National Park Service
U.S. Department of the Interior

Natural Resource Program Center
Natural Resource Information Division

Natural Resource Year in Review–2004

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

"National parks … are a cure for cynicism, an exhilarating rest from the competitive avarice we call the American Way.… Without them, millions of American lives … would have been poorer. The world would have been poorer."

—Wallace Stegner

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Famous for its extensive collection of natural rock arches, Arches National Park (Utah) was also the site of a large-scale deployment of Exotic Plant Management Teams in 2004 to control invasive tamarisk and Russian olive vegetation (see article, page 36). Here, aptly named Frame Arch permits an uncommon view of Delicate Arch.

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The Year 2004 in Review

By Michael Soukup

A PARK SUPERINTENDENT once complained to me, "if it weren't for so many natural resource issues, I'd be able to manage my park." Thankfully, that was in the last century. The new breed of park manager better understands the complexity of the modern landscape and the reality that managers must know their resources and the processes that either maintain or threaten them. They also comprehend that they must invest in a long-term institutional memory that will serve to educate a nation of stakeholders in whose hands the fate of national parks rests. As a small exercise in science education, this volume attempts to recap the experiences and achievements of 2004 and assess their meaning for the natural resources of our national parks. In 2004 we made great progress in delivering the tools parks need to know their resources and to implement actions necessary to protect the quality of both the resources and the visitor's experience.

Part of the role of our Natural Resource Stewardship and Science directorate is to bring objective scientific information to decision makers, supporters, and critics of the National Park Service. This year was a turbulent, challenging one for us, not only because of natural resource gains and losses, but also because of the political context of a national election, even though the environment in general did not become a focus of the national debate.

In 2004 we made great progress in delivering the tools parks need to know their resources and to implement actions necessary to protect the quality of both the resources and the visitor's experience.

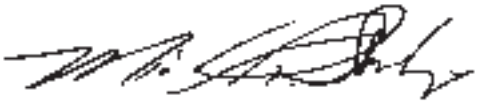
Aside from the relatively pressing affairs of state, I suspect that one reason for the lack of focus on the environment in 2004 is the apparent success the public sees in positive trends in water and air quality in many parts of the United States. Similarly, in many national parks we see progress in restoring populations of condors, whales, wolves, peregrine falcons, and the Miami blue butterfly, as well as reclaimed mining lands and plans to reopen rivers where salmon are sure to return. Other truly inspiring things are happening, too, like the public's fascination with the All Taxa Biodiversity Inventory at Great Smoky Mountains National Park and its spread to Point Reyes National Seashore. In Yellowstone the value of a single species is coming to light with mounting evidence of the impact the gray wolf is having on the entire balance of the greater Yellowstone ecosystem.

A major highlight was the enthusiastic approval of the National Park System Advisory Board of its Science Committee's report, "National Park Service Science in the 21st Century" (available from "Information Links" at http://www.nature.nps.gov/scienceresearch). Among the report's insights was, "The National Park Service has no choice: Mastering the science required to maintain ecological integrity is central to its unimpairment mandate." It also included a positive peer review of the NPS Natural Resource Challenge program and an exhortation for the National Park Service to fulfill its proper role in maintaining parks as natural laboratories and to realize its core mission of biodiversity conservation.

Associate Director Soukup and Deputy Associate Director Abby Miller pause momentarily at a February 2005 celebration honoring Abby, who is retiring from the National Park Service. The two have worked closely with each other in Washington for 10 years, helping to usher in and guide many important natural resource programs.

Another highlight for me this year was perhaps the most succinct statement I've seen that we ought to save all the pieces of the natural systems that mean so much to us as a nation. I spotted it in a letter to the editor of the *New York Times* (9 August 2004) from the Honorable Russell Train, former EPA administrator and recipient of the Presidential Medal of Freedom. The headline read, "National parks, for Americans of all species."

A final item of interest was the calculation by the Environmental Protection Agency that as we began 2004, the gross domestic product during the tenure of the Clean Air Act of 1970 had grown by 176% while emissions of six principal air pollutants had decreased by 51%. Indications that quality of life and a robust economy are compatible should encourage a wide range of interests to get together for a new, dispassionate look at how to tackle the major challenges ahead, including those for the conservation of national parks. I hope that the entire political spectrum can coalesce around a common vision of life on the planet that we want for ourselves and for future generations too. While joking abounds about those who would "save the whales," I think everyone deep down will be glad that, as a generation, we did. Now, on to the oceans!



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Year at a Glance—2004

january

Two weeks before the New Year, the National Park Service launches its new natural resource Web site, Nature & Science, at www.nature.nps.gov. This is not simply a revised look for the former NatureNet; more than 80% of the content is new, including pages about global conservation, hazards and safety, research learning centers, natural sounds, how visitors can help parks, and how the Park Service provides stewardship of natural resources.

The Association for Women Geoscientists selects four new Geoscientists-in-the-Parks positions to address park research, resource management, and interpretation needs through specialized expertise. These park placements are in addition to 13 funded by the Geological Society of America in 2004.

february

Kenai Fjords National Park, the Ocean Alaska Science and Learning Center, and the Alaska SeaLife Center host "Interpretive Research and Resource Liaison" with assistance from the Natural Resource Information Division. This is the first time the course is offered to all NPS employees, and its content focuses on helping participants integrate educational products and outreach services into resource management and research projects. It also helps them develop funding proposals for critical resource issues.

Assistant Secretary Craig Manson announces the initiative to protect Virgin Islands Coral Reef National Monument and the expanded Buck Island Reef National Monument. In cooperation with the National Oceanic and Atmospheric Administration, the National Park Service will commit personnel and $400,000 to support surveying reef habitats and documenting populations over the next four years.

The U.S. Geological Survey publishes "Vulnerability Assessment of Fire Island to Sea-level Rise," the first in a series of about 20 reports produced as a result of a joint project in 2004 with the National Park Service (see article, page 31).

march

Fourteen Exotic Plant Management Teams fight tamarisk (salt cedar) in Courthouse Wash at Arches National Park (Utah). This is the first large-scale deployment of the teams and provides an opportunity for information sharing with resource managers from other countries, federal and local agencies, and academia (see article, page 36).

Virginia Electric and Power Company's (now Dominion) consent decree provides $1 million for air quality mitigation projects at Shenandoah National Park. The air quality mitigation plan seeks to decrease emissions from mobile sources of air pollution in and around the park by the purchase and use of specialized, energy-efficient vehicles and alternative fuels. In addition, park staff will develop a program to educate the public about the environmental benefits of such vehicles.

The National Park Service receives $280,016 in new monies from the USDA Forest Service to treat forest insects and diseases in 12 parks. Six projects will target hemlock woolly adelgids, which surged into the Southeast during the past two years.

With support from the National Park Foundation and the National Teachers Association, the Park Service presents a workshop, "Communicating Complex Biological Stories in National Parks." National Park Service employees and teachers discuss case studies from parks, including West Nile virus management at Fire Island National Seashore (New York) and biological diversity issues at Yellowstone National Park (Wyoming).

At the Natural Resource Advisory Group meeting, Associate Director Soukup announces the winners of the 2003 Director's Awards for Excellence in Natural Resource Stewardship and Science. The winners are a park superintendent, three resource managers, a researcher, and a facility manager.

An agreement settling water rights for Timpanogos Cave National Monument is executed between the United States and Utah. It establishes protections for cave and river resources and will be jointly supported as a resolution of water rights issues before the water adjudication court.

Director Fran Mainella addresses the North American Wildlife and Natural Resources Conference in Spokane, Washington. In her talk, "The National Park Service's Role in the Voyage of Rediscovery," she reinforces the importance of partnerships and Natural Resource Challenge programs to improvements being made in the scientific exploration and stewardship of national parks.

april

The National Park Service launches the Crater Lake Science and Learning Center, the first of three research learning centers established in 2004. In August the Murie Science and Learning Center in Denali National Park is dedicated and the Mammoth Cave International Science and Learning Center begins operating in partnership with Western Kentucky University.

The Biological Resource Management Division convenes a workshop exploring the application and refinement of NPS policy related to resource management and the use or occurrence of genetically modified organisms in or near national parks. Participants discuss the use of such organisms in the management of cultural landscapes and park natural areas and concerns about their unintended introduction to parks.

may

The Chesapeake Watershed and Southern Appalachian Mountains Cooperative Ecosystem Studies Units, in collaboration with the Pennsylvania State University, host "Restoration of American Chestnuts Within National Parks." During the workshop, participants review the status of chestnut blight research and develop a common understanding of NPS policies, objectives, opportunities, and directions for American chestnut restoration programs on park lands.

The Intermountain Power Service Corporation has proposed to build a 950-megawatt, pulverized coal–fired power plant next to two existing units. If it is built, emissions from the proposed unit and those already in operation could impact visibility at Utah's five Class I (air quality) parks: Capitol Reef, Bryce Canyon, Zion, Canyonlands, and Arches National Parks. The Air Resources Division recommends that Utah require emissions reduction strategies to mitigate the cumulative visibility impacts at parks in the region.

june

The National Park Service renews agreements for four Cooperative Ecosystem Studies Units (CESUs), each for a second five-year term: Colorado Plateau, North Atlantic Coast, Rocky Mountain, and Southern Appalachian Mountains. The Colorado Plateau and Rocky Mountain CESU agreements include new partners Fort Lewis College and Colorado State University, respectively.

The Geologic Resources Division convenes park managers for a workshop designed to improve NPS administration of often controversial private oil and gas operations in parks. The session addresses permit processing, environmental compliance, and emerging issues for oil and gas operations in parks.

Deputy Director Randy Jones forms a task force of 10 field managers to implement the NPS "Ocean Park Stewardship Strategy." Chaired by Visiting Chief Scientist Gary Davis, the task force establishes a timeline for addressing the 27 action items identified in the strategy to improve conservation in ocean parks.

The Oklahoma Water Resources Board grants a temporary permit to withdraw groundwater from the Arbuckle-Simpson aquifer up-gradient from Chickasaw National Recreation Area (Oklahoma). In its decision, the board acknowledges concerns raised earlier by the National Park Service for park spring and stream resource protection, by approving only a portion of the amount of water requested for irrigation and by making the permit temporary and subject to the results of an aquifer-wide hydrogeologic study being conducted jointly by state and federal governments. The study is intended to measure aquifer characteristics needed to determine how much development can occur before impacts to other users and resource values occur.

Associate Director Mike Soukup selects six employees to receive the first NPS professional development grants. Awardees will attend the Penn State Executive Program for Natural Resource Managers or USDA graduate school sessions such as the Executive Leadership Program. Their participation in the program will build natural resource management leadership and technical capacity for the National Park Service.

july

In 2003, the U.S. District Court (Southern District of Ohio) ruled that FirstEnergy Corporation made modifications to its W.H. Sammis power plant in Stratton, Ohio, without obtaining proper permits. Analyses showed that the Sammis plant is one of the top five contributors to visibility impairment at Shenandoah National Park, Virginia. In preparation for the remedy phase of the trial, the Air Resources Division provided expert testimony in April about the plant's impact on air quality at the park. The company agrees to an out-of-court settlement this month that will reduce its sulfur dioxide emissions by about 80% and its nitrogen oxide emissions by at least 90%.

august

Olympic National Park, City of Port Angeles, and the Lower Elwha Klallam Tribe sign a memorandum of understanding to remove the two Elwha River dams and mitigate the impacts of dam removal on the local community. This agreement, which was in negotiation for years, clears the way for the restoration of the Elwha River ecosystem and its once-famous salmon runs (see article, page 61).

Secretary of the Interior Gale Norton approves a three-year project totaling $1.9 million for the National Park Service, U.S. Fish and Wildlife Service, and Bureau of Land Management to cooperatively develop information and management tools that assess potential impacts of water development in southern Nevada. The Water Resources Division assisted the bureaus in preparing the proposal for the project, which will evaluate the effects of groundwater pumping on sensitive water resources, water-dependent habitats, and species in the region.

Following settlement of three Park System Resource Protection Act cases, staff of the Environmental Quality Division, park staff, and contractors perform successful seagrass restoration at Biscayne National Park (Florida). Planning for this work began in 1999 when permits were prepared and submitted for the restoration of seagrass (*Thalassia*) in areas where vessels had run aground causing impacts in the form of prop scars, trenches, and blowholes.

The British journal *NewScientist* publishes comparative 1899 and 2003 photos of Muir Glacier in Glacier Bay National Park in an article relating increased earthquake activity to glaciers melting in Alaska. The photo pair is part of an ongoing Geologic Resources Division glacier monitoring project at several national parks.

The Natural Sound Program holds four workshops in the Northeast Region with the help of the Philadelphia Support Office. Each daylong workshop presents an overview of soundscape management, a primer on acoustics science and measurement, and a discussion of the essential elements of soundscape planning. The program assists parks in dealing with the management of activities that may be loud or intrusive; the effects they may have on visitor enjoyment of park solitude, wildlife, and cultural resources; and finding solutions to these problems.

The Water Resources and Natural Resource Information Divisions sponsor a symposium on fisheries management in the national parks at the 134th annual meeting of the American Fisheries Society in Madison, Wisconsin. Eighteen presentations summarize the history of the NPS fisheries program, native species and habitat restoration, ocean fisheries, and individual park projects and programs. Several hundred professional fishery scientists and managers from North America attend.

september

The Natural Resource Program Center and the Albright Training Center host the 2004 Natural Resources Law and Policy course for superintendents. This highly popular training covers NPS legal and policy responsibilities and topics germane to natural resource management, including application of state and local law, the Freedom of Information Act, the administrative record, and protection of sensitive resource information.

A federal court judge rules that the United States owns the sand and gravel resources on a scenic wilderness beach in Olympic National Park (Washington). Private mineral owners, who still hold the rights to gold, oil, and gas that may be present on the beach, had sought to develop the sand and gravel. Because of the speculative nature of the remaining minerals and the remoteness of the area, development is unlikely.

Director Mainella signs Director's Order 14, Resource Damage Assessment and Restoration. The order provides Service-wide guidance for damage assessment activities and related cost recovery for subsequent environmental restoration or compensation for lost or diminished park and visitor use.

The Natural Resource Stewardship and Science Directorate proposes that the "Seamless Network of Ocean Parks and Marine Sanctuaries" initiative be included in the Bush administration's response to the Commission on Ocean Policy report (see article, page 28). The initiative proposes expanded coordination between the Department of the Interior and the National Oceanic and Atmospheric Administration.

october

The American Fisheries Society presents Gary Davis, a longtime NPS scientist at Channel Islands National Park (California) and NPS Visiting Chief Scientist for Ocean Programs, with the William E. Ricker Resource Conservation Award. The society presents the award to an individual or organization it deems to have made nationally or internationally significant accomplishments toward resource conservation.

Staff of the Biological Resource Management Division, Wildlife Health Program, attends three professional meetings to make presentations on chronic wasting disease and other wildlife disease issues (see article, page 19). These presentations are aimed at helping managers understand the importance of host, habitat, and pathogen characteristics that lead to wildlife diseases.

The Shenandoah Watershed Study—the longest continuously conducted watershed research and monitoring program in the National Park System—celebrates its 25th anniversary by hosting the "Virginia Mountain Streams Symposium." The symposium focuses on the challenges facing managers of mountain streams in the East, such as changes within watersheds and external stressors.

Director Mainella participates in the dedication of Cuyahoga Valley National Park (Ohio) as an Important Bird Area (IBA), and recognizes park partners and citizen scientists who provided information supporting the IBA nomination and designation (see article, page 96). The event also launches plans for international cooperation between Cuyahoga Valley National Park and another Important Bird Area, Point Pelee National Park, which lies across Lake Erie in Ontario, Canada. The two parks share many migratory bird species.

As part of the inventory effort under the Natural Resource Challenge, the Geologic Resources Division distributes the first set of completed geologic reports to Glacier and Rocky Mountain National Parks and Natural Bridges and Hovenweep National Monuments. The reports complement the digital geologic maps being developed by the division.

november

The National Park Service publicly launches the Web-based communication system Planning, Environment, and Public Comment (PEPC), which streamlines National Environmental Policy Act (NEPA) and other compliance and planning activities. This online tool consists of both internal and external components: internally for project planning, tracking, analysis, and response, and externally for public comments and checking the status of planning documents. The public side of the system is available at http://parkplanning.nps.gov.

Canon U.S.A., Inc., announces selection of its annual National Parks Science Scholars. Eight Ph.D. students from Argentina, Canada, and the United States receive prestigious $78,000 scholarships to conduct research critical to conserving national parks. Four students receive honorable mention awards of $1,000. An international scientific panel convened by the American Association for the Advancement of Science reviewed 135 proposals for the 2004 competition.

The Sierra Club files a lawsuit challenging the National Park Service's management of directional oil and gas drilling techniques from surface locations outside park boundaries. The suit alleges that a 2003 guidance memorandum revised NPS regulations without public involvement. The Park Service maintains that the memo clarifies existing regulations and compliance procedures.

Geologic Resources Division staff chair five technical sessions at the Geological Society of America's annual meeting, which attracts more than 6,000 geoscientists. Sessions include cave and karst science, geologic mapping and resource management, opportunities for partnerships with the National Park Service, informal geoscience education in parks, and teaching geology of national parks.

december

The NPS Environmental Response, Damage Assessment, and Restoration (ERDAR) Program summarizes the type and number of cases processed under the Park System Restoration Protection Act in 2004, as follows: trespass (5), encroachment (14), groundings (13), pollution incidents (3), facility injuries (4), damages to historic structures (2), and airplane crash (1). The ERDAR Program seeks compensation from responsible parties for the restoration of injured or lost park resources to their pre-incident condition.

1 A Spectrum of Challenges

"Even in the largest and oldest national parks … most often the serious ecosystem stressors … are not so much from tourism and the interaction of park visitors with nature but represent forces operating at regional to global scales."

—Gary E. Davis, David M. Graber, and Steven A. Acker

The National Park Service is grappling with numerous regional and global environmental issues that affect the preservation and management of park natural resources. Topping this list are climate change and related rising sea level, coastal erosion, changes in local and regional precipitation, and flooding; air and water pollution; depletion of marine resources; introductions of nonnative diseases and organisms; and land-cover change. Understanding how park resources respond to these phenomena, whether those changes are within the range of normal variability, and when and how to intervene to prevent impairment of park resources, if it is even possible, is a key information need of the National Park Service today. By detecting change in the condition of park resources, resource monitoring is emerging as a critical tool for managers to use in filling this information gap. Other research is needed, too, to address this broad spectrum of challenges, as are effective policies and performance measures, consultation strategies, interagency cooperation, and enforcement of regulations. The articles that follow offer interesting glimpses into some of these complex, far-reaching environmental issues and the role that science, policy, legislation, leadership, and partnerships are playing in the understanding and management of these issues in the National Park System.

Water Resources Division tracks water quality impairments in parks

By Gary Rosenlieb, John Christiansen, Dean Tucker, and Mike Matz

MEASURING AND TRACKING HISTORICAL TRENDS in water quality has always been a daunting task for park managers. More daunting is the management of problems when they are discovered, because almost all park water quality problems are caused by external sources. Parks are faced with a wide array of pollutants emanating from sources typically outside park boundaries. Nutrient and metal-laden runoff from development, agriculture, and mining activities threatens many park aquatic systems with basic changes in chemical and biological structure. Pollution from atmospheric deposition of mercury is being biomagnified through the wetlands of the Everglades as well as in the many northeastern and midwestern parks.

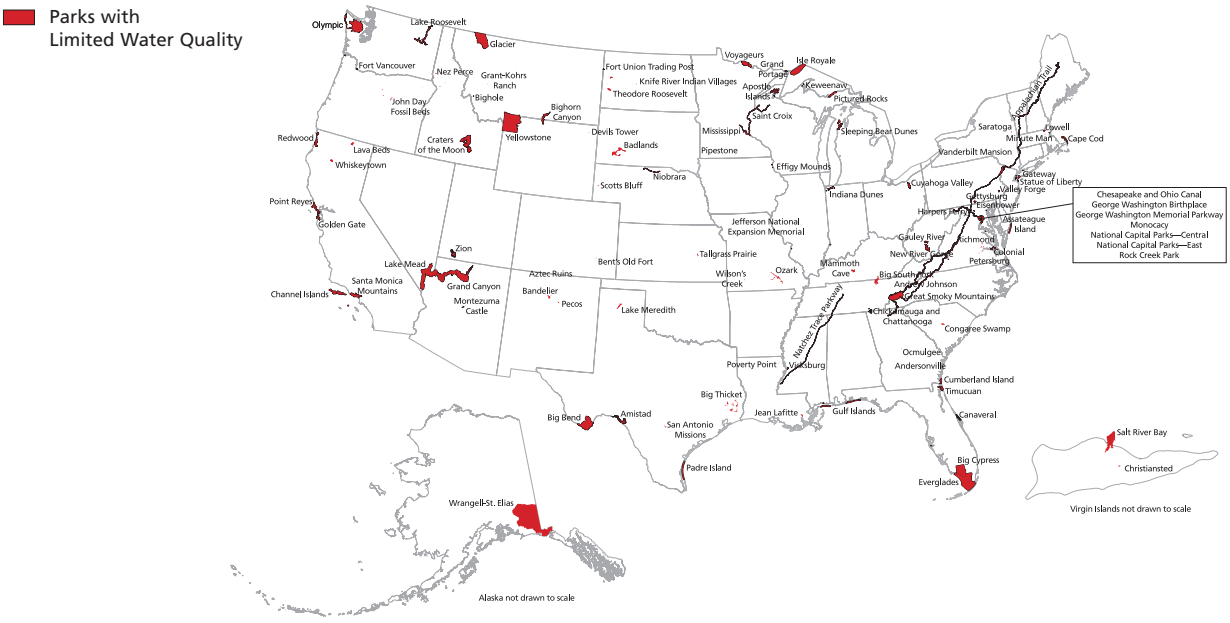
Though the ultimate solution to many of our water pollution problems may be many years in the future, two major program developments during the last five years, the Government Performance and Results Act and the Natural Resource Challenge, have enabled the National Park Service (NPS) to begin to assess the magnitude of water quality problems. Current goals established by the Department of the Interior (DOI) require that bureaus track and report on waters that are meeting Clean Water Act water quality standards. Through the Natural Resource Challenge, $3.1 million has been dedicated to water quality monitoring in parks to identify and monitor water quality problems and issues as resolutions of them are implemented.

To facilitate tracking and reporting for the DOI and NPS strategic plans the Water Resources Division has constructed a Service-wide database entitled "Waterbody Designated Uses and Impairments," which contains the results of park-specific inventories of surface-water hydrography and water quality impairments. The inventory is based on the U.S. Geological Survey 1:100,000 and 1:24,000 scale National Hydrography Dataset, a comprehensive set of digital spatial data representing surface water features. The Water Resources Division uses this framework to house the water quality impairment portion of the water resources inventory. Section 303(d) of the Clean Water Act is currently the criterion for defining water quality impairments in the inventory. This portion of the act requires states to publicly identify waters that do not meet water quality standards. Essentially, water is deemed to be in violation of water quality standards or "impaired" when any narrative or numeric criteria are exceeded or when designated uses are shown to be adversely affected by human activities. Common designated uses of water include recreation, aquatic life (including fisheries), public water supplies, and industrial and agricultural activities.

Nutrient and metal-laden runoff from development, agriculture, and mining activities threatens many park aquatic systems with basic changes in chemical and biological structure.

Based on the estimates developed by the Water Resources Division, the National Park Service manages (within the boundaries of the 342 units currently tracked) about 138,000 miles (222,042 km) of rivers and streams, and about 5,000,000 acres (2,025,000 ha) of lakes, reservoirs, estuaries, and marine areas. Of these, 118 park units have one or more water bodies that do not meet state water quality

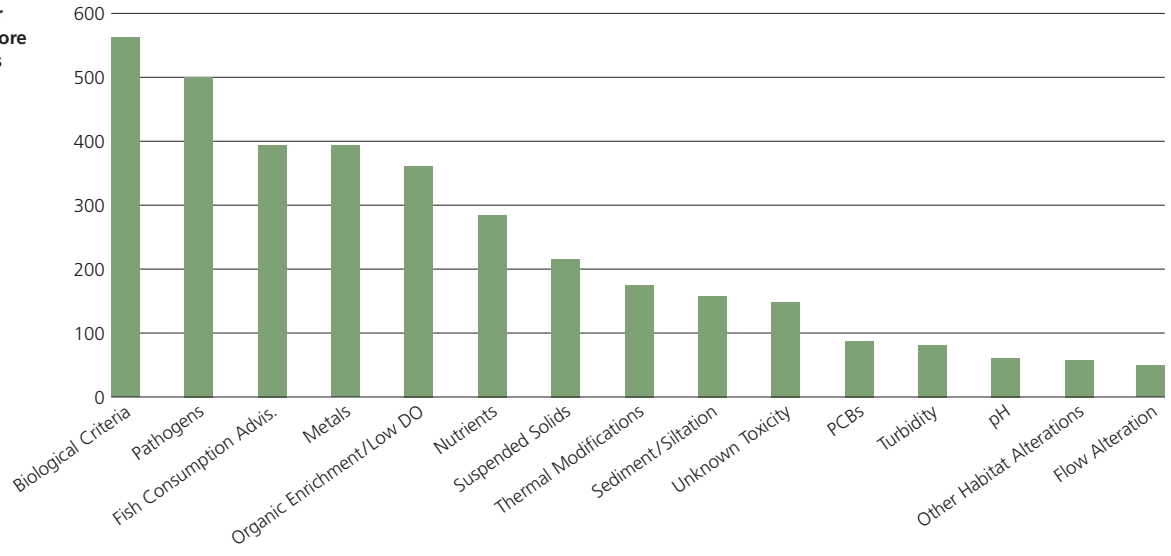
PARKS WITH WATER QUALITY EXCEEDANCES AND USE IMPAIRMENTS



Pollutants That Exceed Water Quality Standards in 50 or More Miles of NPS Managed Rivers

y-axis = Miles

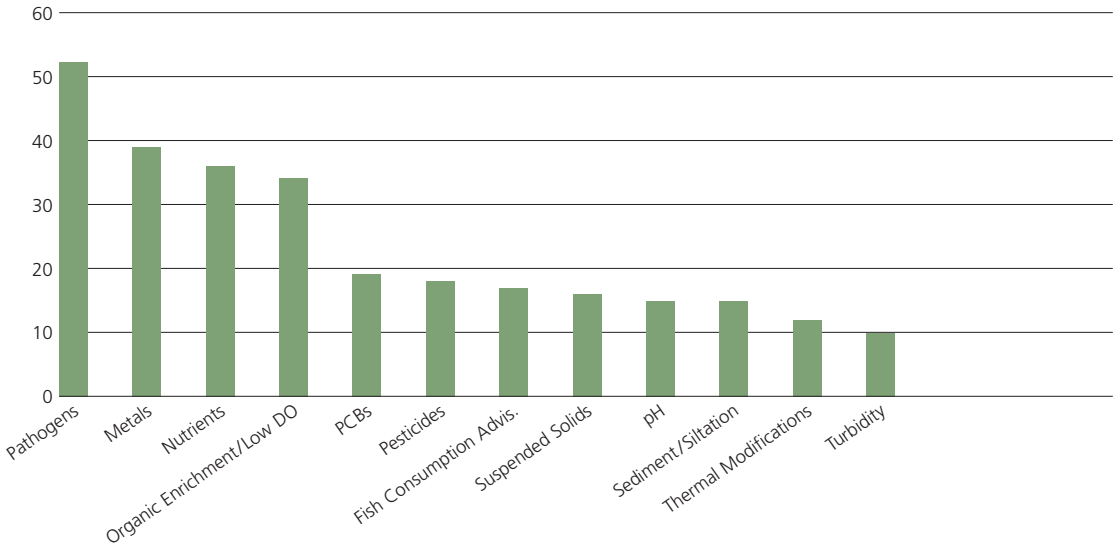
x-axis = Pollutant Category



Pollutants That Exceed Water Quality Standards in 10 or More Parks

y-axis = Number of Parks

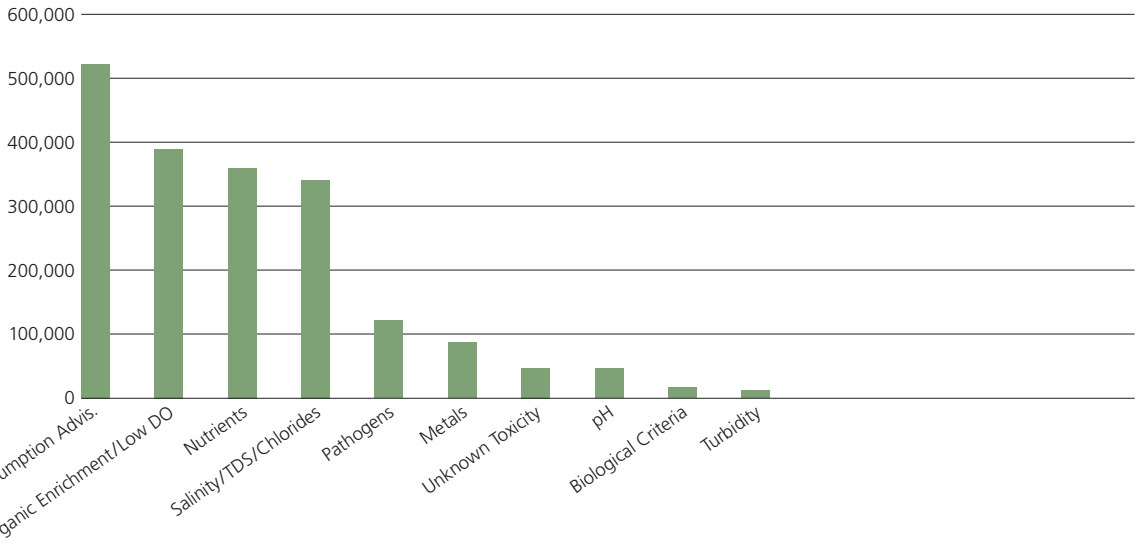
x-axis = Pollutant Category



Pollutants That Exceed Water Quality Standards in 10,000 or More Acres of NPS Managed Lakes, Reservoirs, and Marine Areas

y-axis = Number of Acres Where Water Quality Standards Are Exceeded

x-axis = Pollutant Category



standards for one or more pollutants, on about 1,600 miles (2,574 km) of rivers and streams and 1,114,000 acres (451,170 ha) of lakes, reservoirs, estuaries, and marine areas. Overall, 35 different pollutant groups have been identified that exceed standards and impair recreational and aquatic life uses of water. Fecal-indicator bacteria, the most common pollutant group, impair recreational uses in 52 parks. Metals, nutrients, low dissolved oxygen, polychlorinated biphenyl, and pollutants that primarily impact aquatic life affect the second greatest number of parks. From a hydrographic standpoint, the dominant water quality impairment is the failure to meet biological criteria in almost 560 miles (901 km) of rivers and streams, followed by bacteria, fish consumption advisories, and metals, respectively. In standing waters, fish consumption advisories prompted by organic and metal contamination on about 535,000 acres (216,675 ha) of lakes, reservoirs, estuaries, and marine areas are the dominant use impairment, followed by organic enrichments or low dissolved oxygen, nutrients, salinity, and chlorides, respectively.

Information in the water resources inventory is continually being updated. The Water Resources Division will also be designating the inventory for water quality standard state-designated uses and will begin to merge and use data collected through the Natural Resource Challenge Water Quality Monitoring Program for tracking attainment of the water quality goal. The database can be accessed at http://www1.nrinta.nps.gov/wrd/dui. ■

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Expert team formed to assist parks with wildlife health issues

By Margaret A. Wild, DVM, Ph.D.

The past two decades have seen the worldwide emergence of numerous infectious diseases of wildlife, threatening biodiversity and conservation efforts. Public concern is further heightened when human health is endangered by the sharing of these diseases between wildlife and humans in cases such as West Nile virus, monkey pox, and avian flu. In many instances these diseases are nonnative introductions, or their occurrence has been significantly influenced by people.

As a result, managers with the National Park Service are increasingly faced with addressing these emerging infectious disease issues. Because disease prevention and management actions can be complex, controversial, and time-consuming, and can require urgent implementation to minimize disease impacts or limit spread, response can be challenging. To help attend to this need, the NPS Biological Resource Management Division (BRMD) secured new funds to establish a Wildlife Health Team in FY 2004. The team, patterned after the highly successful Exotic Plant Management Teams, is designed for rapid-response assistance to the national parks. It is a component of the BRMD Wildlife Health Program, located in Fort Collins, Colorado, and consists of a wildlife veterinarian, wildlife biologist, veterinary technician, wildlife technician, and project manager to assist parks with environmental efforts on management plans for elk and deer that are affected by chronic wasting disease. The funding not only pays for the team members and their travel to assist parks but also supports tactical management applications, diagnostic testing of biological samples, and environmental planning.

Wildlife Health Team wildlife technician Scott Ratchford assists park staff by monitoring a mule deer anesthetized for tonsillar biopsy for chronic wasting disease and radio collaring at Rocky Mountain National Park.

Because of the significant concern surrounding chronic wasting disease of deer and elk, the team initially will focus much of its field effort in Rocky Mountain National Park (Colorado) (see related article on page 79) and Wind Cave National Park (South Dakota) where the disease occurs. However, the team is available across the national park system for technical assistance and consultation. The range of diseases addressed and sites of team response will undoubtedly expand as parks identify new threats to wildlife resources. ■

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Colorado River basin drought

By Bill Jackson, Ph.D., and Greg Eckert, Ph.D.

THE MOST SEVERE DROUGHT ON RECORD, and possibly the most severe drought in the past 500 years, has persisted since 1999 in the intermountain West. Nowhere is the expression of drought in the Colorado River basin more dramatic than at Glen Canyon and Lake Mead National Recreation Areas. Lake Powell and Lake Mead have lost approximately half their storage, and reservoir surfaces have dropped more than 100 vertical feet (30 m). In 2004, Lake Mead was at its lowest level in 40 years. Although drought helps define ecosystem structure and function and favors the survival of certain species over others—much as hurricanes, floods, and wildfire do—it presents special challenges to National Park System managers. This is particularly true when park hydrology has been modified or habitat has been lost or degraded. The Colorado River basin drought offers perspectives on both the ecological influences of drought and related challenges for park managers.

Ironically, river regulation on the Colorado and Green Rivers has effectively denied the influence of natural drought on those systems because water deliveries downstream are maintained at unnaturally high levels by depleting reservoir storage. Raising the minimum flow during periods of drought may actually work against the survival of the river's native fish. For example, cold water that supports nonnative trout is thought to be related to decline of the endangered humpback chub (*Gila cypha*) in the Colorado River in Grand Canyon. (See the related article on page 52 for a discussion of conservation of native fish species in the upper Colorado River basin.) Conversely, the largely undammed tributaries to the Colorado River have experienced periods of extremely low flow during the current drought. Flows in the Yampa River in Dinosaur National Monument, for example, dropped as low as 3 cubic feet per second (0.08 m^3/s) in July 2002, compared with the mean monthly July flow of 1,549 cubic feet per second (44 m^3/s). Natural drought would possibly favor native species that are adapted to these conditions over their introduced competitors. Natural drought may also contribute to a decline in native species, especially where these species are already impaired because of compromised habitat and competition with nonnative species.

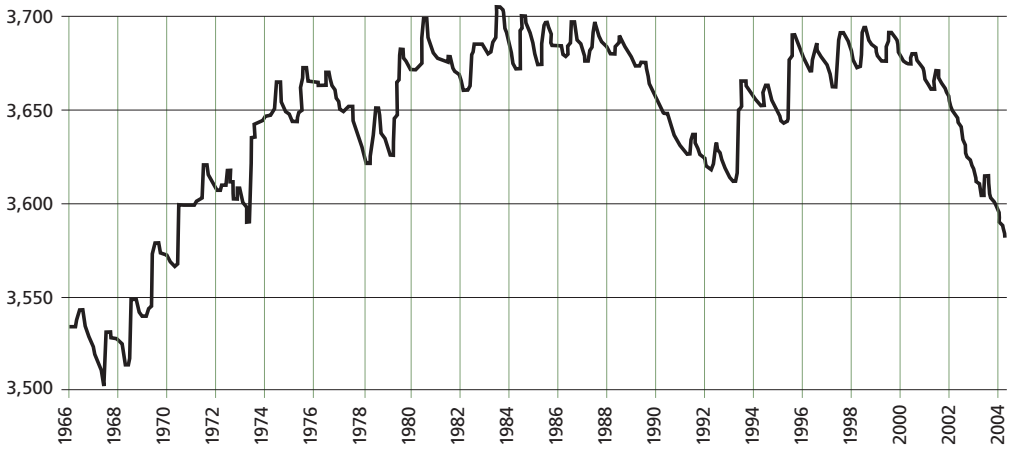
Springs in arid systems like the Colorado River basin are keystone habitats affected by drought. Springs and hanging gardens support a high level of biodiversity and many endemic and rare species. Animals that rely on spring-generated water or plants found only in hanging gardens may be stressed during periods of drought. Reduced spring flow during drought is a natural ecological process; however, the implications of drought-induced stress for species that are dependent on springs may be greater than under natural conditions; many springs in the region are already in decline because of groundwater pumping or overuse by introduced species or domestic livestock.

Though some ecosystems such as cold-desert shrub and spruce-

White sandstone cliffs reveal the high-water mark of Lake Powell, more than 100 feet above the lake's elevation at the end of 2004. The "bathtub ring" is symbolic of a severe drought that has park managers in the Colorado River basin contemplating the implications of the dry period on park resources.

LAKE POWELL WATER SURFACE ELEVATIONS, 1966 TO 2004

The graph shows a series of fluctuations in the level of Lake Powell, Glen Canyon National Recreation Area. In 1983, approximately 20 years after construction of the Glen Canyon Dam, the lake filled. In 2004, its levels were the lowest since the initial filling period in the early 1970s.



fir forest were primed for infrequent, climate-driven, stand-replacing fires that characterize their fire regime, other forest and woodland systems that historically experienced frequent but low-severity fires were not prepared for drought conditions. Because of past management practices that excluded fire, these woodland systems were already vulnerable to unnaturally high-severity wildfire. Drought further increased the risk of these systems to high-severity fire and reduced the effectiveness of recent treatments to decrease fuel buildup in slowing some fires.

Another drought-related phenomenon is the massive dieback of pine trees as a result of the spread of piñon Ips beetle (*Ips confusus*). Numerous trees became established and existing trees grew larger during the 20-year wet period leading up to the present drought. This resulted in more biomass than could be supported during average climatic conditions. In the mid-1990s when the climate plunged into a severe drought and higher temperatures favored insect populations, trees were left more vulnerable to moisture stress and insect attack than they would have been had the previous two decades brought lower, more normal amounts of precipitation.

Both aquatic and terrestrial species' responses to drought must be viewed in the context of long-term success of populations, in addition to the more obvious short-term responses of individuals—that many individuals are now dying from drought. Mobile animals will fare better than plants or species with limited range or ability to disperse. Rare species may have insufficient numbers of drought-resistant individuals to regenerate populations once suitable conditions return.

How should the National Park Service respond to drought? Policies incorporate natural processes such as drought as part of the systems and resources being managed. Yet barriers to recovery now present themselves as causes for providing active assistance to resources during and after a drought. These barriers include effects of fire exclusion, urban expansion, river regulation and water development, and alien species. Increased understanding of the historical range of variability of resources will help managers understand system dynamics and the need for intervention. Park managers must carefully describe what manipulations will be required to achieve desired future conditions of park resources, including maintenance and recovery of unique resources that are the key to diversity across the vast Colorado River basin. They must also identify the range and condition of critical habitats, such as springs and hanging gardens, and develop landscape-scale plans for preservation until research and resource monitoring clearly indicate that detrimental human-induced changes can be rectified to sustain these resources during times of drought. ■

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Monitoring climate change in central Alaska

By Pamela Sousanes

RECORDS SHOW THAT ALASKA WARMED SUBSTANTIALLY over the 20th century, particularly over the past few decades (Overpeck et al. 1997). Since the 1950s, average warming has been 4°F (2°C) across the state. The greatest warming, about 7°F (4°C), has occurred in the state's interior in winter (Chapman and Walsh 1993; Weller et al. 1998). The growing season has lengthened by more than 14 days since the 1950s (Keyser et al. 2000). In 2004, Denali National Park and Preserve headquarters recorded the warmest mean monthly temperatures for May, June, and August based on an 80-year National Weather Service record. How will a continued increase in temperature affect subarctic park ecosystems? Melting permafrost, increased fire activity, receding glaciers, treeline migration, wildlife migration pattern changes, and ozone depletion are all realized effects of climate change in interior Alaska.

The Central Alaska Network is part of the NPS Inventory and Monitoring Program, funded through the Natural Resource Challenge. The primary goal is to build a holistic picture of network ecosystem conditions by detecting change in a variety of ecological components and in the relationships among those components. The three park units of the Central Alaska Network—Denali National Park and Preserve, Wrangell–St. Elias National Park and Preserve, and Yukon-Charley Rivers National Preserve—cover 21.7 million acres (8.8 million ha) and encompass 12 of the 32 distinct ecosystems in Alaska (Nowacki et al. 2002). Elevations range from sea level to 20,320 feet (6,194 m). Latitudes span from 55 degrees north to more than 65 degrees north. Climate in this vast area is extremely variable, ranging from strongly maritime to strongly continental, with large differences in temperature and precipitation. These climate gradients are intrinsic to the ecosystem patterns and ecological communities found in Central Alaska Network parks.

One of the most important outcomes of the winter climate of the subarctic is the creation of snow cover. This variable snow cover protects and insulates the ground and low-lying plants, reduces desiccation, and maintains ground temperatures that are generally higher than air temperatures. Accordingly, climate and snow pack have been identified by the Central Alaska Network as important vital signs (MacCluskie and Oakley 2003).

Melting permafrost, increased fire activity, receding glaciers, treeline migration, wildlife migration pattern changes, and ozone depletion are all realized effects of climate change in interior Alaska.

One of the main objectives of the Central Alaska Network is to monitor and record weather conditions at representative locations in order to identify long- and short-term trends, provide reliable climate data to researchers, and participate in larger-scale climate monitoring and modeling efforts. In an attempt to better understand climate variations, new long-term climate monitoring stations are being installed throughout the three parks. Building upon the Long-term Ecological Monitoring Program initiated at Denali in 1992, compatible research-grade climate monitoring equipment was tested. In 2003–2004 more than 30 sites were visited at the three parks to obtain specific information on the suitability of each site for climate monitoring. A panel of climate experts from the National Weather Service, the Natural Resources Conservation Service, and the Western Regional Climate Center was solicited to review a detailed, technical site evaluation completed in the winter of 2004. Through

Staff of the Central Alaska Network tested 10 climate stations at Denali National Park and Preserve headquarters in 2004 as part of a coordinated program of resource monitoring to understand trends in climate change in the park. Testing allowed resource managers to identify and correct inherent bugs in programming, instrumentation, and power systems before installing the systems in remote park locations.

This weather station was installed in Wrangell–St. Elias National Park and Preserve in 2004 at an elevation of 4,554 feet (1,389 m) above sea level. The location was prioritized as a high-elevation site in the park following a comprehensive evaluation of more than 50 locations in three national parks monitored by the Central Alaska Network.

this review, the National Park Service formed partnerships with each of these agencies, culminating in interagency agreements and Cooperative Ecosystem Studies Unit agreements that will offer longevity for the program by providing a means for data archiving and general support and technical assistance from regional climatologists. The design development phase initiated in 2004 included the placement of stations at remote locations. The near-real-time data generated by these stations will be used in unlimited ways to incorporate local climate variations with individual research projects and other network monitoring components, and to inform visitors and park managers about current conditions. ■

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Landscape dynamics in the Northeast Temperate Network: Thirty years of change

By W. Gregory Shriver, Gregory Bonynge, and Y. Q. Wang

ONE OF THE MOST PROFOUND EFFECTS of humans on the landscape is alteration of habitats critical to plants and animals. As people construct roads and build houses, they convert once-continuous habitats into areas of non-habitat and fragment large areas of habitat into patches that are too small to support native species. In the Northeast, most ecosystems have experienced loss and fragmentation of habitat, and these changes are a principal threat to native biodiversity. National parks are limited in size and many species require critical seasonal habitat that exists or genetic interchange that occurs outside park boundaries. Changes in land use near a park can influence actions to manage invasive species or maintain water quality. Therefore, park managers need information about changes to the landscape both inside and outside parks to effectively conserve a park's native flora and fauna.

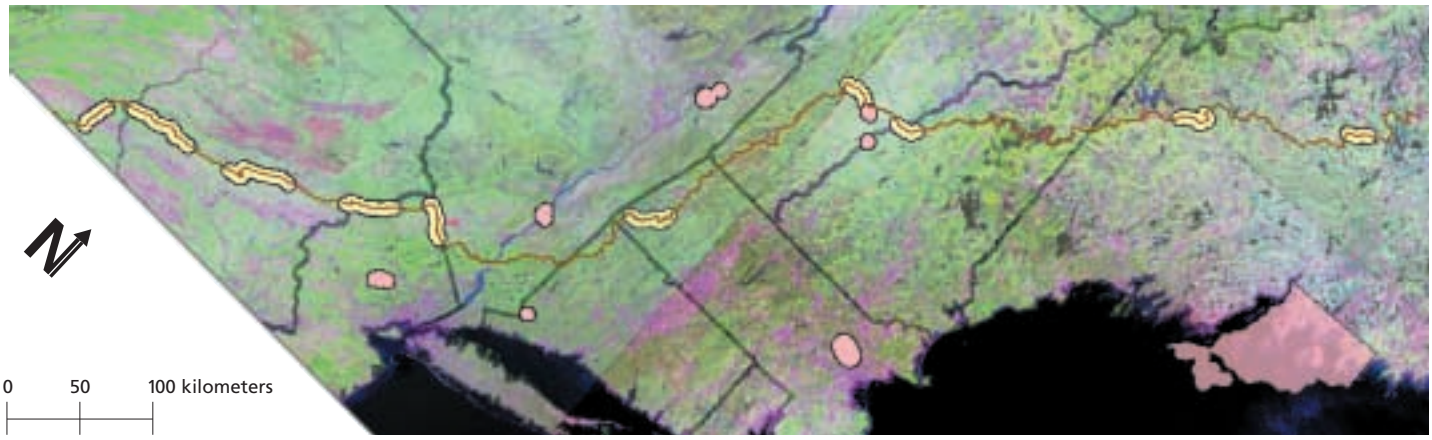
The Northeast Temperate Network (NETN) monitors the condition of resources in 10 national park units in seven northeastern states. Because the network cannot monitor all resources, a subset of information-rich "vital signs" is selected that includes physical, chemical, and biological elements, and indicates the overall condition of park natural resources. Many networks in the I&M Program have identified landscape dynamics as a high-priority vital sign because change adjacent to parks can alter water quality and flow regimes, increase invasive plant and animal introductions, reduce contiguous forest, and influence ambient sounds and clear night skies, among other impacts. For example, feral cats, which prey on native birds, amphibians, and small mammals, are now common in many northeastern parks. To address such issues, the network initiated a project in 2003 using remote sensing data to determine the present land cover and estimate land-cover changes since the early 1970s.

The first step in developing a land-cover change monitoring program is to characterize the existing landscape within and around each park and, if possible, determine how the extent of ecosystems has changed over time. Many types of remote sensing data could be used to determine changes in land cover and provide a consistent, repeatable sampling methodology to monitor change. Project investigators selected the Landsat series of satellite data because it provides a 30-year history from the early 1970s with nearly continuous coverage to the present time. Eight park units and 10 Appalachian National Scenic Trail segments are included in the project, effectively creating a retrospective assessment of land-cover change at 18 sites in the Northeast (see map).

Landscape … change adjacent to parks can alter water quality and flow regimes, increase invasive plant and animal introductions, reduce contiguous forest, and influence ambient sounds and clear night skies, among other impacts.

The land-cover change assessment at each site includes within-park changes and changes within a 3-mile (5-km) buffer around each park. For example, preliminary results for Minute Man National

LAND-COVER STUDY AREAS IN THE NORTHEAST TEMPERATE NETWORK



The Northeast Temperate Network (NETN) has undertaken a project to determine current land cover and estimate its changes since 1970. The project will study areas adjacent to eight units monitored by the NETN (shown in pink) and 10 sites along the Appalachian National Scenic Trail (shown in yellow), where the project will be coordinated with five local monitoring networks. Information from this project will have broad applicability, not just to the National Park Service but also to local land planners.

Historical Park in Concord, Massachusetts, indicate that within a 3-mile (5-km) radius of the park, urban land cover has increased 50% since 1978, while wetland and forest cover have declined by 68% and 8%, respectively. Analysis within these buffer zones provides information for resource managers to quantify land-cover changes adjacent to the parks over the past 30 years and can help in setting priorities for monitoring and restoration. Knowing that old field habitat in the landscape around the park has been converted to residential development increases the importance of these habitats in the park and gives park managers the information they need to make management decisions.

In August 2003 and June 2004, the University of Rhode Island (URI) team undertaking the project visited each of the 18 study sites to meet with NPS and Appalachian Trail Conference (ATC) natural resource managers and volunteers. During these meetings the team reviewed the satellite images and learned about the unique characteristics of each study site. In partnership with these NPS and ATC representatives, the URI team acquired an extensive library of more than 2,800 geo-referenced digital photographs. These photographs permit cross-checking the land-cover data with the Landsat scenes and offer a reference that could be used for the long-term monitoring of land-cover change around the parks.

A final step in this project will provide a "gap analysis," which will assess the extent of land-cover types on conservation lands (lands that cannot be developed) around each park and trail segment. The analysis will determine whether, for example, any ecosystems are missing or rare, and thus how well these areas adjacent to parks protect priority ecological systems. Information from this project will therefore be applicable to a wide audience, including park personnel, ATC volunteers, other networks, and local land planners. ■

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National Park Service joins the U.S. Animal Health Association

By Glenn Plumb, Ph.D., and Margaret Wild, DVM, Ph.D.

The National Park Service recently gained agency membership in and a seat on the board of directors of the United States Animal Health Association (USAHA). The USAHA is a science-based, nonprofit, voluntary organization that has served as the nation's animal health forum for more than a century. Its mission is to protect animal and public health by facilitating communication about and coordination of animal disease management and eradication, serving as a clearinghouse for new information and methods for policy and program development, and finding solutions for animal health issues. Although the organization has traditionally focused on livestock interests, the increase in livestock-wildlife disease interaction has recently spurred the inclusion of wildlife health interests as well. Since the National Park Service joined the association in 2003, the USGS National Wildlife Health Center and U.S. Fish and Wildlife Service have also become members.

Department of the Interior involvement has already led to important cooperative efforts. The USAHA president recently appointed a special committee on brucellosis in the greater Yellowstone area. Its purpose is to plan a symposium that will bring together key individuals from multiple federal, state, academic, and private sectors in 2005 to formulate a strategic plan to enhance brucellosis vaccines, vaccine delivery, and surveillance diagnostics for bison and elk in the greater Yellowstone area. The plan will describe the framework and level of agency support required to develop and test safe and effective bison and elk vaccines and methods for their delivery and to improve live-animal diagnostic capabilities in distinguishing infected animals from those only exposed to the disease. Membership in USAHA is expected to render additional similar opportunities to develop new partnerships that address important animal health issues throughout the National Park System. ■

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Ecosystem restoration in an altered coastal environment

By Courtney Schupp

OVERWASH IS A NATURAL AND NECESSARY COMPONENT of barrier island dynamics at Assateague Island National Seashore in Maryland and Virginia. Over long time scales, overwash processes will enable the island to respond to sea-level rise. On shorter, multiyear time scales, overwash processes deposit sand and cause landform changes, both of which are needed to maintain a healthy ecosystem for coastal plant and animal species. However, the Ocean City Inlet jetty, which was built in 1934 and periodically has been extended, has caused deficiencies in sediment supplies by blocking southward sand transport. When major storms in 1998 threatened to breach the island, the U.S. Army Corps of Engineers constructed a berm at the north end of the island to reduce the immediate breaching threat, and park managers developed a long-term plan to mitigate jetty-induced changes. The Corps of Engineers modeled the berm to be low enough to allow overwash processes but high enough to reduce the risk of island breaching.

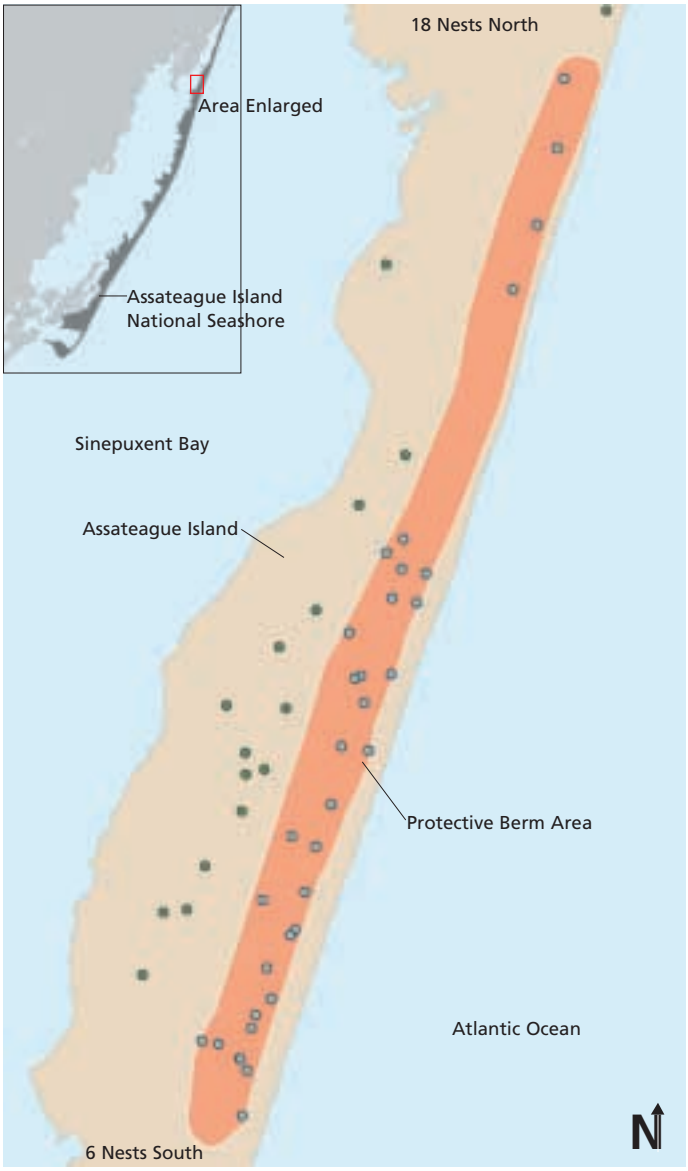
Ultimately, however, models did not accurately predict the geomorphic and ecologic responses, and engineers developed the berm to such a height that it is impenetrable to both breaching and overwash. Furthermore, topographic surveys show that the berm is expanding seaward. The lack of overwash has reduced the number of mid-island depressions, which are a preferred foraging area for the piping plover (*Charadrius melodus*), a threatened migratory bird. As a result, the birds must find the majority of their food in the less productive intertidal areas along the bay and beach, an activity further complicated by an increase in vegetation along the lee side of the constructed berm. The section of the island that includes the constructed berm comprises only 28% of the undeveloped north end; however, it has disproportionately experienced 40% of the reduction in sparsely vegetated habitat. The increase in vegetation has impeded the plovers' access to the beach and bay, leading to fierce competition over the remaining access paths and sometimes resulting in starvation. In addition, a berm-induced decrease in overwash wrack and shell beds has forced plovers to change their nesting behavior, which typically shows a preference for coarse sand and pebbles that offer

Assateague Island … and the U.S. Army Corps of Engineers are working together to address the unintended consequences of the berm to island ecology, and ultimately to restore natural ecologic and geomorphic processes to the ecosystem.

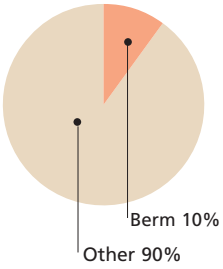
A berm constructed to reduce the potential for island breaching has prevented natural overwash processes and has reduced habitat availability for piping plover. The overwash (foreground) is funneling toward the bay through a low area at the southern tip of the berm. Modification of the berm to allow some overwash during storms will stimulate habitat and ecosystem restoration.

Shell beds deposited by overwash offer camouflage for piping plover nests.

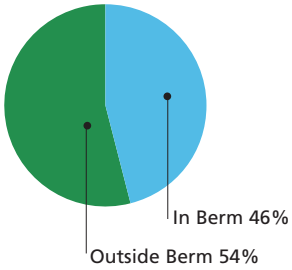
PIPING PLOVER NESTS IN RELATION TO PROTECTIVE BERM, 2004



Piping Plover Habitat



Piping Plover Nest Locations (2004)



Piping plovers have changed their nesting behavior in response to the constructed berm. The small berm area holds a disproportionately high percentage of the nests on the north end of the island because it offers camouflage for eggs, but it also fosters vegetation growth that reduces access to feeding areas and leads to competition and starvation.

camouflage for their eggs. Although the berm represents only 10% of the plover habitat available on the north end, it hosted 46% of the nests; the elevated concentration of birds in an area with reduced feeding access further increases competition and starvation.

Assateague Island National Seashore and the U.S. Army Corps of Engineers are working together to address the unintended consequences of the berm to island ecology, and ultimately to restore natural ecologic and geomorphic processes to the ecosystem. In January 2005, park staff will modify the berm by creating notches to allow occasional overwash into the island's interior. These lowered sections, which will comprise 10% of the berm's 1.2-mile (2-km) length, will simulate the average elevation of the natural storm berm, as measured in areas with reduced jetty impacts. Managers expect that during severe storm events, when overwash occurs in other sections of the island, overwash also will be able to penetrate the constructed berm through the lower notches. In order to analyze topographic changes, determine the success of the modifications, and advance scientific understanding of overwash processes, staff will survey the notched areas periodically and in the event of overwash penetration.

Integration of monitoring data with resource management activities triggered a reevaluation of the engineering models used to plan the construction of a protective berm, engendered a stronger interagency partnership, improved testing of models, and inspired modification of the berm structure. The partnership between the National Park Service and the Corps of Engineers will continue in order to manage park resources successfully and advance predictive modeling capabilities through the integration of science, engineering, and island observation and monitoring. ■

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Report has important implications for NPS management of ocean park resources

By Cliff McCreedy

ON 20 SEPTEMBER 2004 another government commission produced a voluminous report, but instead of disappearing into a file, the U.S. Commission on Ocean Policy's (U.S. COP) final report, *An Ocean Blueprint for the 21st Century*, splashed onto the front pages of newspapers around the country. The headlines read "Troubled Waters" (*St. Petersburg Times*) and "Panel Presses New Ocean Safeguards" (*Los Angeles Times*). The message of the commission was ominous and clear: "Pollution, depletion of fish and other living marine resources, habitat destruction and degradation, and the introduction of invasive nonnative species are just some of the ways that people harm the oceans, with serious consequences for the entire planet."

Mandated by the Oceans Act of 2000, the commission was appointed by President Bush and the Congress to review our nation's ocean stewardship. The first such review in more than 30 years, the U.S. COP report calls for basing ocean policy in a better scientific understanding of ecosystems, reforming fisheries management, doubling the nation's investment in ocean research, strengthening the National Oceanic and Atmospheric Administration (NOAA), and establishing regional ocean councils to coordinate among various levels of government and agencies.

The National Park System conserves a large portion of the nation's ocean and Great Lakes heritage, managing more than 3 million acres (1.2 million ha) of marine waters and 5,000 miles (8,045 km) of coast, including coral reefs, kelp forests, barrier islands, wetlands, and historic shipwrecks. Several of the report's recommendations have important implications for NPS management of threats to ocean park resources. With this in mind, the author served on several working groups coordinated by the White House Council on Environmental Quality (CEQ) to develop the Bush administration's response to the report.

On 20 December President Bush signed an executive order establishing an interagency oceans committee, and the CEQ released the U.S. Ocean Action Plan, the Bush administration's initial response to the U.S. COP report recommendations. The action plan adopts a new ocean resource management and protection strategy developed by the National Park Service and highlights its importance in meeting the goals of the commission report. In development since 2002, the NPS Ocean Park Stewardship Strategy identifies 28 action items under four major themes to protect and restore ocean park resources. The Park Service will formally launch the strategy in 2005, and a task force of park superintendents and NPS staff, led by Chief Ocean Scientist Gary Davis, will work to implement it.

The ocean commission's emphasis on the value of interagency coordination is a position shared by the National Park Service, which currently coordinates many of its management activities with NOAA, the U.S. Geological Survey (USGS), and university partners, and seeks to increase these programs. Recognizing that national parks and national marine sanctuaries are united by their proximity and resource management concerns, the Park Service and NOAA's National Marine Sanctuary Program signed a general agreement in 2000 to foster collaboration. To strengthen these partnerships, the Park Service proposed a "Seamless Network of Ocean Parks, National Wildlife Refuges, and Marine Sanctuaries" initiative. The CEQ also included this proposal in the U.S. Ocean Action Plan, adding the NOAA National Estuarine Research Reserves system. The Park Service, NOAA, the U.S. Geological Survey, the U.S. Fish and Wildlife Service, and university partners will develop national and site-level partnerships on research, habitat mapping, monitoring, education, enforcement, and evaluation of significant threats, including pollution, overfishing, and invasive species.

Congress has held hearings on the report and will consider its legislative and budget recommendations in 2005. *An Ocean Blueprint for the 21st Century* is a call to the National Park Service and the nation to enhance the scientific and organizational capacity to conserve our oceans. As the report suggests, much work lies ahead for the Park Service and its partners to conserve ocean resources, and the guidance of the U.S. COP report will inform many of these efforts. ■

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Poor land management practices and urban development can increase land erosion, leading to large sediment plumes (above) in coastal waters, just one of many types of ocean resource stewardship concerns in national parks. If sufficient sediment settles on nearshore coral reefs, it will smother individual corals (below, left), destroying the foundation of an ecosystem with species diversity comparable to tropical rainforests. National Park Service biological technician Ian Lundgren (below, right) collects sampling equipment at War in the Pacific National Historical Park, Guam, where natural resources staff is measuring sedimentation rates to assess impacts on the park's coral reefs and to monitor the effectiveness of erosion mitigation projects.

Cape Hatteras National Seashore develops beach nourishment guidance

By Julia Brunner and Rebecca Beavers

Rising sea level and hurricanes continually reshape the Outer Banks of North Carolina, including Cape Hatteras National Seashore, causing high rates of erosion. One approach for forestalling damage to infrastructure is to nourish beaches, a process that involves dredging sand and placing it on beaches to temporarily mitigate physical forces that cause erosion, wave damage, and flooding. National Park Service policy generally discourages beach nourishment (except in specific circumstances) because interference with natural geologic processes often causes unforeseen and detrimental impacts to coastal ecosystems.

Interference with natural geologic processes often causes unforeseen and detrimental impacts to coastal ecosystems.

For years, Cape Hatteras National Seashore—along with other locations on the Outer Banks—has been the site of repeated efforts to protect state and private infrastructure, including prevention or removal of overwash, construction of berms, and filling of breaches. Such actions may accelerate narrowing of the Outer Banks and their eventual disappearance. By contrast, natural processes such as overwash, inlet formation and movement, and shoreline migration preserve a barrier island's elevation above the rising sea. Because of ongoing human interference with natural processes, the Outer Banks' interiors are lower relative to rising sea level. Roanoke and Pamlico Sound marshes are eroding at an average rate of 2 feet per year (0.7 m/yr), and Atlantic Ocean beach erosion exceeds 7 feet per year (2 m/yr). If sea level continues to rise at its current rate and present storm patterns continue, the sediment-poor segments of the Outer Banks will "collapse," or drown in place, within a few decades.

To give park managers comprehensive information to evaluate beach nourishment proposals, a multidisciplinary team of planners, geologists, policy and regulatory specialists, and attorneys from the park, NPS Southeast Region, Regional Solicitor's Office, and Washington Office met at Cape Hatteras in early 2004. Throughout the year, the team developed a set of guidelines for park managers, other agencies, and the public to use in discussions and evaluations of beach nourishment projects. The draft guidance, still under review, describes the importance of natural barrier island processes, why the National Park Service generally discourages interference with these processes, and the formal procedure that park managers would use when considering requests for beach nourishment, pending the park's development of a comprehensive shoreline management plan.

Using the draft guidance document and ultimately the shoreline management plan, park managers can inform the public—including 2.5 million annual visitors to Cape Hatteras—and agencies that beach nourishment is not a substitute for natural barrier island processes. With increased recognition that beach nourishment has environmental and other consequences, this outreach effort may help preserve and protect dynamic barrier island processes along the Outer Banks. ■

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The owners of threatened homes and businesses in the seven oceanfront villages situated at Cape Hatteras National Seashore (left) may request beach nourishment to buffer their property from the ocean's erosive forces. Beach nourishment often involves dredging sand offshore, pumping it to the shore in a pipeline, and shaping the sand into a beach with bulldozers and other heavy equipment (below). Nourished beaches usually require periodic maintenance (renourishment). Cumulative, long-term impacts to offshore sand-mining areas and plant and animal communities on artificial beaches have not been well documented.

Sea-level rise impacts coastal parks

By Rebecca Beavers

Sea-level rise is an aspect of climate change that has profound implications for some coastal parks. In areas where beaches and wetlands migrate inland to survive elevated sea levels and increased storm surges, land managers must consider protection or retreat strategies for vulnerable coastal resources. For example, impacts from Hurricane Ivan in September 2004 on sections of Gulf Islands National Seashore in Florida illustrate how storms dramatically change coastal areas and overwash low-lying barrier islands. The destruction of most paved roads in the park near the Gulf of Mexico, particularly areas of Santa Rosa Island that breached from the gulf to the sound side, demonstrates how areas most vulnerable to sea-level rise will likely be most heavily altered by storms. These changes can lead to impaired natural resource conditions, reduced recreational opportunities, and threats to cultural and historical resources and park infrastructure. The direct impacts of sea-level rise include loss of beaches and beach properties, loss of ecologically productive wetlands, and loss of barrier islands that help shield the mainland from the impacts of storm surge. Indirect impacts include decreased revenues from tourism, reduced property values, and increased costs for repairing infrastructure such as roads.

A multiyear cooperative project between the National Park Service and the U.S. Geological Survey (USGS) assessed the spatial distribution of specific risks from sea-level rise (e.g., erosion, shoreline retreat, and inundation) and produced park-specific vulnerability maps and GIS data layers. In 2004, the USGS developed the Coastal Vulnerability Index for shoreline units at seven national parks, including Gateway National Recreation Area in New York and New Jersey, three island parks in the Pacific Ocean, and three parks in California. Investigators used information on coastal geomorphology, shoreline erosion rates, sea-level rise rates, storm surge, wave height, tidal range, and regional coastal slope to develop the index. These maps provide a relative index of park areas most likely to change as a result of sea-level rise. For example, the maps show park managers where new infrastructure should not be located. The maps also indicate the most vulnerable areas where managers may need to develop and implement relocation or retreat strategies in order to protect existing natural and cultural resources.

The USGS published open file reports for Assateague Island, Cumberland Island, Padre Island, and Cape Hatteras National Seashores in 2004. These reports and accompanying GIS data provide quantitative tools for park managers to use in long-term resource management planning, park facilities planning such as relocating buildings and roads, and assessing long-term threats to resources. The project Web page can be viewed at http://woodshole.er.usgs.gov/project-pages/nps-cvi/.■

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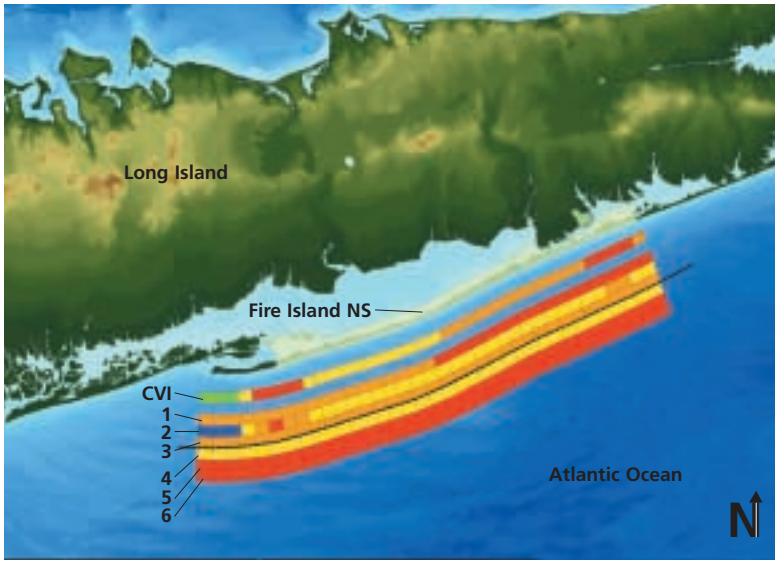
FIRE ISLAND NATIONAL SEASHORE RELATIVE COASTAL VULNERABILITY

Maps like this one of Fire Island National Seashore, New York, are products of the project and indicate relative coastal vulnerability, as shown by the colored bars. The inner color bar (CVI) is the overall coastal vulnerability index; the remaining bars (1–3) indicate the susceptibility of change to geologic processes and (4–6) physical process variables.

Vulnerability Ranking

Very High
High
Moderate
Low
Very Low



Photographic monitoring of glaciers in national parks

By Hal Pranger, Ron Karpilo, Bruce Molnia, and Hassan Basagic

INVESTIGATORS ARE PHOTOGRAPHICALLY CAPTURING glacier changes at Glacier Bay, Denali, Yosemite, and Sequoia and Kings Canyon National Parks. This joint project between the National Park Service and the U.S. Geological Survey demonstrates the value of using repeat photography to monitor glaciers. Investigators gathered more than 1,000 old photographs of glaciers and have located about 150 of the photo points in the field as of 2004. They photographed the glaciers from these photo points and compared the historical and modern images. Approximately 120 historical photographs in Glacier Bay, 25 in Denali, and 16 in Yosemite, Sequoia, and Kings Canyon have been repeated. Nearly all the glaciers in Denali, Yosemite, Sequoia, Kings Canyon, and Glacier Bay have been retreating rather dramatically in the past century. However, at least four glaciers at Glacier Bay have advanced or remained largely stable in the last half century, indicating that regional or even very local climatic changes related to the extremely high coastal Fairweather Mountains might be controlling the growth and decay of these particular glaciers.

The comparative photographs from Glacier Bay illustrate tremendous landscape, geomorphic, and floral changes. Investigators estimate that approximately 0.3 cubic mile (1.3 km^3) of sediment has filled the upper Carroll Inlet—that is, the area went from a several-hundred-foot-deep fjord to a glacial outwash plain high above sea level. Tremendous changes in vegetation accompanied this landscape shift, with vegetation encroaching immediately into the bare ground left by the retreating ice. Additionally, a complete transformation of upper Muir Inlet has occurred in the past 60 years, including the loss of about 0.6 mile (1 km) of ice thickness, several miles of ice length, and approximately 1.8 miles (3 km) of ice width since 1941. And since about 1750, approximately 600 cubic miles (2,500 km^3) of ice has melted from the whole of Glacier Bay.

An outcome of the monitoring has been public education and interpretation. Because investigators took photographs at a high resolution, they have been able to prepare large (10-foot- [3-m-] long) before-and-after panoramas for display in visitor centers. In addition, by using basic software technology, they have produced preliminary "pseudo-animated," retreating images of glaciers at Glacier Bay National Park, which are available at http://www2.nature.nps.gov/geology/GLBA/glaciers.htm. ■

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Stark changes in glacial mass are evident in Muir Glacier in the east arm of Glacier Bay. It has retreated approximately 12 miles (20 km) between 1941 (top left) and 2004 (top right), or approximately 28 miles (45 km) total since 1899.

Carroll Glacier in Queen Inlet in the west arm of Glacier Bay has thinned and stagnated since 1906. The most notable changes are the transition from a calving, tidewater glacier in open water (bottom left, 1906) to a grounded, debris-covered glacier (bottom right, 2004), and the transition from a 558-foot- (170-m-) deep fjord (left) to a glacial outwash plain that is well above sea level (right).

NPS**FACT**

Named glaciers occur in 18 parks in the National Park System, primarily in Alaska, with more than half of that state's 50,000 or more glaciers located in national parks. In the lower 48 states, glaciers occur in nine park units, with more than 95% of those found at North Cascades National Park (Washington).

Glacier mass peaked at the height of the Little Ice Age, from approximately 1750 to 1850. Since then, Glacier Bay National Park (Alaska) alone has lost more ice than any other place in North America—**approximately 600 cubic miles (2,500 cu km) in about 250 years, an amount that would cover the state 6 feet (1.8 m) deep.** Ecological effects of this tremendous loss of ice include the rapid invasion of plant species to newly exposed land and the transformation of the landscape from a glacier-filled valley to a fjord as ice melts, or from a fjord to a river as the fjord fills with sediments. Additionally, **this ice unloading at Glacier Bay is responsible for the world's fastest rate of vertical land rise**—approximately 11.5 feet (3.5 m) per century. Tectonic plates in the Earth's crust can shift more easily once relieved of the tremendous weight of the ice, potentially triggering earthquakes.

It is extraordinarily difficult to distinguish the normal (background) rate of glacial decay (and growth) over the past 250 years or more from rates over the past century, which might be accelerated and reflect large-scale climate change related to carbon dioxide and other greenhouse gas emissions in the atmosphere, or could simply be related to local or regional climate change.

award-winner

Jock Whitworth recognized for stewardship of beach habitat at Padre Island National Seashore

Protecting natural resources by working with partners, consulting experts, and cooperating with others but taking a stand when necessary is **Jock Whitworth**'s approach to working at any national park. Currently superintendent of Zion National Park, Utah, he was the recipient of the Director's Award for Superintendent of the Year for Natural Resource Stewardship for his work at Padre Island National Seashore, Texas.

One of the biggest challenges at Padre Island is managing marine debris (photo). Prevailing currents bring much of the trash that is dumped into the Gulf of Mexico right to the park's beaches, littering them with tons of plastic bottles, Styrofoam, Freon tanks, bags, and miscellaneous trash. More dangerous are the barrels and bottles of hazardous materials. Mitigating this enormous problem was a challenge for the superintendent. To start, Jock coordinated staff, volunteers, and citizens doing community service to pick up what they could, but hazardous materials required an expert removal team. Jock and his staff were able to get NPS base funding for the park to hire its own hazmat crew to do the job. For large heavy items, such as buoys the size of trucks that had washed ashore, the park partnered with a local conservation group to contract for the removal. However, the effort that will have the longest-lasting effect was the publication of a park report completed during Jock's tenure. This report detailed a study of the debris and a method of identifying its source. Report in hand, Jock met with the offshore oil and gas and fishing industries in an attempt to have them take responsibility for their dumping and start working out methods of retaining the trash and keeping it out of the Gulf of Mexico.

Another challenge at Padre Island is mitigating the threat to natural resources from commercial oil and gas drilling. Companies exploring for and developing natural gas wells at the national seashore must access private and state-owned mineral rights underlying the park. This requires large vehicles to travel all over park land; installation of drilling equipment can mean removing small sections of dunes and other surface features. Fortunately, laws protect park land where mining and drilling occur. To comply with those laws, the park, the NPS Intermountain Region, and the Natural Resource Program Center, under Jock's leadership, developed a system for evaluating drilling proposals and then established a series of mitigating measures that raised the bar for protecting the environment. Working with the park, these companies are not only cooperating but in some cases committing themselves to even higher standards than the park requires. Their activities certainly impact the park, but they are limited to impacts that can and must be mitigated.

The most important nesting beach in the United States for the endangered Kemp's ridley sea turtle is on Padre Island. When Jock came to the national seashore in 1998, he found an internationally recognized Kemp's ridley recovery program led by USGS field station leader Donna Shaver, who was formerly Padre Island National Seashore's sea turtle biologist. However, there was little base funding for the program, with most of the work being funded by grants and donations. As nesting at the park increased, in part because of an international experiment to build up the Kemp's ridley population, Jock initiated reviews of the program, resulting in successful negotiations with the U.S. Geological Survey to return the program and some of the funding to the National Park Service. Though Kemp's ridleys are still critically endangered and face many threats, nesting continues to increase, but in a safer habitat, thanks at least in part to Jock's leadership in protecting Padre Island. ■

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2 Controlling Invasive Species

"We are living in a period … when the mingling of thousands of kinds of organisms from different parts of the world is setting up terrific dislocations in nature."

—Charles Elton, 1958

The economic and ecologic impact of invasive (exotic) species—plants, animals, and microbes that have not evolved in concert with an area's native species—is a global problem. By some estimates, these species, which include tamarisk, Asiatic bittersweet, kudzu, West Nile virus, feral pigs and goats, hemlock woolly adelgid, zebra mussels, and Africanized bees, cost the U.S. economy $138 billion annually. In the case of national parks, exotic species are recognized as one of the most serious threats to the integrity of park natural systems, including rare native plants and animals, and are implicated in the decline of approximately 40% of the species listed as threatened and endangered under the Endangered Species Act. Today, exotic plants infest some 2.6 million acres (1.1 million ha) of national park lands, while 234 parks contain invasive animal species in need of management. Controlling exotic species is an urgent priority for the National Park Service, and the articles in this chapter describe some of the ways parks across the nation responded to this challenge in 2004, particularly invasive plants. These articles show that NPS Exotic Plant Management Teams and the creation of extensive partnerships among federal and state agencies, universities, and local citizen groups have emerged as hallmarks of successful control efforts. Protecting the parks from harmful exotic species is a daunting challenge, but certainly an essential part of sustaining our natural heritage and meeting the mission of the National Park Service.

Disposable pets, unwanted giants: Pythons in Everglades National Park

By Ray W. "Skip" Snow and Lori Oberhofer

HUGH WILLOUGHBY, A GENTLEMAN EXPLORER of the late 1890s, referred to the mainland along the southern coast of Everglades National Park as the "Land of the Big Snake." Willoughby, in his telling of an 1896 canoe journey across the Everglades, noted two different Indian accounts "of snakes that were at least 18 feet in length, and evidently belonged to the constrictor family."

Reports of "big snakes" in Everglades National Park a century later include regular and increasing sightings of Burmese pythons and occasional, infrequent sightings of ball pythons, reticulated pythons, and common boas. Unretouched photographs depicting alligator vs. python appeared in the 25 February 2003 issue of the *National Examiner* under the headline banner, "Mighty beasts grapple for *24 hours* as shocked Florida tourists watch!" (The alligator eventually released the snake, although whether it survived or not is unknown.) Remarkably, in February 2004, this event was repeated at a different location in the park. Unlike the rare and infrequent circus animal escapees during Willoughby's time, pythons in the wild today are the result of unwanted and intentionally released exotic pets.

As Burmese pythons are known to eat birds, the proximity of python sightings to the Paurotis Pond wood stork rookery is troubling.

The Burmese python (*Python molurus bivittatus*) can reach a length greater than 20 feet, making it a big snake indeed. The nonnative python's diet in the Everglades includes gray squirrel, opossum, cotton rat, black rat, house wren, pied-billed grebe, and white ibis. Raccoons and other small mammals such as the native mangrove fox squirrel, a species of special concern, could also provide a suitable food base for pythons in the park. As Burmese pythons are known to eat birds, the proximity of python sightings to the Paurotis Pond wood stork rookery is troubling.

Observations of pythons have occurred primarily in three locations in the park: the saline glades and mangroves between Flamingo and Paurotis Pond, the greater Long Pine Key area, and the greater Shark Valley area along the Tamiami Trail. Pythons have also been observed on the eastern park boundary, along canal levees, in the remote mangrove backcountry, and in Big Cypress National Preserve to the northwest. Since December 2003, more than 50 Burmese pythons have been captured and removed or found dead on roads in and adjacent to the park. Individuals 10–12 feet (3.0–3.7 m) in length have been seen with increasing regularity in the park.

In recent years, multiple observations of individuals of different size classes support the probable establishment of breeding populations of the Burmese python in Everglades National Park. Snakes recovered ranged in length from 2 to 14 feet, including five hatchling-sized animals recovered in the summer of 2004.

Burmese pythons are widely bred in Florida and are still imported from Southeast Asia as pets. Proposed management actions must include strategies for preventing their intentional release. Actions currently undertaken by the park's wildlife unit include: (1) preparing and distributing an "exotic snake alert" flyer and prevention materials based on a "Don't Let It Loose" media campaign to encourage responsible ownership and proper disposal of unwanted exotic pets; (2) summarizing information on all observations and specimens of pythons from the park; (3) researching available information on life history, behavior, home range, and food habits, as observed in their native habitat; and (4) investigating methods of capture, restraint, and disposal, including the use of snake-detecting dogs. The park is also participating on the Florida Invasive Animal Task Team, an interagency effort to stem the tide of nonnative animals. ■

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The intentional release of unwanted exotic Burmese pythons into the wild over the last 20 years is responsible for an increasing population of breeding pythons in Everglades National Park today.

The Burmese python can reach lengths greater than 20 feet (6.1 m). Their diet includes birds and mammals. The national park is concerned that the wood stork, a federally listed endangered species, and mangrove fox squirrel, a state-listed threatened species, could be consumed.

Partnering for plant control at Arches National Park

By Linda Drees

SEVENTY WEED WARRIORS FROM NATIONAL PARKS around the United States descended on Arches National Park, Utah, 9–14 March 2004, to take action against invasive plants and accumulated fire fuels that threaten natural resources. Deputy Superintendent Phil Brueck notes that "the Tamarisk invasion in western parks is affecting many of the very resources for which the parks were originally set aside. [Views] are being obscured, portions of streams and rivers are becoming inaccessible to hikers and boaters, and some flora and fauna, including endangered species, are being threatened from this exotic encroachment." To combat the problem, 14 Exotic Plant Management Teams (EPMTs) worked to rid Courthouse Wash of tamarisk (salt cedar, *Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*).

Exotic Plant Management Teams are modeled after wildland fire-fighting strike teams and consist of highly trained plant management specialists who assist parks in controlling exotic plant species. Sixteen teams have been established across the National Park System, each serving national parks in a distinct geographic area.

Given the magnitude of the project and the participation of numerous crews from across the country, Arches initiated the National Park Service's use of the incident command system for an invasive plant management deployment. Before the first teams arrived, staff from the park, Lake Mead EPMT, and other experts developed an incident action plan to organize the project. The plan included a series of objectives for maintaining a safe work environment, controlling tamarisk and Russian olive, chain saw operation training, and international outreach. The teams met or exceeded all objectives.

The National Park Service's recent success in controlling invasive plants has created strong interest in the strike team model of the EPMTs. The deployment at Arches provided an opportunity for

(Above) Exotic plant management specialists strike out toward beleaguered Courthouse Wash, an area in Arches National Park infested with invasive tamarisk and Russian olive. The weeklong deployment in March 2004 was the first to bring together several Exotic Plant Management Teams and NPS partners for a joint training and work exercise, and succeeded in controlling more than 100 acres (41 ha) of the targeted invasive plant species (right).

information sharing with resource managers from other countries, federal and local agencies, and academia. Miguel Mendoza, operations coordinator for Santa Elena Canyon Flora and Fauna Protected Areas of the National Commission of National Protected Areas of Mexico, worked with the teams all week to exchange best management practices for controlling tamarisk. Jeff King, with the U.S. Fish and Wildlife Service Region 6, viewed the teams' operation in anticipation of interagency inventory and control efforts in Arizona and Montana. Dr. Steve Dewey, the first academician to suggest applying the fire model to invasive plant control, spent several days witnessing the teams' use of the model in the field as he had envisioned. Dr. Ron Hiebert and several graduate students of the Colorado Plateau Cooperative Ecosystem Studies Unit field-tested the new restoration ranking tool to help park managers make decisions on restoration priorities. Montana State University students filmed the entire event, and the film will be available for public viewing next year.

The National Park Service is the first land management agency to apply the fire model to fight invasive plants. This innovative approach, initially used at Lake Mead National Recreation Area (Nevada and Arizona), led to the establishment of 16 teams of specialists in invasive plant identification and control. At Arches National Park, the project approach proved a rousing success. Natural recovery of willows and cottonwoods is expected. The teams doubled the size of the planned treatment, resulting in the removal of tamarisk and Russian olive from 108 acres (44 ha) in just seven days. As one team member stated, "this is extreme weed work." Regardless of weather, scope of the problem, species, and location, EPMT members remain undaunted in their daily commitment to stopping invasive weeds to preserve our natural heritage. ■

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NPS**FACT**
Since 2003 the NPS Exotic Plant Management Teams have attracted and spent more than $4 million and directed the equivalent of **more than two years of work by volunteers** to begin controlling the more than 2.6 million acres (1.1 million ha) in the National Park System that are infested with invasive plant species.

Can we beat the weeds? An exotic plant project at Catoctin Mountain Park

By James W. Voigt

Park Ranger Becky Loncosky surveys exotic plants at Catoctin Mountain Park and is surrounded by mile-a-minute (*Polygonum perfoliatum*), an invasive species on the park's top-15 list of control priorities. Though its distribution in the park is more limited than Japanese barberry (*Berberis thunbergii*), another high-priority plant, mile-a-minute dominates sites where it takes hold.

Exotic plant control can be like putting out fires; you deal with the hottest problem at the time. The resource management staff at Catoctin Mountain Park (Maryland) has battled exotic plants for 10 years. Some control efforts appear to be working, but several species continue to expand. Until this year, the park has lacked an understanding of the extent of this problem and an effective strategy for dealing with it.

In 2003–2004 the park conducted an exotic plant evaluation project, funded by a Natural Resource Preservation Program block grant. After compiling the existing records for previous survey and control work, park staff conducted a comprehensive survey to identify the 15 most invasive species. The survey covered 22 miles (35 km) of the park boundary, 8.5 miles (13.7 km) of roads, and 22 miles (35 km) of the park monitoring grid. They used GPS to record the presence and relative density of the targeted species within 33 feet (10 m) of each survey transect and then created a map for each species using GIS.

Studying the mapped data, investigators discovered that the exotic plant invasion at Catoctin Mountain Park is more intense and widespread than previously thought. The control strategy will focus on wetland and riparian areas, where most of the threatened and endangered species are located, in addition to two cultural landscapes. Park staff and the Youth Conservation Corps will deal with small areas and annual maintenance. The regional Exotic Plant Management Team will treat the high-density infestations. Getting rid of all the aliens is practically impossible, but the park's goal, with a concerted effort, is to ensure visitors are never unable to see the forest for the weeds. ■

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Park celebrates the removal of last tamarisk

By Fran Pannebaker and Karl Zimmermann

AFTER 10 YEARS OF HARD WORK, the National Park Service and volunteers have completely eliminated all standing tamarisk (*Tamarix ramosissima*) from Bent's Old Fort National Historic Site in southeastern Colorado. On 4 June 2004, they celebrated this feat by ceremoniously cutting the last remaining tamarisk, which symbolized more than 350 acres (142 ha) of tamarisk being removed from the 800-acre (324-ha) national historic site.

By the late 1980s, tamarisk was visibly outcompeting the park's native riparian vegetation and negatively impacting the historical scene. Moreover, the plant's thick growth habit created a fire hazard for the cottonwood-willow plant community. When resource managers at Bent's Old Fort began assessing the extent of the infestation, they contracted the Colorado Natural Heritage Program to prepare a vegetation map of the historic site using infrared aerial photography and GIS technology. The park subsequently developed a management plan, which laid out goals, priorities, and strategies. They received funding from the Small Park Block Grants of the Natural Resource Preservation Program, Exotic Plant Management Teams (EPMTs) of the Natural Resource Challenge, and the Department of the Interior's Cooperative Conservation Initiative.

Resource Manager Karl Zimmermann cuts the last standing tamarisk at Bent's Old Fort National Historic Site, Colorado, in June 2004. Ten years in the works, the project involved many partners: the Chihuahuan Desert–Southern Shortgrass Prairie EPMT and EPMTs from Lake Meredith and Lake Mead National Recreation Areas, neighboring ranchers, the Colorado Department of Corrections, Comanche National Grasslands, the Natural Resources Conservation Service, the Colorado State Forest Service, and the Colorado Division of Wildlife. In addition, the Alpine Interagency Hotshot crew based at Rocky Mountain National Park; the fire suppression and fuels management personnel, also from Rocky; staff from Florissant Fossil Beds National Monument; Intermountain Region fire staffs; employees from the USDA Forest Service; and several local fire departments contributed to the effort.

Controlling tamarisk required cutting the trees to within 6 inches (15 cm) of the ground and applying herbicide to the stumps. Most of the work was done using chain saws and herbicide in backpack sprayers. Some of the trees were cut with a Bobcat-mounted tree shear; however, in order to minimize impacts to the Arkansas River floodplain, which bisects the park, this was the largest equipment used. After sawing, the limbs were piled and the slash was burned. Because of the small number of park employees, many partners were needed for this operation. Restoration and partnership development greatly contributed to the project's success.

When park neighbors saw the changes in the riparian plant community … they began to ask questions and take action on their own land.

In 2000 the Chihuahuan Desert–Southern Shortgrass Prairie EPMT was formed. The team began to assist the park in 2001 and continues to help control tamarisk resprouting, as well as infestations of other invasive species: whitetop (*Cardaria draba*), Canada thistle (*Cirsium arvense*), and Russian knapweed (*Acroptilon repens*). Monitoring and follow-up control efforts have been incorporated into the park's routine exotic plant management program. The park has been able to maintain control of tamarisk regrowth despite two major floods and a major wildfire. Monitoring has indicated 90% control after the first treatment.

Currently the park is working with its neighbors and other agencies to encourage the organization of additional tamarisk control projects on other stretches of the Arkansas River. When park neighbors saw the changes in the riparian plant community at Bent's Old Fort and realized the value of those changes for their own properties, they began to ask questions and take action on their own land. The Colorado Forest Service and Division of Wildlife are working together on state-owned land along the Arkansas River in the vicinity of the national historic site. Efforts to organize control projects are proceeding on the main stem of the Arkansas River and on several of the major tributaries. The Nature Conservancy, Tamarisk Coalition,

USDA Forest Service, Department of Defense, Natural Resources Conservation Service, U.S. Army Corps of Engineers, and the State of Colorado are all working to control tamarisk in the watershed.

Nationally the efforts at Bent's Old Fort National Historic Site represent a growing trend toward managing invasive species, especially tamarisk, which is found from Pacific Coast states to the Midwest and from Canada to Mexico. Because of this wide distribution, land managers at different levels of government are now forming partnerships to enhance program effectiveness for tamarisk control in western watersheds. ■

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Removal of mouflon sheep from Amistad National Recreation Area

By Rick Slade

In 2004, Amistad National Recreation Area (Texas) began to remove more than 2,000 nonnative mouflon sheep (*Ovis musimon*) from a large tract of the park designated for recreational hunting of whitetail deer (*Odocoileus virginianus*) and other native species. In cooperation with neighboring landowners and a group of wild-game trappers, park staff began the livetrapping operation in May 2004 and had successfully removed more than 1,300 sheep by the end of June, when increasing summer temperatures brought activities to a temporary halt. The benefits of this effort are already evident in the rejuvenation of the shrubs, forbs, and grasses that provide shelter and nutrition to a variety of native wildlife.

Mouflon sheep were first documented in the park in the mid-1970s when a single breeding pair entered the park from a neighboring ranch. The population steadily increased over the next 20 years, reaching more than 400 individuals by the mid-1990s. In recent years, population growth accelerated, creating a number of critical resource management issues. Because mouflon travel in large herds (photo), their grazing and browsing effects are concentrated and particularly stressful to the area's thin soils and limited vegetation. In documenting the impacts of the sheep, the park's resource management staff determined that the sheep were outcompeting whitetail deer for food, leading to a gradual reduction in the area's deer population.

Public consultation, including a well-attended public meeting to explore management alternatives, was an important part of the process. There was unanimous agreement that the sheep should be removed to protect park resources, and that livetrapping of the animals was the preferred option. Park staff engaged adjacent landowners and residents of a nearby housing development as partners, which has proved critical to the operation's success. Access to adjacent properties has allowed the trappers to pursue all of the sheep, not just those found within park boundaries.

The trapping has been accomplished using net guns fired from a helicopter (photo), which has minimized landscape impacts but increased noise in the area. Without the full support and understanding of nearby residents, conflicts over noise would have been inevitable. After trapping, the sheep are transferred to a private ranch near San Antonio where most are sold to out-of-state ranches to ensure they do not return to the park. Park personnel monitor the area for sign of the sheep's recurrence. As work resumed in the fall, all parties remained united in the goal of eradicating the sheep and allowing the recovery of a natural landscape. ■

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Native plant restoration designed to avoid wildlife-traffic conflicts

By Kathy Penrod

Asiatic bittersweet (*Celastrus orbiculatus*) has invaded an old highway corridor through a developed area of the Allegheny Portage Railroad National Historic Site (Pennsylvania). With funds from the National Park Service's Cooperative Conservation Initiative and the help of volunteers (from Senior Rangers to Girl Scouts), the bittersweet and other exotics are being removed and the area restored with native grasses and wildflowers.

The plants had grown wild from former home sites within the park, running rampant and forming dense thickets wherever they found full sun. The threat to natural resources in the park was clear: the bittersweet was overtopping and killing trees.

The bittersweet was sprayed with herbicide in early June 2004, killing 60% of it. A second spraying was completed in September. Meanwhile, 228 volunteers pulled out other exotics over five project days. Literally thousands of garlic mustard (*Alliaria petiolata*) and teasel plants (*Dipsacus sylvestris*) were removed in 2003 and 2004 to prevent their seed from invading the restoration site. In spring 2005 the site will be planted with native grasses and wildflowers.

Asiatic bittersweet overtopped trees along the highway corridor through the park (above). Herbicide treatment in June 2004 reduced the infestation by about 60%.

Though it is improving native habitat for birds, the restoration is designed so that it does not attract deer and other large mammals because of vehicular traffic that is directly adjacent to the site. Rather than switchgrass (*Panicum virgatum*) and Indian grass (*Sorghastrum nutans*), which would provide tall cover for animals, short grasses such as little bluestem (*Andropogon scoparius*), purple top (*Tridens flavus*), deer tongue (*Panicum clandestinum*), and broomsedge (*Andropogon virginicus*) are being used. Wildflower species that are not too tall were also chosen, including Pennsylvania ecotypes of asters, beardtongues (*Penstemon*), goldenrods (*Solidago*), and sunflowers (*Helianthus*). ■

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Manual control of the problem plant can be accomplished by park staff or volunteers. The best results are achieved by grabbing individual stems with both hands close to the soil surface and pulling straight up.

Manual control of Canada thistle: A reasonable alternative for controlling small infestations in sensitive areas

By Marie M. Curtin

PARK STAFF AT WIND CAVE NATIONAL PARK (South Dakota) achieves good results controlling Canada thistle (*Cirsium arvense*) using a simple, old-fashioned method: weed pulling. Manual control was selected over other management alternatives in order to protect diverse native plant communities and the watershed that houses dozens of the park's cave and karst features, including Wind Cave, an extensive maze of more than 112 miles (180 km) of subsurface passages. Manual control is one component of the park's Integrated Pest Management Program, which seeks to control Canada thistle using methods that do not conflict with management goals for the park's natural resources.

Canada thistle, native to Eurasia, arrived in this country during the 1800s. Most of the diseases and parasitic insects that harm Canada thistle are absent from North America. As a result, the invasive plant competes aggressively with native vegetation and can reduce native plant species extent and diversity, and habitat available for wildlife.

The environmental advantages of manual control are also compelling. Weed pulling introduces no exotic biological control agents (insects or pathogens) into the ecosystem.

Pulling Canada thistle by hand is hard work, but well worth the effort because it preserves native plants that might be harmed by chemicals or other control methods. Weed pulling also protects sensitive cave resources, another key management priority. Chemicals most effective against Canada thistle are capable of easy movement through soil and root systems and into groundwater and caves. Cave ecosystems are relatively closed systems that do not recover quickly from changes to their environments. Chemicals applied within the watershed have the potential to leach into Wind Cave, which could impact cave flora and fauna and water resources used for human consumption.

Many infestations of Canada thistle consist of only one plant, but it is a plant with an extensive root system that acts as the support structure for many aboveground stems, flowers, and seed heads. The goal of weed pulling is to starve the root system. When the entire plant is pulled, removing as much root as possible, the plant draws from root reserves to create new stems and leaves capable of conducting photosynthesis. Repeat pulling exhausts the root system, basically starving the plant to death.

The most intensive weed pulling efforts are directed against infestations occurring in riparian areas, drainages, and otherwise pristine areas throughout the park. To reduce potential for seed dispersal by humans, sites along roads and trails are also a priority. Remaining infestations are kept in check with biological and mechanical control methods. These sites are eventually designated for manual control, replacing sites that no longer require treatment. Park personnel monitor treated sites annually for plants that regrow and new plants that germinate from seed.

During the 2004 field season, dozens of small infestations in sensitive areas were pulled or repulled by park staff. At some locations this was a continuation of weed-pulling efforts initiated in previous years. Each return visit required less time and energy. The sites experienced dramatic reductions in overall size, stem density, or both. At several locations, Canada thistle could not be located upon return visits.

Exotic vegetation poses a significant threat to diverse native plant communities at Wind Cave National Park, where measures to control the invasive plant species must consider potential harm to cave resources that lie beneath the landscape.

Manual control has many advantages. Equipment is minimal, consisting essentially of heavy-duty leather gloves. Weather is seldom a problem, although a breeze makes the work more pleasant and rain-moistened soil releases roots better than dry soil. No training or licensing is needed to pull weeds, allowing volunteers and park staff alike to participate. The environmental advantages of manual control are also compelling. Weed pulling introduces no exotic biological control agents (insects or pathogens) into the ecosystem. And, as opposed to many biological and chemical control methods, manual control is specific to the targeted species. It does not affect native plant species, except to free them from competition with exotic weeds, preserving native species diversity.

In the absence of Canada thistle, future visitors to Wind Cave National Park will discover diverse plant communities of native grasses, sedges, rushes, wildflowers, shrubs, and trees. ■

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The Middle Niobrara Weed Awareness Group: A collaborative approach to exotic plant management

By Carmen Thomson

THE NIOBRARA NATIONAL SCENIC RIVER (Nebraska) is an unusual park unit in that it does not own any land in fee title but is responsible for management of approximately 23,000 acres (9,315 ha). Exotic plant management has been a long-standing concern. Purple loosestrife (*Lythrum salicaria*), which overruns wetlands, is the main invading species, but leafy spurge (*Euphorbia esula*) and Canada thistle (*Cirsium arvense*) are also becoming problems. The park, however, has limited financial resources and personnel to implement an exotic plant management program. The unit does receive some assistance from the Northern Great Plains Exotic Plant Management Team, but in order to implement a successful exotic plant management program on a predominantly private landscape, the National Park Service works with partners.

In the past, park resource staff and other natural resource agencies conducted exotic plant management activities within the unit's boundaries, but there was a lack of standardization or coordination in these efforts. To remedy this problem, in 2002 the various agencies formed the Middle Niobrara Weed Awareness Group (MNWAG) to coordinate efforts, share expertise, and develop realistic project goals agreeable to all agencies involved. The group comprises 13 partners from state, federal, and private organizations, including the U.S. Fish and Wildlife Service, National Park Service, U.S. Geological Survey, Niobrara Council, The Nature Conservancy, Nebraska Department of Agriculture, North Central Nebraska Resource Conservation and Development, Nebraska Board of Education Lands and Funds, Rock County Weed Control, Cherry County Weed Control, Keya Paha County Weed Control, Brown County Weed Control, and private landowners.

The Niobrara National Scenic River … does not own any land in fee title but is responsible for management of approximately 23,000 acres [of predominantly private land].

Since its inception, MNWAG has made significant strides in exotic plant management. A major accomplishment in 2004 was defining a cooperative weed management area. This area encompasses the entire 76-mile-long (122-km) scenic river, and extends 1 mile (1.6 km) north and south of its banks. Plans include increasing the weed management area to the far western and eastern boundaries of both Cherry and Rock Counties in 2005.

An invasive species that overruns wetlands, purple loosestrife is a major concern of managers at Niobrara National Scenic River in Nebraska. By forming a partnership group to coordinate weed control efforts and planning and to share expertise, the National Park Service has recently completed a weed management plan for the park.

For this area, a Site Weed Management Plan has been completed. This plan includes GIS maps of specific management zones, landownership layers, and management treatments for each zone (e.g., biological control release sites, chemical application sites). A database has been created to record species present at each site, treatment type, size of treatment area, and digital photographs.

A major accomplishment in 2004 was defining a cooperative weed management area … [that] encompasses the entire 76-mile-long … scenic river, and extends 1 mile … north and south of its banks.

The efforts of MNWAG are receiving official recognition. It has been designated the seventh national pilot project for the USGS Early Detection and Rapid Response System for Invasive Plants. Furthermore, it was awarded a Pulling Together Initiative grant for $57,750 by the National Fish and Wildlife Foundation. With this grant the group was able to implement a cooperative cost-share program with private landowners within the scenic river corridor to control invasive plants through the application of chemical or biological control agents. Additionally, the group hired a contractor in August to produce aerial maps of infested areas that were difficult to reach by foot or all-terrain vehicle. These mapped areas will be treated in 2005.

Finally, a public meeting was held in December to update landowners and other NPS partners on MNWAG's achievements for 2004. This was a highly successful event because the National Park Service and MNWAG heard both positive feedback and suggestions for continued improvement of the program.

Without the willingness of private landowners and the various resource agencies involved, adequate exotic plant management at Niobrara National Scenic River might not be possible. The commitment and resources of these partners continue to make the scenic river a beautiful place that will be preserved forever for the enjoyment of future generations. ■

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Clonal tunicate invades Tomales Bay, California

By Ben Becker

A group of international experts in tunicate biology and taxonomy recently discovered the invasion of a clonal tunicate (*Didemnum lahillei*) in Tomales Bay, California. During a rapid biodiversity inventory in 2003, the scientists noted the presence of this soft, pink, spongy species—commonly called a "sea squirt"—and alerted staff at Point Reyes National Seashore. The tunicate has invaded many other estuaries, often overrunning both disturbed areas and native species with its matlike growth. An indication of the potential problem facing Tomales Bay is the recent discovery of *D. lahillei* in the famous Grand Banks fishing grounds off Massachusetts, where the species now covers 6 square miles (16 km^2) of seafloor. Investigators at Point Reyes are currently mapping the distribution of the species in Tomales Bay and have begun a small-scale experimental removal program with a local high school. The students are carefully removing the species by hand from

several test sites on both a monthly and a bimonthly basis to determine the optimum frequency of removal required for the most efficient control.

This clonal tunicate is native to the estuaries of Europe, and like most invasive marine species, was likely transported as a "hitchhiker" growing on the hull or in the ballast water of a ship, or possibly in a shipment of juvenile oysters from another estuary. In Tomales Bay the tunicate overgrows and chokes out native barnacles, sponges, and bryozoans (a plant-like marine animal) and has the potential to severely limit the amount of inter- and subtidal rocky habitat available to these native encrusting organisms. Tomales Bay also has a thriving oyster industry that relies on metal and wooden racks to grow the oysters. *Didemnum lahillei* could overrun these racks as it has in other estuaries, leading to costly losses for local harvesters. Because the clonal nature of the species ensures that even microscopic remnants regrow after removal, large-scale removals in other estuaries around the world have been unsuccessful. Nevertheless, park staff at Point Reyes hopes that periodic removals will keep the species at a low enough level that it does not become a significant threat to the ecosystem. ■

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3 Preserving Threatened and Endangered Species

"A civilization able to envision God and to embark on the colonization of space will surely find the way to save the integrity of this planet and the magnificent life it harbors."

—Edward O. Wilson

The national parks are treasure houses of our rich natural heritage. Every year, wonderful new discoveries of organisms not previously known to science add to already sizable species lists and increase the value of these sanctuaries as places to study, reflect upon, and interpret the diversity of life. Yet among this richness is a small minority of species that are at risk. Threatened and endangered species are plants and animals that require special attention, and in 2004 the National Park Service took action to help secure their future in the national parks. The evolving success stories reported in this chapter include a record number of Kemp's ridley sea turtles at Padre Island National Seashore, restoration of freshwater mussels at Big South Fork National River and Recreation Area, local expansion of sensitive joint vetch at Colonial National Historical Park, the recovery of piping plovers at Great Lakes parks, and a thriving wolf population in Yellowstone that is having effects throughout that ecosystem. Some of the successes are simply the result of research and reintroduction. In most instances, however, threatened and endangered species require constant attention because of particular challenges: habitat fragmentation, competition with invasive species, poaching, limited genetic diversity, and disease. As demonstrated by many of the articles, actions to recover these species in national parks are increasingly being taken with partners, including federal agencies, state governments, and private landowners.

Endangered species in national parks

By Peter A. Dratch

MORE POPULATIONS OF THREATENED AND ENDANGERED species in the national parks made progress toward recovery in 2004 than ever before (see table 1). The varied management activities that led to this success have become more complex and now include not only species and habitat restoration, but also sociological studies of visitor attitudes and new agreements with a variety of state and federal agencies.

Improving the management of federally listed species depends foremost on identifying where these species occur. Over the last five years the number of populations of listed species that parks have recognized as presently or historically occurring within their boundaries has more than doubled, from 442 to 1,042 (see table 2). The next challenge for parks and the Endangered Species Program is to work closely with the NPS Inventory and Monitoring program to assess the status of those species' populations where it is still unknown.

Wolves from the Yellowstone population are now established in Grand Teton National Park (Wyoming) and surrounding lands. A sociological study of attitudes toward wolves was recently completed in the park. Conducted under an agreement with Colorado State University, this human-dimensions research identified a difference in attitudes toward lethal control of wolves among visitors to the park and residents of the area. As the population requirements for delisting the wolf in the northern Rocky Mountains have been met, and as some management responsibilities for wolves are likely to be transferred from the federal government to the states, a memorandum of understanding between the NPS Intermountain Region and the State of Wyoming has been signed to facilitate sharing information on wolves.

While parks provide habitat for a diverse range of protected species, plants make up the largest group (table 3) and are increasing as the focus of restoration efforts. Along these lines, the endangered Mauna Loa silversword at Hawaii Volcanoes National Park has made momentous progress in 2004. Research on the plant's habitat needs has helped increase the survival rate of transplanted individuals to more than 83% for the 9,400 seedlings that had been transplanted by the end of 2004. According to park Chief of Resource Management Tim Tunison, resource managers at the park "find the best micro-sites, those with the deep soil," for transplanting the greenhouse-raised seedlings. The park also has acquired the Kahuku Ranch, site of one of the three remaining wild silversword populations. This native silversword remnant was saved when one of the ranch workers fenced the area to keep out introduced mouflon sheep. Tunison is excited about the Kahuku acquisition, remarking that the naturally occurring silversword population there is "a fantastic genetic resource." Its presence will enable park staff to genetically diversify greenhouse stock and attempt species restoration over a wider range of habitats.

TABLE 1

Population trends of federally listed, proposed, and candidate species in the National Park System for 2003 and 2004

Status Trend in National Parks	Number of Populations		Percentage of Populations	
	2003	2004	2003	2004
Not at risk	82	103	7.2	8.6
Stable	225	286	19.9	23.9
Increasing	93	88	8.2	7.3
Declining	101	91	8.9	7.6
Extirpated	204	206	18.0	17.4
Unknown	402	424	35.5	35.4

TABLE 2

Species and populations in the National Park System managed under provisions of the Endangered Species Act

Status	Number of Species	Number of Populations
Endangered	266	613
Threatened	111	460
Experimental	9	13
Proposed	4	6
Candidate	67	97
Total	466*	1,198*

**When different populations of a species have a different status category, they are counted twice under number of species and number of populations (e.g., green sea turtle is both threatened and endangered; gray wolf is both endangered and experimental).*

TABLE 3

Endangered, threatened, proposed, and candidate species in the National Park System by group

Group	Number of Species
Plants	243
Mammals	54
Birds	65
Reptiles	20
Amphibians	7
Fish	43
Invertebrates	65

TABLE 4

Federally listed, proposed, and candidate species in each region of the National Park System, and the park within each region with the most of those species

Region (Parks)	Number of Species
Alaska (Kenai Fjords National Park)	7
Intermountain (Capitol Reef National Park)	88
Midwest (Indiana Dunes National Seashore)	30
National Capital (C&O Canal National Historical Park, Prince William Forest Park, and Rock Creek Park)	8
Northeast (Gateway National Recreation Area)	27
Pacific West (Haleakala National Park)	245
Southeast (Everglades National Park)	120

Several federally listed bat populations are more secure as a result of habitat protection efforts during the year. At Buffalo National River (Arkansas), park staff posted sensors to monitor cave airflow to benefit three endangered bat species. In California, matching funds from the Cooperative Conservation Initiative paid for the installation of bat "gates" in abandoned-mine openings at Death Valley and Joshua Tree National Parks and Whiskeytown National Recreation Area. The new structures allow bats to continue to use the openings as habitat but keep people out (see article, page 66).

Every action in a park that could affect a federally listed species requires consultation with the U.S. Fish and Wildlife Service or the National Marine Fisheries Service, the regulatory agencies responsible for species recovery under the Endangered Species Act. Streamlining the consultation process without sacrificing its effectiveness in protecting species has been a government priority. Regulations passed in December 2003 proposed alternative consultation procedures, particularly for National Fire Plan projects. Data collected by the NPS Endangered Species Program from the fire management officers recorded 204 prescribed burns in national parks over the past two years that required consultation. However, an alternative consultation agreement was proposed to expedite this process for parks in which personnel have been trained to determine whether park actions to reduce fire fuels are unlikely to adversely affect federally listed species. A half-day course in proactive consultation is now available for parks that want to use the new streamlined process.

Endangered species are not evenly distributed across the National Park System (table 4), and the Pacific West Region, with so many listed species, has also been the region with some high-profile recovery efforts. One is this year's limited release of the captive-bred island fox back into its native habitat at Channel Islands National Park (California). In 2004 the island fox on three of the park islands was listed as endangered. Its sharp decline was caused by predation from golden eagles that had probably been drawn to the islands by feral pigs. In 1999 the park initiated a fox captive-breeding program, and the following year began to live-capture and relocate golden eagles and later to reintroduce the historical bird of prey on the islands, the bald eagle. Working with the U.S. Fish and Wildlife Service, The Nature Conservancy, the California Department of Fish and Game, and other species experts, the park has begun releasing foxes from the captive-breeding facilities on the islands, and is moving forward on feral pig removal from Santa Cruz Island. ■

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Orchids: Indicators of healthy ecosystems

By Bruce Rittenhouse

ORCHIDS, WITH AS MANY AS 35,000 SPECIES, comprise approximately one tenth of the world's flowering plants. Though their greatest diversity occurs in the tropics, they are found worldwide in a wide range of habitats, including arctic tundra. In the National Park System, orchids number approximately 200 species occurring in 145 units. These park sites range from Noatak National Preserve, north of the Arctic Circle, Alaska, with 1 orchid species, to Everglades National Park, Florida, which has the greatest number of species, 42. Ironically, Hawaii, though tropical, has only 3 native orchid species while Alaska has 29. National parks in the Appalachian Mountains and upper Midwest exhibit a high diversity of orchid species. Summer coralroot (*Corallorrhiza maculata*), known from 43 parks, occurs in the most national parks.

Orchids have adapted several biological strategies unique to the plant kingdom. For example, their seeds lack nutritive materials and cannot successfully germinate naturally without a fungal host. Following germination, orchid seedlings maintain contact with a fungus for successful establishment. This strategy allows them to persist in less than ideal habitats, such as tropical forest canopies and nutrient-poor soils.

Orchids can give managers information on whether an ecosystem is healthy and functioning. This is because many species … require stable habitat conditions and are sensitive to human-caused disturbances.

This group of plants has also evolved several intricate and deceptive pollination systems. For example, the pink lady's-slipper (*Cypripedium acaule*), which occurs in 32 national parks in eastern North America, is pollinated by the bumblebee. Lured into the flower by its color and scent, the bee becomes trapped and must first deposit pollen on the stigma before it can pick up more pollen, escape, and repeat the process in other flowers.

Some orchid species use the strategy of prolonged dormancy and do not produce any aboveground tissue for a year or more. The threatened small whorled pogonia (*Isotria medeoloides*) is able to remain dormant for two or more growing seasons. Reasons for this adaptation are not well understood but may be related to specific environmental conditions or previous reproduction success. This strategy allows orchids to survive periods of nonoptimal environmental conditions such as drought.

Four orchid species occurring in national parks are listed under the Endangered Species Act. Small whorled pogonia is known from Prince William Forest Park (Virginia) and Blue Ridge Parkway (Virginia and North Carolina). Hawaii bog orchid (*Platanthera holochila*) occurs at Haleakala National Park. Ute ladies'-tresses

Small whorled pogonia (*Isotria medeoloides*) is a federally listed threatened orchid species that occurs at Prince William Forest Park, Virginia, and Blue Ridge Parkway, Virginia and North Carolina. Its preservation in these parks depends in part on protecting the habitat that supports it and not disclosing its locations.

Round-leaf orchid (*Amerorchis rotundifolia*) occurs in the northeastern and upper midwestern states, including Voyageurs and Isle Royale National Parks. Like many orchids, this species experiences periods of prolonged dormancy to conserve resources in nonoptimal growing conditions.

Mountain lady's-slipper (*Cypripedium montanum*) inhabits the mountainous regions along the West Coast and northern Rocky Mountains, including Glacier and Yosemite National Parks. This species apparently responds favorably to prescribed fires.

(*Spiranthes diluvialis*) is known from Dinosaur National Monument (Colorado and Utah), Lake Roosevelt National Recreation Area (Washington), and historically Capitol Reef National Park (Utah). Western prairie fringed orchid (*Platanthera praeclara*) occurs at Pipestone National Monument (Minnesota).

The National Park Service is working under a cooperative agreement with the Center for Plant Conservation (CPC) to collect seeds for all federally listed plant species in national parks, including the four listed orchid species. Participating botanical gardens and arboretums are beginning to work with parks where listed plant species occur to collect seeds under sampling guidelines developed by botanists to ensure that a genetic representation of the species is gathered. These seeds will be stored at the National Center for Genetic Resources Preservation in Fort Collins, Colorado. The objective of this project is to store these seeds for potential reintroduction or augmentation of populations to help achieve future recovery goals. The project began in 2004 and will continue through 2006.

Dinosaur National Monument recently mapped the geomorphic resources along the Green River to determine the relationship between high water discharges from Flaming Gorge Dam and the distribution of the threatened Ute ladies'-tresses in the monument. Surveys indicate a strong correlation between the floodplain and the orchid's presence. Results from this project were used for an environmental impact statement to establish times and patterns for future discharges of dam water to protect endangered fish, which would also improve habitat for the orchid.

Though they are not the dominant vegetative component in most areas, orchids can give managers information on whether an ecosystem is healthy and functioning. This is because many species in North America require stable habitat conditions and are sensitive to human-caused disturbances. Conversely, certain natural disturbances such as fire may benefit some orchid species. Because of this sensitivity, orchids may be viewed as the "canary in the coal mine," that is, indicators of healthy, functioning ecosystems, and would be good candidates as ecological vital signs for resource monitoring. Their survival or death following a disturbance may indicate whether certain disturbances are within the range of natural conditions or require management intervention. ■

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Sensitive joint vetch rediscovered at Colonial National Historical Park

By Charles D. Rafkind and Betsie Blumberg

Jamestown Island, part of Colonial National Historical Park (Virginia), is the site of the first permanent English colony in North America. The 400th anniversary of the founding of Jamestown will be celebrated in 2007. Among other preparations for the anniversary, the park has initiated a series of natural resource inventories with different partners. The Virginia Division of Natural Heritage, under a cooperative agreement, resurveyed the area for rare, threatened, and endangered plants and animals to ensure that construction and renovation activities to be undertaken for the celebration on and around Jamestown Island will not impact these species.

The first find, actually a rediscovery, was of sensitive joint vetch (*Aeschynomene virginica*), an annual, bushy member of the Fabaceae (legume) family endemic to mid-Atlantic tidal wetlands (photo above). The plant was last observed in the park in 1938. In 2000, approximately 15 plants were found near the 1938 site. Sensitive joint vetch is rare throughout its range and is currently on the federal list of threatened species. The Virginia Natural Heritage program ranks the species as very rare and imperiled both statewide and globally.

As of 2004 the plant appears to be thriving. To protect sensitive joint vetch during construction activities for the Jamestown 2007 celebration, the park partnered with the Virginia Institute of Marine Science. The institute's Dr. James Perry and a summer intern observed more than 100 plants in June 2004 (photo right); by September they counted more than 200. The population expansion may be due to two seasons of unusually high rainfall, which reduced the salinity of the water. The park is considering experimenting with methods to enhance sensitive joint vetch habitat and to increase its chances to thrive and expand. Future research may include clearing away early-season vegetation that shades the late-blooming vetch, and planting its seed to expand the area where it grows. The park has also moved the path of a proposed boardwalk away from the vetch habitat, and it is being monitored to ensure that celebration activities do not harm this survivor. ■

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Big South Fork restores endangered mussels

By Steve Bakaletz and Dick Neves

THE RECOVERY OF FIVE FEDERALLY ENDANGERED mussel species in the Big South Fork of the Cumberland River in north-central Tennessee and southeastern Kentucky is being implemented through the propagation of juveniles. An environmental assessment for recovery of these mussel species was completed in fall 2003, endorsing augmentation and reintroduction of federally listed species as the preferred conservation action. The river is currently home to 26 mussel species, including the endangered Cumberland elktoe (*Alasmidonta atropurpurea*), Cumberland combshell (*Epioblasma brevidens*), Cumberland bean (*Villosa trabalis*), tan riffleshell (*Epioblasma f. walkeri*), and littlewing pearlymussel (*Pegias fabula*). Because of damming and other impacts, the Big South Fork remains the last stronghold for these species within the Cumberland River system, and is of national significance to the conservation of mussel resources in the United States.

Artificial propagation can dramatically increase the successful recruitment of juveniles into the populations.

A cadre of partners representing federal agencies and state natural resource departments teamed up with the Freshwater Mollusk Conservation Center at Virginia Tech to augment resident endangered mussel populations and to plan for the restoration of species now extirpated from the park. Historical collection records document 55 mussel species that once resided in the river, including 4 endangered species: clubshell (*Pleurobema clava*), cracking pearlymussel (*Hemistena lata*), dromedary pearlymussel (*Dromus dromas*), and orangefoot pimpleback (*Plethobasus cooperianus*). This conservation project is consistent with the 1973 Endangered Species Act, the goals of the 1916 National Park Service Organic Act, and the national recovery plans for each of these species.

A preliminary research and feasibility study in 2002–2003 provided essential information on host fish requirements for the parasitic larvae of these species, and allowed juveniles to be experimentally produced and cultured in recirculating culture systems at Virginia Tech, to monitor growth and survival of the early life history stage.

Although each female may contain between 1,000 and 100,000 larvae for release to the river and attachment to host fish, research results suggest that fewer than 1% of the larvae attach and transform to the juvenile stage under natural conditions. Hence, artificial propagation can dramatically increase the successful recruitment of juveniles into the populations. During this exploratory stage of the project, more than 42,000 juveniles of four of the endangered species were released to an extensive shoal area of the river, to augment natural reproduction at this site. The release of juveniles two weeks to

Freshwater mussel restoration at Big South Fork involves several partners (top) working to optimize laboratory propagation methods of endangered mussel species, followed by the release of juveniles in the park. In 2004, approximately 12,000 mussels, including the littlewing pearlymussel (bottom), were introduced to park waters.

six months of age bolstered recruitment of naturally produced juveniles in the river.

The laboratory propagation process begins with collection of egg-carrying females from the river. Larvae are removed without harm to the mussels and are induced to attach to the gills of suitable host fish. Female mussels are returned to the river unharmed, to reproduce in subsequent years. The infested host fish are held in tanks at controlled temperatures until the larvae transform from the parasitic larval stage to the free-living juvenile stage. These juveniles are then placed in water recirculating systems with a layer of fine sediment and daily additions of small unicellular algae as their main diet. Once juveniles achieve a size large enough to avoid being consumed by most invertebrate predators in their natal rivers, they are released to fend for themselves and grow to adulthood.

Approximately 12,000 juveniles were released to the river upon completion of the culture experiments.

In FY 2004, this restoration project focused on four of the five endangered species with previously identified host fish. Experiments conducted with juveniles of the Cumberland combshell and littlewing pearlymussel tested various culture conditions to improve their survival within the recirculating aquaculture systems. Survival success can differ greatly among broods, and the causes for this variability continue to be evaluated through the manipulation of culture conditions. During this period, approximately 12,000 juveniles were released to the river upon completion of the culture experiments. Plans for 2005 include additional host fish testing and the production and release of additional endangered juvenile mussels at sites selected by park personnel.

It will take several years to evaluate the success of this recovery project, but the documented success of such releases in other rivers provides confidence that endangered populations of resident species and perhaps extirpated species will one day thrive in this national park unit. ■

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The prickly price of threatened and endangered cacti

By Dave Worthington and Pete Fonken

POACHERS COLLECT THE THREATENED Winkler cactus (*Pediocactus winkleri*) and endangered Wright's fishhook cactus (*Sclerocactus wrightiae*) from park lands and sell them internationally over the Internet. These federally listed plants are small (about the size of a 50-cent piece) and in spring have attractive, colorful blooms, making them popular for planting in personal rock gardens. Web sites offer individual plants of these two species for $10 and packets of 10 seeds for about $2. These prices are high enough to make collection profitable but low enough to ensure continued demand.

Illegal collecting of these sensitive cactus species occurs in Capitol Reef National Park—Utah's second largest national park. Situated on the Colorado Plateau roughly halfway between Zion and Arches National Parks in south-central Utah, Capitol Reef is 70 miles (113 km) long and, though only 13 miles (21 km) across at its widest point, encompasses 378 square miles (979 km^2) of remote and rugged topography. In addition the park's perimeter measures nearly 200 miles (322 km), intersecting many backcountry roads and multiple entrances and making protection of sensitive resources challenging.

Through the Natural Resources Protection Fund, the NPS Biological Resource Management Division funded a three-year project at Capitol Reef to test surveillance products for detecting illegal collection of these cacti. Many parks use similar technology to protect resources, such as intrusion-detection systems in historical buildings and remote sensors to detect people entering an archaeological site. At Capitol Reef, however, staff faced an additional challenge: scattered, remote locations. Most off-the-shelf products are not appropriate for installation in isolated areas where response times are measured in hours or days. This situation required technology that could record events for later review, securely notify personnel when an event occurred, and remain unattended for long periods.

Winkler cactus (*Pediocactus winkleri*), a plant federally listed as threatened, is illegally collected from federal lands in and near Capitol Reef National Park in southern Utah.

Prices [for federally listed cacti] are high enough to make collection profitable but low enough to ensure continued demand.

Staff members of the Division of Resource Management and Science and the Division of Visitor and Resource Protection sought the assistance of personnel from three agencies as they developed surveillance techniques. Technicians and law enforcement personnel from the USDA Forest Service combined tried-and-true equipment with new technologies, including Web-based and satellite systems. A special agent with the National Park Service helped test and deploy equipment, and a U.S. Fish and Wildlife Service special agent ensured that the selected techniques would be legally valid under the Endangered Species Act of 1973 and Lacey Act Amendments of 1981, which are used to prosecute poaching.

In the second year of this project and the first year of field-testing equipment, park staff has learned that it is not possible to schedule too much time to test, place, and check equipment. That is, equipment can break, and resoldering a broken wire may require a two-hour trip. A long drive may result in the discovery that a suspected cactus poacher is really a rabbit or a cow. Nevertheless, park staff is excited by the potential that this cutting-edge technology possesses. Having figured out most of the quirks and system

Staff members at Capitol Reef National Park have spent countless hours installing, testing, checking, and repairing surveillance equipment in the field.

The open, sparsely vegetated habitat of the cacti makes installation of surveillance equipment challenging.

limitations and how to remotely differentiate between a thunderstorm and a passing vehicle, employees at Capitol Reef are optimistic that the systems deployed in the field will work effectively. In addition, because plants and animals cross administrative boundaries, park managers are developing a memorandum of understanding with the Bureau of Land Management and USDA Forest Service that will allow law enforcement personnel to work across boundaries to enforce resource laws. Staff at Capitol Reef believe that in cooperation with these other agencies, the techniques and lessons learned thus far will help lead to apprehension of plant poachers and be useful to other managers caring for threatened and endangered resources in remote areas.■

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Yellowstone sand verbena: A one-of-a-kind plant

By Jennifer Whipple

Yellowstone sand verbena (*Abronia ammophila*), an endemic species with a narrow distribution along the shoreline of Yellowstone Lake, is the rarest of Yellowstone plants. In 1990 only one known location for this species had been documented. In the summers of 1995, 1998, and 1999, however, surveyors found three new locations (and counted the total population of plants at about 8,000). With such a small isolated population of plants, two critical questions emerged during these surveys: What are the pollinators of Yellowstone sand verbena, and what is its reproductive strategy? Matching grants from Canon U.S.A., Inc., and the National Fish and Wildlife Foundation enabled park managers to contract Dr. Sedonia Sipes of Southern Illinois University–Carbondale to answer these questions. Dr. Sipes and graduate student Liz Saunders performed fieldwork in 2003 and 2004 and completed the final report in fall 2004.

This study indicates that *Abronia ammophila* exhibits a number of fortuitous traits that may assist in its persistence. First, *A. ammophila* is self-compatible (i.e., it employs self-pollination among its reproductive strategies). Second, it seems to suffer no significant inbreeding depression resulting from self-pollination and pollination by near-neighbors. It also seems to enjoy a long reproductive season with high reproductive output and low, but apparently adequate, numbers of potential pollinators, including noctuid and sphingid moths, and possibly butterflies and bumblebees.

Many questions remain about the life history of Yellowstone sand verbena, for example the average life span of the plant, its demographic trends, the relationships of this taxon with close relatives, and how much visitor disturbance (i.e., trampling) the plants can tolerate before being extirpated from an area. Nevertheless, the knowledge gained through this recent study is an excellent start for ensuring the survival of this one-of-a-kind plant.■

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Swimming upstream: Endangered fishes in the Colorado River struggle to survive

By Melissa Trammell

The National Park Service is a partner in the Upper Colorado River Endangered Fish Recovery Program, a multistakeholder effort to recover four endangered fishes while allowing water development to continue. Several park units in the NPS Intermountain Region are within the recovery program management area, including Dinosaur National Monument and Glen Canyon National Recreation Area. In 2004, NPS staff expanded efforts to control invasive fish within this area.

Home to four federally listed endangered fish species, the upper Colorado River basin is being managed cooperatively to reduce competition by nonnative fishes. Efforts to improve conditions for native fish in 2004 included removing nonnative species through electrofishing (above), moving nonnative game fish such as smallmouth bass to ponds and reservoirs and tagging them to study their ability to return to the river (below left), and documenting endangered species such as pikeminnow (below right).

"SWIMMING UPSTREAM" is a phrase used by the Upper Colorado River Endangered Fish Recovery Program to underscore the struggle that endangered fish endure to survive in the Colorado River, which is both overallocated and teeming with nonnative competitors. The National Park Service is a member of the recovery program, a multistakeholder partnership dedicated to recovering four endangered fishes while allowing water development in the Colorado River basin to continue. The program works to recover the Colorado pikeminnow (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), razorback sucker (*Xyrauchen texanus*), and bonytail (*Gila elegans*). As a program partner, the National Park Service greatly expanded efforts to control and manage invasive nonnative fish in the upper Colorado River basin in 2004.

In the upper river basin, more than 40 introduced species of fish compete with 12 native species, four of which are federally listed as endangered. Nonnative fish can be both predators (usually game fish) and competitors for food and habitat. The Yampa River, a tributary to the Green River in Dinosaur National Monument, was previously considered relatively pristine and unimpaired by water development and nonnative species. However, it suffered a severe blow in the early 1990s when a reservoir on a tributary stream was nearly emptied on

Where challenges facing park resources transcend park boundaries … partnerships are perhaps the only strategy for safeguarding the natural heritage found in our national parks.

an emergency basis, releasing nonnative northern pike (*Esox lucius*) and smallmouth bass (*Micropterus dolomieu*) into the river. The released invasive fish quickly established thriving populations in the river, and their numbers have exploded in recent years, helped by the current five-year drought. Both northern pike and smallmouth bass have expanded their range downstream into Dinosaur National Monument.

Concerns about the impacts of nonnative fish on the Colorado pikeminnow and humpback chub, the two endangered fish presently found in the Yampa River, led to expanded control efforts in and upriver from Dinosaur National Monument in 2004. Channel catfish (*Ictalurus punctatus*) and smallmouth bass were the main targets for removal in the monument. Experimental removal of catfish has been going on since 1998, and though these efforts have not resulted in reduced numbers of catfish, the average size of the fish has decreased as the larger adults are removed. This is desirable because smaller fish are less effective predators and produce fewer young. Control of smallmouth bass began in 2004 and resulted in the removal of approximately 20% of its population this year. Northern pike were removed upstream of the park in 2003 and 2004. The early 2004

results are encouraging and suggest that up to 50% of adult northern pike can be removed in a single year.

In 2004, expanded control efforts in and upriver from Dinosaur National Monument led local anglers to oppose removal activities because of a perceived loss of game fish and angling opportunities, including guided fishing trips. To address these concerns a cooperative solution was developed with the Colorado Division of Wildlife to live-capture game fish and move them into local ponds and reservoirs. This solution allows anglers to continue to enjoy fishing for the nonnative fish; however, confining these fish to ponds lessens the risk posed to endangered fish. The risk of translocated fish returning to the river and again becoming a problem for native fish will be assessed, and based upon the findings, this solution may have to be reevaluated in the future.

A final measure of successful removal would be an increase in native and endangered fish, which has not yet occurred.

The San Juan River Basin Recovery Implementation Program also has been removing channel catfish and other nonnative fish for several years in that river in and above Glen Canyon National Recreation Area. As in Dinosaur, no overall reduction in numbers has been seen, but there has been a shift toward smaller fish.

A final measure of successful removal would be an increase in native and endangered fish, which has not yet occurred. Where challenges facing park resources transcend park boundaries, as is the case for the native fish of the Colorado River, partnerships are perhaps the only strategy for safeguarding the natural heritage found in our national parks. With this in mind, the National Park Service and the recovery program are dedicated to working together to improve the opportunities for native and endangered fish to survive. ■

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NPS**FACT**
The bald eagle has made a magnificent recovery since the era when prevalent pesticides led to eggshell thinning and its listing as one of the first threatened species more than 30 years ago. Though this American symbol is still classified as threatened, the U.S. Fish and Wildlife Service is considering delisting the species. **Bald eagles are found in 125 national parks,** the greatest number of parks for the occurrence of any federally listed species.

Despite hurricanes, coastal national parks offer hope of survival for sea turtles

By Cliff McCreedy

At 29 sites within the National Park System, threatened or endangered nesting sea turtles find a rare haven on undeveloped beaches. National Park Service biologists, seasonal workers, and volunteers actively monitor and protect sea turtle nests, cooperate with local stranding networks, and conduct tagging programs to track nesting sea turtles. In 2004, however, turtle nesting numbers declined in many coastal national parks as a result of hurricanes.

The severe storms inflicted substantial damage to beach habitats at Gulf Islands National Seashore in Florida and Mississippi, flooding or washing away nests and reducing sea turtle reproduction rates. At Florida's Canaveral National Seashore, Resource Management Specialist John Stiner reported 2,508 sea turtle nests, the lowest total since 1988, including 2,281 loggerheads (*Caretta caretta*), 255 green sea turtles (*Chelonia mydas*), and 6 leatherbacks (*Dermochelys coriacea*). Although the first 1,000 nests produced hatchlings, more than half of the nests had not yet hatched when Hurricane Frances struck the national seashore in late August, and the handful that remained were destroyed by Hurricane Jeanne about a month later. Jeff Cordes, resource management specialist, said that Cape Lookout National Seashore in North Carolina also experienced the fewest number of nests since 1988, where a total of 74 loggerhead nests and 3 leatherback nests were found. Seven nests washed away during Hurricane Alex in early August and 30 other nests were flooded by Alex or other storms and failed to hatch.

A female hawksbill sea turtle covers her nest after depositing eggs on the beach in Buck Island Reef National Monument.

However, nesting rates increased at Buck Island Reef National Monument in the Virgin Islands. Typically the park records 20 to 40 nesting hawksbills (*Eretmochelys imbricata*), reports Chief of Resources Zandy Hillis-Starr. In 2004, though, 52 nesting hawksbills, along with 9 greens, several leatherbacks, and 1 loggerhead, were observed. In 2003 the park documented the nesting of a hawksbill first tagged as a juvenile in the coral reef surrounding Buck Island seven years ago. Additionally, Padre Island National Seashore in Texas experienced a record-setting year for Kemp's ridley sea turtles (see article, page 55).

Despite impacts from a troublesome 2004 hurricane season, many coastal national park sites continue to serve as critical nesting grounds for sea turtles. ■

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Yellowstone wolf found near Denver

By Alice Wondrak Biel and Douglas W. Smith

The experience of wolf F293 (not shown here) demonstrates that human challenges will be the major barrier to wolves becoming reestablished across the Rocky Mountains.

IN JUNE 2004, YELLOWSTONE WOLF F293, a two-year-old female, was found dead along Interstate 70 near Denver, Colorado. Wolf F293 originated from the Swan Lake Pack, whose territory includes the Mammoth Hot Springs area, in Yellowstone's northwest corner; she was last located in Yellowstone in January 2004. Investigators estimated that F293 traveled 300–400 miles (483–644 km) of straight-line distance. Because wolves usually travel in random patterns rather than in straight lines, however, she may have covered twice or as much as four times that distance before she was killed.

Finding vacant territory in Yellowstone in which to start a new pack is getting more difficult for a dispersing wolf.

At the time she was found, rumors circulated that F293 actually had been killed elsewhere and was then dumped along the highway, which has been known to happen in the past. However, investigations by the U.S. Fish and Wildlife Service have shown that such is probably not the case here. Rather, wolf F293 traveled to Colorado on her own and was killed when she was hit by a car.

Wolf F293's journey may have begun because finding vacant territory in Yellowstone in which to start a new pack is getting more difficult for a dispersing wolf. With 175 wolves in 15 packs, the Yellowstone wolf restoration program is meeting all expectations, and Yellowstone National Park probably is approaching its carrying capacity for wolves. Wolf F293 could likely have remained in Yellowstone if she had been willing to settle in a poor habitat area, but instead she moved on.

Also noteworthy is that large-scale moves such as this are characteristic of young wolves of either sex; the record straight-line wolf dispersal is 600 miles (965 km). Not much genetic segregation occurs in wolves for this reason; because they are such good travelers, they intermix. What makes F293's dispersal remarkable is that she achieved it in the lower 48 states, where significant barriers to such movement—such as large interstate highways and humans prone to shooting them—exist.

The discovery of wolf F293 in the Denver area indicates that the existence of other wolves between Yellowstone and central Colorado is not very likely. Because wolves are extremely good at finding other wolves, if F293 had found a male mate, she would have stopped instead of continuing to travel. Although F293's dispersal resulted in death, other wolves from the northern Rocky Mountains restoration are starting to establish territories in surrounding states. Whether they will persist outside protected lands depends on the management plans being developed by states in conjunction with the U.S. Fish and Wildlife Service. ■

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Timucuan partners with Jacksonville University to protect gopher tortoises

By Shauna Ray Allen and Ken Hoover

The gopher tortoise (*Gopherus polyphemus*) is a species of special concern in Florida, where its status will be elevated to "threatened" if a recent proposal is accepted. It is a keystone species, providing refuge through its burrows to a variety of other organisms, and is thus an indicator species of ecosystem health. Existing tortoise populations in the Timucuan Ecological and Historic Preserve are small and widely separated. Ideal gopher tortoise habitat is a pine savannah of widely spaced trees with an understory dominated by wiregrass, legumes, shrubs, and other herbaceous vegetation on which the tortoises feed. This habitat requires sunlight for the growth of these food species. In the past this landscape would be burned naturally on an average cycle of 7 to 10 years by lightning strikes brought by summer thunderstorms, preserving the open canopy. However, the Timucuan Preserve is near areas of human residential development where fire is controlled and prescribed burning cannot be practiced.

Several mature gopher tortoises have colonized the sand hill habitat within the headquarters complex of the Timucuan Preserve. Prescribed fire, which would help maintain an open canopy, is excluded in this area because of the densely populated human neighborhoods nearby.

To protect gopher tortoises within the constraints of a landscape shared with humans, the preserve undertook a project to identify and classify areas suitable for gopher tortoise habitat and to recommend management practices in these areas that will promote viability of existing tortoise populations. The project was conducted from September 2002 through May 2004 with Dr. Ken Hoover, professor of biology at Jacksonville University, under a cooperative agreement with the Southern Appalachian Cooperative Ecosystem Studies Unit. The fieldwork began in April 2003 and was completed in September of that year.

The project findings were based on field surveys of known and potential habitat, which were classified based on established criteria. The survey also included vegetation sampling and statistical analysis to determine the most important vegetation species in occupied habitat. Preserve resource management staff provided GIS and GPS training and technical assistance for the fieldwork. In the course of its research, the project created a bibliography of 178 references on gopher tortoises.

The project determined that under current conditions, the longleaf pine sand hills are succeeding to oak-hickory hardwood forests or scrub oak–dominated communities. Sunlight penetration through these heavily canopied areas is greatly reduced, affecting herbaceous species needed by gopher tortoises.

Recommendations for good management of the gopher tortoise include mechanically removing trees, selectively planting food species, and creating corridors to link isolated populations and help promote genetic variability. Other suggestions are relocating isolated tortoises from weedy, disturbed habitats to populations in areas that are being managed, and protecting gophers and burrows from human and domestic animal intrusion. The project recognizes the possibility of increasing Jacksonville community involvement; volunteers might provide labor necessary to implement each of the management steps to preserve habitat areas. Recommended management actions will be incorporated into the preserve's resource management plan in the hope that the gopher tortoises will thrive.■

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Record-breaking nesting year for Kemp's ridley sea turtles

By Donna J. Shaver

The year 2004 marks an endangered species success story in the making. The story began in 1978 with the initiation of an international, multiagency, experimental project to reestablish a nesting colony of endangered Kemp's ridley sea turtles (*Lepidochelys kempii*) at Padre Island National Seashore. Today Padre Island conducts a program to detect and protect Kemp's ridley nests through patrols, public education, and community involvement. Thanks to funding from the Natural Resource Challenge, Department of the Interior Cooperative Conservation Initiative, Texas Parks and Wildlife Department, and other partners, a record 42 Kemp's ridley nests were found on the Texas coast in 2004, including 22 at Padre Island National Seashore. Eggs from 32 of the 42 nests were transported to the Padre Island incubation facility for protected care, and the 2,608 hatchlings produced were released at the park this year.

More Kemp's ridley nests have been recorded at Padre Island National Seashore than at any other location in the United States. Overall, the number of nests found on the Texas coast has increased over the last decade (1995, 4 nests; 1996, 6 nests; 1997, 9 nests; 1998, 13 nests; 1999, 16 nests; 2000, 12 nests; 2001, 8 nests; 2002, 38 nests; 2003, 19 nests; 2004, 42 nests). Much remains to be done in this long-term restoration effort, but findings in recent years are encouraging. With continued effort it is likely the Kemp's ridley will be downlisted to threatened status and a secondary nesting colony of this native species will become established at Padre Island National Seashore.■

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Recovering the Mohave tui chub

By John Wullschleger, Debra Hughson, and Danette Woo

The Mohave tui chub (*Siphateles bicolor mohavensis*) evolved as the only native fish in the Mojave River system during the Pleistocene Epoch, a period when the river flowed into three large lakes in the heart of the present-day Mojave Desert. This fish is one of several subspecies that descended from a common ancestor that occupied intermittently connected Pleistocene lakes covering much of the western United States. Speciation began as the lakes receded, isolating populations in separate basins.

In the early 20th century, dams and diversions in the Mohave River watershed began to modify natural flow regimes and alter riverine habitat; these activities were the primary cause for the decline of the Mohave tui chub. Introduced species, particularly the arroyo chub, also hastened its demise. By 1970 the Mohave tui chub seemed to have been extirpated from the Mojave River and was federally listed as endangered. Fortunately, a relict population persisted in an isolated spring on the edge of Soda Lake playa, near the river's terminus. In 1984 the recovery plan called for the establishment of six self-sustaining populations for downlisting and three additional populations in the river for delisting. Although fish from the Soda Springs site were used to establish populations both inside and outside the Mojave River basin, most of these populations failed.

In an effort to reinvigorate recovery efforts, Mojave National Preserve, California, hosted a workshop in September 2003. Participants representing multiple agencies reviewed the 1984 recovery plan and determined that securing the species would require more than the six populations necessary for downlisting; they also identified potential sites for new populations. Participants discussed emerging threats and made recommendations for research to better quantify and reduce or eliminate these threats. Participants also recognized the need for an active public education program that would build support for recovery.

Human population growth and increased water demand in the Mojave River drainage may make delisting the Mohave tui chub impossible. However, the renewed interest generated by the workshop already has had positive results. For example, studies of the effects of the Asian tape worm and the ecology and population dynamics in lakes have been funded. In addition, a Safe Harbor Agreement with the Lewis Center for Educational Research may allow reintroduction of Mohave tui chub into a section of the Mojave River. If this proves feasible, it will constitute the first attempt to reestablish the species within its native range. ■

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Sampling allows biologists to assess the status and trend of populations of the Mohave tui chub in Lake Tuendae, an artificial pond that is now home to the federally listed endangered fish species. Located in Mojave National Preserve, Lake Tuendae lies on the edge of the Soda Lake playa.

Piping plover making a comeback

By Kimberly Struthers

Piping plover (*Charadrius melodus*), a federally endangered Great Lakes shorebird, is making a comeback through the teamwork of a multiagency recovery effort. The number of breeding pairs of plovers within the Great Lakes reached an all-time high of 55 during the 2004 breeding season. This number included 19 pairs of plovers that nested at popular recreational beaches in Sleeping Bear Dunes National Lakeshore (Michigan). Recovery efforts helped the birds nesting within the park to fledge a record number of chicks, 38% (36 of 93) of the entire Great Lakes fledglings, despite an exceptionally wet season that threatened to destroy some of the nests.

Great Lakes–wide plover conservation management practices included establishing perimeter fencing around nesting areas to allow birds to incubate without disturbance, erecting exclosures around full clutches to protect eggs from depredation, and collecting abandoned eggs for captive rearing. Park staff and volunteers conducted daily plover patrols to ensure that adults and chicks were accounted for. They also informed visitors about the park's plover conservation program and helped them view the birds through spotting scopes.

Park staff continued a predator control program at Dimmick's Point on North Manitou Island, which helped to fledge the highest number of chicks (18) at any nesting location within the Great Lakes. The predator control program was jointly funded by the Cooperative Conservation Initiative of the Department of the Interior, the NPS Natural Resource Preservation Program, and the U.S. Fish and Wildlife Service.

Partnership is the hallmark of the recovery effort for the piping plover and a critical component of recent success. In 2004, because of the conservation efforts of several agencies, the Great Lakes piping plovers are a third of the way to reaching the recovery goal of 150 pairs, which is a milestone worth celebrating. ■

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Park staff manually raises a piping plover nest to protect it from storm surge at Sleeping Bear Dunes National Lakeshore, one of several resource management measures that are aiding the comeback of the federally listed endangered bird species.

Wildlife ecologist receives Director's Award

Pinnacles National Monument, California, protects the remains of an ancient volcano. The park's spires, sheer-walled canyons, and talus passages stand as evidence of millions of years of erosion and faulting. Today Pinnacles is also known as a haven for rare wildlife, thanks in part to the commitment of NPS Wildlife Ecologist Amy Fesnock. Given the Director's Award for Professional Excellence in Natural Resources, Amy worked hard to secure a brighter future for three rare species at the monument: California condor (*Gymnogyps californianus*), California red-legged frog (*Rana aurora draytonii*), and Townsend's big-eared bat (*Corynorhinus townsendii*).

Her most impressive accomplishment was getting the monument selected as the newest release site for endangered California condors and securing three years' worth of project funding. By late 2004, five free-flying California condors were making their home at the monument. One could argue that Amy's efforts on behalf of the condor were reason enough for an award, but she did not stop there. Concurrently, Amy launched an effort to bolster the monument's population of California red-legged frogs, a federally listed threatened species, developing an experimental recovery program that restored frogs to the Bear Gulch Reservoir. The project more than doubled the monument's population of frogs and protected them from invasive green sunfish. Thanks to Amy's efforts to develop a cave management plan, Townsend's big-eared bats, a species of special concern in California that was unexpectedly found in the park, are managed both to protect the species and to allow the public to enjoy the popular caves the bats use as roosts.

Amy was motivated to focus on these three rare species because findings from the Inventory and Monitoring program showed that these three animals were critical parts of the park ecosystem that were missing or likely to become so. "In the case of the California red-legged frog and Townsend's bat, some of the motivation was to make sure these species were not lost on my watch, which I think many park managers can understand," notes Amy. "And condors, condors are just cool."

"One person cannot do great things alone," says Amy. "Great things require the right environment, including support from upper management and the willingness to do the right thing, even if it is hard." Amy credits park Superintendent Cicely Muldoon and Chief of Resource Management Tom Leatherman for encouraging her to set the bar high and achieve difficult goals. ■

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4 Restoration

"At least as important as the ecosystems the restorationist gives back to nature is the deepening of understanding, awareness, and caring that is the direct result of this work, when it is carried out thoughtfully and attentively."

—William R. Jordan, III

Though preservation of park resources is a central part of the National Park Service mission, restoration of those resources, in particular ecological restoration of degraded natural resources, is an important strategy that provides for the well-being and enjoyment of the national parks. As park units have been added to the National Park System, the Park Service has inherited many degraded resources: altered habitats, eroded soils, extirpated native species, changed landforms, and impeded ecological processes. In many cases, restoration can reverse environmental damage and lead to the recovery of deteriorated sites. And though it is not a substitute for preservation, restoration is more than just a technical prescription for landscape healing. Done thoughtfully and thoroughly, it involves specialists acting as landscape historians, turning up information from a site's past that is critical to the quality of its future. An expression of human creativity and respect, restoration offers hope for damaged park natural landscapes and gives them meanings they never had before. Surely limitations of scale and cost are real, but as the following articles indicate, restoration is a significant conservation strategy for the future of the national parks.

Restoration of the American chestnut

By James L. Sherald, Ph.D.

IN THE EARLY 20TH CENTURY the American chestnut (*Castanea dentate* [Marsh.] Borkh.) extended from Maine to Mississippi and eastern Michigan, comprising 25% of the forest and covering more than 200 million acres (81 million ha). Throughout the natural range where the American chestnut was dominant, the National Park Service now manages more than 80 units, including parks where the chestnut was a prominent feature, such as Great Smoky Mountains and Shenandoah National Parks and Blue Ridge Parkway. Trees 100 feet (31 m) tall and more than 7 feet (2 m) in diameter were not uncommon. The tree's easily worked and resilient wood, as well as its abundant and nutritious nuts, played a significant role in the cultural and ecological heritage of the Appalachian Mountains. In just 50 years, however, this magnificent species was reduced to a few scattered survivors and sprouts arising from stumps of dead and declining trees. Its demise was an introduced fungal pathogen (*Cryphonectria parasitica* [Murr.] Barr), which was first noticed in 1904 at the New York Zoological Park.

In just 50 years … this magnificent species was reduced to a few scattered survivors and sprouts arising from stumps of dead and declining trees.

A growing interest in the long-range implications for American chestnut restoration prompted the National Park Service to host the conference "Restoration of Chestnut to Forest Lands within the National Park System," held 4–6 May 2004 at the North Carolina Arboretum in Asheville. Twenty-four speakers addressed the ecological history of the American chestnut, the impact of its loss, developments in chestnut blight resistance, genetic issues, practical considerations associated with restoration, and NPS restoration policies, objectives, and opportunities. The conference was funded by the NPS Natural Resource Stewardship and Science directorate through the Chesapeake Watershed and Southern Appalachian Mountains Cooperative Ecosystem Studies Units and organized by the Pennsylvania State University. More than 80 individuals, representing national parks, national and state forests, and academic and nonprofit institutions, participated.

Throughout the history of chestnut blight, considerable research has been devoted to understanding the disease and its control, primarily through breeding programs. In recent years, several areas of research have shown promise: crossing American chestnut with the resistant Chinese chestnut (*Castanea mollissima* Blume), selecting and breeding putative resistant American chestnuts, genetic engineering of the American chestnut to enhance resistance, and developing hypovirulent (less harmful) pathogen strains as biological controls.

The most promising advance presented is the development of blight-resistant hybrid chestnuts. The American Chestnut Foundation has incorporated disease-resistant genes from the Chinese chestnut through successive backcrossing to the American chestnut. (Backcrossing

The National Park Service manages 80 park areas where the American chestnut was once dominant. Devastated by a nonnative fungus, most mature trees vanished by the early 1940s. Promising research in the development of disease-resistant hybrids has helped arouse interest in eventual restoration of the species. This American chestnut in West Salem, Wisconsin, has survived the blight.

The American chestnut once occupied 30% to 40% of some forested areas of Great Smoky Mountains National Park, according to the park's first naturalist, Arthur Stupka. Specimens regularly measured 4 feet (1.2 m) in diameter, with some as large as 10 feet (3.1 m) in diameter.

In 2003, staff at Great Smoky Mountains National Park recorded nearly 300 living chestnuts, of which more than 50% had flowers and 10% had fruit. Sprouting from roots unaffected by the fungus, young chestnuts from the park provide pure American chestnut pollen, nuts, and tips of branches from which researchers hope to develop disease-resistant hybrids.

is crossing a hybrid with one of its parents.) Resistant hybrids will be indistinguishable from the American chestnut after three successive backcrosses. The process is laborious and will take many years before sufficient progeny are available for restoration plantings. The overall performance of the hybrids under varying field conditions is still undetermined, and resistance could break down when confronted by more virulent strains of the pathogen.

Although the National Park Service's ability to engage in chestnut restoration is still in the distant future, resource managers in parks with American chestnut legacies should consider the extent to which

The process [of developing disease-resistant hybrids] is laborious and will take many years before sufficient progeny are available for restoration plantings.

restoration could and should be pursued. There are appropriate near-term measures that NPS managers can take to contribute to the restoration of the chestnut. First, they can catalog existing trees and sprouts and document chestnut habitats. They can also maintain pure American chestnuts by opening tree canopies over sprouts to allow for long-term replenishment of sprouts and the development of pollen that can be used by researchers. Another practical approach in the near term may be establishing interpretive demonstration plantings of backcross hybrids or, when available, transgenic plants (i.e., plants that have had foreign DNA stably integrated into their genome). National Park Service policy permits the use of hybrids or genetically engineered plants, providing they closely approximate the species lost. Demonstration plantings would provide opportunities to develop restoration techniques and evaluate hybrids while giving the public the opportunity to experience chestnuts and appreciate the role of science in population and landscape restoration. An information paper discussing the implications of new technologies and their practical applications to American chestnut restoration is being developed by the NPS conference organizers. The conference proceedings will be available in 2005. ■

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Elwha River system to be restored in Olympic National Park

By Brian Winter

Two dams on the Elwha River that eliminated salmon and steelhead runs in Olympic National Park, Washington, will be dismantled beginning in 2008. The Elwha and Glines Canyon Dams have also caused the inundation and degradation of important riverine and terrestrial habitat in and near the park and have degraded water quality (increased temperatures and reduced nutrients) downstream. A series of important milestones over the past 15 years led to the 6 August 2004 signing of a multiagency memorandum of understanding that charts the area's eventual restoration.

In 1992, Congress enacted the Elwha River Ecosystem and Fisheries Restoration Act. This act directs the Secretary of the Interior to fully restore the Elwha River ecosystem and native anadromous fisheries, which is determined to be feasible only through the removal of both dams. As stated in the act, the federal government purchased the dams in 2000 for $29.5 million. The Bureau of Reclamation coordinates the operation of the dams with the National Park Service while the Bonneville Power Administration markets the power and funds the operation and maintenance of the hydropower generation.

Summer 2004's memorandum of understanding identifies the National Park Service, the City of Port Angeles, and the Lower Elwha Klallam Tribe as responsible parties in executing agreed-upon industrial, fish hatchery, and municipal water quality mitigation measures. Two other project partners, the Washington Department of Fish and Wildlife and Nippon Paper Industries, have agreed in principle to their roles in the restoration project as negotiations with the Dry Creek Water Association continue.

Construction of facilities to protect the domestic water supply for area homeowners was completed in 2003. Construction of the remaining mitigation facilities will begin in 2005 and 2006, followed by removal of the dams beginning in 2008. Their removal will ultimately allow for the restoration of an estimated 392,000 salmon and steelhead in and near the national park. ■

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Glines Canyon Dam in Olympic National Park as it looks today (top) and a simulation of the site following restoration (bottom). The spillway will be retained so that the National Park Service can interpret the reasons for the dam's construction and removal, and to preserve a part of the dam, which is on the National Register of Historic Places.

Wetland and historic landscape restoration at Manassas National Battlefield Park

By Bryan Gorsira

MANASSAS NATIONAL BATTLEFIELD PARK, VIRGINIA, was established in 1940 to preserve and interpret the sites of the First and Second Battles of Manassas. The first, fought on 21 July 1861, was also the first major land battle of the Civil War. Thirteen months later, Union and Confederate forces returned to the same ground and fought an intense battle over three days, during which about 33,000 soldiers died. The National Park Service manages these landscapes by protecting the large tracts of land that represent the scene as it existed at the time of the battles 143 years ago. The open fields, wooded areas, ridges, valleys, and streams helped define the fields of battle.

In 1988, Manassas National Battlefield Park acquired 558 acres (226 ha) as part of a legislative taking of the Stuart's Hill tract, which is now located in the southwestern portion of the park and incorporates a portion of the Second Battle of Manassas. This tract contained a 100-acre (40-ha) area that was heavily disturbed prior to the purchase (aerial photo, this page); a developer had drastically altered the landscape for a combined residential and commercial development. Alterations included recontouring the area, constructing an entrance road, and reconfiguring the drainage network in preparation for construction of a subdivision and a mall. In addition to these changes, the development company altered the natural hydrology, including filling in wetland areas.

In 1997 the Smithsonian Institution approached managers at Manassas National Battlefield Park to determine whether an appropriate location existed within the park for a wetland replacement project. The Smithsonian Institution was developing plans for its new Air and Space Museum on a wetland tract at Dulles Airport, but could not build without a wetland mitigation plan, which required replacement of wetland loss somewhere off the airport's property. A potential mitigation project at the battlefield would not only meet the Smithsonian's needs but would also achieve the park's requirement to preserve historical landscape features and the integrity of the battlefield site.

Fortuitously, several years earlier the National Park Service had contracted with the School of Design at the University of Georgia to study the newly acquired Stuart's Hill site and develop a general plan for restoring the heavily disturbed area to its 1862 conditions. With this study in hand, the Smithsonian Institution and Manassas National Battlefield Park agreed that the disturbed area would be an appropriate location for this mitigation project.

After years of planning and negotiations, restoration and mitigation were completed in November 2003, taking six months. This involved excavation of more than 100 acres (40 ha), grading slopes to their 1862 contours, and restoring approximately 30 acres (12 ha) of emergent wetlands and 15 acres (6 ha) of forested wetlands that had been altered by the development company. Staff planted upland areas in native warm-season grasses, creating a habitat type that is rapidly dwindling in Virginia, reduced by 55% since 1945. This project was a classic win-win situation for the Smithsonian Institution, which was able to mitigate its wetland damage in the most economical manner possible, and for the National Park Service, which was able to restore its severely compromised cultural and natural resource.

Today parks encounter many threats to their resources, requiring managers to develop a variety of strategies to solve complex conservation issues. Incremental loss of wetlands is likely to continue, with the potential to affect many parks and their resources. The case of Manassas National Battlefield Park shows that wetland banking and other collaborative partnerships with private and public entities can provide opportunities to help compensate for resource damage outside park boundaries with restoration of both natural and cultural resources within parks. ■

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An aerial view of the Stuart's Hill tract of Manassas National Battlefield Park (left, park boundaries shown in red) reveals a site disturbed by planned development (yellow area) as it appeared before restoration. The previous landowner had filled in a portion of wetland for a road crossing and altered the area's drainage, negating the site's former characteristics as a wetland. Removal of the road and restoration of the downstream channel (top) produced conditions suitable for the reestablishment of a forested wetland (bottom).

Freshwater tidal marsh recovery under way at Cape Cod

By Carrie Phillips

Suffering from poor water quality, high turbidity, and periodic fish kills, East Harbor in Cape Cod National Seashore was not always in such bad shape. A dike constructed in 1868 isolated the 717-acre (290-ha) estuary from Cape Cod Bay, robbing it of tidal waters needed for native species to flourish. Over time the now-artificial, freshwater lake became dominated by nonnative fish and plants. But in 2001, resource managers at Cape Cod National Seashore and the town of Truro, Massachusetts, had a different idea for East Harbor's future: restoration. They opened the tide-gate in the culvert connecting the lake to Cape Cod Bay, allowing marine waters to reach the lake during rising tides. This simple change has prompted an apparent ecological recovery, with noted improvements in water quality and an increase in native vegetation. It has also encouraged the return of crabs, shrimp, estuarine fish, and bottom-dwelling species such as clams, mussels, and marine worms.

In 2004, two additional developments came to light that indicate recovery is under way. First, while monitoring salt-marsh vegetation, biologists detected eelgrass (*Zostera marina*), a submerged aquatic plant that requires clear, clean water for growth. The reappearance of *Zostera* in East Harbor confirms a biotic response to the improvement of water quality, particularly increased salinity and decreased turbidity. It also signals recovery of important ecosystem functions because *Zostera* is a primary food source for brant and an important habitat for crab, shrimp, the juvenile stages of commercially important finfish, and other marine species. The second development of note is the return of hard clams (*Mercenaria mercenaria*), soft-shelled clams (*Mya arenaria*), and blue mussels *(Mytilus edulis*). These species were detected during benthic-community monitoring supported by the Atlantic Research Learning Center in collaboration with the Cape Cod Prototype Monitoring Program. These species also indicate improved sediment and water quality, and are of high cultural, recreational, and commercial importance on outer Cape Cod. ■

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Just three years after allowing tidal waters into a former estuary, resource managers at Cape Cod National Seashore documented eelgrass (left) and several species of bivalves (right) in 2004, signs of ecological recovery.

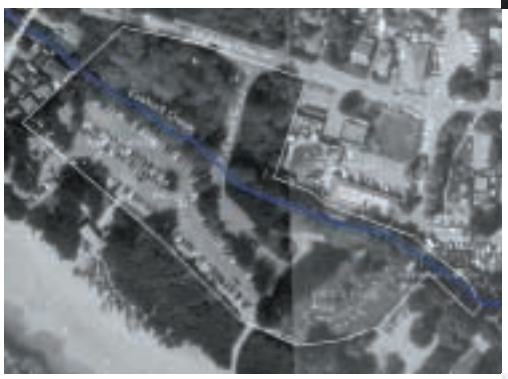
Small-stream habitat restoration projects pay big dividends

By Jim Tilmant, Randy Ferrin, and Darren Fong

AS THE NATIONAL PARK SERVICE STRIVES TO PROTECT native species and habitat in parks, the need for aquatic habitat restoration efforts has emerged as an important means of healing previous human disturbance of river and stream environments. Restoration projects are seldom possible in big rivers, but restoration of small-stream habitats can often pay big dividends and help fulfill strategic land-health goals. Restoration projects completed in 2004 at the Saint Croix National Scenic Riverway, Wisconsin and Minnesota, and Golden Gate National Recreation Area, California, serve as good examples of how these efforts can benefit native fish. Both projects were undertaken with Natural Resource Program Center funding.

Brook trout (*Salvelinus fontinalis*) were once abundant in the upper Namekagon River and its cold-water tributaries. However, habitat destruction altered the aquatic community in favor of more warm-water-tolerant species. This led to concerns about potential extirpation of brook trout from the river system. To help protect river resources, Congress authorized the National Park Service to purchase land and scenic easements within a narrow corridor along two rivers. Once the land was acquired, the purpose of Saint Croix's restoration project was to restore a heavily disturbed area on Caps Creek—a tributary of the Namekagon River—as a means of protecting water quality and scenery while providing high-quality habitat for aquatic organisms, including native brook trout.

The National Park Service began the project in 1989 by removing buildings and restoring sites to more natural conditions. One of these sites is the Schultz Ponds, a former private trout hatchery where the hatchery's owners had diverted Caps Creek and excavated a number of shallow ponds with a connection to cold-water springs. Although the building had been removed, the remaining ponds dominated the view from the river, creating a visual distraction from the otherwise wild setting. In 2000 the Wisconsin Department of Natural Resources and the National Park Service agreed to restore the Schultz Ponds area by filling in the ponds and reconstructing a natural meandering channel for Caps Creek. A restoration plan was developed with oversight from the park. Once the channel was excavated and banks stabilized, suitable substrate and woody debris were placed in the creek to provide spawning areas and cover for trout and habitat for insects that trout use as food. For the next three years the Wisconsin Department of Natural Resources will resurvey fish in Caps Creek to determine project success. Early observations have already revealed several hundred brook trout overwintering at the junction of Caps Creek and the Namekagon River.



Two stream restoration projects in 2004 are good examples of how restoration efforts can benefit native fish species. Restoration of lower Easkoot Creek at Stinson Beach, California (aerial photo, left), improved riparian vegetation and rearing habitat for federally listed threatened steelhead and coho salmon (above). Restoration of Caps Creek (below) at Saint Croix National Scenic Riverway, Wisconsin and Minnesota, has led to the return of native brook trout.

Golden Gate National Recreation Area completed a stream habitat restoration project on lower Easkoot Creek at Stinson Beach in 2004. The primary goal of the project was to improve rearing habitat for federally threatened central California coast steelhead (*Oncorhynchus mykiss*) and coho salmon (*O. kisutch*) and to improve the area's native vegetation and floodplain. The creek ecosystem was rehabilitated by re-creating sinuosity, developing scour pools, increasing in-stream structure, and developing riparian vegetation and cover. Adjacent native riparian and wetland communities were also expanded to allow viable biological processes to occur, and all nonnative vegetation was removed. Local landowners, community organizations, and resource agencies were invited to participate in the planning and implementation of restoration actions.

Restoration projects completed in 2004 … serve as good examples of how these efforts can benefit native fish.

Post-project monitoring suggests that the effort is a success. Two large winter storms resulted in bank overflow and inundation of the adjacent floodplain for more than a week. Following these storms, channel alignment remained similar to the restored channel and meanders remained intact. Desirable scour holes have developed and gravel bars have been more naturally shaped. Future monitoring will help determine the overall increase in fish populations and survival of transplanted vegetation within the project area.

The Saint Croix National Scenic Riverway and Golden Gate National Recreation Area restoration projects are outstanding examples of what can and needs to be done at numerous parks throughout the National Park System. As the Park Service moves forward in achieving its land-health and restoration goals, these small-stream projects can serve as valuable learning experiences. ■

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A participatory approach to salt-marsh restoration in Jamaica Bay, New York

By George W. Frame and Doug Adamo

How does a highly urban park counter the loss of a salt marsh to erosion and rising sea level? In the case of Gateway National Recreation Area, the answer is to build up rather than out. The park includes New York City's Jamaica Bay estuary, where centuries of urban development reduced coastal wetlands to 10% of their pre-settlement extent. The remaining 1,000 acres (405 ha) of unfilled salt-marsh islands shrink by at least 40 acres (16 ha) each year. The city's hardened shorelines and filled coastal wetlands leave almost no place where the salt marshes can follow a natural course of moving farther inland as the sea level rises. The problem is compounded by contaminants from sewage, boat wakes, and other factors being studied.

Cooperative investigations with community groups, universities, and agencies in 2001–2003 identified possible courses of action to restore disappearing salt marshes. In September 2003 the park used a small swing-ladder dredge with a high-pressure nozzle to spray 6,800 cubic yards (5,202 m^3) of sand on top of 2 acres (0.8 ha) of Big Egg Marsh to raise its elevation by up to 20 inches (51 cm) and provide suitable soil for growth of 20,000 plugs of smooth cordgrass (*Spartina alterniflora*). Funding for the project came from National Park Service regional and national grants and from the State of New York.

A self-propelled swing-ladder dredge with a high-pressure spray nozzle applies a thin layer of sand to the marsh to raise its elevation. Building up the marsh counters the destructive effects of shoreline hardening, boat wakes, and urban contamination.

More than 130 volunteers, 30 park staff, and collaborators from universities and government agencies helped with preparation and maintenance of the restoration site and with monitoring physical and biological parameters. The ongoing monitoring activities conducted in 2004 contribute to a better understanding of salt-marsh processes in Jamaica Bay, provide useful information for future large restoration projects by the U.S. Army Corps of Engineers in Jamaica Bay, and increase public awareness and stakeholder involvement in conserving Gateway National Recreation Area's natural resources in the urban environment. ■

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Securing bat habitat in mines and caves at six national park areas

By John Burghardt

The National Park Service is working with partners to protect critical bat habitat in mines and caves in California, Nevada, and Arizona. The Cooperative Conservation Initiative (CCI) enabled the NPS Geologic Resources and Biological Resource Management Divisions, Bat Conservation International, the State of California, private industry, and other nonfederal and international entities to work together toward bat conservation. Matching federal and partner funds totaling $155,000 provided the means for projects at Death Valley and Joshua Tree National Parks, Whiskeytown and Lake Mead National Recreation Areas, Coronado National Memorial, and Organ Pipe Cactus National Monument.

During a bat gate fabrication workshop at Death Valley National Park, class participants and instructors installed a cupola over two sinkhole entrances to Devil's Hole. The cupola covers an 85-foot- (26-m-) deep upper cave chamber that hosts a maternity roost of Townsend's big-eared bats (*Corynorhinus townsendii*). This chamber connects to a partially flooded lower chamber that is home to endangered desert pupfish (*Cyprinodon diabolis*).

During a workshop on bat gate construction in Death Valley, for example, NPS and U.S. Fish and Wildlife Service employees joined staff from state programs, Bat Conservation International, Frontier Environmental Solutions, U.S. Borax, and Ecological Ventures California, Inc., who provided in-kind support in constructing a bat cupola over two sinkhole entrances to the Devil's Hole cave system. Cupolas cover vertical mine and cave openings, keeping humans out (and safe) while allowing bats to pass through. The park purchased steel for this sizable structure with CCI funds. Staff of U.S. Borax has conducted initial follow-up studies, which indicate that bats have already accepted the new closure at this site. In addition, park staff installed three shaft cupolas and five adit gates at three mine sites in Joshua Tree; the California Department of Conservation provided funding for mobilization and demobilization activities and the purchase of steel. Matching funds from a U.S. Borax–NPS partnership made possible the installation of an adit gate at Homestake Mine at Lake Mead. Managers at Whiskeytown have purchased supplies and hired temporary staff to construct nine bat gates at three mines in the national recreation area, to be completed in early 2005. To determine the best type of mine closure for endangered lesser long-nosed bats (*Leptonycteris curasoae*), NPS staff is joining partners from the Arizona–Sonoran Desert Museum and other state, private, and Mexican partners in trapping, cataloging, marking, and releasing the bats as they migrate among seven maternity and transient roost sites in mines and caves throughout southern Arizona and northern Sonora. Information gathered from this inventory will aid in evaluating bat gate alternatives for the Copper Mountain Mine at Organ Pipe Cactus and the State of Texas Mine at Coronado. ■

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NPS**FACT**

In 2004 the National Park Service revised its five-year goal under the Government Performance and Results Act (GPRA goal Ia1A) **to restore 5%** (21,850 acres or 8,840 ha) **of the total 437,150 acres** (177,046 ha) of park lands disturbed by development or agriculture by 2008.* It exceeded the first-year (FY 2004) target of 4,700 acres (1,904 ha) by restoring 6,600 acres (2,673 ha) of those lands. **The total number of acres restored** since annual goals were first adopted under GPRA in 2000 **is 20,125 (8,151 ha) over four years.**

**The goal is specific to park lands disturbed by development or agriculture and does not address restoration of fauna, control of invasive plants, and use of fire as a restoration tool. Causes of disturbance include facilities, roads, mines, dams, abandoned campgrounds, farming, grazing, timber harvest, and abandoned irrigation ditches. The goal is updated every three years to account for progress and changes in the total area being targeted for restoration.*

Restoring the endangered Miami blue butterfly in south Florida national parks

By Sue Perry

THE MIAMI BLUE BUTTERFLY, *Cyclargus thomasi bethunebakeri*, was once common in habitats in coastal areas of south Florida and the Keys, including Everglades, Biscayne, and Dry Tortugas National Parks. It declined rapidly over the last several decades and was feared extinct until 1999, when a small population was discovered in a state park. The reasons for the steep decline are unknown, but rapid urban development and the resulting loss of habitat, as well as widespread mosquito spraying and the replacement of its host plants by exotic vegetation, are known to be important factors. In 2002 the Florida Fish and Wildlife Conservation Commission issued an emergency endangered species protection order, and then listed the Miami blue as an endangered species in November 2003. Researchers estimated that no more than about 50 individuals occurred in the only remaining population. No other populations were discovered in south Florida, making the Miami blue one of the most endangered animal species in the world.

Government agencies, conservation organizations, and biologists have worked together in an intensive conservation effort. In February 2003, researchers from the McGuire Center for Lepidoptera Research at the University of Florida collected eggs and began a captive breeding program. The goal is to distribute individuals from the captive colony to protected lands to try to establish new breeding populations. The Miami blue working group made the decision to begin the restoration program in Everglades and Biscayne National Parks in late May 2004. Researchers are releasing caterpillars and adult butterflies monthly at sites that cover a wide geographic area, in hopes of avoiding the species' extirpation by a hurricane in any one area. Specific locations will not be revealed to the public initially, to protect the butterflies from collectors, but the general restoration effort will be featured in interpretive programs.

The Miami blue is currently reproducing and doing well in the parks, but it is too soon to know if the reintroduction will ultimately be successful.

The reintroduced butterflies have already had to adapt to a severe drought in June and hurricane winds and storm surge in August and September. The Miami blue is currently reproducing and doing well in the parks, but it is too soon to know if the reintroduction will ultimately be successful. Researchers at the University of Florida are seeking answers to a number of questions that may affect its survival, such as the relationship of the Miami blue to ants that protect the caterpillars from predators in exchange for a sweet secretion.

The Miami blue is only one of a suite of south Florida butterflies that have become very rare. Many butterfly species have been extirpated in the national parks. One species that was planned for reintroduction appears to have recently become extinct. A number of subtropical butterfly species can be seen only in the southernmost areas of the United States. Some butterflies migrate south from northern areas to spend the winter in Florida's national parks.

The Miami blue butterfly (female, top; male, bottom) is one of the most endangered animal species in the world. Agency and university scientists are working together in a cooperative conservation effort to restore the species in south Florida. Releases of caterpillars and adults in Everglades and Biscayne National Parks began in 2004.

As butterfly watching becomes increasingly popular, the south Florida parks are putting more emphasis on invertebrate conservation. A major cooperative effort among all the divisions within each park will attempt to protect both the endangered butterflies and endangered ecosystems. Planning includes possible changes in prescribed fire plans to include consideration of the many smaller organisms, like butterflies, that cannot disperse far. Changes in the maintenance plan will result in less mowing in natural areas with native plants that provide food for caterpillars and butterflies. If successful, these changes may result in the Miami blue's becoming one of the species that draws visitors to the parks. ■

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5 Parks for Science

"The parks are invaluable for unraveling the mysteries of natural and human history, evolutionary adaptation, ecosystem dynamics, and other natural processes."

—National Research Council

As home to relatively intact natural systems and significant cultural treasures, the National Park System offers enormously important opportunities for investigating scientific questions. The designation of 38 national park units as biosphere reserves and world heritage sites largely reflects the international scientific significance of these resources. As stewards of many of the world's premier natural and historical sites, the National Park Service is working to encourage parks-for-science research because the potential contribution to society is tremendous. The articles that follow highlight some of the fascinating discoveries, interesting research findings, and other research-related events in 2004, focusing on the myriad ways national parks contribute to scientific understanding of our world. Articles include a discussion of the activities of research learning centers to facilitate research, the use of elk and deer brain tissues from Rocky Mountain National Park to advance insights into chronic wasting disease, and recent discoveries of fossils and species new to science in national parks. From these articles we can see that the value of national parks as scientific laboratories will continue to grow in the face of accelerating local, regional, and global causes of environmental change and declining biological diversity, for the national parks contain precious information-gathering potentials that are not available anywhere else.

Long-term data show declines in insect composition on Plummers Island, Chesapeake and Ohio Canal National Historical Park

By John Brown

FOR MORE THAN 100 YEARS, insects have been collected on Plummers Island, a 49-acre (20-ha) site on the Potomac River and part of the Chesapeake and Ohio Canal National Historical Park. Before the island became a part of the National Park System, it was owned by the Washington Biologists' Field Club (a group of local naturalists and scientists) from about 1901 to 1958. The field club members conducted countless biological investigations on the island, resulting in significant collections of natural history specimens of plants and animals, which now reside in the National Museum of Natural History (USNM).

Because of the field club's active collecting and studies, Plummers Island is one of the few national park sites for which a prolonged survey of any biotic component has occurred. Data from these specimens provide the opportunity to examine changes over the past 100 years, showing the value of intensive local studies in the national parks. Insects are major contributors to ecosystem stability and serve a vital role in community structure. Understanding changes in the composition of the insect fauna may allow the National Park Service to better manage for biodiversity when undertaking habitat management, restoration, and pest management.

In 2004 the Natural Resource Preservation Program–Biological Resource Management Division funded a compilation and analysis of the insect data from Plummers Island. Researchers supervised the bar coding of more than 25,000 specimens and the data entry into a database maintained at the museum. Three USNM staff members were instrumental in facilitating the study: Dr. John Brown, for butterflies and moths (Lepidoptera); Dr. Thomas Henry, for true bugs (Heteroptera); and Dr. David Furth, for beetles (Coleoptera). These scientists documented a remarkable 2,761 insect species in 194 families, encompassing 10 insect orders (Odonata, Psocoptera, Dermaptera, Heteroptera, Neuroptera, Coleoptera, Diptera, Trichoptera, Lepidoptera, and Hymenoptera). Leading the pack are butterflies and moths, with a whopping 686 species; beetles are second, with about 600 species.

Preliminary analyses of the data indicate considerable turnover, or change, in the species composition in most families of insects since 1900. These findings may shed light on the types of changes that may be expected in the insect fauna in response to different land management strategies. One hundred years of development and urbanization of the area adjacent to and surrounding Plummers Island have resulted in considerable fragmentation of formerly large, contiguous tracts of habitat. Because past management of the site has been passive, primarily in the form of "protection" (i.e., limited active management), the vegetation has undergone natural succession from old field–open juniper (*Juniperus virginiana*) grassland with a heterogeneous (or diverse) patchwork of communities to a somewhat uniform subclimax oak-maple-hickory forest. The result is that many species of insects that prefer or even require open or successional habitats have disappeared. As many as 20% of the leaf-roller moths (Tortricidae) and 30% of the inchworm moths (Geometridae) present at the turn of the last century have disappeared. Likewise, colonization of the site by invasive weeds likely has replaced some native plants that formerly may have served as host plants for the larvae or caterpillars of phytophagous or plant-feeding insects.

The Washington Biologists' Field Club used the cabin atop Plummers Island, now a part of Chesapeake and Ohio Canal National Historical Park, as a research station in the early 20th century. Club members collected insects like the two adult limacodid moths (opposite page) and the common leaf-roller moths—*Endothenia hebesana*, above, and *Choristoneura rosaceana,* below. Afforded more than 100 years of insect collection data, in 2004 scientists analyzed changes in insect composition at the site.

Active management strategies that maintain a varied landscape, accompanied by the suppression of invasive weeds, may result in protected lands that support the highest species richness. The maintenance of some early successional habitat with accompanying "edges" may be critical for the maintenance of high species richness for many insect taxa, such as moths whose caterpillars specialize on herbaceous annuals, pollinators such as bees, and some predaceous beetles. Conflicts may arise between competing management alternatives. For instance, is it better to allow protected lands to revert to their former state through "natural" processes or to actively maintain small patches of open habitat for specific taxa or groups of species? As parks define the desired future conditions of sites, such questions must be answered and goals established. This scientific data summary gives management insight about the path their decisions will take regarding biodiversity on Plummers Island. ■

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Tomales Bay biodiversity inventory at Point Reyes and Golden Gate

By Ben Becker

THOUGH TOMALES BAY is still one of the most pristine, beautiful, and biologically diverse estuaries on the coast of California, past and present human uses of the bay and its watershed have had significant cumulative impacts on water quality, habitats, and species, resulting in a need for comprehensive watershed management. To accomplish this task, local, state, and federal stakeholders formed the Tomales Bay Watershed Council (www.tomalesbaywatershed.org) in 2000 to promote coordinated watershed-based resource management. The narrow, 12-mile- (19-km-) long bay is a combination of National Park Service, National Oceanic and Atmospheric Administration, and California state waters, with overlapping jurisdictions and significant water inflow from private and public lands throughout the watershed. Thus, collaborative stakeholder decision making by the watershed council is essential to addressing regional impacts on the bay from throughout the watershed.

Past and present human uses of the bay and its watershed have had significant cumulative impacts.

Following the lead of Great Smoky Mountains National Park, the Pacific Coast Science and Learning Center at Point Reyes National Seashore began an All Taxa Biodiversity Inventory of Tomales Bay in 2002. The Science and Learning Center primarily facilitates the marine and coastal research and educational programs for Point Reyes National Seashore and Golden Gate National Recreation Area, but also provides educational support to other national parks in the San Francisco Bay area. The purpose of this collaborative inventory is to catalog all forms of life in the bay, which will inform conservation and management decisions initiated by the watershed council, the National Park Service, and other stakeholders. The Pacific Coast Science and Learning Center coordinates research, secures funding, and serves as a data repository and disseminator, thereby providing sound environmental data for local conservation groups and government agencies. Without a scientific program or funding for researchers or database management, the Tomales Bay Watershed Council is the center's primary customer for data. Hence, the Pacific Coast Science and Learning Center has adopted the role of scientific aid for the council, and results from the biodiversity inventory will be critical for making sound conservation and restoration decisions.

The Science and Learning Center's biodiversity inventory program is currently coordinating and funding many projects. For example, native oyster restoration will create habitat and improve water quality on the bay. Mapping and experimental removal of invasive green crab and other invasive species, including *Didemnum lahillei* (a clonal tunicate that fouls native communities; see sidebar on page 43), will help in developing effective control plans. In addition, staff is compiling all existing biodiversity and habitat data into a single database. This information is now available at www.tomalesbaylife.org for those who need references to keying out newly found species. The center is developing online field guides, a comprehensive online bibliography of all scientific literature concerning the bay, and a water quality monitoring database. Also, each year the Science and Learning Center sponsors 10 graduate-level research projects that pertain to understanding, mapping, and protecting the biodiversity of the bay. Fundraising for future water quality monitoring and pollution source detection is ongoing. To complete all these projects, staff works extensively with faculty and students from local universities and with foundations interested in funding projects that will help

Macrocystus kelp beds occur in several small pockets in Tomales Bay, enriched by the strong tidal action that brings abundant nutrients in contact with the rapidly growing kelp.

This scanning electron microscope image shows the head of the Tomales sea flea, a newly discovered crustacean in the family Leptostraca, genus *Nebalia*, that has not yet been assigned a species name.

preserve watersheds and marine systems in the context of community involvement.

The biodiversity inventory in Tomales Bay has already uncovered several new management concerns: discovery of invasive tunicate *Didemnum lahillei* in the bay and discovery of a crustacean new to science in the family Leptostraca, genus *Nebalia*. The new crustacean lives in the eelgrass beds of Tomales Bay; its bright green color blends with the deep green eelgrass. A collaborator in the biodiversity inventory, Leslie Harris of the Natural History Museum of Los Angeles County, who oversees much of the invertebrate inventory work, first collected the species. Currently, a graduate student at UCLA, Todd Haney, is describing and naming the crustacean. Investigators also have found a new sea anemone never before seen on the West Coast, but believed to be a species common on the East Coast. Genetic tests will soon reveal if this is another invader or if it is a new species.

While interacting with both park and local stakeholders, the Pacific Coast Science and Learning Center meets scientific and data management needs. Its adaptable core facility and specialized staff can provide research assistance, information management, and fundraising for rapidly changing resource management needs. ■

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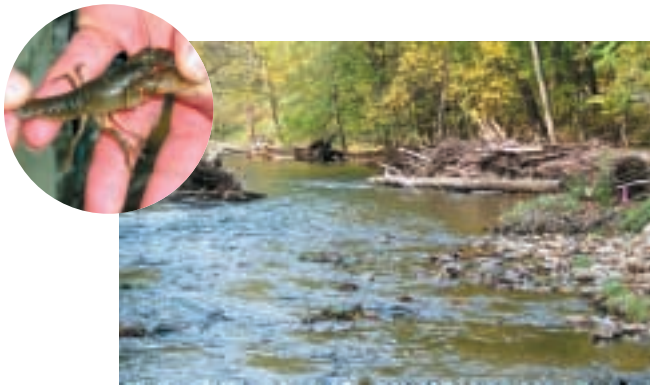
Crayfish previously unknown in Pennsylvania found at Valley Forge

By David A. Lieb and Betsie Blumberg

A species of crayfish is thriving in Valley Creek at Valley Forge National Historical Park, although scientists have never before seen it in Pennsylvania. Researchers from Penn State University, David Lieb and Dr. Robert Carline, surveyed the portion of the creek that flows through the park and identified the crayfish as part of the *Cambarus acuminatus* complex, a group of related species, most of which have not yet been described and named. The survey, undertaken with NPS regional funding, has resulted in a commitment of the two monitoring networks in Pennsylvania (Mid-Atlantic and Eastern Rivers and Mountains) to do crayfish surveys in all Pennsylvania park units. No member of the subgenus *Pucticambarus,* which includes *C. acuminatus*, has previously been reported in eastern Pennsylvania, and no member of the *C. acuminatus* complex has ever been recorded north of the Patapsco River basin in Maryland.



This crayfish, of the *Cambarus acuminatus* complex, was found in Valley Creek. Its identity has yet to be determined, but no member of this complex has ever been identified as far north as Pennsylvania.

Dr. John Cooper at the North Carolina State Museum is the expert who is currently describing and naming the various species in the complex. In 2004 he began studying the Valley Creek specimens collected in 2003. His work on the taxonomy will determine whether these samples belong to a species new to science or represent a range extension of a species reported farther south. It may be years until the *C. acuminatus* complex is sorted out and the Valley Creek crayfish is assigned a scientific name. In the meantime the park is home to a reproducing population of crayfish previously unknown in Pennsylvania. Furthermore, Valley Creek clearly supports a unique and potentially threatened crayfish population that is in need of further study and protection. ■

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Research learning centers contribute to understanding of coastal resources

By Lynne Murdock

THE NATIONAL PARK SERVICE develops research learning centers to facilitate research and provide educational opportunities throughout the National Park System. Each center is unique and focuses on resources particular to an area's geography, landscape, culture, and history. Hence, research learning centers are places where research, education, and community partnerships come together over shared natural, fiscal, and human resources. Several research learning centers that serve national parks along coasts made significant progress in research and education in 2004.

Ocean Alaska Science and Learning Center staff is using video to describe inventory and monitoring work. The finished product, available in 2005, will showcase three inventories: freshwater fish at Kenai Fjords National Park, small mammals at Katmai National Park, and vascular plants at Aniakchak National Monument. At Kenai Fjords, interpreters regularly present programs on the center's archaeological survey and research findings on the black oystercatcher (*Haematopus bachmani*), a bird species whose striking appearance (black plumage, large size, and bright orange bill) makes it quite unlike any other. Cooperating scientists at the science and learning center presented seminars in which they shared their research findings with the public. Staff also transfers scientific information to the public via regularly updated exhibits. For instance, at a facility operated by Fox Tours, a company owned by Alaska Natives, more than 30,000 people who participated in tours had the opportunity to see an exhibit that highlighted coastal archaeology, particularly research on the Aleutiiq culture.

The Urban Ecology Research and Learning Alliance and the National Capital Region hosted a science symposium, "Spotlight on National Park Resources," in March 2004. Investigators presented results from several ongoing research projects, including pollutants in the Chesapeake Bay watershed. Students and NPS staff attended the symposium, held at the University of the District of Columbia in Washington, D.C. Afterward, in order to inform other audiences, staff displayed posters from the symposium at the National Park Service offices at 12th and Eye Street.

In July 2002, Acadia National Park acquired a 100-acre (40-ha) property on the Schoodic Peninsula in Maine. This property, which will host the Schoodic Education and Research Center, houses a former naval base, including 36 buildings on 30 developed acres (12 ha); it is also home to pristine intertidal areas. Although park staff is already using the developed area for existing programs, it is investigating market demand and partnership possibilities for the future research learning center and considering research opportunities in the intertidal zones.

Education staffs from Channel Islands National Park and the Southern California Coast Research Learning Center, located in Santa Monica National Recreation Area, continue to benefit from

University of Alaska graduate student Julie Morse prepares to draw blood from a black oystercatcher with the assistance of NPS Resource Management Specialist Mike Tetreau. University involvement, fostered by the Ocean Alaska Science and Learning Center, has resulted in a high quality and quantity of data that would not otherwise have been gathered.

An archaeologist with the Smithsonian Institution shows a newly unearthed artifact to a park visitor in Kenai Fjords National Park, Alaska. This collaborative research project, sponsored by the Ocean Alaska Science and Learning Center, brings the National Park Service together with the Smithsonian, the University of California–Berkeley, the Pratt Museum, and the Alaska Native villages of Nanwalek and Port Graham.

academic and cultural connections made during the JASON Project, held at Channel Islands in January 2003. The yearlong program exposed 1.6 million students and 35,000 teachers to leading scientists who worked with them as they explored and examined planet Earth and its biological and geological development. Long-term relationships made with researchers at NASA, the National Oceanic and Atmospheric Administration, and the Santa Barbara Maritime Museum during the JASON Project have raised the quality of educational programs at Channel Islands National Park and increased the number of schools the Southern California Coast Research Learning Center reaches.

North Coast and Cascades Learning Network partnered with academic institutions such as the University of Washington to provide seed money in the form of grants for graduate students to do aquatic research in Olympic, Mount Rainier, and North Cascades National Parks. Additionally, investigators completed cultural research on the history of a large basket collection from Olympic National Park. Park interpreters will make this information, which had been stored in the park's natural history collection, readily available via the University of Washington Web site. ■

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Biodiversity explorations continue at Great Smoky Mountains ATBI

By Becky Nichols

The All Taxa Biodiversity Inventory (ATBI) aims to document all life in Great Smoky Mountains National Park (Tennessee and North Carolina), identifying not only the species but also their life histories, seasonality, distribution, and abundance. In 2004 the ATBI continued to make steady progress with new findings, fieldwork, and collecting events. Fifteen "mini-grants" were awarded for projects, including inventories of tardigrades (tiny animals called water bears), lichens, micromoths, ants, beetles, flies, worms, aphids, grasshoppers, and microfungi, to name a few.

Since the inception of the ATBI seven years ago, some taxonomic groups, such as the Lepidoptera (moths, butterflies, skippers), have a nearly complete checklist. Although the lepidopterists have selected slightly different summer dates for the three Lepidoptera blitzes to date, a reduced number of new discoveries has occurred with each subsequent blitz, as expected. About 300 species were added to the park's already active checklist during the first blitz, approximately 150 in the second blitz, and about 25 from summer 2004. The consensus is that many (but not all) species that fly in the summertime have been sampled adequately. Currently, more than 1,600 species of Lepidoptera are known from the park, and most of the researchers involved believe that the final number will be 2,000 to 2,500 or perhaps a little higher. Species that are difficult to find, such as those that live in unique habitats or that are highly seasonal, will add to this number. An autumn or late-winter/early-spring blitz is proposed for the next activity.

Documented as part of the Great Smokies ATBI are a spread-winged damselfly (family Lestidae, above) and an American climbing fern (*Lygodium palmatum*, below). Insects in this family are common inhabitants of small ponds, swamps, and stream pools. The fern has been found sporadically throughout the eastern United States but is considered rare in the national park.

In addition to collecting ecological, distributional, and other types of information about species, many scientists are collecting DNA material. In 2004 the lepidopterists concentrated on providing vouchered specimens for genetic analyses as part of the "Bar Code of Life" project at the University of Guelph in Ontario, Canada. Mycologists also are using genetic analysis, particularly for taxonomically difficult groups, some of which were collected at the national park as part of the Fungi Quest in the summer.

As of mid-December 2004, the number of new records for the park is 3,351. The number of species new to science has increased by more than 100 since November 2003, making the total now 539. ■

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Three new research learning centers open their doors in 2004

By Lynne Murdock

PEOPLE AND PARTNERSHIPS ARE THE HEART of research learning centers, but facilities—primarily existing park structures—and innovative funding arrangements keep it beating. In 2004, three new research learning centers opened their doors and began facilitating research and education in the National Park System in Alaska, Oregon, and Kentucky. In Denali National Park, a new building, with a dividable classroom, exhibit area, and office space for staff and visiting researchers, will house the Murie Science and Learning Center. Located next door is a new dining facility, which is shared with the park concessionaire, Doyon/ARAMARK Joint Ventures. In Crater Lake National Park, the former chief naturalist's and superintendent's houses, both on the National Register of Historic Places, will become the Crater Lake Science and Learning Center. In Mammoth Cave National Park, an existing park facility, known as the Maple Springs Research Complex, was remodeled to provide space for 43 visiting researchers and graduate students and classrooms to accommodate university and school groups.

Funding for the Murie Science and Learning Center in Alaska comes from a variety of sources: Doyon/ARAMARK Joint Ventures, the Denali Institute, and the Denali Borough School District. Crater Lake Trust, an offshoot of the National Park Foundation and a progressive friends group, manages an interest-bearing account with revenue from the sale of the Crater Lake "Centennial" license plate. This funding and a grant from Jeld-Wen enabled work crews to begin structural rehabilitation on the Crater Lake Science and Learning Center building. The Mammoth Cave International Center for Science and Learning entered into a cooperative agreement with Western Kentucky University to coadminister the research learning center's program. Under the agreement the university will provide a research director to manage scientific research projects that are associated with the center; the director will begin working in January 2005.

An important revenue stream for the Murie center is the park tour booklet, *Denali: A Living Tapestry*, published by the Alaska Natural History Association and marketed by Doyon/ARAMARK Joint Ventures to all visitors who take a tour in Denali National Park. Based on a percentage of profit from fee-based programs, the Denali Institute assists in operation of the center by providing additional funding for equipment and supplies. The Denali Borough School District is a

Department of the Interior (DOI) staff and friends celebrated the official dedication of the Murie Science and Learning Center on 16 August 2004. Visible left to right: Mike Sfraga (Denali Foundation), Jack Reiss (Doyon/ARAMARK Joint Ventures), Marcia Blaszak (Alaska Regional Director), Jan Murie (son of Adolph and Louise Murie), James Tate (DOI Science Advisor), Mark Moderow (Alaska Natural History Association), Randy Jones (NPS Deputy Director), Carol Lewis (University of Alaska–Fairbanks), and Paul Anderson (Denali National Park Superintendent). Not visible but also in the lineup were Bob Whicker (Denali Borough School District) and Marie Monroe (Doyon Limited).

Beginning with a carcass, middle-school students from the Denali Borough School District (Cantwell School) cleaned the bones and rearticulated this wolf skeleton, which now stands as the main display in the Murie Science and Learning Center.

donor and partner in the design and development of the Wireless Cloud Network, a state-of-the-art video teleconferencing and distance learning tool for park use. One strategic goal of the school district is to collaborate with the Murie center. As a frequent partner in grant writing, the district has made many of the center's programs possible. Through dedicated work with partners and the commitment of Denali National Park management, this research learning center is making great strides in serving a large geographic area with quality information and opportunities.

Ever since the discovery of Crater Lake—the deepest lake in North America at 1,932 feet (589 m)—scientists have been analyzing the lake's clarity and biological components. In addition to the decades of aquatic-based information that park staff and cooperators have collected, synthesized, and maintained, terrestrial studies are ongoing. Crater Lake National Park cultivates important working relationships with academic institutions such as Oregon Tech and Oregon State University; it also cultivates community appreciation. Not surprisingly, then, the National Park Service conceived the idea for a Crater Lake Science and Learning Center years ago, but in 2004 it was finally implemented.

The Mammoth Cave International Center for Science and Learning worked with the Karst Field Studies Program at Western Kentucky University to offer eight weeklong field studies to teachers, university students, and professional scientists. Research included monitoring of park salamander populations to determine species richness, abundance, and preferred habitats; a study to determine the impacts of introduced rainbow trout on the endangered Kentucky cave shrimp; quantification of ozone concentrations in Cumberland piedmont parks; mercury biomagnification in park biota; and long-term monitoring of cave fish, cave crayfish, and cave shrimp.

Through the use of innovative funding methods, existing park structures, and facilities integrated with park construction plans, these three research learning centers now serve parks, communities in which they reside, and other National Park System units in their regions. ■

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Electronic Authentication tested for Research Permit and Reporting System

By Derrick Dardano and Bill Commins

THE INTERNET PROVIDES AN EFFICIENT WAY to interact with the public, informing people about requirements and protocols and enabling them to participate in the permit application process. The Research Permit and Reporting System provides a Web site to communicate park research needs, park-specific permit conditions, and important contact information. The public uses the site to access this information and to apply for permission to conduct natural resource and social science research and collecting activities within U.S. national parks. Annual progress reports of permitted research are submitted to the National Park Service through the Investigator Annual Report process. The Research Permit and Reporting System also provides a Web site available only to National Park Service staff, which includes password-protected park research coordinator accounts used to track the processing of the applications into permit decisions. The system uses a standard set of procedures and products that respond to requirements of the Paperwork Reduction Act, including the use of auto-messaging to communicate with park research coordinators, curators, superintendents, and principal investigators.

The E-Authentication Initiative … is establishing a government-wide identity verification service for Web-based federal applications.

The current process for permit approval requires a paper component at the signature stage, with signatures required from the applicant, park approving official, and repository manager. Applicants must sign a copy of the permit, which is then countersigned by the park approving official. Specimen collection also invokes a signature routine between the park and repository manager.

NPSFACT

The National Park Service **issued 2,774 permits in 2004 for scientific research** and collecting activities conducted throughout the National Park System.* Since 2001, when such permits were first tracked, the numbers have continually risen, beginning with 2,231 that year, followed by 2,367 in 2002 and 2,501 in 2003.

**Permits are required for scientific research activities that involve natural resource or social science fieldwork and specimen collecting of biological, geological, or paleontological resources. Activities such as birding and noncommercial photography are not regulated by permit; some official research and collecting conducted by NPS staff requires a permit. Other permit procedures apply to scientific activities pertaining solely to cultural resources.*

As the National Park Service moves this process to an online environment, an important legal question must be addressed: Is an agreement binding if it is made online by parties whose identities have been electronically authenticated? To answer this question, the National Park Service sought the assistance of the E-Authentication Initiative.

The E-Authentication Executive Steering Committee awarded funding in 2004 to allow the National Park Service to test whether an electronic agreement using trusted credentials at an appropriate level of assurance matches the level of confidence it would have in an e-signature. Managed by the General Services Administration, the E-Authentication Initiative (an E-Gov project) is establishing a government-wide identity verification service for Web-based federal applications. A single, government-wide approach to electronic authentication allows the public to reuse identity proofing among different agency applications. The E-Authentication approach to identity proofing is based on four levels of assurance of the asserted identity of a person attempting to access online services. Agencies determine the level of risk associated with the transaction by performing a risk assessment, and then decide what level of assurance best mitigates the risk. The Research Permit and Reporting System can experience several levels of risk when working with each user. For example, the transaction of issuing a permit has a higher risk level than the submission of an application for a permit. The public acquires electronic credentials through a credential service provider. The electronic credential identifies the holder and his or her level of identity verification.

If the test proves the concept is workable, the National Park Service will consider adopting it for the Research Permit and Reporting System, making the process entirely electronic. The one-year project has a reporting extension of six months to allow for an entire research cycle (application, permitting, field season, Investigator Annual Report). The National Park Service provides project management, and Colorado State University supplies technical support and research under a cooperative agreement through the Cooperative Ecosystem Studies Unit of the Colorado Plateau. Field-testing will involve up to 20 volunteer parks, and Research Permit and Reporting System applicants who are willing to participate. Results of the testing will determine whether E-Authentication serves the needs of the parks and the scientific community. ■

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Fossil rhinoceros discovery at Wind Cave National Park

By Greg McDonald and Rod Horrocks

Fossils, like gold, are where you find them, but you can never be sure what type of fossils you will find—common or rare, fragmentary or complete. This is the challenge of not only the science of paleontology but also the management of fossil resources in national parks. What can start as a simple survey may result in an exciting discovery of scientific importance, which is exactly what happened at Wind Cave National Park in South Dakota.

In an effort to update the status of the park's fossil resources in 2003, resource managers inventoried some exposures where investigators had previously found fragmentary fossils. They fully expected that this survey would take only a single day and produce fossils similar to those previously found, for example ends of bones and teeth of a variety of animals. No fossils were found at the first few surveyed sites, but in the last area checked, investigators found both upper tooth rows of a skull. Examination of the immediate area revealed numerous remains of bones and teeth, which appeared to be from the skull and lower jaw of an extinct hornless rhinoceros called *Subhyracodon occidentalis.* Because of the fossils' fragile nature, park managers quickly made plans to conduct an excavation to properly document this find.

Totally unexpected, however, was the discovery of additional rhinoceros bones, indicating that the skull was not an isolated find but part of a disarticulated skeleton. Further excavation uncovered a partial skeleton of a small early horse, *Mesohippus*, and the remains of other animals such as an unidentified carnivore, a tortoise, and an early deerlike animal. Hence, what had started as a one-day excavation turned into two weeks of work during summers 2003 and 2004.

What makes this discovery so exciting is that in the Black Hills, fossils the same age as those of the well-known Badlands are rare, and the recovery of two partial skeletons even rarer. The study of both the animals and the sediments of the Centennial site, named in honor of its discovery during the park's centennial year, will provide important information about the environment of the Black Hills 34 million years ago. ■

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Physical science staff Rod Horrocks and Kali Pace apply plaster bandages to the articulated foot of a rhinoceros discovered at Wind Cave National Park.

Because the park does not have a fossil preparation lab, it developed a partnership with the nearby Mammoth Site in Hot Springs to enable volunteers, such as Niranjala Kottachchi (shown with the rhinoceros skull and jaw), to clean, repair, and catalog fossils for the park's museum collection and to prepare them for study.

award-winner

L. David Mech, leader in wolf research, receives Director's Award for Natural Resource Research

Dr. L. David Mech has studied wolves across North America, and his understanding of their behavior and ecological role has become the basis of wolf management throughout the Northern Hemisphere. He began his research 45 years ago in Isle Royale National Park (Michigan) as a graduate student observing wolves as they stalked, chased, and killed moose. Over the course of his career, he has continued to conduct research in the national parks and train students to do the same, especially in Isle Royale, Yellowstone National Park (Wyoming), and Denali National Park and Preserve (Alaska). These vast wilderness areas have been his laboratories. "National parks have long been critical locations for wolf studies," Dave says, "and I feel very privileged to have conducted most of my studies in them."

Perhaps his best-known contributions have come from his work at Yellowstone, where he played a significant role in the reintroduction of wolves at the park. At the beginning of the process, he was part of a group of 15 scientists who contributed to a report for Congress, *Wolves for Yellowstone?*, that laid the groundwork for the restoration. When the wolves were captured in Canada in 1995 and 1996, Dave helped oversee their capture, holding, processing, and transportation. After the wolves were brought back to Yellowstone and central Idaho, Dave testified as an expert witness on behalf of the government in a court challenge to wolf restoration. He started the Durward Allen Fund (named for his own mentor) with a large personal contribution to the Yellowstone Park Foundation to initiate an intensive wolf research program. He continues to lead research on wolf-prey interaction at Yellowstone, and his published findings have had a direct impact on current understanding and management of these predators.

Dave's work at Yellowstone is a small sample of his accomplishments. He pioneered the use of wildlife telemetry and, with graduate student Shannon Barber, produced a report for the National Park Service discussing and critiquing its use. The report has been very helpful to wildlife biologists in many park units. He founded the International Wolf Center in Ely, Minnesota, to support the survival of wolf populations by teaching about their role in the wilderness. He has published numerous articles and 10 books, including two comprehensive works on the wolf. Currently he is senior scientist at the USGS Biological Resources Division, Northern Prairie Wildlife Research Center, and works out of the Raptor Center at the University of Minnesota in St. Paul. Dave is a lifelong student of wolves and teacher about wolves for professionals and the public. As a result of his efforts, the human role in the wolf's future will be an enlightened one. ■

Documenting a 30-million-year-old landscape and its inhabitants at Badlands National Park

By Rachel C. Benton, Emmett Evanoff, Carrie Herbel, and Dennis O. Terry, Jr.

The Badlands of South Dakota are teeming with evidence of life from 30 million years ago. Slopes, pinnacles, and buttes are eroding and revealing a once-verdant grassland. In summer 2004, field paleontologists recorded new fossil localities in the Poleslide Member of the Brule Formation in Badlands National Park. They used GPS to record the information and entered the data into the park's GIS database. They also collected, prepared, and cataloged all scientifically significant fossils through the NPS Automated National Catalog System (ANCS+) curatorial database. The three-year project, funded through the Natural Resource Preservation Program, is a detailed study of the abundance and diversity of vertebrate fossils, their stratigraphic position, and their associated depositional environment. In addition, researchers from the park, museums, and universities are looking at the impact of visitor use on these fragile resources. By comparing areas of high visitor use with isolated locations, investigators can estimate the amount of fossil material lost to theft.

The three-year project … is a detailed study of the abundance and diversity of vertebrate fossils, their stratigraphic position, and their associated depositional environment.

The Poleslide Member provides the earliest evidence of the widespread prairie that now covers the Great Plains. Geologists have determined that the member is composed of homogeneous, windblown sediments (loess), punctuated by periods of landscape stability represented by ancient soils. Even after several years of intensive paleontological surveys, the Poleslide Member in the Cedar Pass area continues to yield rich fossil finds, except in heavily used areas. The Cedar Pass location is distinctive because it provides access to rocks and fossils from the Poleslide Member not readily available in other parts of the park; therefore, this study site reveals the relative abundance of fossils that are likely to be found in this rock unit as it is exposed throughout the park. The Poleslide Member around Cedar Pass provides a unique opportunity to inventory an ancient ecosystem, decipher fossil loss, and obtain a baseline of animal assemblages that existed 30 million years ago. ■

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The White River Group, which is composed of three rock formations, is exposed at Badlands National Park. The Poleslide Member of the Brule Formation has yielded many new fossil localities and valuable information about animal assemblages in a 30-million-year-old ecosystem.

Rocky Mountain National Park archives animal tissues for research on chronic wasting disease

By Terry Terrell

Unparalleled as laboratories for certain types of research, national parks also are invaluable as sources of research materials for scientists who may never set foot in a park. Rocky Mountain National Park (Colorado) has been working with NPS veterinarian Margaret Wild (see related article on page 19) to archive deer and elk tissues collected by park staff for purposes of chronic wasting disease (CWD) management. Chronic wasting disease is a fatal brain-wasting disease that affects ungulates across most of the United States and parts of Canada and is becoming more prevalent among wildlife in national parks. Most of the animals collected are known or highly suspected to have CWD and are being removed from the population to prevent disease transmission; a few were found dead, appearing to have died of the disease. The tissues are used by researchers interested in studying CWD and in developing animal-side tests (those that can be accomplished in the field—beside the animal) and vaccines for control of this disease. Most management actions undertaken by state game management agencies do not include testing animals slaughtered to control CWD or archiving tissues, and, though they may use tissue samples for their own research purposes, they are unable or unwilling to share samples. This has hampered the infant field of research on quick diagnoses and vaccine development that will ultimately provide vital tools for managing the disease.

Park staff administers antibiotics and fits a radio collars to a mule deer after performing a tonsillar biopsy. The collar will help staff find the deer in about two to four weeks if tests show the animal has chronic wasting disease.

Interest in this scarce resource is growing. Rocky Mountain National Park issued one permit in 2003 and three permits in 2004 for researchers to obtain samples from NPS archived tissues for further study. Under contract to the National Park Service, Colorado State University (CSU) performs the necropsies on the ungulates sent by the park. Tissues are archived in cold storage at CSU under the supervision of Dr. Wild. They are delivered to researchers after they obtain a research permit and sign a materials transfer agreement specifying that if any economically valuable benefits come from their research, they will sign a revenue-sharing agreement with the National Park Service. Although researchers are not sampling tissues in the park, they are accomplishing research vital to the park's future management of its deer and elk populations. The potential benefits of this research extend well beyond the boundaries of Rocky Mountain National Park to any land managers struggling to deal with the devastating effects of CWD. The park's contributions to this research may someday result in a way to control or cure this devastating disease. ■

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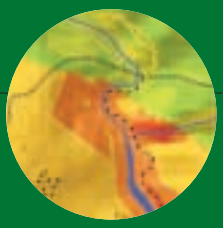
6 Science for Parks



"Although an adequate science program alone cannot ensure the integrity of the national parks, it can enable faster identification of problems, greater understanding of causes and effects, and better insights about the prevention, mitigation, and management of problems."

National Research Council

Stewardship of the vast array of resources in the national parks is a tremendously important and increasingly exacting responsibility for the National Park Service. Spread out over 85 million acres (34 million ha) in 388 units located in 49 states and 4 territories, park resources are incredibly diverse and dynamic. Ensuring their well-being amid global, regional, and local environmental forces of change and providing for their enjoyment by the roughly 275 million annual visitors to the national parks require sound management based on scientific information. As the articles in this chapter illustrate, science and collaborative scientific partnerships are addressing a wide variety of information needs and aiding park management decision making. Ecological information detailing the presence, distribution, sensitivity, and condition of park resources is helping managers to protect, restore, and recover natural systems. Sociological information about park visitors, such as their opinions about natural resource protection and their preferences for park interpretive information, is helping staff of the National Park Service become better stewards and public servants. Economic information, too, is being used to prioritize and plan resource management activities. Though the following articles highlight but a small portion of the scientific applications to park management for 2004, they are indicative of a healthy attitude toward park science for the future that includes collaboration, innovation, and dedication.

Assessing riparian system recovery at Santa Rosa Island, Channel Islands National Park

By Joel Wagner, Kate Roney Faulkner, Sarah Chaney, and Michael Martin

IN 1995 THE STATE OF CALIFORNIA DIRECTED managers at Channel Islands National Park to correct water quality problems on Santa Rosa Island caused by year-round grazing of approximately 5,000 cattle. Authority for regulating water quality in the park is delegated to the state in accordance with the federal Clean Water Act. To respond, park managers needed a rapid evaluation of riparian conditions on the island; they also wanted to know if changes to existing livestock management would help achieve water quality goals. A multiagency, interdisciplinary team decided to use the Bureau of Land Management's (BLM) "Process for Assessing Proper Functioning Condition" (PFC) to evaluate 10 stream reaches in seven of the island's watersheds. Three of the 10 reaches were "reference reaches" that were largely or completely inaccessible to cattle, while the other 7 were subject to year-round cattle grazing.

Investigators completed fieldwork for the initial assessment in March 1995. Of the seven stream reaches that were subject to year-round cattle grazing, six were "nonfunctional" and one was rated "functional at risk." Of the three reference reaches, two were in "proper functioning condition" and one was rated "functional at risk." In nonfunctional systems, an oversupply of sediment from upland and channel sources had exceeded the streams' transport capability, resulting in mostly braided channel forms, high lateral instability, and other characteristics that were out of balance with the landscape setting. In addition, riparian-wetland vegetation was almost completely absent, exposing banks to excessive erosion in each flood event.

The National Park Service eliminated cattle from the island in 1998 and substantially reduced deer numbers. Riparian vegetation cover and water quality then dramatically improved. In 2004, park managers requested assistance from the NPS Water Resources Division to perform postgrazing riparian reassessments on the island. In order to evaluate and document vegetative and geomorphic changes, investigators reapplied the same (PFC) method and took repeat photographs on the stream reaches that were assessed in 1995. The main inquiry was: by removing cattle, had riparian areas that were "nonfunctional" in 1995 returned to "proper functioning condition," or were additional management steps necessary for recovery?

All six reaches that were rated nonfunctional in 1995 regained proper functioning condition.

The 2004 team found that all six reaches that were rated nonfunctional in 1995 regained proper functioning condition. Sediment-choked, braided channels evident in 1995 have progressed to narrower, deeper, meandering channels with well-developed floodplains that are in balance with the landscape setting. Herbaceous riparian-wetland vegetation that was nonexistent in 1995 now covers more than 90% of the area along most of these reaches. However, the expected woody riparian components (willows and cottonwoods) have not reestablished. Although willows and cottonwoods may not be absolutely necessary for bank and floodplain stabilization in these

In just six years since cattle grazing was discontinued, Arlington Canyon on Santa Rosa Island has been transformed from a nonvegetated, braided stream channel considered "nonfunctional" (left) to one with appropriate riparian-wetland vegetation, and evaluated in 2004 as functioning properly (right). The change was documented by resource managers who repeated an appraisal process to determine stream condition that they had first applied in 1995. In the 1995 photo (left), excess sediment derived from the overgrazed watershed and nonvegetated stream banks fills the channel and degrades water quality. In the 2004 photo (right), sediment deposits have created a functional floodplain, and the narrower, meandering channel has improved water quality and aquatic habitat characteristics.

The BLM "Process for Assessing Proper Functioning Condition" *is a rapid assessment of riparian function according to 17 hydrology, vegetation, and stream geomorphology factors. Ratings include "proper functioning condition," "functional at risk," and "nonfunctional." The proper functioning condition of a riparian area refers to the stability of the physical system, which in turn is dictated by the interaction of geology, soil, water, and vegetation. A riparian system in proper functioning condition is in dynamic equilibrium with its streamflow forces and channel processes. The system adjusts to handle larger runoff events with limited change in channel characteristics and associated riparian-wetland plant communities. Because of this stability, properly functioning riparian areas can maintain water quality, fish and wildlife habitat, and other important ecosystem functions even after large storms. In contrast, nonfunctional systems in the same storms might exhibit excessive erosion and sediment loading, loss of fish habitat, and loss of associated wetland habitat.*

reaches, they would enhance such stability, help dissipate flood energy, and provide valuable wildlife habitat that likely occurred historically in the canyons. Hence, the 2004 team identified management actions (including planting willow and cottonwood) that would put the recovering riparian systems on a trajectory toward desired future conditions.

The remarkable improvement in Santa Rosa Island's riparian conditions since 1995 demonstrates these systems' abilities to restore themselves once the major stressor—year-round cattle grazing—is removed. The transition from nonfunctional to properly functioning riparian systems became possible when vegetation recovery in the watersheds led to decreased runoff and sediment delivery to the island's stream systems and when appropriate riparian-wetland vegetation became established. ■

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Search for aquatic invasive species in Mississippi and Gulf Islands National Seashore

By James M. Long

Fishery biologist Jim Long sorts and identifies a sample of fish that was captured as part of the rapid assessment.

Rapid assessment is a quick and intensive inventory of species and evaluation of ecological conditions that often involves tens or hundreds of scientists investigating an area of management concern. It is an efficient way to describe baseline conditions and is an especially valuable tool for recording the presence and extent of invasive species. In August 2004 the National Park Service at the Mississippi unit of Gulf Islands National Seashore teamed up with AMRAT (Alabama-Mississippi Rapid Assessment Team), a multiagency consortium, to conduct a rapid assessment of the Mississippi Sound.

Twenty-nine agencies involving 116 individuals participated in the weeklong study. Team members pulled seines through nearshore areas, lagoons, and ponds to collect plants and animals. They scraped bridge pilings for attached invertebrates, combed the beach, and examined terrestrial plant communities. They also trawled the bottom and mid-depth areas of the ocean, electrofished upper estuaries, sampled oyster beds, and trapped crabs. As investigators in the field collected specimens and recorded notes, a team at the Gulf Coast Research Laboratory sorted and identified the samples that were being brought in.

Though the plant data are still being processed, the assessment documented 330 animal species. Most (109) were fish, but the samples also included 95 crustaceans, 54 mollusks, and 31 annelids or segmented worms. Two invasive species were discovered: the Asian clam (*Corbicula fluminea*) and the Nile tilapia (*Oreochromis niloticus*). The Asian clam has been known to take over aquatic systems, whereas impacts from the escapement of Nile tilapia, a species introduced from Africa to the United States for food production, into natural systems are not known. These data will eventually be housed in a geographic information system format accessible through the Gulf States Marine Fisheries Commission Web site (http://www.gsmfc.org).

With this assessment, Gulf Islands National Seashore has obtained regional species data, enabling it to compare park species lists with those of the surrounding area. In particular, this information will allow seashore managers to deal with threats of exotic aquatic species that might invade park lands. ■

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Using bat assemblages as a measure of ecosystem health

By Leslie Chow, Elizabeth Pierson, and William E. Rainey

IN 2003 THE U.S. GEOLOGICAL SURVEY and University of California–Berkeley began a three-year study to investigate patterns of bat distribution and activity in response to aquatic insect emergence and abundance in Yosemite National Park, California. Called "Project Bats and Rivers," the study is funded by the Yosemite Fund, a private, nonprofit partner of the park. Using a combination of acoustic sampling and mist (fine mesh) netting, investigators learned that the number of bat species declines as elevation increases; the number of species with reproductive populations also declines with elevation. Preliminary analyses reveal considerable night-to-night variation in activity levels at most sites. Bat activity in the summer and autumn generally correlates with ambient temperature, with the greatest activity occurring on the warmest nights. In 2004 the team made the unexpected discovery that, though activity is low on the coldest nights, insect emergence and foraging continue at temperatures near freezing. Although the Bats and Rivers project started as an investigation of bat distribution and activity, two years of fieldwork suggested that the techniques being used were also applicable to monitoring ecosystem function by detecting changes in bat assemblages (groups of bat species inhabiting specific areas).

As predators that rely almost exclusively on insects, bats may provide a reliable measure of ecosystem function.

Until recently, bats have been hard to study because they are nocturnal and capturing them in mist nets is challenging. Acoustic detection now provides a reliable technique for recording and identifying each species based on its unique echolocation calls. During the 2004 field season the team continued to modify and improve the reliability of the Anabat acoustic detection system so that it can be used for long-term monitoring. Falling prices and lower power requirements for data storage devices have allowed investigators to deploy equipment that can operate without intervention for up to three months. These devices, which turn themselves on at dusk and off at dawn, store bat calls on small memory cards. The solar-powered systems have allowed researchers to sample simultaneously at multiple locations for extended periods with minimal labor. The system automatically identifies the species and records its abundance for a given night.

The team tested the efficacy of using this equipment in July 2003 by deploying 15 detectors simultaneously at selected elevations for six to eight nights. The detector in Yosemite Valley, when downloaded in late January 2004, revealed highly unexpected results: very high levels of bat activity (rivaling levels in summer) over the river, even on nights when the temperature dropped well below freezing. To place this finding in context, there is almost no information regarding where California bats winter. Although very large aggregations hibernate in caves in the eastern and midwestern United States, very little is known about winter behavior or overwintering sites for most western species. The intense bat activity, involving at least three species, suggests that Yosemite Valley, with its combination of granite cliffs and nearby river, may serve as a significant winter refugium for bats.

Comprising the second largest order of mammals in North America, bats trail only rodents in number of species. The NPSpecies database has records for 77 species and subspecies of bats in 141 units of the National Park System, with an average of 5 species per unit. Seventeen bat species occur in Yosemite National Park, including the spotted bat (*Euderma maculatum*, juvenile shown). The park is the site of a three-year study of bat activity and overwintering habits. The study tested solar-powered Anabat acoustic detection systems to monitor winter bat activity at 15 sites in Yosemite National Park, including this one along the South Fork of the Merced River.

As predators that rely almost exclusively on insects, bats may provide a reliable measure of ecosystem function. Changes in the composition of bat species in a particular location may reflect ecosystem changes that require more intensive study. Using arrays of 8 to 10 acoustic detectors spread among a variety of habitats enables investigators to "capture" the widest diversity of bat species, increasing the chances of detecting those that are rare or habitat-specific.

The Sierra Monitoring Network is currently inventorying bats in three parks. In Sequoia National Park, two Anabat acoustic detectors are monitoring bat activity over the 2004–2005 winter. A remaining challenge for the Anabat system is developing filters that will fully automate the identification of bats from their calls. Though the Anabat acoustic detection system recognizes the sonogram of the calls of many species, some species still require visual examination of call sequences. The team is also working on designing a statistically valid sampling protocol for detecting real changes in bat assemblages. When the protocol is fully developed, assemblages of bat species could be selected as a "vital sign," an indicator of ecosystem conditions for monitoring networks where bats abound. ■

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Evaluating ecological services and replacement costs of the urban forest in our nation's capital

By Gopaul Noojibail and Brad Conway

URBAN FORESTS PROVIDE FUNDAMENTAL ecological and psychological benefits to cities and their inhabitants. Trees in urban areas act as biological machines that reduce air pollution, filter and absorb storm water, and cool temperatures. Additionally, trees give people a sense of well-being amidst a hectic urban environment.

Altogether, the National Park Service manages more than 16,000 culturally significant trees in the National Mall and Memorial Parks and at President's Park (the area around the White House) in Washington, D.C. Managing these trees for sustainability and longevity is important because many are global icons, including the American elms that line the National Mall and the delicate Japanese cherry trees that surround the tidal basin. Trees that are historical, culturally valued as memorials, given as donations, and highly visible and charismatic are major assets that can be translated into dollars in terms of their values both as capital assets (i.e., replacement costs) and ecological services (i.e., pollution removal and carbon sequestration). Moreover, because of the relatively harsh conditions of the urban environment in Washington, D.C., these trees require exceptional care.

In 2003–2004, the National Park Service partnered with the USDA Forest Service, the Casey Tree Foundation, and the University of Maryland to assess the health, diversity, and age of one of the nation's most recognizable urban forests and to assign dollar values to its capital worth and ecological services. Teams of trained technicians composed of seasonal rangers, university interns, and volunteers conducted fieldwork to collect information about the urban forest during summer 2003 and 2004. These technicians collected data on the geographic locations of all the trees, including site information; tree identification; biometric measurements (e.g., diameters at breast height, tree heights, and crown volumes); and numerical and qualitative characteristics of crown, trunk, and root deformities and conditions. Investigators inputted the data into the USDA Forest Service Urban Forest Effects (UFORE) quantitative computer model, which allowed them to quantify ecological services, forest structure, and capital asset value.

Teams collected and analyzed data on 16,238 trees, then estimated the capital asset value of the trees at more than $30 million. This is not the ecological or societal value of the forest but an estimate of tree replacement costs. Of the trees inventoried, 87% were in good to excellent condition and provided ecological services amounting to more than 8.8 million pounds (4,000 metric tons) of carbon storage with about 200,000 pounds (90 metric tons) of carbon sequestered per year. Carbon stored in trees and other plants can help mitigate atmospheric effects of carbon dioxide released into the environment by motor vehicles. The inventoried trees provide additional benefits in the form of pollution removal to the sum of 121,254 pounds (55 metric tons) of pollution removed annually, a service estimated at more than $26,000.

The National Park Service manages more than 16,000 culturally and ecologically significant trees in Washington, D.C. During summer 2003 and 2004, teams of trained technicians collected biometric data on these trees using personal data assistants (PDAs) linked to GPS units (below). Investigators used the information to quantify the trees' ecological services, forest structure, and capital asset value; NPS staff will continue to use the information for future maintenance and site planning.

Using baseline data from the inventory, resource management staff at the National Mall and Memorial Parks is developing a maintenance-based data collection tool and GIS program to better address management needs. For example, future data applications will include identifying where trees are missing in accordance with site planting plans, tracking diseases throughout the community, tracking survivorship of Dutch elm disease–resistant elm cultivars, identifying survivorship of tree species in different areas, creating a historic-tree preservation plan, and directing maintenance efforts. Staff will continually update this database with information about new tree plantings, removals, and causes of removal.

In order to track changes in the urban forest over time, teams will reassess 10% of the community every year to detect overall changes and trends, with the intention of completing a new inventory every 10 years. In addition, the tree maintenance crew will use this collection system during tree care activities, and the information will facilitate planning efforts directed at maintaining and increasing the number of healthy trees in National Park System units in our nation's capital. ■

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Sources of regional haze identified at Big Bend National Park

By John Vimont

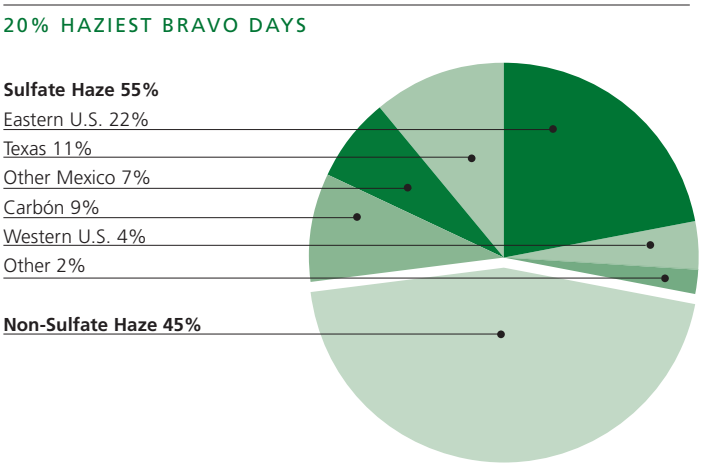
LOCATED IN SOUTHWEST TEXAS, BIG BEND is one of the few national parks where haze has been increasing since the late 1980s. Haze is caused by scattering and absorption of light (light extinction) by suspended particles in the air. Particles can stay suspended in the atmosphere for many days and can be transported for hundreds of miles. Sulfate particles are the single largest contributor to haze at Big Bend, accounting for about half of the haze on average and half on the haziest days. They form from chemical reactions of sulfur dioxide gas, which is emitted by coal-fired power plants, metal smelters, refineries, other industrial processes, and volcanoes.

During the 1990s, new coal-fired power generation, without sulfur dioxide pollution controls, was developed at the Carbón facilities near Piedras Negras, Mexico, 130 miles (209 km) east-southeast of Big Bend. The associated increase in emissions raised concerns about Carbón's contribution to sulfate and haze levels at the park. To determine the causes of haze at Big Bend, the National Park Service and the U.S. Environmental Protection Agency carried out the Big Bend Regional Aerosol and Visibility Observational (BRAVO) study in 1999, with participation by the Texas Commission on Environmental Quality and the Electric Power Research Institute. The Mexican government took part in the planning stages of the study, but declined to do so in the field measurement, data analysis, and modeling efforts. The long duration of the BRAVO analysis period was due to an ambitious consensus-building, stakeholder process with an emphasis on scientific peer review.

The BRAVO study included four months of intensive monitoring from July through October 1999, followed by extensive data analysis and modeling. Field measurements and subsequent laboratory analyses determined the concentrations and chemical composition of the atmospheric particles and the concentrations of unique tracer compounds that were released at four locations to assess particle transport. A number of methods were used to ascertain which source regions were contributing to the sulfate haze at Big Bend. Some involved examining the relationships among different measured chemical components and tracer compounds, while others were based on numerical models of the meteorology, pollutant transport, and chemical reactions of the atmosphere. One notable aspect of the BRAVO study was the innovative way in which numerical atmospheric modeling was reconciled with the measured chemical compounds to give a more accurate assessment of the contributors to sulfate haze.

The results of the study were published in 2004 and can be downloaded from http://www2.nature.nps.gov/air/studies/bravo/index.htm. A short sampling of the findings follows:

- On average, during the study period more than half of the sulfate at Big Bend National Park came from the United States, particularly the eastern region and Texas.
- On average, Mexican sources contributed about a third of the total sulfate; about a fifth of the total came from the Carbón I and II power plants.
- Eastern U.S. and eastern Texas sources were the largest contributors to peak particulate sulfate episodes.
- Airflow from eastern Texas and the eastern United States is most frequent in late summer and early fall when sulfate contributes most to haze.
- Mexico and the western United States were the largest contributors on the least hazy days of the study, which were frequently associated with air transport from the western United States.



The pie chart summarizes the estimated contributions of particulate sulfate by source region to haze levels at Big Bend National Park for the 20% haziest days of the BRAVO study period. Here, haze is expressed in terms of light extinction, which is the fraction of light lost from a sight path per unit of distance. The units used here are "inverse megameters" (1/Mm). Particulate haze of 56 1/Mm corresponds to a visual range of 37 mi (59 km).

For the future, sulfur dioxide emission reductions generally should help reverse the trend of worsening visibility in the Big Bend region. This is particularly true of sources in Texas and the eastern United States, given the significance of their contribution to haze. Reductions in these emissions from the western United States and northern Mexico would help maintain and improve the least hazy days.

Current and pending federal regulations should help reduce these emissions throughout the United States and make significant progress toward improving visibility in Big Bend National Park. Although sources in Mexico also contribute to visibility impairment at Big Bend, U.S. regulations have no effect in Mexico. Partnerships between agencies in Mexico and the United States to address transport of pollution might be of use in the Big Bend region. ■

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Resource management specialist caps career with precedent-setting projects

Some people have a talent for stirring things up. Others have the skill to smooth troubled waters. Occasionally, both attributes can be found in the same individual. Such is the case with **Carroll Schell**, recipient of the 2003 Director's Award for Natural Resource Management, given in spring 2004. Throughout his 34-year career with the National Park Service, Carroll initiated and participated in a variety of innovative resource management projects that will have lasting impact on the agency and the resources under his care. "I believe very strongly that when you surround yourself with quality staff, they make you look good. And, frankly, I was surrounded by the best," Carroll says. "Consider, for example, that in 14 years we introduced red wolves (attempt was unsuccessful), otters, barn-owls, native southern Appalachian brook trout to streams formerly occupied by exotic rainbow trout, and elk. But it wouldn't have happened if my staff wasn't driven by a cause. I did all I could to make sure they had the resources and tools to do their job.… And it worked."

As the supervisory natural resource management specialist at Great Smoky Mountains National Park, Tennessee and North Carolina, for 14 years prior to his retirement in 2004, Carroll Schell supervised an ongoing stream of projects related to air and water quality, vegetation, fisheries, and wildlife, many of which set new standards for Park Service resource management activities. As an example, the Tapoco project for relicensing four dams operating near the park challenged Carroll to work collaboratively with multiple partners through complex legal issues. He emerged as a conciliatory force that brought divergent interests together in a spirit of compromise to the benefit of all concerned. In resolving violations of federal legislation in the decades-old agreements, the project will create a land corridor for wildlife that links Great Smoky Mountains National Park with adjacent national forests and will create a fund from which about $100,000 will be available annually for natural resource projects along the corridor.

Carroll's successful and significant strides in natural resource management also speak to his ability to cultivate human resources. As Student Conservation Association (SCA) coordinator, Carroll employed more SCA workers at Great Smoky Mountains National Park in 2003 and 2004 than did any other federal agency. In 2003 alone, the Volunteers in Parks program under his coordination compiled 30,559 hours of service, including the SCA hours.

Carroll Schell's career contributions represent the best of the National Park Service, bringing parks and people together in a lasting legacy of stewardship of America's natural resource heritage. ■

NPSFACT
The FY 2005 budget for the National Park Service funds an additional two vital signs monitoring networks: the Arctic Network in northwest Alaska and the Southeast Coast Network in Florida, Georgia, Alabama, and North and South Carolina. This brings **the number of funded networks to 24 (shown in green), with 8 proposed for funding in FY 2006 (gray).** Monitoring networks are designed to document the status and trends of park natural resources in support of management decision making and resource protection.

Using GIS to define resource sensitivity at Prince William Forest Park

By Paul Petersen

An ongoing challenge for resource managers is to develop methods that identify areas of special concern, or highly sensitive areas, to protect natural and cultural resources. At Prince William Forest Park, Virginia, a geographic information system (GIS) is being used to analyze resource sensitivity in order to model suitable trail routes within the park. The Sensitive Area Model (SAM) is being used to identify forest communities that are inherently sensitive. The model evaluates location and terrain of natural and cultural resources, unique habitats, rare species, historically significant areas, and areas stressed from visitor impacts. The analysis results in output of geographic data, identifying zones of higher and lower resource sensitivity and suitable for display on a map.

The 37 miles (60 km) of trails in the park make it a popular destination for hikers from the Washington, D.C., area. Continual visitor use may impact resources associated with the trail network. In winter 2004, park staff used SAM to identify suitable locations for potential trail routes and areas that should be considered highly sensitive. The model included information on trails, streams, slope, historical structures, sensitive habitats, campgrounds, picnic areas, and rare species. The output is displayed as a map with a ramped color scale, with green corresponding to low sensitivity, yellow corresponding to medium sensitivity, and red corresponding to areas of high sensitivity (see illustration).

The SAM trail model was implemented in 2004 to evaluate a 1-mile (1.6-km) reroute of the South Valley Trail. The results helped staff to adjust the route to follow a path with low sensitivity. SAM methodology has many potential applications for use in any park. Two additional SAM applications planned for Prince William Forest Park are the evaluation of potential new entrance points and the assessment of areas at high risk for exotic plant infestation. ■

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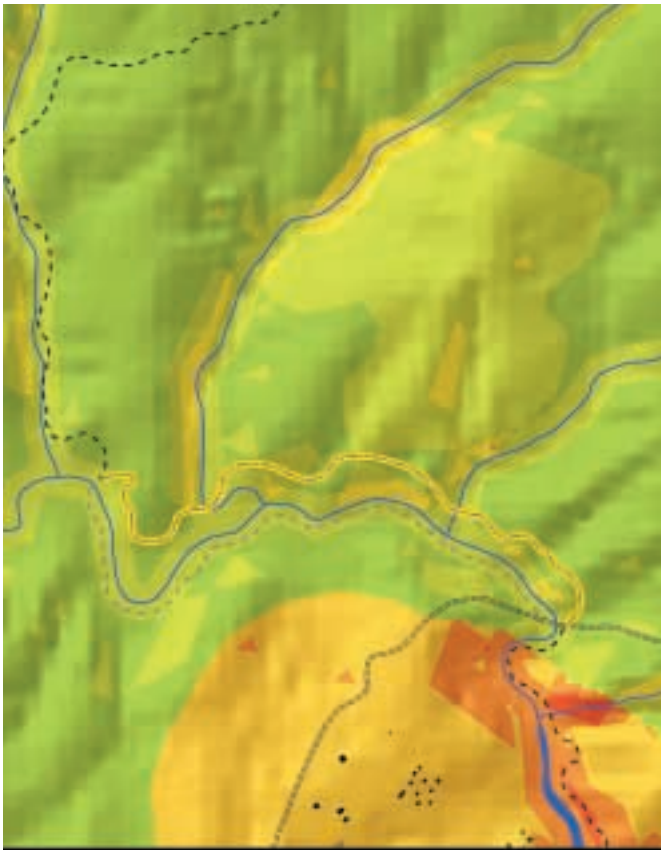
PRINCE WILLIAM FOREST PARK—CABIN CAMP 2&5 DISTRICT

SAM OUTPUT COLOR RAMP



Legend

Trail
Trail Reroute
> 25-degree Slope
Eastern White Pine
Structure
Paved Road
Unpaved Road
Hydrology

Resource Sensitivity

Low
Moderate
High

New Visitor Information System helps parks better understand visitor needs

By James Gramann and Chris Ellis

A NEW SYSTEM FOR THE ANALYSIS of national park visitation was piloted at Shenandoah National Park, Virginia, in 2004. In the past, parks have only counted the number of visitors, which gives park staff little insight into the people being served by the park and their needs. The new Visitor Information System (VIS), developed jointly by the NPS Social Science Program, the Recreational Fee Demonstration Program, and participating parks, will help park managers better understand such characteristics of park visitors as home location, racial and ethnic characteristics, and education attainment levels. This information can be used to improve park services and identify special needs.

The Visitor Information System collects data on visitors' Zip codes, countries of origin, and persons per vehicle. These data are then analyzed using census databases to create information based on what is known about people living in a particular Zip code. The project takes advantage of a fact long known to demographers and market researchers: people tend to live near people like themselves. Thus, in most cases the social and economic profile of a Zip code provides a reasonable picture of a visitor without invasion of privacy, since the information is not linked to specific individuals.

How does the Visitor Information System work on the ground? In the pilot effort, park personnel at Shenandoah began collecting information about people using park admission passes at entry points. The National Parks Pass and the Golden Age Passport (plastic version) have a magnetic strip encoded with a unique serial number that allows researchers to collect and track visitor data over time. For example, when an admission pass is swiped at a fee collection point, the data captured can be used to determine the frequency of the card's use and park travel patterns. Additionally, all visitor groups were asked for their Zip code and the number of adults and children in their vehicle. Park staff recorded this information on cash registers and the data were downloaded to a computer. Country codes were recorded for international visitors. Data were compiled periodically and sent to the Social Science Program in Washington, D.C., where additional analysis was performed. Currently, participation in the VIS program is limited to parks that use the Advantage Point of Sale fee collection system.

In March 2004, 14,080 vehicles from 3,129 unique Zip codes entered Shenandoah National Park. The red marks represent the spatial distribution of park visitors rather than visitation frequency, and each accounts for a single, unique Zip code area where visitors reside.

Park staff welcomes visitors to Shenandoah National Park, the site of a new Visitor Information System trial in 2004. Visitors' Zip codes and other data were recorded at entrance stations and later analyzed, giving managers information to help them better serve the public.

Shenandoah National Park began collecting VIS data in March 2004, with country codes added in June. By the time visitation peaked in the fall leaf-viewing season, fee collectors were highly experienced with the system. Data entry typically took 30 seconds or less per vehicle, so queuing at entrance stations was not significantly greater than normal for a peak-season visit.

What has Shenandoah learned about its visitors? First, the person-per-vehicle multipliers currently used to calculate visitation are accurate. International tourists in the period June through October accounted for 4% of park visitation, with the rest coming from the United States. From March through October, Virginia (39%), Maryland (8%), and Pennsylvania (4%) contributed the largest numbers of U.S. visitors. Nearly 5% were from three Zip codes located near the park. In these three local Zip codes, about 80% of the population 25–34 years of age were high school graduates and 12% had a bachelor's degree. Racially, communities in the three areas were predominantly white (74–93%), with a small to moderate percentage of African Americans (3.5–20%). Finally, 28–47% of each community reported an annual household income of $50,000 or more.

The information generated by the Visitor Information System can be used to improve visitor services and communication strategies, monitor trends in visitor characteristics following significant events such as wildfires or fee changes, and identify underserved populations and communities. For example, if park staff learns that many of its visitors come from a specific foreign country or ethnic group, educational material and safety information can be modified to meet these visitors' needs. Also, outreach programs can be targeted to nearby areas or groups that are underrepresented in current visitation. The Visitor Information System harnesses social science techniques developed by the private sector to meet the needs of national park visitors. ■

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Visitor use and evaluation of interpretive media: Analysis of visitor surveys

By Brian E. Forist

Park managers planning for visitor services and resource protection need accurate information on visitors, their trips to parks, how they acquire park information, and how good parks are at interpreting resources for the public. To this end the Social Science Program of the National Park Service (NPS) published the report "Visitor Use and Evaluation of Interpretive Media" in early 2004. Distributed to park and program managers, the report was based on analyses of 23 in-depth surveys of visitors to national park units in 14 states and two U.S. territories. The surveys were conducted from 1997 to 1999 by the NPS Visitor Services Project, a branch of the NPS Social Science Program based at the University of Idaho Park Studies Unit. What makes this report unusual is its comprehensive analysis and compilation of the earlier data, which until 2004 had only been analyzed on a park-by-park basis. Visitor use of nine types of interpretive media (audiovisual programs, bulletin boards, Internet/park Web sites, park brochures, park information radio stations, park newspapers, self-guided tours, visitor center exhibits, wayside exhibits) and ranger-guided programs was examined (see top graph, next page). In addition, visitor evaluation of the importance and quality of each media type was included.

Overall, park brochures were used by the greatest proportion of visitors (62%). By contrast, 22% of visitors reported participation in ranger-guided programs. Except for bulletin boards, park information radio stations, and Internet/Web sites, all other types of interpretive media were used by a greater proportion of visitors than were ranger-guided programs. (Surveys conducted by the Visitor Services Project in national parks since 1999 indicate greater use of the Internet.)

Self-guided tours were rated as the most important type of interpretive media. Only self-guided tours and park brochures were considered more important to visitors than ranger-guided programs. Audiovisual programs were assigned the highest quality rating by visitors. Ranger-guided programs were considered the highest-quality interpretive medium.

The full report is available on the Social Science Program Web site at http://www.nature.nps.gov/socialscience/docs/Visitor_Use_and_Evaluation.pdf. ■

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Understanding visitor opinions of park resources

By Margaret Littlejohn and Steve Hollenhorst, Ph.D.

Knowing how visitors view park resources is a key element in the protection of those resources. Such information helps managers determine resource quality indicators and standards, patterns of resource degradation, and public support for resource protection decisions. Because park managers simply cannot talk to all visitors, studies of visitor attitudes conducted by the NPS Visitor Services Project (VSP) are one way of getting direct, scientifically valid feedback. Since 1988 the Visitor Services Project has conducted nearly 150 visitor studies in more than 120 units of the National Park System. All past study reports, executive summaries, and surveys are available online at http://www.psu.uidaho.edu/.

How visitors value park resources has been an important part of many VSP studies. Park managers often design questions for their particular VSP visitor studies about the importance of selected resources such as clean air, scenic views, wildlife, and native plants and animals.

What resource or resource-related quality received the highest combined "extremely important" and "very important" ratings over the past 10 years? Not surprisingly, scenic views have consistently received the highest importance ratings (99%), although responses have been as low as 60%. Results for each park can easily be compared. For instance, air quality importance responses ranged from 97% at Acadia National Park (1998) to 73% at Mojave National Preserve (1997), as shown in the graph at the bottom of the next page. Ranges for other selected resources or resource-related qualities were: solitude—87% to 48%, natural quiet/sounds of nature—92% to 57%, wildlife—93% to 37%, and native plants/animals—95% to 72%.

Visitor behaviors and the intent to behave a certain way are other types of information that is valuable for resource protection. For example, do visitors care enough about park resources that they would change their behavior to help the park protect those resources? At Mount Rainier National Park, a survey was directed at visitors from Puget Sound, Washington, who were asked whether significant deterioration of the air quality at the park would be a major factor in making a decision to alter their driving habits (e.g., carpooling). More than half of visitors (61%) responded that they would be likely to change their driving habits to prevent further deterioration of air quality at Mount Rainier.

Visitor studies are an important and valuable information tool to park managers in helping them steward park resources effectively throughout the National Park System. The Visitor Services Project is working toward creating a database to allow easy comparison of data among parks and regions and to give an overall picture of visitor opinions for the National Park System. Still a few years off, this tool for comparing data will provide a wealth of information for park managers and the public. ■

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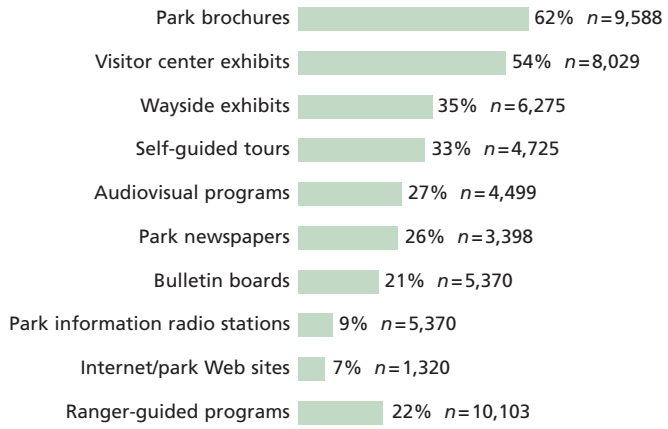
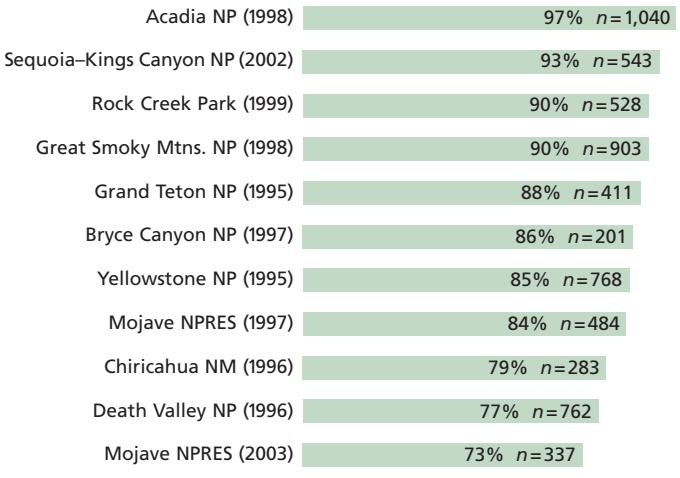
Director, Park Studies Unit; University of Idaho, Moscow, Idaho

VISITOR USE OF INTERPRETIVE MEDIA



Park brochures and visitor center exhibits were used by more than half of respondents to 23 visitor surveys conducted in units of the National Park System in 1997, 1998, and 1999. Less than a quarter of visitors surveyed participated in ranger-guided programs.

VISITORS AND AIR QUALITY IMPORTANCE



The graph shows the percentage of visitors at 11 national park areas who consider air quality to be either extremely or very important.

award-winner

Coral reef biologist recognized for conservation efforts at War in the Pacific

Brimming with life and protecting land from storm surge, coral reefs surround Guam, a small U.S. territory in the Northern Mariana Islands that is closer to the Philippines and China than it is to Hawaii. Though a 1,000-acre (40-ha) area of reef is protected as part of the seven-unit War in the Pacific National Historical Park, it is nonetheless threatened by the suffocating effects of topsoil deposition caused by erosion of the island's uplands. "If you can't manage the issues on land, you can't conserve the reefs," according to **Dr. Dwayne Minton**, the park's chief of resource management and 2004 winner of the Trish Patterson–Student Conservation Association Award for Resource Management in a Small Park. Dwayne has aggressively tapped into a variety of funding sources since coming to the park as its first resource manager four years ago. In that time he has built a program of terrestrial and marine-based research and education focused on the erosion problem and reef preservation.

Dwayne laid out a five-year plan that has brought direction to resource conservation at the park. "We went through a process of identifying the resources of the park, impacts to them—where they're coming from and how severe they are—and planning for their mitigation," he says. War in the Pacific now has species lists for fish and small mammals, in addition to a plant inventory, and is on its way to establishing a resource monitoring program.

Significantly, research has linked the local practice of burning upland grasses to enhance hunting and create firebreaks with erosion of the savannah and degradation of the reef. Dwayne explains that the park's northern units offer a chance to protect the reefs because they encompass almost an entire watershed. "Because the system is interconnected, we can measure sediments that have eroded from land and deposited onto the coral reefs and try to get an idea of how much erosion is occurring."

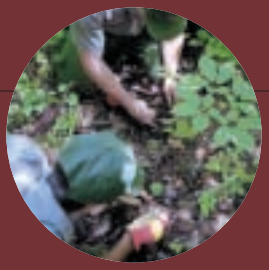
Dwayne incorporates outreach education as part of the park's resource protection strategy. "Our goal is to help the local people see the connection between burning, erosion, damage to the reef, and a decline in the fishery, which is an important consequence to them," he says. "We are working with lots of great partners to try to make these connections evident to the people of Guam."

Given the team approach to resource management at the park, Dwayne is uncomfortable at being singled out. "I really don't like the idea of this being an individual award," he says. "It's certainly nice to have one's work be appreciated, but our program really won the award. We have a great staff that works very hard on our conservation issues, and they get the work done. They deserve a lot of credit."

For the future, Dwayne and his staff have set their sights on finding new ways to restore the savannah grassland. Exactly how to do this is not clear, he admits, as many areas are denuded of vegetation and resemble badlands. Yet, through the hard work of his talented staff and by taking a scientific approach, Dwayne has hopes for success. The reef is counting on him. ■

7 Behind the Scenery

Profiles in conservation assistance



"We have to help each other or we would never make it through. Everything is a team effort."

—Bruce Sefton, Facility Manager, Yellowstone National Park

It is tempting to think of national parks as self-sustaining islands of our rugged, natural heritage. But the care and protection of the natural and cultural resources entrusted to the National Park Service require the talents of a wide range of professional staff and volunteers. You may envision a federal or university researcher or an NPS biologist working directly with park natural resources to learn about, restore, and manage them on a daily basis. However, the following articles celebrate a different group: a committed cadre of NPS staff and partners who work "behind the scenery," providing, in many cases, indirect support of the NPS science and preservation mission. These profiles are neither comprehensive nor inclusive of all who carry out worthwhile and important functions, but represent the collective contributions of the many unsung but essential support staff. Profiled are contracting officers, a computer programmer, the International Affairs Office, a federal attorney, and volunteers who donate their free time to improving national parks through inventory and monitoring data collection and building public awareness about resource stewardship, among others. Many of the activities needed to ensure that park resources thrive can only be accomplished with the help of this focused and knowledgeable staff who operates behind the scenes.

Ken Johnson, former special agent, Shenandoah National Park

Leading efforts to increase NPS natural resource protection capabilities since 1997

NATIONAL PARKS ARE THE victims of increasingly sophisticated poachers who take everything from rare reptiles and cacti in the Southwest to medicinal plants in the Appalachian Mountains. Park law enforcement is also responding to violent crimes like the notorious murders at Yosemite, Shenandoah, and other national parks, which can undermine visitor perceptions of safety and have lasting Service-wide effects on visitor experiences. Protecting park resources and ensuring an enjoyable visitor experience are central to the mission of the National Park Service. For this reason, the NPS Law Enforcement Program is evolving to mitigate these risks. Ken Johnson, a 30-year NPS veteran who spent 10 years as a special agent at Shenandoah National Park (Virginia), is one of the people helping to transform conservation law enforcement to meet the needs of national parks in the 21st century.

In 1997, law enforcement operations at Shenandoah got a wake-up call. Resource Management Specialist Tom Blount bravely appeared at a protection division staff meeting and asked tough questions: Why was law enforcement largely irrelevant to his priorities in natural resource protection? For instance, why were the park's rangers spending a large part of their time pursuing deer poachers when the park had an overabundance of deer? How are the rangers contributing to the park's other priorities?

"After our initial consternation, we realized the resource staff had a point," says Ginny Rousseau, former chief ranger at Shenandoah. "In spite of the best efforts of our talented rangers, park resources were in decline. We needed to improve our mission effectiveness."

"Park law enforcement had evolved largely reactive capacities to effectively respond to visitor needs," notes Ken Johnson. "Until recently, resources in peril could not dial 911. Now, maturing park science programs are 'dialing 911' for the resources. We must meet those mission requirements as well. These emerging needs may be different from those of visitors and will likely require conservation law enforcement to develop new protective capacities."

"Protection efforts must also look beyond individual park boundaries to address growing ecosystem risks," continues Clay Jordan, former deputy chief ranger at Shenandoah. "Park enforcement and compliance programs need to set priorities or performance measures based on resource and visitor values at risk."

(Opposite page) Park staff at Shenandoah National Park marks ginseng roots with benign material that contains magnetic-coded marking chips and color-coded fluorescent dye, allowing law enforcement officers to apprehend diggers with roots illegally taken from the national park. Ginseng, which is valued for the medicinal qualities of its root, is federally protected as a species of special concern, but can be harvested legally in some national parks with proper permission. Prime dried wild roots legally harvested sell for $350 to $400 per pound. Plant marking was one of the natural resource protection components of the Appalachian Chain Demonstration Project designed by Ken Johnson.

Recognizing that park law enforcement was facing new challenges and needed to develop new strategies to be effective, Ken Johnson went on a search for answers. He researched key NPS reports, such as the "Vail Agenda" and five recent evaluations of NPS protection capacity. The need for a law enforcement capacity, carefully prioritized and linked to science and the agency's performance measures, emerged as a consistent theme. These same issues emerged for all levels of park law enforcement.

Ken Johnson … is one of the people helping to transform conservation law enforcement to meet the needs of national parks in the 21st century.

With these findings in hand, the law enforcement staff at Shenandoah sought financial support from the Natural Resource Protection Fund, part of the Natural Resource Challenge. This funding paid for the design and creation of the three-year Appalachian Chain Demonstration Project to experiment with ecosystem-level interdiction that combined science, enforcement, education, and regulation. Enhancing regional protection for ginseng (*Panax quinquefolius* L.), a plant valued for the medicinal qualities of its root, and three other plants sought by poachers was the project's focus. Demonstration project partners included not only Shenandoah National Park but also Blue Ridge Parkway, Great Smoky Mountains National Park, six state and federal agencies, and researchers at three universities.

As the project got started, some of the initial challenges were surprising. For example, reliable data for the four plant species were scarce, despite long histories of commercial exploitation. In fact, two parks had no population data, and only fragmentary case incident information supported beliefs about the exploitative risk to the plants.

To better focus resources and understand the extent of the risk, the project under Johnson's leadership employed science tools to gather population data and engaged resource economists to research market factors driving poaching. In the law enforcement arena, the project used covert operations to determine the level of resource risk, developed models to predict the behavior of violators and target patrols, and improved forensics to support enforcement and deter violators. Another important component was the use of information tools to link rangers for improved collection, analysis, and sharing of information. The project also sought ecosystem-level improvements in regulations.

The benefits of the demonstration project were substantial. The covert work, led by Special Agent Skip Wissinger, revealed a risk of unimagined proportion and resulted in 694 charges, including 300 felonies, brought against 103 defendants. Because of this project, one of the species at risk, galax (*Galax urceolata*), will be protected under

the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Additionally, monitoring plots have been established and forensics and marking techniques have improved.

"We accomplished much, but learned even more," says Ginny Rousseau. "We learned to work effectively across departments and developed new skills. For example, covert officers were able to guide the plant-marking teams to areas mere hours in advance of the poachers! And the National Park Service's only intelligence analyst, Joan Yorkey, tracked the flow of park resources to international destinations."

For his design and leadership of the Appalachian Chain Demonstration Project, Ken Johnson was recognized with an award issued jointly by the deputy associate director for Natural Resource Stewardship and Science and the Law Enforcement Program administrator. Johnson, now retired from the Park Service, continues to advance this work as the director of the Institute for Conservation Law Enforcement, a partnership among three Cooperative Ecosystem Studies Unit universities. Clay Jordan, Ed Clark, Beth Waldow, Neil Labrie, and many others who worked on the project continue the good work from within the National Park Service. ■

Derrick Dardano, software engineer

Improving scientific research permitting in the national parks since 2001

SCIENTISTS APPLYING TO CONDUCT research in the National Park System and park staff processing research applications may not know Derrick Dardano, but they rely on his work to make the application process go smoothly. A software engineer and research associate with Colorado State University, Derrick is responsible for the inner workings of the Research Permit and Reporting System (RPRS), an online data management system that facilitates the creation of natural resource and social science research and collecting permits, and documents this research in the National Park System. For the past three years Derrick has been supporting the National Park Service as the sole RPRS programmer, a job he finds both challenging and satisfying. "Sometimes the job seems daunting because I'm doing so many more things than just programming. But I get to spend a fair amount of time interacting with park staff to get feedback on how the system is working for them. I try to make their lives easier. It's rewarding work."

Derrick is responsible for the inner workings of the Research Permit and Reporting System.

Research in parks fulfills the mandate of the National Park Service by increasing knowledge of park resources, enlightening today's visitors and managers, and contributing to the health of resources for the enjoyment of future generations. The idea behind the RPRS is to standardize how electronic applications for research and collecting permits are received and processed in the National Park System. Before it was launched in 2001, researchers often encountered a variety of requirements and procedures when applying to parks for permission to conduct their studies, which was a common source of confusion and frustration. The Research Permit and Reporting System allows parks to easily solicit valuable research efforts and affords researchers the convenience of a consistent, Service-wide permitting process that is available over the Internet. Standardization has also sped up the process. "It's been very satisfying to see that the end results of our efforts are useful and make the process easier," Derrick says.

Derrick's accomplishments include creating and maintaining the present version of the permitting system, customizing it to meet park needs, and integrating a new pilot program called E-Authentication (see article, page 76) that will eventually simplify and speed up the process even more. He continually improves the system based on input from parks and researchers and from his firsthand knowledge of park needs and work procedures. Derrick likes this aspect of his job particularly and says, "What's cool is that I get to come up with ideas for improvements and develop my own specifications that address a need. After getting feedback from users, the next thing you know I'm building something I suggested." For example, park staff can now download park-specific data from the RPRS in MS Access format, giving them tremendous freedom to design their own data reports. Derrick facilitates documentation of research by contacting researchers through an automated e-mailing procedure at the start of the annual call for Investigator Annual Reports, and by providing a means to track the submission of research reports. Thanks to a modification he made, the system now addresses the needs of the NPS curatorial community by reinforcing the communication of NPS policy on resource collecting and curatorial standards; it also facilitates communication among museums and other repositories and park curators. Derrick recognizes that while he plays a central role in how the RPRS operates, his NPS coworkers coordinate other important aspects of the system, contributing outstanding leadership and support, and he is proud to work among them.

An online system that facilitates transactions between the public and government requires constant maintenance. Derrick's expertise and hard work keep the Research Permit and Reporting System current with Internet technology developments, policy changes, expanding user needs, and increased security requirements. His skill and innovation as a software engineer are helping to make national parks more accessible to researchers who explore scientific frontiers and address park management questions. ■

Rob Eaton, attorney-advisor, Office of the Field Solicitor, Santa Fe, New Mexico

Providing expert legal advice in support of NPS natural resource stewardship since 1989

THE NATIONAL PARK SERVICE has been conserving parks for the enjoyment of future generations since 1916, when the NPS Organic Act announced the bureau's purpose. However, as our nation's population has grown and the National Park System has expanded, adding lands to the system that were once owned privately or by states, natural resource management has become more complex. An example is the Geologic Resources Division's (GRD) work related to helping park staff manage nonfederal oil and gas operations in National Park System units. Fortunately, GRD staff and park managers in the Southwest can turn to Rob Eaton for guidance when things get complicated. Eaton, an attorney-advisor with the Department of the Interior Office of the Field Solicitor in Santa Fe, New Mexico, sees his primary role "as helping the National Park Service survey and stake out reasonable and legally defensible positions on contentious issues."

Although the issues the Park Service faces can be discordant, Rob thinks "resource-related work is fun," and a fine complement to the high volume of often tedious general law work that is part of his everyday endeavors: title options for federal lands acquisitions, reviewing and approving contracts and agreements, and resolving procurement disputes. Specific resource-related projects that Rob is working on are assisting the National Park Service in using its legal authority to manage oil and gas development in national parks in Texas, helping stakeholders with varying viewpoints see eye to eye on the river management plan in Grand Canyon National Park, and guiding federal entities toward a legally appropriate attitude and action (e.g., not using motor vehicles in designated wilderness) in parks along the Mexican border.

Rob views himself as a teacher who educates park personnel about their legal authority.

Rob says he came to law "late in life," but one would never know it from his command of this critically important component of natural resource management. His motivation comes from a desire to see specific projects, some of which he has worked on for years, to their conclusion. Like most lawyers, he also enjoys a good argument, for example struggling with the tension between federal and state authority, what he calls "the good stuff for lawyers." In addition, he says, "I like to do my job well." GRD staff appreciates his honest work ethic and explains, "Rob's expertise and helpful attitude make him one of the many people and partners of the division that help it do its job more effectively."

Rob Eaton (right) with former Secretary of the Interior Stewart Udall at the June workshop on managing nonfederal oil and gas operations in parks.

In 2004, as in years past, Rob provided expert advice and assistance to the Geologic Resources Division, the Intermountain Region, and parks. He also was an invaluable participant in answering numerous questions during a three-day workshop on managing nonfederal oil and gas operations in national parks (detailed in *36 Code of Federal Regulations Part 9, Subpart B*) that the Geologic Resources Division hosted in Santa Fe. In addition to being a lawyer, Rob views himself as a teacher who educates park personnel about their legal authority. As such, he gave a presentation for superintendents at the Natural Resources Law and Policy course held in late August, which underscored the importance of the National Park Service compiling a solid administrative record to prevail in the face of litigation. According to Carol McCoy of the Geologic Resources Division, "No matter how pressed Rob may be, he always finds a few minutes of his time to speak to staff and park resource managers to address their questions, and unfailingly returns their phone calls. Rob is a delight to work with, along with being an awesome, helpful lawyer." ■

Citizen scientists recognized for decades of quiet volunteer service at Cuyahoga Valley

Informing natural resource stewardship at the park since 1974

MORE THAN 30 YEARS AGO, a small group of avid birders in northeastern Ohio decided that it would be fun to document the birds they saw in their favorite birding spot throughout the year. Each week they tallied the numbers of birds of each species observed. Weeks turned into months, months into years, and the bird surveys continued, with observations faithfully recorded.

Soon, their chosen survey location along the Cuyahoga River was included as part of the Cuyahoga Valley National Recreation Area (designated National Park in 2000), established in 1974 as one of the country's first urban national parks, to preserve the scenic, cultural, and natural heritage of the river valley between the cities of Cleveland and Akron, Ohio. Through the years, these and other volunteers continued the weekly surveys in various locations within the park, faithfully submitting their data to park staff. In addition, members of three regional National Audubon Society chapters initiated a number of other parkwide survey efforts, and the current bird list for the park was created entirely by these volunteer experts. Most recently, 10 of these citizen scientists were enlisted to gather bird abundance data in surveys across the 33,000-acre (13,365-ha) park as part of a monitoring project supported by the NPS Park Flight Migratory Bird Program. Monitoring birds is essential for assessing population status and trends and for evaluating the success of conservation actions.

These skilled volunteers have provided an invaluable service in the form of long-term data on changes in the bird community of the valley since creation of the national park.

The combined efforts of these skilled volunteers have provided an invaluable service in the form of long-term data on changes in the bird community of the valley since creation of the national park. Yet, because of turnover in park staff over the years, many of the efforts of the three dozen most active and expert birder volunteers largely went unrecognized by the park, and most of their efforts over three decades were not included in reports of park volunteer-hours. If they had been, the time tallied by just a single individual doing the weekly surveys would have totaled nearly 8,000 hours, equaling more than $137,000 in services according to today's volunteer time value estimation. Finally, in October 2004, during an official dedication of the park as an Important Bird Area by Audubon Ohio, these citizen scientists were formally recognized by the National Park Service for their important contribution to the conservation of birds in Cuyahoga Valley National Park. Fran Mainella, Director of the National Park Service, participated in the dedication ceremony and presented certificates of appreciation to these bird monitoring volunteers. ■

Director Mainella (left) presents certificates of appreciation to citizen scientists at Cuyahoga Valley National Park for three decades of regularly reporting bird observations and abundance data.

NPSFACT

Volunteers to the National Park Service **donated 955,787 hours, valued at $16,429,979**, in FY 2004 related to natural resource management projects that ranged from ecological restoration and data gathering to resource monitoring and wildlife management. Natural resource management is the second largest category, behind interpretation, for NPS volunteer-hours.

Bruce Sefton commended for support of resource stewardship

Supporting natural resource stewardship through maintenance at Yellowstone since 1989

THROUGHOUT HIS 15 YEARS AS YELLOWSTONE National Park's Lake District maintenance supervisor, Bruce Sefton has demonstrated a remarkable commitment to protecting resources, supporting resource stewardship programs, and working across divisional lines to ensure that the park's resource stewardship mission is achieved.

Specifically, Bruce and his maintenance team designed, constructed, and installed 60 floating dock units that prevent pollution of Yellowstone Lake. The old docks, dating from the 1960s, were made of encapsulated Styrofoam that broke down constantly, creating millions of minute waste particles that were deposited in a bathtub-ring fashion around the lakeshore. Rather than despair, Bruce saw the dilapidated state of the docks as a special opportunity. Unable to find an affordable new dock that met the park's needs, he designed a dock that replaced the Styrofoam flotation with a polyurethane–encapsulated foam chamber, eliminating the source of pollution. Bruce's crew created the docks in their "spare time" over the course of five years. By investing the "sweat equity" of his staff, Bruce was able to save $3,000 per dock over commercially available units, realizing a total savings to the park of more than $180,000. This nonpolluting, inexpensive dock design could be incorporated in other national park areas with similar issues.

Bruce has also been the champion of Yellowstone's greening initiative in the Lake District, devoting staff time and energy to replacing long-standing maintenance practices with new, more sustainable practices. Perhaps most importantly, he and his staff have ensured that the fisheries and aquatic resources biologists, wildland fire staff, and partner researchers based at the Lake District have been provided with the housing, facilities, and logistical support they need to accomplish the park's resource stewardship objectives.

Bruce has demonstrated a remarkable commitment to protecting resources [and] supporting resource stewardship programs.

Bruce has been a leader in interdivisional cooperation, at times sacrificing other projects in order to support resource stewardship staff. "Yellowstone's Lake District has the best interdivisional relations of any place I've ever been," he says. "We try to take care of our customers, and I think over time, the resource managers have gained an appreciation for Maintenance—they're at our doorstep helping us too, when we're in trouble. Because we are remote and have so few people, we have to help each other or we would never make it through. Everything is a team effort."

For his resource-friendly dock design as well as his exemplary greening initiatives and extensive assistance to park biologists, independent researchers, and firefighters, Bruce received the NPS Director's Award for Excellence in Natural Resource Stewardship through Maintenance for 2003.■

Bruce Sefton and one of the environmentally friendly docks he designed for Bridge Bay Marina, Yellowstone Lake

The big spenders: Tom McConnell and Kathleen Batke

Purchasing goods and services critical to NPS natural resource stewardship and science

ACHIEVING ALMOST ANY GOAL set by the National Park Service requires spending money, but actually purchasing something with federal funds requires an expert who knows how to maneuver through the extensive and complicated procurement process. The people in the National Park Service who can take a park unit's wish list and turn it into new equipment, a report on a park's bird inventory or any number of research questions, or the construction of new buildings are the contracting specialists. These wizards know which of the myriad regulations apply, for example, to the purchase of scientific expertise through a Cooperative Ecosystem Studies Unit (CESU), in the development of an Inventory and Monitoring Program database, or for the rehabilitation of an old building. They can look at a park's statement of needed work; refine it until it is perfectly clear and expressed in contractual terms; select the appropriate contract, task agreement, cooperative agreement, or other "instrument"; and then make the transaction according to regulatory requirements. At the end of the process, they have purchased goods and services critical to the National Park Service at the best price and in a timely manner.

What makes an excellent contracting specialist? The people who work closely with two of them are especially appreciative of the in-depth knowledge these contract officers bring to the labyrinth of red tape, and of their skill at knowing when and how to negotiate—hard but fairly. They evaluate vendors, budgets, and services, and they save the National Park Service a lot of money. They also work with government lawyers to make sure that problems of liability, intellectual property, and other issues will not arise later.

Tom McConnell

Diane Pavek, research coordinator for the National Capital Region, says that Tom McConnell, supervisory contract specialist for that region, saves her weeks of frustration wading through paperwork when he works with her to obligate Natural Resource Challenge funds. He cares about the parks' projects and in 2003 presented a training workshop for natural resource managers to help them both make their requests most effectively and acquire the research and technical assistance they need. Tom has been with the National Park Service for 23 years and is still cheerful and ever willing to help. He enjoys working with his NPS colleagues and says, "It's enjoyable to work with the natural resource people and others in the region. What I like about the … Park Service is that it's small. In other government agencies, people in my job don't get to see what they purchase because the projects are so big. If I buy the design for a building, or a scientific report, I like the fact that when it's done, I can see it."

Kathleen Batke has been a contract specialist for the Southeast Region for the past five years. She was a lifesaver, according to Larry West, Southeast Region branch chief for inventory and monitoring (I&M), when he first had to figure out how to write agreements for I&M projects. Kathleen stepped forward and put her previous 15 years of experience working with NASA scientists to work in developing task agreements for scientists providing services through four

At the end of the process, they have purchased goods and services critical to [the natural resource stewardship and science programs of] the National Park Service at the best price and in a timely manner.

CESUs, which were created to encourage and facilitate cooperation among partners from many different federal and nonfederal organizations. "The difference between working at NASA and working here," she says wryly, "is that the Park Service is much more down to Earth!" Kathleen has developed standard formats for various agreements so that the terms and conditions are in compliance with the procurement regulations and the agreements can be completed efficiently to meet the requestors' needs. She works on all kinds of projects, including contracting for a new science center at Great Smoky Mountains National Park. Larry West says, "She's hardworking and fast, and she saved us from making a lot of mistakes when we first got started. Somehow she keeps track of everything, everyone gets paid, and she's a lot of fun while she's doing it all."

Kathleen Batke

In addition to being involved in a whirlwind of regional projects, Tom and Kathleen have been instrumental in managing the contracts and cooperative agreements that form the basis of many natural and social science activities Service-wide. Tom has supported projects and conferences in five NPS regions and at the national level through the Chesapeake Watershed CESU, the Watershed Condition Assessment, the Socioeconomic Atlas, and this year's chestnut restoration conference (see article, page 59). Kathleen, as the contracting officer for NPS participation in the aforementioned CESU agreements, has facilitated Service-wide activities of the Visiting Chief Social Scientist through the Gulf Coast CESU cooperative agreement with Texas A&M University and the Biosphere Reserve Assessment through the Southern Appalachian CESU agreement with the University of Tennessee, Knoxville. In both of these cases she works with technical representatives outside her region and focuses on program goals that transcend her region.

Both Kathleen and Tom are unsung heroes of the National Park Service's natural resource stewardship and science programs. ■

Supporting NPS migratory bird conservation through exchanges in technical expertise since 2001

HOW DOES A TEAM OF DEDICATED EMPLOYEES working quietly behind the scenes in the Office of International Affairs (OIA) in Washington, D.C., contribute to natural resource conservation in the parks? Just as migratory birds create connections between our parks and areas to the south, Jonathan Putnam, David Krewson, and Linda Bennett of the OIA facilitate the human connections that help conserve these shared species.

Through the International Volunteers in Parks program, this team of international conservation experts has made it possible for the NPS Park Flight Migratory Bird Program to bring talented biologists from Latin America to assist with bird conservation and education projects in the national parks. The office handles the visa application process for all international volunteers and processes training plans for the candidates. These internships provide opportunities for the exchange of knowledge and experience—scientific, cultural, and language—helping the National Park Service meet its mission and allowing the interns to improve their resource management capacity in their home countries.

The Park Flight Program has benefited tremendously from the involvement of international volunteers, who have gathered valuable data for park managers and reached out to new audiences. During the 2004 field season, for instance, Pablo Petracci from Argentina assisted with the first-ever land-bird inventory in Gates of the Arctic National Park and Preserve (Alaska), while Mariamar Gutiérrez from Nicaragua checked nests for cowbird parasitism in Cuyahoga Valley National Park (Ohio). Roberto Quintero Domínguez from Mexico led members of the local Latino community on bird field trips in North Cascades National Park (Washington), and Ruby Zambrano from Panama gave bird-banding demonstrations to school students (grades 5–12) at Bandelier National Monument (New Mexico). The impact of these international volunteers on park resources, visitors, and staff is significant. Stephen Fettig, wildlife biologist at Bandelier, explains that "the Park Flight Program brings children to a remote but magnificent part of the monument and gives them a chance to see migratory birds up close. The experience deeply touches the students with feelings of awe and respect in a way that is striking to parents and teachers alike. The students are also interested in Ruby's life in Panama and what birds New Mexico shares with Panama. Creating such a multinational consciousness in our young people is vital to the conservation of migratory birds." Since 2001, 19 Latin American biologists from six countries have assisted with Park Flight bird monitoring and education efforts in national parks, contributing more than 7,400 hours valued at more than $127,000.

"Creating … a multinational consciousness in our young people is vital to the conservation of migratory birds."

Jonathan Putnam, Linda Bennett, and David Krewson of the NPS Office of International Affairs

The Office of International Affairs also guides the international component of the Park Flight Program, which has projects in Latin America and the Caribbean, and coordinates technical assistance by NPS employees to the Park Flight projects in these broad regions. These exchanges help to make the projects viable and allow technical experts to experience firsthand the issues faced by shared migratory bird species at both ends of the migration route. Considering that many bird species spend part of their lives beyond the borders of this country, it is only logical that those who protect their habitats here are interested in working with those who manage them elsewhere.

Park Flight is only one of many exchange programs conducted by the OIA that bring conservation students and leaders to the United States for training and to share their expertise. Similarly, when outside funding is available, NPS personnel participate in conservation and management projects abroad. The OIA also facilitates "sister park" relationships among national park sites in this country and protected areas overseas with similar resources or management concerns. (Further information about the OIA is available at http://www.nps.gov/oia.)

Though unable to experience the dawn chorus or the children's look of wonder, the staff of the Office of International Affairs can take pride in contributing from afar to the conservation of migratory birds in parks across the National Park System and the hemisphere. ■

8 Looking Ahead

Kent Turner

Jon Jarvis

Abby Miller

EDITOR'S NOTE: This edition of *Natural Resource Year in Review* concludes with three forward-looking articles instead of the usual one. Ironically, the first, by Kent Turner, looks back on the tremendous change over the past 25 years or so in how natural resource management in the national parks is conducted. His experience at Lake Mead National Recreation Area over much of that period puts into perspective the remarkable gains we have made in professional resource management capabilities of the National Park Service, but also highlights significant concerns for sustainability of those gains for the future. Jon Jarvis takes us in a different direction, describing his vision for a cooperative national network of parks, unified in purpose and able to serve Americans better than can national, state, county, and city parks alone. Finally, Abby Miller reflects on the importance of developing leadership and seizing opportunities to continue to strengthen the National Park Service. Publication of the *Year in Review* coincides with Abby's retirement, and we can never thank her enough for the prime example of leadership and focus that she set during her tenure as Deputy Associate Director for Natural Resource Stewardship and Science. Her career in the National Park Service parallels many of the advances in natural resource management that Kent Turner observes in his article. Without Abby's sharp mind, comprehensive attention, and prodigious energy, the National Park Service might not have come as far in as short a time. These three articles paint a picture of the future for park resource stewardship that is certain to be challenging yet potentially satisfying. What more could we hope for?

A revolution in NPS resource management: Amid progress, challenges for the 21st century

By Kent Turner

HISTORY

Resource management in the National Park Service before the 1980s was limited to a scattered collection of resource specialists, most of whom began their careers as park rangers. They worked alone, focusing on taking advantage of limited funds and opportunities to solve manageable problems at the local level while identifying larger issues that would require nonpark staff assistance and funding. However, in 1982 the resource management profession in the Park Service began to grow with the first in a series of Resource Management Trainee classes. As a result, the goal for much of the 1980s became establishing at least one resource management specialist position in every park with significant natural resources. Though funding for project implementation remained limited, the initial infusion of resource management staffing was able to accomplish many things, the most significant of which may have been to create, for the first time, the professional capability to document the need for more resource management activities across the National Park System.

The establishment of 11 "prototype monitoring parks," the precursor to today's monitoring networks, and the 1990s program for "professionalization of resource management" led to significant increases in resource management capability at a number of parks. By the 1990s, several parks had the staff to strategically mount a comprehensive resource program and marshal the growing availability of fiscal resources to advance their programs. Since then, relatively stable budgets, combined with operational cost increases at all park levels, have necessitated reductions in staff at many parks. Over the last five years the question for natural resource managers across the National Park System has become, How can NPS core staff work most efficiently in garnering and managing available resources?

LAKE MEAD: A CASE IN POINT

Resource management at Lake Mead National Recreation Area mirrors that pattern. In 1987 this large park, located along the Arizona-Nevada border, had one professional resource management specialist and a budget of about $100,000. By 1989 the staff had grown to four, creating a core group sufficient to document the needs for additional resource specialists. Reflecting the trend in resource management growth throughout the National Park Service, by 1997 Lake Mead's staff of resource managers had grown to 14 full-time professionals. In 1997, at the peak of park staffing, the Division of Resource Management spent approximately $1.34 million.

Permanent staff during the 1990s accomplished many important planning tasks at Lake Mead, in particular outlining the needs and elements of a comprehensive resource management program. Other activities included a burro management plan and environmental impact statement, a prototype workshop to identify resource "vital signs" for monitoring, and park strategic plans for disturbed-area restoration, fisheries, fire management, and exotic plant management. To a large extent, the park resource program is living off the planning foundation set in the 1990s, as changing conditions make it increasingly difficult to focus on strategic and long-term issues.

By the late 1990s the administration of natural resource management in the National Park Service had begun to change. Federal and state agencies began to dramatically increase the number of regionally based conservation partnerships and initiatives. As these increased, so did the number of funded conservation projects that required management. True to this trend, the full-time professional staff at Lake Mead began to switch from implementing field projects to coordinating broad, regional planning efforts and managing temporary funds. At this time the Natural Resource Challenge initiative brought a further infusion of needed resource management project funding, and the newly established Inventory and Monitoring networks created additional regional partners across the park system.

BUDGETS INCREASE, THEN STABILIZE

In the early 1990s, Lake Mead National Recreation Area received several significant operational base funding increases, including increases for resource management. Since 1997, however, those budgets have remained generally static as operational costs have grown. Employees who were under the Civil Service Retirement System have retired and have been replaced by more expensive staff under FERS, the Federal Employees Retirement System. Additionally, utility costs have gone up, as have certain significant contracts (garbage collection). The nature of resource management at Lake Mead needed to change in response to these realities.

Coordination is the right thing to do.... Long-term preservation depends upon managers working broadly across ecosystems.

The park has had to stay within operational budget constraints through attrition of staff, and by 2004 resource management had declined to 8 full-time professional staff, down from 14 seven years earlier. Yet the amount of work for these employees remains tremendous because the resource management program at Lake Mead is almost entirely driven by interagency forums and programs and resultant project funding. To illustrate, in FY 2004 those staff obligated approximately $3.8 million, of which only about 32% was from park base funding (i.e., operation of the National Park Service). About 70% of the park's projects are paid for by other than park base funding, the vast majority coming from non-NPS sources.

The scope of projects managed by partnerships at Lake Mead is tremendous and includes water quality, conservation of various species and their habitats, and several types of planning across multiple

political jurisdictions. In 2004, resource managers were involved in more than 60 interagency and multi-interest-group partnerships and oversaw project operations that involved 50 non-NPS employees from agreements and contract sources. The time just to coordinate meetings for the groups involved in these functions is 160 days or more per year. Moreover, many functions require progress and data reports, with an annual time of about 60 days. Lake Mead's data systems and GIS also add to the complexity of coordination, as they must be compatible with the needs of more than six interagency ecosystem planning and management teams, including the NPS Inventory and Monitoring network. Finally, the need to respond to about six funding proposal calls per year, more requirements for compliance activities, and an increased focus on results and accountability also compete for the limited time of professional staff.

One of the largest losses is the staff resource manager's familiarity with park natural resources and visitor use patterns.

Lake Mead National Recreation Area does benefit from a number of unique, local funding sources not available across the National Park Service. Though the type and amount of project funding from outside sources are different from park to park, the nature of the resource management work throughout the National Park System is becoming more similar. Increasingly, professional park resource staffs are being asked to participate in and accomplish their work through regionally based ecosystem forums. The number of park staff who can be supported by park base funding is declining, and implementation of resource programs is occurring more and more through the application and management of soft funding sources and partnerships aligned with park mission purposes.

CONCLUSION

Parks definitely benefit from increases in project funding that may be available from nontraditional sources. Another positive result of working through partnerships and networks is consensus building and establishing support for needed actions. Plus, coordination is the right thing to do; parks do not exist as insular sanctuaries. Long-term preservation depends upon managers working broadly across ecosystems.

Nonetheless, many challenges are associated with this emerging trend away from park-funded and -managed projects. It is not always possible to perfectly match park needs and priorities with those of a multiagency framework; the activities funded and the issues pursued by partnerships and regional forums are not always the park's highest priorities. Biologists and other specialists are increasingly working outside areas of the bulk of their professional training. As important as technical competencies are, staff must develop new skills to work in interagency arenas, write proposals, develop contracts and agreements, manage projects, and account for expenditures and results. Park capabilities must keep up with increases in contracts, procurement, and administration of a variety of funding sources. Improved communication systems are essential, as there is less "face time" among managers and employees. Continuity and focus on strategic objectives are difficult to maintain, and knowledge of park and NPS policies is hard to ensure when the majority of a program is being carried out by contractors and temporary employees. One of the largest losses is the staff resource manager's familiarity with park natural resources and visitor use patterns. Furthermore, as time for field tours and inspections becomes critically limited, resource managers are making more and more decisions about natural resources that are less and less familiar to them.

The largest challenge may be one of building or even maintaining morale for the remaining permanent staff. Many are being asked to adapt to management arenas different from the ones they were hired for. They are being asked to learn a battery of new skills and give up activities that brought them deep personal satisfaction. The pace of work is quickening, with schedules being set by the various interagency forums within which they must participate. Employees must write grant proposals and contracts, train new temporary staff, and report on accomplishments—sometimes quarterly—for tasks they may have performed a few years earlier. For individual parks and the National Park Service to succeed in this transition to partner-based resource management, we must actively work to maintain the morale and wellness of our operational staff, provide adequate training and employee development, maintain a focus on overall strategic objectives, and help staff maintain a connection with the park resources they love. ■

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Building a national network of parks

By Jonathan B. Jarvis

IN 2001 THE NATIONAL PARK SYSTEM ADVISORY BOARD, chartered by Congress to advise the NPS Director and the Secretary of the Interior on the future of the National Park System, called for the National Park Service to "serve as a catalyst to encourage collaboration among public and private park and recreation systems at all levels—to build a national network of parks and open spaces across America." A big problem with implementing this idea is that no one really knows what it means. I cannot define it to the satisfaction of everyone, but I can articulate my vision for it and how it relates to the direction we are headed in the Pacific West Region.

A national network of parks is not a new bureaucracy or an evil plot to "lock up the land," but rather a way of thinking, organizing, and sharing the connections among special places. National parks are just one type of park in a continuum that includes the "tot lot," city, county, state, and regional parks, open spaces, and forests, all maintained for public purposes. The units in the National Park System are no better or worse than these other places and cannot satisfy all the needs for recreation and environmental protection of a growing nation. Though national parks exemplify natural and cultural history on a national level, they do not represent the entire richness of our cultural heritage. Nor are they, as small islands in a sea of land uses, ecologically sustainable. In order to achieve the broad mandate of the NPS Organic Act—to preserve the national parks for future generations—we need all "parks" to be appreciated and protected. I see at least three threads that make logical connections among all parks.

The first is the resource connection. The cultural resource parks appear as isolated dots on a map, linked only by the inventiveness of a visitor and tourism bureau, which sees a marketing opportunity to attract tourists to an area with a theme. Notable exceptions are the Civil and Revolutionary War sites of the East and the Native American ruins of the Southwest. Yet many cultural themes remain unnoticed and dispersed, such as the migrant agricultural worker camps that stretch from the "Grapes of Wrath" to Cesar Chavez. The public would be better served if protected sites were linked thematically so that the entire story could be told and experienced. Such links would enhance local economies, enrich the stories of all Americans, and help identify gaps that need protection and interpretation by the appropriate entity.

Natural resource parks have clearly been set aside as areas of rare beauty and interesting geology, or as lands that could not be developed for agriculture or other commerce. Whereas each park was once thought to preserve what A. Starker Leopold called a "vignette of primitive America," contemporary park management requires us to think in terms of ecosystems, natural processes, habitat corridors, migratory species, and indicators of resource condition. No park can have it all, but a network of parks could, if there were logic to its linkages. Imagine a system of parks extending along a river from the Cascade Range to the Puget Sound, providing a mixture of habitat and travel corridors for migratory species that includes urban, rural, industrial, and wilderness areas. Each pearl along this necklace could be managed by a different entity and provide both natural resource protection and appropriate recreational opportunity, from soccer fields and golf courses in the urban setting to free-flowing streams and backcountry trails on forested slopes. This network is not unbroken, for it can be crisscrossed by bridges and interstates, and easily accommodates adjacent development that allows neighboring communities to enjoy the fruits of a local natural area in association with an active recreation site. Overlying it all are the vision and principles of a sustainable ecosystem.

A national network of parks is not a new bureaucracy or an evil plot to "lock up the land," but rather a way of thinking, organizing, and sharing the connections among special places.

The second component is the recreational spectrum. We Americans expect much of our parks: the distinct babbling of a sun-sparkled brook, the tug of a trout on a fly line, the sweaty camaraderie of a touch football game, the downhill challenge of a black diamond ski run, the thrill of seeing our child score the winning soccer goal, the bonding of family over charcoal-broiled chicken and sticky marshmallows, the commanding view of a distant horizon gained through mountaineering, and the occasional glimpse of wild animals living free. Active or passive, all are forms of recreation, and parks are where we go for many of these experiences. When parks exist, we use them; when they do not, we create them or demand they be established. Surveys show that parks are located mostly in wealthy communities and that poorer parts of our country are truly underserved in this way. All Americans have a birthright to a park near their home, for it is essential to their health and welfare and serves as a threshold to the full spectrum of outdoor recreation and self-discovery.

The third component is the social value of parks, an area in which we are often inarticulate. Social value includes economics, a well-documented but often poorly understood aspect of the many positive influences of local, regional, or national parks. Parks are major contributors to the economy by the tourism they attract; the quality of life they provide for business owners, their employees, and the populace; and the clean air and water they ensure through the protection of natural systems. The health benefits of parks are incalculable, but a recent *USA Today* article stated that obesity cost American taxpayers $39 billion in 2003. Parks, as places to exercise, lengthen life spans, to be sure, but also save society money. Less well understood is the value of parks to the human spirit. Recent studies

show that hospital patients heal faster when they can see natural landscapes out their windows. Similarly, employees' productivity increases when they have views of natural areas and parks from their workplace. When is the last time you saw a "peace parking lot"? We designate peace parks because of the serenity derived from these places. Within parks are our hopes and dreams for a peaceful and civil society, and from them we gain inspiration.

By making organizational changes we can shift our thinking from the success of individual parks to the success of the park system.

I believe a national network of parks, interwoven recreationally, ecologically, economically, culturally, and socially, is necessary for the pursuit of happiness. I also believe this vision is possible and that the National Park Service, as the most visible symbol of the park idea, has a special role to play in its realization. The problem, however, is that the Park Service has not yet embraced this role. We are too busy taking care of our parks, too busy looking *in* rather than *out*. This is the product of our establishment and of many of our own policies. For example, most parks have their own enabling legislation, and in most cases this legislation is specific to that park and indicates almost as an afterthought that the park is part of a system. Each park has its own budget, line-itemed by Congress. Every park competes annually for hundreds of millions of dollars allocated to special accounts in more than 120 program areas. In some cases more energy is expended in the competition for funding than is derived from the small allocation the park receives. Operational increases, the most desirable of all funds, are often hoarded when received and resented when others get more than their "share." As we well know, the real power in the national parks lies with the superintendent, and because of the expectation that the superintendent will make his or her park the best, competition—instead of cooperation—is inherent. Finally, our rewards, appraisals, and recognition procedures are all about the success of individual parks rather than the success of the National Park System.

My key point is that by making organizational changes we can shift our thinking from the success of individual parks to the success of the park system as a whole, creating a partnership culture that leads us closer to a true system of parks. For the Pacific West Region, we took our first step in this direction last February when we launched our new internal organization. We are using the organizing principle of the natural resource monitoring networks, which groups parks by their ecological similarities or linkages to share staff and funds for monitoring member parks' resource conditions. Now park superintendents in those same groupings, eight networks in the Pacific West Region, are being asked to share their fiscal and human resources for cooperative network goals.

The Regional Leadership Council, our highest deliberative body, is now represented by superintendents chosen from each network. The advisory committees of the various program areas, the worker bees of the organization, are also network-based, and as they recommend the allocation of soft funding, they see the opportunities for resources to be shared among parks. The assignment of the deputy regional directors to oversee network collaboration brings unity to the overall regional structure and offers sharing opportunities among the networks. Public recognition of asset sharing and increasing the priority of funding requests among parks that share resources reinforce this new approach to park relationships. Through supervision, selection of new superintendents, and performance expectations, we are recognizing and rewarding cooperation and collaboration among the superintendents in these networks. We are also engaging our Rivers and Trails Conservation Assistance staff to work closely with park units and their surrounding communities to envision network connections outside of park boundaries.

The consequences of these changes will determine the way superintendents, the regional directorate, program chiefs, and their staffs think and act. Interdependency will develop and competition will diminish. When we begin to think, operate, and behave like a system of parks, then (and only then) will the National Park Service assume its broader responsibility of fostering a linked national network of parks.

I never doubt the ingenuity of NPS leaders, so I expect to be amazed at where this new journey takes us. Once "system" thinking takes root, we will see it expand to our neighbors in the parks family. Superintendents will develop the attitude that they have something to contribute to the larger system of parks rather than look for something to gain for their particular park. Then the National Park Service will be ready to lead the nation to a national network of parks, taking one of the greatest ideas America ever had and raising it to its next logical level. We in the Pacific West Region cannot claim that we had the idea, but we will be able to show how to make it happen. ■

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Leadership key to NPS future success

By Abigail B. Miller

I AM RETIRING FROM THE NATIONAL PARK SERVICE at a time of change for natural resource programs and issues. A large budget deficit and the need to stabilize federal spending due to the war in Iraq mean that the National Park Service is not likely to see a near-term repeat of the recent, unprecedented growth in our capability to manage park natural resources. In addition, the climate for managing public lands is changing, along with the climate itself. Stresses on natural resources continue to increase, and the modes of enjoying the national parks are changing as society changes. Aesthetics and ethics that many senior resource managers hold dear have changed: enjoying park scenery from an airplane, a big movie screen, or a fast recreational vehicle is not what we are used to, and often not what we like either. All of this change is unsettling for many natural resource managers in the National Park Service, who must continually adapt.

Beginning in the 1980s and building to the first years of this century, the National Park Service made significant progress in addressing deficiencies in natural resource management that were first identified in the 1960s. Before 1990, for example, only a small number of research scientists and trained natural resource specialists and managers worked for the National Park Service. As of 2003, the number of professional resource managers in the National Park Service had more than doubled to 1,093 from 487 just 10 years earlier. These employees are the first significant cadre of natural resource personnel in the Park Service. For many in this cadre the strides made in professionalizing resource programs, developing inventories of park resources, initiating monitoring programs to track resource conditions, addressing complex management issues, and undertaking ambitious resource restoration projects have come at the peak of their careers. And for many the future of natural resource management in the national parks is daunting because of the mounting pressures and complex issues we face.

We … will need quality leadership and hard work to further advance the tools that work well, to develop new approaches for what does not work, and to inspire perseverance in all.

I have always believed that change presents opportunity. In the belt tightening that will undoubtedly follow, along with ABC (the Department of the Interior's Activity-Based Cost management system), FBMS (the Financial and Business Management System), and an alphabet soup of other changing ways in which the National Park Service will do business, the path forward may not seem clear. But it is there. It lies in resource managers who will take the chance to lead. This includes those at the peak of their careers who now have a great opportunity to provide strong and wise leadership for their less experienced colleagues. The path ahead is also there in those who will add new perspectives, tools, and skills to meet the needs of the parks. This group includes all the wonderful new blood infused into the National Park Service in the last few years in new biologists, hydrologists, and other professionals who love the natural world. They too have the opportunity to take their place in NPS leadership. To them, changes are not as stark as they are for many of us old guard. We need the energy, education, and vision of younger leaders, combined with the wisdom of experienced NPS managers, to figure out how to adapt old paradigms to new conditions.

The National Park Service has laid a foundation for the future. The important next step is to find the means to strengthen this foundation so that the progress we have made to date will not erode and so that it can be built upon further when the time is ripe. This will take the work of all who care about park natural resources and especially will require their willingness to take on difficult leadership jobs. We have made a wonderful start in the last few years, but will need quality leadership and hard work to further advance the tools that work well, to develop new approaches for what does not work, and to inspire perseverance in all. The challenge now is to seize this opportunity. ■

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