the Utah Division of Wildlife Resources near Page, Arizona. The Colorado Division of Wildlife and the U.S. Fish and Wildlife Service transported the fishes to the release sites, where the National Park Service assisted with the releases. The agencies are members of the Upper Colorado Recovery Implementation Program, which consists of federal and state agencies, environmental groups, and water- and power-user organizations in Colorado, Utah, and Wyoming. The goal of the program is the recovery of endangered fish species while allowing development of water resources for human uses.



▲ **Endangered bonytail,** which can reach 24 inches in length, were restored to Dinosaur National Monument in 2000.

Award-Winner Profile — Dinosaur National Monument resource manager honored

▲ **Stephen Petersburg**

Stephen Petersburg, Resource Manager at Dinosaur National Monument (Colorado and Utah), received the 1999 Director's Award for Natural Resource Management in June 2000. Steve raised national park values and concerns throughout the complex negotiations for the life and health of the Green River and its tributary, the Yampa. During the year, he was the key player in creating a vision for improved stewardship of river resources below Flaming Gorge Dam. Steve was also largely responsible for the successful recovery of peregrine falcons (*Falco peregrinus anatum*) in the monument; his pioneering efforts increased the number of breeding pairs from two in 1977 to more than a dozen in 1999. In addition, Steve initiated groundbreaking work with prescribed fire in the natural ignition season (summer) with stunningly successful results.

Steve recognizes the importance of partnerships to success in managing park resources. "Virtually all of our activities, [from] fire to peregrines to endangered fish, are conducted in interagency arenas. With river and fish issues alone, we deal with several ... groups ... both in one-to-one interactions and in … formal groups (e.g., recovery teams, Yampa River Basin Partnership, Flaming Gorge Work Group). In all of these, we are now full partners…. I spend a lot of time in meetings, but we cannot accomplish anything lasting by ourselves."

Like many of the award-winners, Steve recognizes many other people who contributed to the monument's resource management program. "The credit for the award should go to a lot of other people—Tom Zimmerman and others in the fire arena, Jerry Craig (Colorado Division of Wildlife) for the peregrine work, and the NPS Water Resources Division and others related to the river and fish work. I credit them with much of the work and ideas that have shaped my participation in these programs."

Milestone reached in the removal of Elwha and Glines Canyon Dams

The Elwha River Ecosystem and Fisheries Restoration Act of 1992 authorized the Secretary of the Interior to acquire and remove the Elwha and Glines Canyon Dams on the Elwha River, on the Olympic Peninsula of Washington. This action is being taken to restore the river ecosystem and native salmon and steelhead fisheries. The first major step in the restoration process, acquisition of the dams, was completed on 29 February 2000. The Bureau of Reclamation is operating the dams under NPS oversight until they are decommissioned and removed. Planning and design activities are under way to protect the water supplies of municipal and industrial users and for fisheries restoration and revegetation. More information can be found on the project website at www.nps.gov/olym/elwha/home.htm.

◀ **Glines Canyon Dam** on the Elwha River, Olympic National Park, Washington.

Restoration of Bonneville cutthroat trout populations in Great Basin

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Since ancient Lake Bonneville dried up 8,000 years ago in what is now eastern Nevada and Utah, Bonneville cutthroat trout (*Oncorhynchus clarki utah*) have persisted in the isolated small mountain streams of the eastern Great Basin. Unfortunately, water diversions, subsistence harvest, and especially stocking with nonnative fish caused the extirpation of the Bonneville cutthroat trout from most of its range. The local extinction was so widespread that the U.S. Fish and Wildlife Service is now conducting a second status review for listing the trout under the Endangered Species Act of 1973. However, Great Basin National Park near Baker, Nevada, on the Nevada-Utah border provided a unique opportunity to promote conservation of the trout and potentially preclude the need for listing it in eastern Nevada.

The Bonneville cutthroat trout was believed to be extinct in Great Basin National Park because past surveys revealed only nonnative hatchery fish or hybrids of the Bonneville cutthroat and rainbow trout (*O. mykiss*). After the park established a reintroduction program for the trout in 1998, a survey in one stream system of the park in 2000 revealed only fish with strong characteristics of the Bonneville cutthroat trout. Subsequent genetic analysis of fin tissues confirmed the presence of a pure population of the species. The timely discovery of the trout was fortunate because cleansing of the stream system with chemicals to remove the nonnative trout and the hybrids that were thought to be there was planned as the next step in the reintroduction program. Instead of being inadvertently annihilated, the population is now being genetically compared with other populations of the Bonneville cutthroat trout in nearby streams. If appropriate, the preservation of the genetic stock that developed in the park will be attempted.

▲ **Conservation of the Bonneville cutthroat trout** in Great Basin National Park may preclude the need for listing the species as threatened under the Endangered Species Act.

With discovery of this population, a source stock became available for reintroductions elsewhere in the park. The park established a new population of Bonneville cutthroat trout in a stream of another watershed by transplanting 60 trout from the source stock. Another historical Bonneville cutthroat trout stream has been chemically cleansed to remove the nonnative fish and hybrids in preparation for a reintroduction of Bonneville cutthroat trout in 2001. Private landowners adjacent to the park supported a more diversified fishery and allowed chemical cleansing of streams on their lands. The extension of cleansing beyond park boundaries may facilitate restoration of a native fishery throughout an entire watershed.

▲ **A stream survey** in Great Basin National Park, followed by genetic analysis in 2000, confirmed a pure population of rare Bonneville cutthroat trout. The local population subsequently became a source for restoration of the species in a different park watershed.

The intensive surveys to determine the need for chemical cleansing of streams in the park revealed not only the Bonneville cutthroat trout but also another group of sensitive species, the Great Basin spring snails (*Pyrgulopsis* spp.). To protect these sensitive organisms from adverse effects of chemicals, the park adjusts the timing and extent of chemical cleansing. Such proactive work prevents the need for listing the species under the Endangered Species Act. It also benefits neighboring federal land agencies, the state, private landowners, and the public by allowing continued multiple land use with fewer restrictions.

NPS

Beyond Park Boundaries

Working with park neighbors to protect habitat for anadromous fish

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✎ By Brannon Ketcham

Effective management and protection of resources in national parks often require that natural resource managers seek the cooperation of landowners beyond the boundaries of parks. In 2000, the staff of Point Reyes National Seashore elicited the participation of landowners downstream in the protection of habitat for steelhead trout (*Oncorhynchus mykiss*) and the eventual reintroduction of coho salmon (*O. kisutch*) in the 9-square-mile (14.5-square-kilometer) Pine Gulch Creek watershed. Both species are federally listed as threatened.

The National Park Service manages the upper 75 percent of the Pine Gulch Creek watershed, which provides excellent habitat for steelhead trout and, historically, for populations of coho salmon, last documented in 1979. However, a successful reintroduction of the species hinges on improved management of riparian water to ensure survival of the fish during low water flow in summer when farmers withdraw water for agriculture. In 1997, park staff began to contact and visit each of the five organic farmers in the watershed to solicit cooperation for managed water withdrawal. Within one year, staff convinced the farmers of the merit of managed water withdrawal for agricultural sustainability and operational efficiency. In 2000 the National Park Service developed a water management plan and received $125,000 of state and local grants for its implementation. The farmers and the National Park Service continue to meet every other month to work out details for the implementation of the plan.

The restoration is part of a five-year undertaking funded by the Natural Resource Preservation Program of the National Park Service. Water of the Pine Gulch Creek must continue to meet agricultural needs. To ensure sufficient water flow for the survival of fish in late summer, staff of Point Reyes National Seashore and organic farmers in the Pine Gulch Creek watershed designed off-stream riparian water-storage ponds and selected lower-rate diversion pumps. Stored water in the ponds and the pumps will allow farmers to balance the effects of pumping throughout the growing season and to stop withdrawal from the creek before flows in the lower watershed become critically low. Implementation of the designed infrastructure will facilitate adaptive water management on the property of legal water users and protect essential water flow for the federally listed threatened steelhead trout.

▲ **Star Route Farms** is one of five organic farms adjacent to Point Reyes National Seashore that use water from Pine Gulch Creek, a habitat for steelhead trout and a potential restoration site of coho salmon. In 2000 the National Park Service and farmers agreed on a plan to manage use of the water within the creek in a more sustainable manner that will benefit the farmers and protect habitat of steelhead trout and coho salmon.

The farmers have committed to cooperate with Point Reyes National Seashore and other regulatory agencies to ensure implementation of the design. Construction is expected to begin in summer 2001 after all necessary permits have been obtained. When the infrastructure is in place, the National Park Service, the National Oceanic and Atmospheric Administration–Fisheries, and state and local agencies will coordinate to reintroduce a population of federally listed threatened coho salmon into the watershed.

Finding solutions and designing plans that meet multiple and seemingly opposing needs are never easy. Eliciting the cooperation of neighboring landowners and formulating a water management plan that meets the needs of both the fish and farmers were often frustrating for all participants, and at one time stalled for nine months. The implementation of the project is the result of all participants' persistence, patience, and understanding of one another's needs.

Point Reyes and Golden Gate take first step in restoring wetlands

▲ **Tomales Bay at low tide,** Golden Gate National Recreation Area, California. Copyright, 1994, Bruce Farnsworth

In February 2000 the National Park Service, with additional funding from the California Department of Transportation, acquired the 560-acre (227-hectare) Giacomini Dairy. Located at the head of the ecologically sensitive and significant Tomales Bay within the Northern District of Golden Gate National Recreation Area, the property has separated Lagunitas Creek from the bay and confined the estuary to the leveed stream channel for nearly 60 years. This acquisition is the first step in reversing this trend and will lead to full-scale restoration when the land is relinquished in 2007. The restoration of the tidal wetland and floodplain habitat will add significantly to the already diverse aquatic and terrestrial ecology of Point Reyes National Seashore and Golden Gate National Recreation Area. In addition to their herring runs and oysters, Tomales Bay and the Lagunitas Creek estuary are vital to anadromous fish, catadromous fish, and marine aquatic species. Lagunitas and Olema Creeks, which flow through the property, are passages for nearly 10 percent of the remaining federally threatened coho salmon (*O. kisutch*) in central California.

2000 Outreach Education

▲ **Children participate** in a hands-on environmental education program along the Green River in Dinosaur National Monument (Colorado and Utah). The Young Naturalist Program gives participants a chance to discover river organisms like aquatic insects, identify their habitat needs and food webs, and relate them to changes in river flow from dams upstream.

Resource protection that hides in the woods and does its thing shyly, silently, and without explaining what it's doing is not protection at all. Unobserved, it will be unsustaining, unappreciated. Resource protection has to walk out of the park in the heart of the visitor.

—Roger Kennedy
14th Director of the National Park Service

Countless Americans first stepped into wilderness and developed a better understanding of themselves and their country's fine natural heritage in a unit of the national park system. The National Park Service facilitates this role by stimulating a sense of public ownership, understanding, and appreciation of parks through its educational programs. This lasting and powerful effect has the potential to become even greater. As the following articles for 2000 indicate, the National Park Service is developing innovative educational programs that reach people beyond parks, encourage their involvement in natural resource management, and invite them to develop and share their own meanings for parks. To do this properly requires scholarship and inclusion of all people and perspectives. By following this approach, outreach education, like effective in-park interpretation, can enable the National Park Service to help people see their own reflections in parks and to contribute to their care.

Developing ambassadors for endangered fish

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Children are the key to long-term preservation of park resources. For 10 years Dinosaur National Monument has provided a summer Young Naturalist Program for local children 8–10 years of age. Through this program children experience nature firsthand and discover some of the interconnections in the natural world and their relationship to it. They contemplate the concept of community and how an ecosystem works. Finally they have the opportunity to use this information and their observations to predict outcomes for a variety of river management scenarios that affect several species of endangered fish and other natural resources at Dinosaur National Monument.

The U.S. Fish and Wildlife Service has issued a biological opinion concerning the flow and temperature recommendations for the endangered native fish in the upper Green River: bonytail, razorback sucker, humpback chub, and Colorado pikeminnow. The Bureau of Reclamation is developing an environmental impact statement (EIS) to address the recommended change in water releases from Flaming Gorge Dam, which is upstream of Dinosaur National Monument on the Green River. The prospect of increasing springtime releases from the dam for the benefit of native fish is generating public concern and controversy. Sensitive issues include flooding of agricultural land, increasing mosquito populations, and impacts on power generation.

In 2000, interpreters at the monument changed the afternoon half of the Young Naturalist Program by taking the kids on a river trip. Each child is given an inner tube, life vest, and safety instructions to float down a flat-water portion of the Green River. The boys and girls are literally immersed in the habitat of the endangered fish. Interpreters guide them to a backwater where, under a permit from the Utah Wildlife Resources Division, they use collection equipment to temporarily capture and examine aquatic animals. They discover the benthic macroinvertebrates and small fish that comprise the bottom of the endangered fishes' food chain. The group discusses predation by the Colorado pikeminnow and the endangered fish's biology, particularly its need for spring floods, clean gravel bars, and backwater environments. Finally, interpreters pose the question, "If a dam were placed in the river, how would this affect the fish?" As a result of this directed discussion the children realize the importance of varied water releases from Flaming Gorge Dam to the survival of the native fish.

"Children ... discover some of the interconnections in the natural world and their relationship to it."

Why is this significant? At the end of the day these kids are tired but excited. Their parents commonly report in the post-activity evaluation that their children babbled about the water insects they found, the catfish they caught, the frog swimming in the aquarium. They see their children's excitement and hear why some fish species might become extinct. Their 10-year-old becomes an "ambassador" for endangered native species.

Ten years from now when these "young naturalists" are voting, attending a new Green River EIS scoping meeting, or reading about how county commissioners want to fund a project that may affect fish, they will remember their day on the river and possibly become advocates for the fish. This important interpretive program is taking on this challenge one child and one household at a time.

NPS

Black Canyon of the Gunnison opens new exhibit about the Gunnison River

The visitor center at Black Canyon of the Gunnison National Park, Colorado, began featuring a new exhibit in 2000 that interprets the historical flows of the Gunnison River at various levels and times of the year. Because most visitors never visit the river itself (an arduous hike is required to reach it), they can now hear what it sounds like by playing recordings of the river at various flows and reading about the corresponding ecological role of its former variable flow rates, for example, in creating beach habitat and in cleaning and establishing gravel beds for eggs of native fish and invertebrates. The exhibit also includes information on changes in vegetation, riverbed morphology, and habitat along the river based on the upstream dams; shows changes in the erosive power and sediment load because of the dams; contrasts natural sounds and quiet in the canyon with noise such as construction equipment and airplanes; and compares the power of the Gunnison River with that of the Colorado River in the Grand Canyon and that of the Mississippi River.

◀ **Sounds of the distant Gunnison River** are brought to visitors and interpreted in an ecological context in a new exhibit at Black Canyon of the Gunnison National Park.

Watershed science program unites park and neighbors

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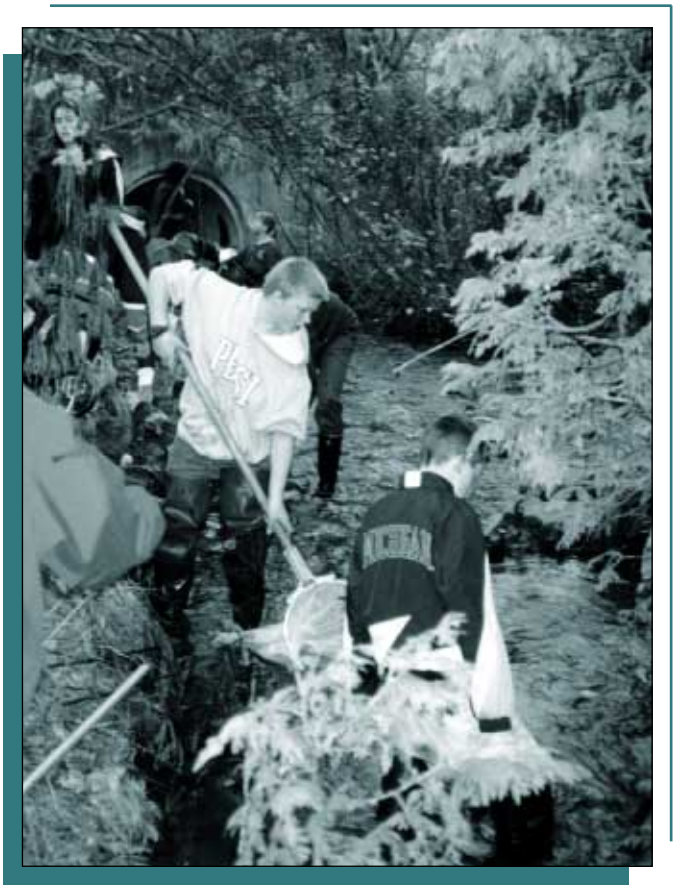
Although it functions as a geographic divide, a watershed also unites its inhabitants who share an interest in maintaining water quality and natural resource health throughout a landscape. This concept was recently used to involve school kids in the vicinity of Pictured Rocks National Lakeshore, Michigan, in a science program that spotlights the many common connections people and park resources have with a watershed.



▲ **Students collect stream data** near Pictured Rocks National Lakeshore, Michigan, as part of an outreach education program that interprets the importance of science and resource management within the watershed and park. The activities also help kids understand potential human impacts on stream quality.

In spring 2000 the conservation district adjoining Pictured Rocks received a grant to set up a local watershed advisory council. The purpose of the council is to advise the community about the conservation and proper use of natural resources within that watershed. It is a strictly advisory group with no legal authority.

The education outreach coordinator for the national lakeshore jumped at the opportunity to be a part of the Munising Bay Watershed Council and help park neighbors understand the importance of science and resource management within the watershed and park. The director of the council was hired in the fall, and together the two quickly joined forces to plan methods of collecting data on the watershed with help from local schoolchildren. State of Michigan science goals and objectives emphasize that students should be able to apply science concepts to real-world contexts. Thus, finding a middle school teacher who was willing to work with the park and the council to help meet these classroom objectives was not difficult.

"National lakeshore [staff help] park neighbors understand the importance of science and resource management within the watershed and park."

The collaboration began with the watershed council director mapping the watershed, identifying its streams, and locating important data collection sites. The park's role was to prepare the students for conducting the water quality tests at various plots, including a site within the national lakeshore. Educational materials from the Izaak Walton League called Hands on Save Our Streams and the GREEN Water Quality Monitoring Kit were used to show students in the classroom how they would go about collecting stream macroinvertebrates; testing the water for pH, dissolved oxygen, temperature, nitrates, phosphates, and turbidity; and measuring stream flow and volume in the field. The teacher divided his classes into teams responsible for different tests or data collections. A high school journalism teacher joined in by sending a photographer and reporters to document the fieldwork and would later help the watershed council publish a biannual newsletter. Over several days in fall 2000, the participants had a lot of fun collecting real-world stream data in order to better understand their watershed, identify potential natural resource issues, and make informed recommendations to protect watershed quality. The national lakeshore will use the data as part of the resource inventory and possibly the aquatic monitoring program.

The council director and the park coordinator visited the school after the data were compiled and worked with the students to analyze the results. The kids participated in activities from an excellent curriculum called Project WET, which helped them understand potential human impacts on stream quality. In closing, the two activity leaders thanked the teacher and his classes for participating and explained that though conservation districts and national parks are working to protect water quality within their boundaries, some watersheds are very large and extend far beyond park or district boundaries. Therefore, they explained, when citizens become involved in resource management by examining the watersheds in their own backyards, they may also be helping to protect the watersheds of the national parks.

Student stewardship in Glacier National Park

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With nearly 2 million visitors annually, Glacier National Park, Montana, faces expanding use and construction. These pressures harm vegetation, denude the ground, allow further invasion by exotic plants, displace animals, and can reduce the ecological and aesthetic values of the park. Soil erosion and loss of vegetation are particularly great in campgrounds and popular scenic areas.

To deal with these resource impacts, since 1988, Glacier National Park has developed a comprehensive native plant program to restore structure, function, and plant diversity of disturbed areas. Indigenous plant material is used to maintain genetic integrity. Whenever possible, native soils and plants are salvaged and stored for replanting. Seeds and cuttings are collected annually and propagated in the park's native plant nursery for use in restoration.

A lasting solution to resource degradation is perhaps the greatest challenge in restoration. To that end, Glacier National Park has entered into an exciting cooperative relationship with several local schools to engage students in the park restoration program as advocates and practitioners. Funds from the Natural Resource Preservation Program and the Recreational Fee Demonstration Program have provided money for the construction of two cooperative greenhouses in neighboring schools on either side of the park. The greenhouses serve as laboratories for students and provide needed native plant materials for restoration in park areas.

▲ **Nine hundred students** from eight schools participated in the Student Stewardship Program in 2000, collecting seed and growing 8,800 native plants for campground restoration in Glacier National Park. The program provides curriculum-based learning and life skills experience in science, horticulture, mathematics, record keeping, experimental design, teamwork, and cultural and natural resources.

In FY 2000, more than 900 students participated in environmental education activities as part of this Student Stewardship Program. In fall 1999, they toured the native plant nursery in the park and discussed the cause of disturbances, helped determine restoration needs, and collected seed at various campgrounds. During winter 1999–2000, park staff provided classroom instruction in botany, seed biology, and plant propagation and assisted students in the production of nearly 9,000 native plants. In late spring 2000 the students participated in site preparation, planting, monitoring, and removal of exotic plants. They used the seed and plants they had collected and grown. In summer 2000 the students assisted in the revegetation of more than 1 acre (0.4 hectare) of denuded ground in five campgrounds.

▲ **The Student Stewardship Program** emphasizes the cultural importance of native plants in the park and encourages participation of a diverse group of students and teachers from the area. Students learn not only how to grow native plants, but also the Blackfeet names (shown here) for and traditional uses of the plants.

Also in 2000, park staff used funds from the Parks as Classroom program to develop a workbook called *STARS* (Students Taking Action for Restoration and Stewardship) for teachers. Modules of the workbook tie the activities of the Student Stewardship Program to the state-required science curriculum.

The Student Stewardship Program furthers lasting improvements in the park by an ethnically diverse group of staff, students, faculty, and community members. The program members' exchange of ideas and application of skills in the restoration enhance public appreciation for resource management, land stewardship, and support of park heritage.

NPS

2000 New Horizons

A popular winter activity in Yellowstone National Park and several other units of the national park system, recreational snowmobile use is being reevaluated.

It's very hard to create what you haven't experienced.... When you do bring it into reality it always looks and feels different than what you anticipated. Reality never shows up according to our plans exactly.

—Peter Senge
Author, global sustainability advocate, and
senior lecturer, Massachusetts Institute of Technology

Change is a hallmark of successful organizations, yet organizational change is never easy. To prepare for new situations and develop new capabilities is a constant process of anticipating future unknowns, capitalizing on new opportunities, and summoning the courage to create. But change is not always proactive or bold; often it is reactive and measured. Whatever the impetus, the National Park Service must continually strive to improve as caretaker of irreplaceable park resources. With the help of dedicated staff, innovative partners, and the caring public, in 2000 the National Park Service faced a variety of challenging and controversial natural resource management issues. As the following articles suggest, technological advances, public input, analysis of past actions and historical events, use of law, programmatic innovation, and, to a small degree, chance are shaping the future of natural resource preservation in the national park system. Collectively, the following articles represent adaptations that are leading toward new horizons.

Environmental impacts from snowmobiles scrutinized

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The flurry of activity surrounding snowmobiles in national parks reached new heights in 2000. The public sentiment and action sparked by this issue have brought much attention to NPS attempts to refine its snowmobile policy and ensure compliance with existing executive orders requiring monitoring of off-road vehicle use. To the Natural Resource Stewardship and Science Directorate, the issue of snowmobiles has proven to be an opportunity where natural resource information and expertise can help shape national policy and management decisions.

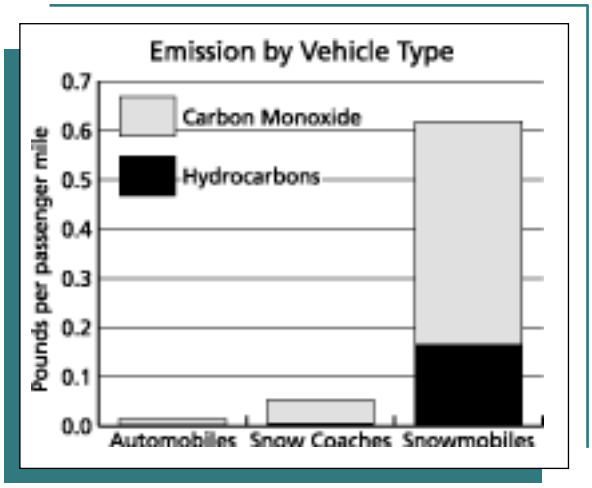
In January 1999 the National Park Service received a petition from the Bluewater Network, a coalition of environmental organizations, requesting it to begin immediate rule making to prohibit snowmobile use within units of the national park system. This petition sparked the process of gathering information concerning such things as snowmobile use patterns, known impacts on park resources and values from use, and what monitoring, if any, was being conducted at parks. In February 2000 the National Park Service held a two-day snowmobile "summit," which was attended by both Department of the Interior officials and superintendents from parks with snowmobile use. The summit provided a chance to review the information that had been gathered over the previous year and to evaluate information on the environmental impacts from snowmobile use. During the summit, representatives from the NPS Natural Resource Program Center shared summaries of literature surveys from their respective areas of expertise and presented available data concerning possible environmental impacts (i.e., impacts to air and water quality, the soundscape, and wildlife).

In April 2000 the Department of the Interior held a press conference to announce that the Park Service would significantly reduce recreational snowmobile use in national parks. The following month, the Assistant Secretary for Fish and Wildlife and Parks testified on behalf of the Park Service at both House and Senate hearings. Representatives from the snowmobile industry, outdoor recreation associations, local communities, and environmental organizations also testified. Congressional interest in this issue is expected to remain high throughout 2001.

In order to ensure compliance with the monitoring requirement of the executive orders, the Natural Resource Directorate has been working with the Operations Directorate on the design and development of a monitoring plan for parks with snowmobile use. Protocols for monitoring air, water, soundscape, and wildlife impacts are currently being developed. The NPS Inventory and Monitoring Program, for which funds have been requested as part of the Natural Resource Challenge, may provide an initial framework for parks to begin building a strategy for monitoring snowmobile use and impacts. In addition the Water Resources Division will be implementing a study in 2001 and 2002, funded through the Recreational Fee Demonstration Program, of the presence or absence of snowmobile contaminants in water resources at some of the parks currently allowing snowmobile use.

In 2000 the Park Service initiated the rulemaking process for the phaseout of snowmobiles at Yellowstone National Park in accordance with Yellowstone's Winter Use Plan Record of Decision. The final rule was published in the *Federal Register* on 22 January 2001. Further rule making for the remainder of the parks with snowmobile use has been initiated, but had not been released for public comment at year's end.

Discussions surrounding winter uses of our national parks such as snowmobiles will continue into the future. With the natural resource information and data gathered from monitoring programs, NPS managers will be better equipped to make informed decisions by knowing the nature and extent of winter use impacts on park resources and values.



▲ **How polluting are snowmobiles?** On a per-passenger-mile basis, 39 automobiles or 11 snow coaches produce as much total pollution as one snowmobile. One snowmobile produces about 98 times more hydrocarbons and 36 times more carbon monoxide than one automobile, or about 31 times more hydrocarbons and 9 times more carbon monoxide than one snow coach. NPS Air Resources Division

Notes

- Automobile, snow coach, and snowmobile passengers per vehicle, respectively, are 2.6, 7.6, and 1.2 (Yellowstone NP).
- Emission estimates vary depending on vehicle operating conditions such as speed and temperature and whether the measurements are conducted in the field or in a laboratory.
- Emission estimates for the following vehicles are based on the following sources: Automobile—EPA Mobile 5 model; snow coach—EPA publication AP-12, volume 11, appendixes H and J; snowmobile—tests conducted by the Southwest Research Institute, and an assumed four-hour, 100-mile trip.
- Particulate matter and nitrogen oxide emissions are much lower than carbon monoxide and hydrocarbons and are not included in the graph.

EPA asked to restore and protect air quality in parks

On 19 July 2000 the Department of the Interior asked the Environmental Protection Agency (EPA) for a rule to restore and protect air quality–related values in national parks and wilderness areas (Class I areas). The Department also requested more immediate action to reverse deteriorating air quality trends at Great Smoky Mountains and Shenandoah National Parks and Blue Ridge Parkway. The National Park Service has documented that air quality–related values are being adversely affected by air pollution at numerous national parks and wilderness areas, such as acidification of streams, surface waters, or soils at Shenandoah, Sequoia–Kings, and Great Smoky Mountains National Parks; visibility impairment in many parks and wildernesses; and damage to foliage from ozone at a number of parks and wildernesses, including Great Smoky Mountains, Shenandoah, Sequoia–Kings, and Yosemite National Parks. In other areas it is strongly suspected that resources are, or may soon be, damaged by air pollution (e.g., increasing nitrate deposition at Rocky Mountain National Park, where episodic acidification already occurs; possible symptoms of ozone injury at some parks on the Colorado Plateau). The EPA extended the public comment period regarding the rulemaking request, and a related request from several northeastern states, until 2 April 2001.

On a related matter, Shenandoah National Park hosted a September meeting among EPA, Shenandoah, Great Smoky Mountains, USDA Forest Service, and U.S. Fish and Wildlife Service representatives to further discuss the air pollution problems in parks and wilderness areas, and to discuss short-term (one to three years) and long-term (three to five years) expectations and actions. In the short term, the EPA will issue guidance to the states regarding the need to look more closely at impacts on parks. In the long term, the EPA will consider information the National Park Service and others submit during the public comment period before deciding on a course of action.

▲ **Ozone-injured** tall milkweed, Great Smoky Mountains National Park.

Zion's new transportation system and visitor center receive accolades

The Zion Canyon Transportation System kicked off with a grand opening on 26 May 2000. The mandatory shuttle system, required for motorized travel up the 6-mile scenic Zion Canyon, exceeded all expectations for its inaugural year. The 2000 operational period continued until 29 October, during which time more than 1.5 million passengers boarded the system. Each full shuttle bus, carrying 66 people, replaced 25 cars that previously would have clogged the canyon. Ninety percent of all visitor comments received were positive. In addition, resource benefits in the canyon included a return to a more natural sound environment, restoration of roadside vegetation, an increase in wildlife sightings, and improvement in the area's air quality. Shuttle operation for 2001 will start up again on 1 April, with the hope to extend the operational period later in autumn.

An integral element of the transportation system is the new 10,000-square-foot Zion Canyon Visitor Center complex, which was designed by the National Park Service and the U.S. Department of Energy's National Renewable Energy Laboratory. Sustainability was a key element in the design of the complex, which incorporates the area's natural features and energy-efficient concepts. It also uses daylighting strategies, photovoltaics, an advanced energy management system, passive downdraft cooling towers, Trombe walls for solar heating, energy-efficient landscaping, and other green systems. In its first year of operation the new visitor center consumed 80 percent less energy than a standard building of its size. In December 2000 the visitor center received an award from the journal *Energy User News* under the public spaces category in the 2000 Efficient Building Awards Program.

▲ **Shuttle bus** at Weeping Rock, Zion National Park, Utah.

Restoring a Watershed

Applying new technology to mitigate acid mine drainage in the Northeast

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For decades the water quality of the Monongahela River and its tributaries in Pennsylvania has been impacted by the vast amount of coal mining in the region. One of the areas affected by this legacy is Friendship Hill National Historic Site (NHS) near Point Marion, Pennsylvania. An abandoned drift mine in the southeast corner of the park has been the discharge location for acidic water generated by oxidation of pyrite in the abandoned mine workings. This drainage has severely polluted Ice Pond Run, which flows through the park for almost 2 miles. Only species of invertebrates and plants that are tolerant of acid mine drainage can survive in the highly acidic environment. Although resolving this resource management problem has been a high priority throughout the past decade, until this year a feasible solution has been elusive.

Fortunately, a resourceful partnership that integrates the work of scientists from several organizations has brought new hope for the reclamation of Ice Pond Run. The partners include the National Park Service; the U.S. Geological Survey Biological Resources Division (USGS/BRD) Leetown Science Center (Kearneysville, West Virginia); the Conservation Fund's Freshwater Institute; the Pennsylvania Department of Environmental Protection; and California University of Pennsylvania. In July 2000 the partners began diverting up to 60 gallons per minute of flow in Ice Pond Run for treatment at a facility using a process recently developed by the USGS. Funding for this research—which is the first full-scale application of the new process—has been contributed primarily by the USGS Natural Resources Preservation Program. Additional funding was provided by a generous grant from Canon U.S.A., Inc., through the National Park Foundation.

The innovative treatment process comprises eight distinct phases, but at the heart of the technology are four pulsed-bed limestone reactors. After the acid mine drainage has been saturated with carbon dioxide, pumps alternately force it to flow between two pairs of limestone columns in a pulsed cycle of 60 seconds. The highly acidic water comes into contact with a form of limestone commonly referred to as "glass sand." At most sites using conventional fixed-bed reactors, a process called armoring (formation of an impervious coating) prevents limestone from being dissolved. However, the fluidization that results from using pulsed-bed reactors creates a highly energized environment where particle abrasion hinders armoring. The high quantities of free carbon dioxide and limestone then buffer the water's pH, an essential step in the mitigation process.

Attempting to use this active treatment strategy in a remote location created several challenges. Perhaps the best evidence of the partners' resourcefulness is the manner in which they addressed the problem of supplying one of the process's chemical ingredients. The experimental treatment system in some cases requires bulk liquid carbon dioxide, which is expensive. However, neutralizing the acid with limestone produces high quantities of carbon dioxide within the reactors because the acidity of the acid mine drainage at Friendship Hill is extremely high. By modifying the system, researchers have been able to strip excess carbon dioxide from the water and recycle it at a rate that eliminates the need to purchase the chemical from outside sources. In fact, this facility is capable of capturing and reusing about 70,000 pounds of carbon dioxide per year. Additional carbon dioxide is available, when needed, in the exhaust from an on-site propane-powered electrical generator.

▲ **Ice Pond Run** at Friendship Hill National Historic Site has been severely polluted by acid mine drainage until recent use of an innovative treatment process. Water is diverted into four pulsed-bed limestone reactors that buffer its pH before returning it to the run. As the stream begins to recover, yellow iron precipitate falls out of solution with a rise in pH.

In terms of this research facility's early performance, from July through September 2000 the plant had already processed 3.3 million gallons of acid mine drainage, consumed 30,000 pounds of limestone in its reactors, and removed 250,000 pounds of wet sludge (metal hydroxide precipitates). Over a three-year period the partners will monitor the effects of the treatment on water quality, aquatic macroinvertebrates, and fish. Those results will be compared with the characteristics of a reference stream (Dublin Run). As the operation and monitoring of the treatment plant proceed, the National Park Service welcomes scientific investigators, educators, and students to take advantage of the unique opportunities to study and teach others about this ecosystem and the detrimental effects of acid mine drainage.

Of course, reclaiming Ice Pond Run is just the first goal of the partners who have constructed this demonstration facility. In southwestern Pennsylvania alone, three of the four units in the National Park Service supervised by Superintendent Joanne Hanley are affected by acid mine drainage. As she has observed, "With this important research project, we can monitor the new treatment technology developed by the U.S. Geological Survey and determine its effectiveness in restoring good water quality and biological diversity to severely polluted park water resources." Because the National Park Service protects and restores the quality of all surface and ground waters, the application of the pulsed-limestone technology at Friendship Hill National Historic Site has clearly assumed national importance.

Geoindicators: A tool for monitoring and understanding ecosystem change in parks

✎ By Bob Higgins and Jim Wood

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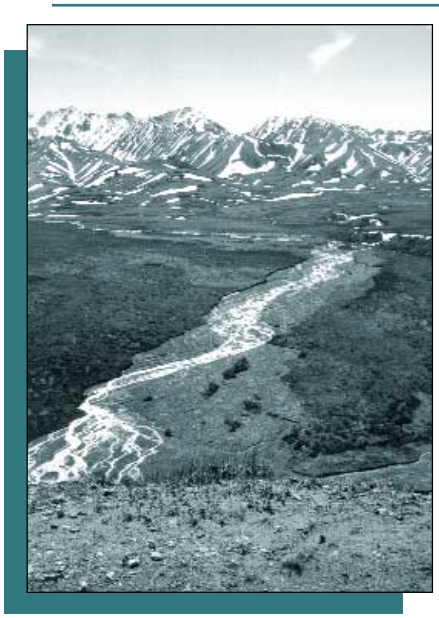
In 2000 the Geologic Resources Division introduced geoindicators to NPS resource management as a new ecosystem management tool. Geoindicators are measures (magnitudes, frequencies, rates, trends) of physical processes on the earth's surface that may undergo significant change in less than 100 years and be affected by human actions. These indicators, developed by the International Union of Geological Sciences, provide a science-based method to assess rapid change in the natural environment.

The geoindicator tool is a checklist that enables parks to identify geologic and hydrologic processes that help evaluate the state of the environment, changes in ecosystems, and effects of humans on natural systems. The easy-to-use checklist includes 27 indicators selected for ecological importance. Some indicators are single parameters such as shoreline position, and others are aggregates of several measures such as parameters of groundwater quality. Examples include dune formation; groundwater level; karst activity; soil and sediment erosion; and extent, structure, and hydrology of wetlands. The tool provides separate criteria for each geoindicator so the user can determine the importance of the indicator for specific natural systems.

Geoindicators help answer NPS resource management questions about what is happening to the environment, why it is happening, and whether it is significant. They may also be used to establish baseline conditions and trends so that human-induced changes can be identified. In 2000, geoindicators were successfully integrated into several NPS projects to obtain science-based information for resource management.

The year 2000 was the pilot year for the NPS Strategic Plan goal Ib4, the identification of human influences on geologic processes. This goal entails the combined expertise of park personnel and geologists to identify natural, earth-system processes that are being influenced by humans. In September the first scoping meeting for this goal was conducted at Craters of the Moon National Monument, Idaho, involving staff from the park, the Geologic Resources Division, and the USGS. The geoindicator checklist was a focal point of the meeting, which identified critical geologic components of the park ecosystem for long-term ecological monitoring and research. Over the next five years, parks throughout the national park system will be using geoindicators to conduct ecological assessments, evaluate monitoring needs, and meet strategic goals.



In Denali National Park, Alaska, and other units of the national park system, stream channel morphology and sediment load are geoindicators that can reflect changes in basin conditions, including climate, soils, erosion rates, vegetation, topography, and land use. Fluctuations in sediment discharge affect a great many terrestrial and coastal processes and ecosystems, because nutrients are transported together with sediment.

Geoindicators are also being integrated into the park vital signs monitoring program for NPS Strategic Plan goal Ib3 to identify geologic "vital signs" of ecosystem condition in the 32 monitoring networks and individual parks. In April 2000 the concept was introduced as an assessment tool at the Northeast Barrier Network's Vital Signs Scoping Meeting. The checklist and criteria were used during the meeting to evaluate options for monitoring, and shoreline position was selected as a critical ecological indicator.

Also in 2000, the NPS Inventory and Monitoring Program initiated work on development of a handbook for natural resource monitoring. In August the Geologic Resources Division drafted a chapter on geologic resource monitoring that includes the geoindicator concept.

Geologic Resources summit held

In April the Geologic Resources Division convened a workshop of NPS resource managers and geology specialists to focus on integrating geosciences into park planning and natural systems management. About 70 NPS staff participated, representing more than 40 parks and six regions. Sessions ranged from geologic education to regulatory compliance to ecosystem restoration. The workshop included breakout sessions by region and theme, covering caves, fossils, geologic hazards, shorelines, NPS extraction of sand and gravel for administrative purposes, and disturbed lands restoration. The summit delineated park resource management and research needs and helped define the priorities and future direction for the geology program.

Science-based Decision Making

Implementing the National Parks Omnibus Management Act of 1998

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Title II of the National Parks Omnibus Management Act of 1998 explicitly directs the National Park Service to use a broad program of the highest-quality science and information in managing and protecting units of the national park system. Park administrative records must reflect this mandate. In 2000 the Park Service undertook several important steps to integrate this important language into its management actions.

Foremost, NPS *Management Policies 2001*, released 27 December 2000, contains direction for enhanced decision making that reflects the highest-quality science and information. In particular, park decision makers must now preface decisions to approve a proposed activity with a written finding that the activity will not impair park resources and values.

To provide assistance to park decision makers, the Natural Resources Directorate kicked off an effort to develop detailed guidance on needed scientific information and analyses underlying the written finding on nonimpairment called for in *Management Policies 2001*.

New guidance (NPS-12) on implementing the National Environmental Policy Act (NEPA) and the new NPS companion NEPA Handbook both explain and provide guidance on the interrelationship of the Omnibus Act with NPS responsibilities under NEPA.

The NPS course titled Integrating NEPA into NPS Activities provides participants with a solid understanding of the science mandate contained in the Omnibus Act and the interface of this act with NEPA.

The Natural Resources Law and Policy Course for Superintendents now contains a session on the act and the duties it places on park managers in making well-reasoned, informed decisions.

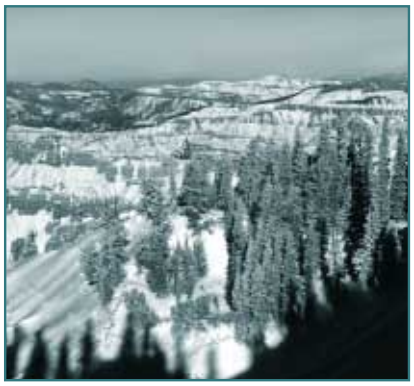
> *"Park decision makers must now preface decisions … with a written finding that the activity will not impair park resources and values."*

The National Park Service continued its efforts to systematically inventory and monitor park resources to establish baseline information and provide information to park decision makers about the long-term trends in the condition of park resources. The Park Service also received a funding increase of $7.3 million in its base budget to accelerate completion of baseline park resource inventories. With this increase the Park Service plans to complete all inventories, except for vegetation mapping, in seven to eight years. Funding for mapping vegetation in all parks outside of Alaska is being provided by the USGS Biological Resources Division.

In addition, in 2000 the NPS Natural Resources Advisory Group examined a variety of options for integrating the Omnibus Act into day-to-day park management, and the National Leadership Council affirmed the need for the Park Service to thoroughly embrace the act's science mandate.

Utah parks water rights agreements signed

On 18 April 2000, representatives from the Utah Department of Natural Resources, Utah Attorney General's Office, National Park Service, Department of the Interior's Office of the Solicitor, and Department of Justice signed water rights settlement agreements for Cedar Breaks National Monument and the Utah portion of Hovenweep National Monument. The agreements, which quantify reserved water rights and establish protective administrative mechanisms, must be submitted to the adjudication court for approval. In the interim the Utah state engineer has agreed to enforce the settlement conditions. The parties hope to use these two agreements as a template to quickly resolve water rights issues at many other park units in Utah not directly associated with the mainstem Green and Colorado Rivers.



▲ **Cedar Breaks** National Monument, Utah

Prudential algebra

✎ By Glenn Haas

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Some 229 years ago, Benjamin Franklin realized that even with a plethora of information, its utility was for naught without a systematic means of full consideration. His letter to a friend (see page 49) introduces Franklin's moral or prudential algebra, known today as decision science.

Decision science is a field of applied cognitive psychology. It attempts to understand and improve human reasoning and the systematic integration of diverse information for the purpose of improved decision making.

The dilemma is that, although the world is enormously complex and science continues to add to this enormity, the human brain has a limited capacity to store, recall, analyze, and interpret information. A recent analogy might be helpful: communications technology and 24-hour political analyses greatly increased the amount of information about the presidential candidates reaching our homes, but it seems we forgot to upgrade the voting box. Decision science is about improving the voting box and is as applicable to natural resource management in the national parks as it is to politics.

"Today's decision science will help guarantee that the increasing volume of scientific information will be used intelligently by decision makers."

The vast majority of federal land litigation is based on lack of compliance with the National Environmental Policy Act (NEPA) and Administrative Procedures Act (APA). NEPA gives procedural guidance on how to make complex decisions, which is further embellished by NPS planning guidance. APA gives substantive guidance by directing that all decisions not be arbitrary, although operational details on how to meet this responsibility are limited.

The Federal Interagency Task Force on Visitor Capacity on Public Lands was initiated by the Assistant Secretary of the Interior in July 2000. At first glance the charge of the task force is to help resolve the old "visitor carrying capacity" question in parks and on other federal lands, but a close examination reveals an effort to develop tools for making decisions that are not arbitrary but based upon decision science.

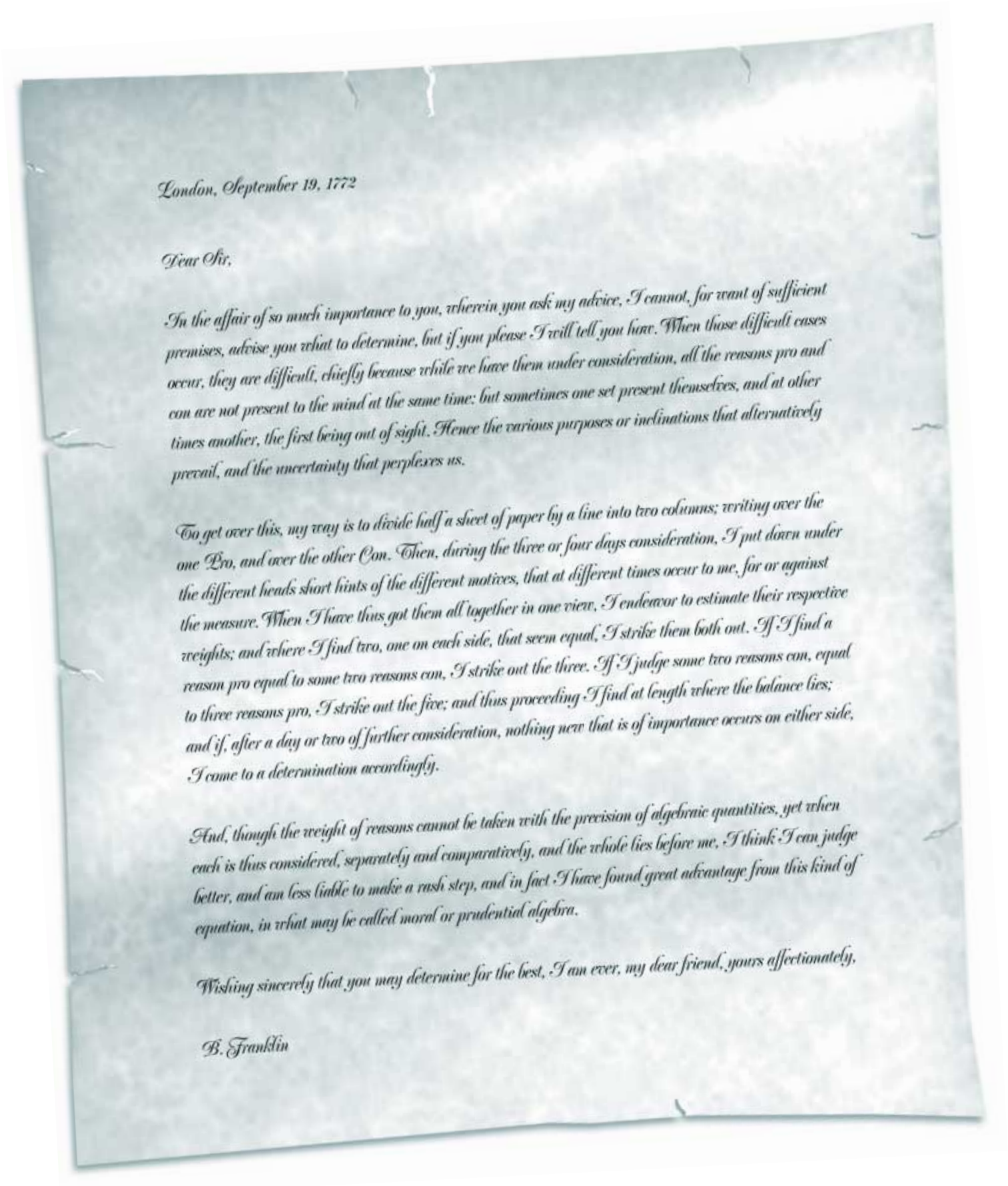
The approach is simple. Arbitrary decisions are those without principle and reason. Thus the task force is developing an explicit set of principles and reasons (i.e., decision criteria) that can guide decision making, along with decision-making protocols that will help ensure, and document for the administrative record, a reasoned and systematic integration of science, circumstances, and assumptions defining a particular situation.

The goal of the task force is ambitious. It is intended to improve the substantive guidance to make better decisions; to improve the clarity of NPS plans; and to increase public understanding and support, and managerial confidence and resolve to make the difficult decisions.

Will this effort reduce judicial challenges? No, not in the short run, because complex, new, and controversial decisions such as visitor capacities will always stimulate a body of case law initially. But our judicial system operates on the principle of judicial deference—that is, administrative decisions should be made by the responsible person and not by the courts. Thus the strategy is that the courts will defer to NPS decision making if we can demonstrably ensure that principled and reasoned decisions are made through a NEPA-compliant planning process.

Benjamin Franklin's prudential algebra and today's decision science will help guarantee that the increasing volume of scientific information will be used intelligently by decision makers.

NPS



London, September 19, 1772

Dear Sir,

In the affair of so much importance to you, wherein you ask my advice, I cannot, for want of sufficient premises, advise you what to determine, but if you please I will tell you how. When those difficult cases occur, they are difficult, chiefly because while we have them under consideration, all the reasons pro and con are not present to the mind at the same time; but sometimes one set present themselves, and at other times another, the first being out of sight. Hence the various purposes or inclinations that alternatively prevail, and the uncertainty that perplexes us.

To get over this, my way is to divide half a sheet of paper by a line into two columns; writing over the one Pro, and over the other Con. Then, during the three or four days consideration, I put down under the different heads short hints of the different motives, that at different times occur to me, for or against the measure. When I have thus got them all together in one view, I endeavor to estimate their respective weights; and where I find two, one on each side, that seem equal, I strike them both out. If I find a reason pro equal to some two reasons con, I strike out the three. If I judge some two reasons con, equal to three reasons pro, I strike out the five; and thus proceeding I find at length where the balance lies; and if, after a day or two of further consideration, nothing new that is of importance occurs on either side, I come to a determination accordingly.

And, though the weight of reasons cannot be taken with the precision of algebraic quantities, yet when each is thus considered, separately and comparatively, and the whole lies before me, I think I can judge better, and am less liable to make a rash step, and in fact I have found great advantage from this kind of equation, in what may be called moral or prudential algebra.

Wishing sincerely that you may determine for the best, I am ever, my dear friend, yours affectionately,

B. Franklin

The unprecedented 2000 fire season

✎ By Tom Zimmerman

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Extreme fire intensity and rapid rates of spread characterized the beginning of the 2000 fire season, one that would become unprecedented in the history of wildland fire management in the United States. Drier-than-normal winters and summers of normal to above-normal temperatures and below-normal precipitation over the past two to three years created the severe fire conditions.

The season began in May with the Cerro Grande fire, which occurred as a result of an escaped prescribed fire in Bandelier National Monument, New Mexico. It threatened and impacted high-value resources, including property and developments in the park and Santa Fe National Forest, at Los Alamos National Laboratory, in the towns of Los Alamos and White Rock, and in Santa Clara Pueblo. Losses were extreme and 235 structures were destroyed. A board of inquiry convened by the National Park Service to draw conclusions about this fire and its management had not completed its activities by year's end.

Wildland fire activity escalated dramatically in the Southwest and rapidly progressed northward in late May and June. Demands for fire fighting and emergency rehabilitation increased in mid-June and continued into July because of Cerro Grande and the number and size of fires burning in Colorado, Utah, and Nevada. The timing and completion of rehabilitation were critical to mitigate potential adverse impacts to ecosystems, such as erosion, from the eventual wet season. By the end of July, fire activity rose to an unparalleled level in the northern Great Basin and northern Rocky Mountains.

"Fire behavior and growth routinely exceeded initial attack capability."

Fire behavior and growth routinely exceeded initial attack capability. Scores of fires ignited daily, taxing the ability of the wildland fire management agencies to control the blazes quickly. When August arrived, needs for management teams, crews, engines, and aircraft markedly exceeded the nation's total resources. As the need to protect life and property increased, large fires could not be staffed adequately. The situation was comparable to or even exceeded the historic 1910 fire season in Idaho and Montana.

The number of wildland fires in 2000, though not the greatest on record, was 90,821 for all wildland fire management agencies. Of these, 886 occurred on lands of the national park system and burned 114,578 acres (46,404 hectares); nearly one-fourth of all units in the national park system (92) reported a fire. In addition to suppressing fires the National Park Service managed 131 wildland fires for resource benefits on 49,253 acres (19,947 hectares). More importantly, in proportion to the magnitude of the fire activity, the safety record during this season was possibly the best ever.

▲ **Wildfires burned throughout the western United States** and in nearly one-fourth of the units of the national park system in 2000. The severe fire season led to a review of national fire policy and resulted in a plan to increase federal fire-fighting capabilities.

This extreme fire season prompted several actions to strengthen wildland fire management capability. After the Cerro Grande fire, the Secretary of the Interior formed a team to review the applicability and implementation of the 1995 Federal Wildland Fire Management Policy and to recommend improvements. During the season a new level of international cooperation developed as firefighters and equipment were contributed by Canada, Mexico, New Zealand, and Australia to aid efforts in the western United States. Also, President Clinton and Congress initiated a plan to dramatically increase fire-fighting capabilities of federal agencies, manage hazardous fuels in the wildland-urban interface, and provide greater support to cooperating rural fire organizations.

In response to the President's proposal, called the National Fire Plan, the National Park Service will increase its preparedness in 2001 by adding new firefighters, helicopter contracts, helitack crews, and other resources. Through an infusion of funds it will also improve fuels management in areas of risk in the urban-wildland interface and complete emergency and long-term rehabilitation of burned areas. Finally, it will provide assistance to rural fire protection organizations located near units of the national park system in order to increase personal safety and fire-fighting capability. Other federal agencies will be responding in similar fashion.

Award-Winner Profile

Redwood superintendent receives award

▲ **Andrew Ringgold**

In June 2000, Andrew Ringgold, superintendent of Redwood National Park, received the 1999 Director's Award for Superintendent of the Year for Natural Resource Stewardship. Andy was recognized for consistently providing outstanding and innovative leadership in protecting the natural resources of Redwood National and State Parks. He accomplished this by developing and strengthening partnerships with state, local, and federal agencies as well as with private landowners and conservation organizations. Andy developed collaborative relationships with the Yurok Tribe and identified and obtained funding to support park resource management programs through nontraditional sources.

According to Andy, one of his most significant accomplishments was developing a partnership with the California Department of Parks and Recreation. He noted that partnership "forms the basis for managing and protecting Redwood National Park and the three state parks within its boundary as a complex of parks [Redwood National and State Parks], blurring administrative boundaries and managing resources on an ecosystem basis."

The award also singles out the General Management Plan (GMP)/General Plan for Redwood National and State Parks, which was completed under Andy's leadership in 1999–2000. It also firmly established natural and cultural resource stewardship as the primary emphasis of the parks. The plan called for many actions, including eliminating or phasing out all off-road vehicle use on beaches, strengthening watershed restoration efforts, initiating second-growth forest management, restoring prairies, and restoring and maintaining cultural landscapes.

Andy felt honored by the award. He said, "The award is the greatest honor I've received in my 34-year NPS career. In a region known for its emphasis on resource stewardship and in an organization with many, many highly talented professional managers dedicated to protecting park resources, it is very special to be recognized." Andy also gives credit to his staff: "I am very fortunate to have the opportunity to work with a staff as talented as the one at Redwood. With such a staff, I believe it would be very difficult for a superintendent not to be successful at protecting park resources."

Rare sea turtles nest at Cape Hatteras

▲ **The leatherback** turtle differs from other sea turtles in having a black, leathery shell divided by seven longitudinal ridges.

Cape Hatteras National Seashore staff and volunteers located 84 sea turtle nests in the North Carolina park in 2000. Most of the nests were laid by loggerhead sea turtles (*Caretta caretta*), although four green sea turtle (*Chelonia mydas*) nests were also found. Both turtle species are classified under federal law as threatened.

The most unusual sea turtle to nest on Cape Hatteras in 2000 was the leatherback turtle (*Dermochelys coriacea*), a federally endangered species. The leatherback is the largest marine turtle, often exceeding 1,000 pounds. It typically breeds in the tropics but is often found foraging in North Atlantic waters. Three leatherback nests were laid in the national seashore, two on Ocracoke Island and one on Hatteras Island. A fourth nest was discovered in Cape Lookout National Seashore.

Leatherback nesting was first recorded at Cape Hatteras in 1998. Because adult females nest every two years and may lay several nests each breeding season, this year's nests could have been laid by the same female. Leatherback turtles venturing far out of their normal nesting range often lay infertile eggs. However, two of the nests laid on the Outer Banks this year were fertile. The eggs at Cape Lookout only partially developed. A fertile nest, located near Hatteras village, produced 86 hatchlings. Little is known of hatchling behavior and movements.

2000 Looking Ahead

The national parks … are the baselines of our relatively undisturbed environment, and they need to be thoroughly understood, not only for their beauty and their wilderness and deep history, but also to realize their unique and vital contribution to science and education, particularly of the future.

—E. O. Wilson
Harvard biology professor, naturalist, and author

Long anticipated, New Year's Day 2000 ushered in a new century that will surely test the National Park Service in many substantial ways. The fledgling century has already witnessed the first primate extinction in two centuries, Miss Waldron's red colobus monkey in western Africa. This is a compelling reminder of the alarming influence of human population growth and land use practices on natural systems. These trends also pose troubling challenges for the preservation of national parks in the United States. To sustain parks unimpaired for present and future generations the National Park Service must be as active as possible to understand the intricate functions of ecosystems and to educate the public about the requirements for park survival. As the following articles demonstrate, the new millennium affords the National Park Service the opportunity to consider expert viewpoints, gather information, and refine its strategy to perpetuate park ecosystems.

Discovery 2000 participants paint a vision of future park management

✎ By Jeff Selleck

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Approximately 1,200 caretakers of America's heritage—employees, partners, and supporters of the National Park Service—gathered in the shadow of the Gateway Arch in St. Louis in mid-September to develop a context for the care of the national park system in the 21st century. *Discovery 2000*, the National Park Service general conference, convened as a beginning rather than an event, as a time to think anew and develop a vision of the future, and as an opportunity to create possibilities. In the spirit of inclusion, a strong theme for the week, conference chair Jerry Rogers brought the session to order by addressing the participants as "ladies and gentlemen of the world of parks and park-like places." He asked everyone not to focus on plans or actions but instead to conceive the future, to envision what each individual and the National Park Service as an organization could become. Director Robert Stanton further defined this opportunity by encouraging participants to "speak freely" and "listen openly" in the quest "to dream, anticipate, and begin to formulate the role the National Park Service will play in the future of this nation."

The conference was organized around four themes—cultural resource stewardship, natural resource stewardship, education, and leadership—with a day devoted to each. Of particular distinction were the many world-class speakers who addressed the group in plenary sessions throughout the week and challenged the National Park Service to greatness. According to John Hope Franklin, historian, author, and chair of the National Park System Advisory Board, the National Park Service must become more relevant and inclusive if it intends to fully engage all Americans. It needs "to be more truthful" and "include stories about everybody," he said. The "teachers" of the National Park Service, he explained, "must be as diverse as the materials they use." Furthermore the Park Service must deliver its message outside the parks to help "translate places of geography and history into places of this society's sense of self and purpose."

"The conference brought out many ideals that constitute a vision of where the National Park Service is headed."

Poet Maya Angelou delivered a dramatic and emotionally packed address that took the audience apart, exposing their very souls, and built them back up again—as humans. She encouraged everyone to embrace the full power and responsibility of being human; to be open to people of any background, appearance, or belief; and to help tell the stories of parks by using poetry. Finally, she challenged the group to be courageous as individuals. "You can be anything for a while, but to be that thing consistently, you need courage."

Peter Senge drew out participants' ideas on the often-misunderstood subject of leadership. Leadership is not a function of a person's position, the group resolved; it is a role and it is transitory. Dr. Senge defined it as "the capacity of a human community to shape its future." He envisions NPS leadership as a key to creating a world in which people are more in tune with the primacy of nature, no longer succumbing to the centuries-old conditioning of continually speeding up like machines to become more and more productive. "My vision … is that you become … dedicated to helping people reconnect with what is primary," he said. The NPS mission is "about giving people tangible experiences of reference."

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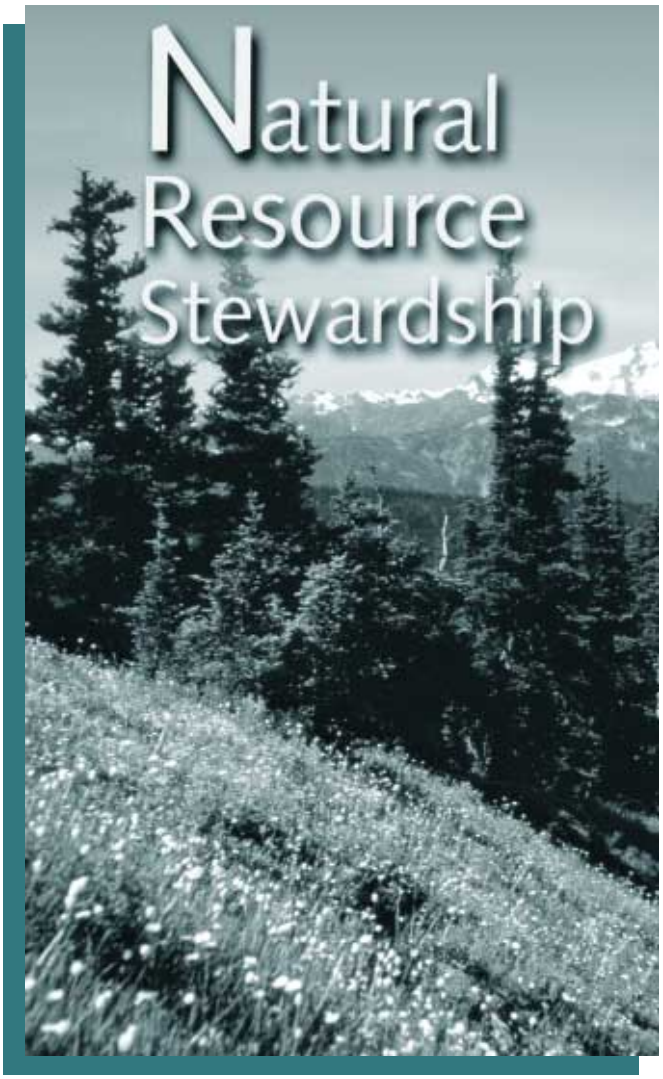


▲ **Discovery 2000 banner** representing the day of the conference devoted to natural resource preservation.

The conference featured addresses by biologists E. O. Wilson and Peter Raven, whose remarks are detailed in the following feature article. Both analyzed the century at hand and how the National Park Service can improve its natural resource protection. Among their many observations was that the All Taxa Biodiversity Inventory, presently being conducted at Great Smoky Mountains National Park, is a potent model for public-private collaboration and the ambitious scope of documenting all living things in a park. It will be emulated widely, they said.

The conference included breakout sessions in addition to the plenary addresses. Summarized on-line at www.nps.gov/discovery2000/sessions.htm, these sessions were designed to stimulate interdivisional and interorganizational dialogue among participants. They explored a broad array of topics of concern, including increasing the capacity for knowledge-based decision making in the National Park Service, expanding partnerships with park neighbors and nongovernmental organizations, dealing with invasive species, and effecting long-term ecological goals through fire. Others focused on visitor use management, long-term impacts of subsistence use of park natural resources, sustainable design of park facilities, and appropriate uses of national parks. Participants explored the concept of impairment of park natural resources and ways to improve management of migratory species through enhanced international cooperation. The session on NPS "brand" identity revealed useful principles that may be applicable to marketing natural resource management strategies more effectively. The discussion of changes in demographic trends affecting future park management (see page 55) was regarded as especially relevant and interesting.

Overall, the conference brought out many ideals that constitute a vision of where the National Park Service is headed. For example, the National Park Service and the national park system will become more relevant. The Service will become more diverse and the scope of stories told in parks will broaden and reflect society at large. Communications will strike at the heart. Science and environmental education will be delivered widely outside parks, inviting public participation in innovative and meaningful ways, and shaping the way society identifies with and values its national parks. The distinction between cultural and natural resource preservation in the National Park Service will diminish and be replaced by a unified approach to resource preservation. Already critical to park management, partnerships will help the National Park Service advance in the key growth areas of education and research. Buttressed by broad, collaborative inventories and scientific investigation, national parks will play an increasing role in biodiversity preservation, in understanding ecological function, and in perfecting ecological restoration. The National Park Service will become a leader in helping other countries deal with their environmental problems. The management skills being developed in small parks and heritage areas today, such as working effectively with park neighbors to minimize negative external impacts on park resources, will be emphasized in managing the generally large, exclusive-federal-jurisdiction parks. As more and more of the natural world is developed and ecological processes are compromised, the value of national parks for recreation, self-renewal, understanding, and scientific discovery will increase. The National Park Service will help people recognize the need to take care of the natural world and to connect with it in ways that will advance global environmental sustainability.

"Parks will play an increasing role in biodiversity preservation, in understanding ecological function, and in perfecting ecological restoration."

Discovery 2000 was intended as a beginning, and in that spirit many participants followed up by meeting with coworkers in their respective parks to digest the ideas and discuss actions for the future. Feedback from several resource managers and park superintendents generally suggests that many of the big ideas from the conference resonated with participants. Several described their understanding of the need to view parks in a global context and to see the National Park Service as a world environmental leader. The Park Service is already widely admired and trusted. It can be of greater value to society if it adopts this broader global perspective and accentuates the connections between the parks and their larger ecosystems. Twenty thousand potential leaders already work for the Park Service, and by tapping the human spirit (theirs and that of the public), progress toward an integrated and coordinated national park system is possible. But inspiration alone is not the answer, some noted. The Park Service is progressing only as time, money, technology, staff, research, and other factors allow.

As a result of the conference, several managers now plan to approach their resource management programs with new resolve and emphasize new ways to engage and educate the public. John Tucker of Fort Sumter National Monument will incorporate more natural science in his park's resource management program. He explained that recognizing the need for natural science understanding in cultural parks is not as apparent as it is in predominantly natural resource parks. Bob Hickman of Prince

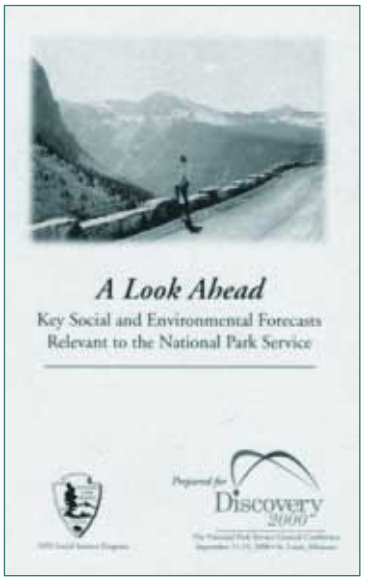
William Forest Park described how his staff will strive to involve people outside of the park in sustaining the larger ecosystems that sustain all parks. Gary Somers of Shenandoah National Park is working to blend natural and cultural resource management into one pursuit to achieve overall resource preservation. Finally, Becky Mills of Great Basin National Park contemplated inviting her colleagues to write letters to their parents, friends, and children explaining what their work as caretakers of America's treasures means to them. Such heartfelt letters could be published in a book to share widely.

Did the conference fundamentally change attitudes about the use of science in park management? Several respondents indicated that Discovery 2000 was not an awakening for them in this regard. They were already of the opinion that effective and responsible park management requires scientific information. However, several mentioned that the conference reinforced this concept and refined their understanding of accepted preservation philosophies. Chris Shaver, Chief of the Air Resources Division, noted that the Park Service has only just scratched the surface of the scientific information potentially available about park resources. The challenge will be to use this information well.

In all, Discovery 2000 stimulated and refreshed most of its participants. It gave them a chance to connect with new ideas and guiding principles, to grow personally and professionally, and to envision what the National Park Service can become. It required a leap of faith beyond the familiar problems and demanding pressures of the workaday world of national park management to a broader perspective of the world and the National Park Service's place in it. Not everyone succeeded in making the shift, but most sensed a very meaningful confluence of big ideas, even the possibility for hope in the environmentally challenging times that are upon us.

NPS

A Look Ahead published



The NPS Social Science Program published a brief report on future trends for the *Discovery 2000* conference. *A Look Ahead: Key Social and Environmental Forecasts Relevant to the National Park Service* is intended to assist park managers in understanding how key trends may affect park management over the next 20 years. It includes information on current conditions and provides forecasts on a number of key social and environmental indicators relevant to the National Park Service. The indicators are grouped into five categories: demography, technology, economics, environment, and culture. In each category, a description of the trend data for current and predicted conditions, sources of information, and potential impacts on park management are provided. Most of these trends will affect park resources and their management. Among the predictions in the report are the following:

- The population in the Pacific West Region is projected to have the greatest growth of the seven NPS regions, increasing 15.2 percent by 2010; the Northeast Region is expected to experience the least growth, 3.4 percent.
- An estimated 102 million international tourists are expected to visit the United States in 2020, a 98.1 percent increase over 2000.
- By 2030, workers are expected to take an average of 30 days of annual leave, a 194.1 percent increase over 2000 (average 10.2 days).
- Between 2000 and 2010, acreage in wilderness and other extensive roadless areas is projected to decrease 6 percent, and undeveloped areas near roads will decrease by 8 percent.

A Look Ahead is posted on the Internet at www.nps.gov/socialscience/waso/products.htm.

E. O. Wilson and Peter Raven highlight biodiversity preservation, education, and international assistance as growing NPS roles

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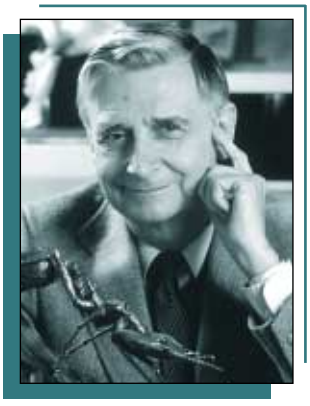
Day 2 of Discovery 2000 dawned with the promise of bringing to life new ideas about the preservation of wild landscapes and natural systems in the national park system in the 21st century. The National Park Service had invited eminent scientists E. O. Wilson (Harvard entomologist and author) and Peter Raven (Washington University botanist and president-elect, American Association for the Advancement of Science) to address the 1,200 conference participants "for their understanding of the world today, for the power of their vision for a better world tomorrow, and for their value … as pilots for uncharted waters." Each speaker presented a sobering view of a future fraught with major natural resource preservation challenges linked to human population growth and development. To deal with this reality, they shared insights into a growing national and international role for the National Park Service in environmental conservation.

Introduced as a great scientist, great citizen, and revered teacher, Dr. Wilson was first to speak and addressed the staff of the National Park Service as "stewards of … America's deep history." He acknowledged the irreplaceable nature of national parks, their popularity, and their expansive role in satisfying "an innate craving for … wildness." He reasoned that the national parks "are destined to play an ever-larger role" in society and around the world because of human population growth and the "conversion of the surviving remnants of the natural environment" to serve human purposes. "The bottom line that matters," he said, is "the ecological footprint," the land and shallow sea used by people "for food, housing, water, energy, transportation, commerce, and waste management." If current trends continue, he said, "the planet could easily lose a quarter of its plant and animal species within the next 30 years and half by the end of the century." The goal, he explained, is to survive this period "and come out the other end, as the [human] population begins to subside, with as much dignity and as high a quality of life and with [as] much of the rest of life accompanying us as possible."

Switching to slides, Dr. Wilson launched into a primer on biological diversity that articulated a leadership role for the National Park Service in fostering a better understanding of the biosphere. He recommended an expansion of biological inventories to include smaller organisms—insects, fungi, and microbes. Any of these species, he cautioned, could be a keystone species that, upon disappearing, could cause a reduction in other park species even before they had been discovered or studied. He said, "Ecologists … need the opportunity to monitor natural systems that are protected over many years.… We are just at the dawn of this particular era of long-term studies for which the national parks are ideally suited." He also explained the consequences of habitat loss with disturbing simplicity. "When you reduce the area of a natural environment … by 90 percent … the number of species that can be maintained … [drops] by half." The implications for national parks are frightening because parks are becoming increasingly isolated by conversion of land all around them.

In closing, Dr. Wilson stated, "I speak for a growing number of scientists who look to the National Park Service as a major force in fundamental research on biodiversity, ecology, and conservation in much the same way that medical scientists look to the National Institutes of Health and space scientists to NASA." Scientists will gladly form partnerships, he stressed, and will welcome access to the parks and collaboration with park staff. "They will help … further the primary aims of the Service with support and solid information of the kind needed to solve the complex and accelerating problems you face in this century." Ultimately, Dr. Wilson views the National Park Service as promoting science education and filling an international conservation role. He said, "You are, whether you planned it … or not, natural leaders on a broadening front whose actions will have growing influence in the United States and elsewhere, especially in the developing countries and far beyond the traditional venue of the national parks."



▲ E. O. Wilson

"Dr. Wilson views the National Park Service as promoting science education and filling an international conservation role."

Peter Raven framed his remarks in the context of environmental history. "While we were … slashing and cutting our way through a wilderness continent, the wilderness was working on us," he said. The foresight and unselfishness of setting aside portions of America for all to enjoy has "profoundly … molded … our national character." Yet, despite the most recent technological advances in biology and information, he explained, "we are just beginning … to take the first faltering steps in learning … how … we might … live at peace with the earth that nurtures all of us."

The lesson in this history, according to Dr. Raven, is that current land use practices, population growth, and increasing consumption cannot be sustained. In the last 50 years humankind has brought about losses in agricultural land and topsoil, reduced forests, developed chlorofluorocarbons (CFCs) and harmed the ozone layer, fragmented habitat and accelerated extinctions hundreds of times over prehistoric levels, and increased carbon dioxide in the atmosphere, contributing to global warming. These circumstances are problems for parks, but they

also have a high human cost. He repeated a stunning observation made earlier by his friend and colleague, E. O. Wilson, that for humankind to obtain the standard of living enjoyed by U.S. citizens today would require four additional planet Earths. Although it has just 4.5 percent of the world's population, the United States currently uses 25 percent of its resources. This inequity, Dr. Raven argued, is discriminatory and wrong, and cannot be sustained. He argued that we need the creative energies, different philosophies, and vision of all people, even those in the poorest countries who are too busy collecting water and firewood for their families to contribute to the larger society, to help solve the world's environmental problems. "Sustainable development is not a goal," he said. "Rather, it is more like freedom or justice, a direction in which … we search for a life good enough to warrant our comforts."

"Dr. Raven encouraged the National Park Service to manage the parks 'for the maintenance of the greatest amount of biodiversity possible.'"

Obviously, many environmental pressures affect the national parks, and the preservation of parks requires bright minds and good ideas from all quarters. To protect the parks, Dr. Raven urged the National Park Service to make the parks as accessible and meaningful as possible to every American. "The parks have an indispensable role to play in helping to preserve biodiversity," he said, and he encouraged the National Park Service to manage the parks "for the maintenance of the greatest amount of biodiversity possible." The concerns of landowners must be taken into consideration in order to progress in preserving biodiversity, and he encouraged better intergovernmental and private-sector collaboration. He also called for adequate funding of the National Park Service so that it is able to do its job, emphasizing that an appropriate and adequate scientific staff needs to be selected for every park. He stressed the need for alien invasive species to be studied, understood, and managed, and explained that national parks are excellent places to develop and test ecological models and apply knowledge. Finally, global climate studies should be increased, he reasoned, because of the considerable potential influence of climate-related change on the national parks.

In his conclusion, Dr. Raven stated that "the greatest value of the national parks in producing a healthy and a sustainable future for Americans is … in the educational arena." Advancing as educators will require partnerships, but the National Park Service should not underestimate its own strength as an educational institution. Finally, Dr. Raven recognizes the desirability of increasing the role of the National Park Service in helping other countries confront their environmental problems. Developing nations, he argues, are not going to rise to the U.S. standard of living. Providing international assistance of this kind is one way in which the United States could contribute significantly to a more sustainable world.

Following the lectures, Mike Soukup, NPS Associate Director for Natural Resource Stewardship and Science, led a riveting question-and-answer session with both speakers that drew on questions submitted by the audience. Asked whether the Park Service should direct its restoration energies toward the species or community level, Dr. Raven replied that the two are closely related and that restoration requires a broad view of the landscape. "We don't have the mechanisms in the United States to deal with ecosystems as ecosystems," he said. Regional approaches to ecosystems and species preservation can be effective, he reasoned, but these have proven "very difficult across the … government." Although both he and Dr. Wilson praised the Endangered Species Act for providing some protection for species and for its educational value in raising public awareness, they see effective collaboration among government and private landowners as key. Dr. Wilson urged that remedies be developed to address aggrieved landowners who perceive species protection as a seizure of their land. Additionally, much more information on population dynamics is needed.

When asked about prioritizing research and resource management activities in and around national parks, Dr. Wilson indicated that even fundamental research in parks is limited at present. He recommended that the National Park Service argue the "increasing returns to scale" of a more robust NPS budget that could address the priorities enumerated earlier by Dr. Raven. To hearty applause, he said, "We need … some amount of parity … of preoccupation with personal health, … personal comfort, and planetary health."

▲ Peter Raven

The two biologists bantered back and forth about the importance of exporting U.S. know-how in environmental problem solving. "Over 150 countries," Dr. Raven said, have "basically no scientific or technical infrastructure." He suggested that much more could be done in international training and foreign work assignments to benefit those countries and the world while also enhancing the careers of those who participate in this manner. Dr. Wilson summed it up this way: "If we recognize the … environment … as crucial for the future of the whole world … then we will want to see scientists of the first rank staying in the developing countries." Biodiversity is concentrated in these countries,

Continued on page 58 ▶

which makes them perfectly suited as world leaders in its preservation. He said, "We should be encouraging that leadership with programs of education and with support from private [and] … public sources."

The topic of educating the public on the importance of preserving biological diversity was raised, and Dr. Raven responded by saying that both education and science-based management depend on "knowing what's out there." He encouraged the National Park Service to look for ways to involve the public in the scientific process of determining status and trends, collecting data, counting birds, and so on. The resulting information would supply education in a very natural way. Even though intellectual arguments are easily made for preserving biodiversity, he said, the "aesthetic, … moral, … and … ethical aspects" will be most meaningful to people. He suggested that the National Park Service communicate the wonder of biological diversity in refreshing and even spiritual ways.

The presentations were extraordinary for their depth and for the applicability of their ideas. The speakers stirred emotions in the audience that ranged from inspiration to desperation. More importantly, the insights shared by E. O. Wilson and Peter Raven gave the National Park Service a new footing and a fortified resolve to meet the challenges of the new century, aptly referred to at Discovery 2000 as the "century of the environment."

NPS

Advisory Board continues to boost scientific management of national parks

The National Park System Advisory Board has completed its approximately 18-month investigation of several wide-ranging questions about the future of the national parks and the National Park Service. A report of their findings and recommendations will be published in 2001 by the National Geographic Society. It is expected to be visionary and to describe the future legacy of the national parks and the role of the National Park Service in conserving resources. The board also voted unanimously in November to establish a permanent science committee to guide and advise the National Park Service on its programs and overall management of park resources. Dr. Sylvia Earle, marine biologist and 1998–2000 explorer in residence with the National Geographic Society, made the motion and sees the commitee constituting a blue-ribbon panel of preeminent scientists. The mission of the committee was being drawn up and its members were being selected at year's end.

▲ The National Park System Advisory Board

Natural Resource Challenge funding increases in FY 2001

A total of $15.2 million was appropriated in late 2000 (FY 2001) under the Natural Resource Challenge for a variety of natural resource programs and emphases: $4.2 million for monitoring park vital signs of ecosystem health; $3.4 million for threatened and endangered species recovery and invasive species control in parks; $1.7 million for vegetation mapping; $1.6 million for establishing four cooperative ecological studies units; $1.3 million for monitoring water quality and assessing watershed conditions; $1.1 million for making natural resource data usable for management decisions and the public; $900,000 for establishing five learning centers; $823,000 for expanding water resource protection and restoration efforts; and $200,000 for inventorying air emissions in parks. During 2000, program managers were planning the use of the funds, which will be spent mostly in 2001. Among the highlights are the following:

- The appropriation more than doubles the funding for vegetation mapping in national park units. With this funding the Vegetation Mapping Programs of the NPS and the USGS Biological Resources Division should be able to complete their work for parks in less than half the time, initiate new mapping in other units, and increase and improve long-term planning for the program.
- Money for monitoring park vital signs is being allocated to about 55 parks to establish monitoring networks.
- The water quality–monitoring dollars are funding 12 park vital signs monitoring networks to establish a nationwide water-quality data management and analysis program.
- Funding for invasive species control and threatened and endangered species recovery is a budget base increase that is being used by 17 parks to pay for staff to address these emphases.
- The air quality funds are being used to establish emission inventory programs in 20 parks.

Social Science Implications

National Park Service conducts a comprehensive study of the American public

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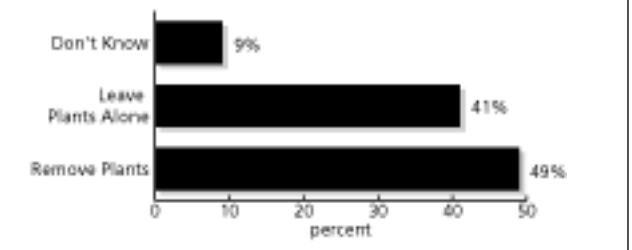
Did you know that one-third of adults in the United States have visited a national park system unit within the past two years? Did you know that the main reason more people have not visited parks recently is that they are simply too busy? And did you know that people are divided over whether they prefer that nonnative animals and nonnative plants be removed from national parks or left alone?

This information comes out of a recent study of the American public sponsored by the National Park Service. The Park Service commissioned the Social Research Laboratory at Northern Arizona University to conduct its first comprehensive survey of a random cross-section of the American public, including park system visitors and nonvisitors. The main purpose of the survey was to gather public perceptions of the National Park Service and its performance in units of the national park system.

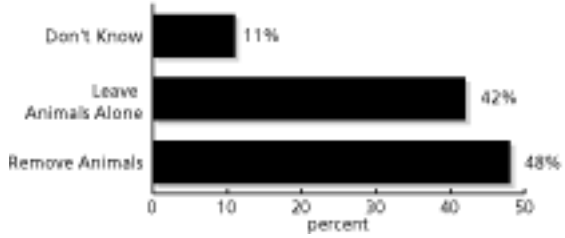
Survey data were obtained by interviewing randomly selected adult members of 3,515 households in the United States. Data collection was completed between February and May 2000, after which two data sets were developed. A national data set reflects attitudes, opinions, and behaviors of the adult population of the United States and a regional data set allows for comparisons of information across people living in the seven NPS regions.

The survey data profile trends in visitation and nonvisitation of national park system units in the United States. For purposes of this research, a national park system visitor is defined as an individual who entered a park system unit within the previous 24 months of being contacted for this survey and who is able to properly identify the unit entered. The data also define demographic differences between visitors and nonvisitors, as well as differences in their motivation, interest, and attitudes. Details of the trips visitors make to units of the national park system and what visitors do once inside are included in the data. Research data also provide a perspective of the barriers to more frequent visitation of park system units, future usage patterns, images of the National Park Service and national park system, and public attitudes about specific resource management issues. The survey margin of error is ± 1.7 percent for the national-level data and ± 4.5 percent for the regional-level data.

Overall, the national park system is very well regarded by visitors. Previous visitors gave an average rating of 8.09 on a scale of 1 to 10, with 10 being the highest rating. People living closer to the East Coast tended to give slightly higher ratings to the national park system than people living in the West (8.41 for those living in the National Capital Region compared to 7.47 for those living in the Alaska Region). Visitors who have used national park reservation systems overwhelmingly had a positive experience. Among those familiar with NPS efforts to include the public in policy decisions, there is a widespread belief that the Park Service does a good or excellent job of responding to public input.



The proportion of the general public that felt nonnative plants should be left alone or removed from national park units. (Numbers do not add up to 100 percent because of rounding or reporting of selected results.)



The proportion of the general public that felt nonnative animals should be left alone or removed from national park units.

Social science research plays an important role in NPS policy decisions. Policies that incorporate an understanding of public needs and desires better enable the National Park Service to serve the public interest. The National Park Service took a bold step in 2000 by scientifically collecting information about public values, attitudes, and images of the National Park Service and national park system units. Survey data will contribute to a wide range of policy decisions for years to come.

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