

Science Education, Outreach, and Citizen Involvement

National parks enjoy great public support and admiration, yet they can play an even greater and more meaningful role in the lives of Americans. One need is to expand the reach and relevance of national parks so that broader segments



of society can enjoy the outstanding values they offer. Moreover, engaging the public in exciting and motivating ways not only helps them form personal connections with the parks but also raises their awareness and appreciation of park purposes and stewardship.

Science education and public involvement in the scientific resource management

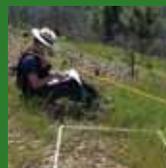
activities of the National Park Service are two important areas that address this need. This chapter discusses a variety of innovative programs

“Parks generate passion for learning, with deep, personal, emotional connections born out of experience, and stimulate the curiosity that is the bedrock of science.” — Gary E. Davis, David M. Graber, and Steven A. Acker

developed by the National Park Service and its partners for the public to learn about their national parks in the context of science and to participate directly in their care. Techniques vary from integrating principles of biology and physical sciences exemplified in the national parks into school curriculums to designing park management projects that give participants—often volunteers or students—practical experience in



resource restoration or data collection for resource inventory and monitoring. Some of the activities described herein reach out to new audiences; all extend opportunities for the public to establish or deepen their relationships with parks and develop a more sophisticated knowledge of park resources and their management. The results are stimulating, both for park managers who work to preserve national park values on a daily basis and for the public who ultimately decides their fate.



Native American science students study camas lily at Nez Perce's Weippe Prairie

By Tom Rodhouse

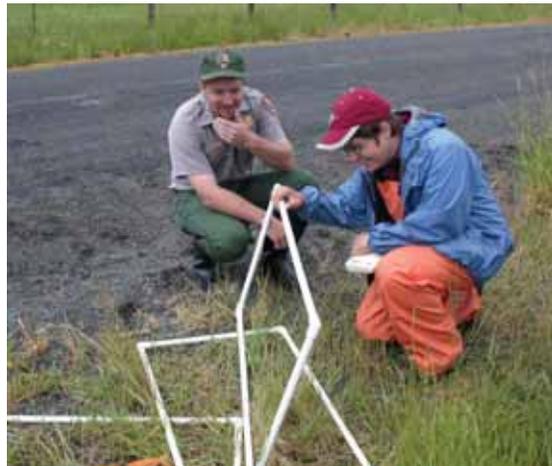
NATIVE AMERICAN HIGH SCHOOL SCIENCE STUDENTS participating in the Oregon Museum of Science and Industry's Salmon Camp program visited the Nez Perce National Historical Park in June 2005 to survey camas lily (*Camassiah quamash*), a plant of both cultural and ecological importance. The park is part of the Upper Columbia Basin Network, and together with the network's Inventory and Monitoring Program, has identified camas as a key park resource and high-priority vital sign, or indicator of ecosystem health, for long-term monitoring.

Camas, an ecologically significant wetland species, is historically one of the most widely used root crops of the Nez Perce people, and remains so for many tribal members today. It is also a focal resource at many historical events memorialized by the park. In September 1805, during the camas harvest at Weippe Prairie, located near Lewiston, Idaho, the Lewis and Clark Corps of Discovery first encountered the Nez Perce. The Corps had just completed the grueling journey over the Bitterroot Mountains and were out of food and exhausted. The Nez Perce fed them camas, among other foods, and many historians believe that the expedition would have failed without this assistance. Camas is therefore a central element of the cultural landscapes that the park seeks to interpret for the public, and its status as a focal cultural resource is one of the rationales for establishing a camas monitoring program.

Salmon Camp is a National Science Foundation-supported program designed to introduce Native American students to natural resource careers through the unifying theme of Pacific Northwest salmon conservation and recovery. Camas, like salmon, is also a culturally significant natural resource in decline throughout the region. In a natural extension to the salmon theme, students engaged in a "camas camp" and spent three days at the park site working with network and park resource staffs surveying camas and the invasive species sulphur cinquefoil (*Potentilla recta*). Park interpretive staff introduced the students to the cultural history of the site. Three student teams, each led by National Park Service staff, visited a set of sampling plots along a preestablished grid of transects and measured stem density and frequency of the two target plant species. They collected data that were stored in handheld computers (PDAs) with GPS and specialized GIS mapping software provided to the network by the Rocky Mountain Cooperative Ecosystem Studies Unit. The group spent their final afternoon together compiling and reviewing results, and discussed the significance of their findings for site management and long-term monitoring.

Altogether the teams completed measurements at 177 plots along 16 transects. Preliminary results suggest a negative correlation between camas and sulphur cinquefoil, in which camas is more frequent and abundant in areas with less cinquefoil. This is encouraging

Nez Perce National Historical Park resource manager Jason Lyon helps a Salmon Camp student assemble sampling frames for use by Native American science students in the camas field surveys. Camas (below) is a significant cultural and ecological resource at the park, where it has been selected for long-term monitoring as a vital sign, or indicator of park ecological health.



Successful partnership with The Nature Conservancy fosters corps of volunteers to tackle nonnative plants in Potomac Gorge

By Mary Travaglini



Salmon Camp students look for camas and sulphur cinquefoil inside a 5.4-square-foot (0.5-m²) sampling frame. Over two days they measured stem density and frequency of the two plant species at 177 plots.

news to the park resource staff, who is conducting an active invasive species control program at the site. Encouraging results were also obtained from a preliminary calculation of required sample size for detecting change in the frequency of these plant species over time. If these data are representative of the entire site over subsequent years, it appears likely that a cost-effective and efficient camas monitoring program can be conducted at the site. A monitoring program will provide park resource staff with a direct measure of the camas population in addition to that of threatening invasive weeds.

The Upper Columbia Basin Network is focused on developing a camas monitoring protocol that will accommodate citizen scientists such as Salmon Camp students and others like them. As a means of stretching limited dollars and providing state-of-the-art science education, the network hopes to develop citizen science components of several of its monitoring efforts. The experience of the 2005 Salmon Camp program at Weippe Prairie clearly demonstrates that with proper training, clearly defined objectives, and detailed protocols, this can be done. The network plans to test a fully developed monitoring protocol for camas with Salmon Camp students at Weippe Prairie again in 2006. ■

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EACH YEAR THE EXOTIC PLANT MANAGEMENT TEAMS (EPMTs) of the National Park Service tackle thousands of acres of invasive nonnative plants threatening natural resources around the country. The expanding problem with nonnative plants in the national parks, though, is beyond what these teams alone can manage. Through a partnership among two national parks, the National Capital Region Center for Urban Ecology, and The Nature Conservancy, volunteers from local communities in Washington, DC, Maryland, and northern Virginia have been mobilized to respond to the problem. They contributed more than 2,000 hours of service in 2005 to control invasive nonnative plants in the Potomac Gorge, a 15-mile (24 km) river corridor that includes parts of two national parks: the George Washington Memorial Parkway and Chesapeake and Ohio Canal National Historical Park.

Weed Warrior and Weed Buster volunteers have assisted the National Park Service in the control of 19 invasive plant species.

The Potomac Gorge, a 9,700-acre (3,929 ha) conservation area in Maryland, Virginia, and the District of Columbia, is one of the most biologically significant natural areas in the eastern United States, with occurrences of 134 rare plant species and five globally rare plant communities. Yet, more than 130 nonnative invasive plants threaten the diversity of life in this short stretch of river valley.

Invasive nonnative plants have been identified by the National Park Service, The Nature Conservancy, and the States of Maryland and Virginia Natural Heritage Programs as one of the greatest threats to rare plants and communities in the Potomac Gorge. Through a Cooperative Conservation Initiative grant from the National Park Service and matching funds from The Nature Conservancy and other partners, The Nature Conservancy has enlisted more than 300 volunteers in a series of supervised "Weed Buster" volunteer workdays and trained 30 volunteers as "Weed Warriors" to combat nonnative plants in the gorge.

Volunteers in Parks (VIPs) have been invaluable in helping the National Park Service accomplish numerous essential activities, but volunteers are often ephemeral or lack the training to do delicate resource protection tasks. The Nature Conservancy assisted the National Park Service by developing a 10-hour training for Weed Warriors so that they can confidently, professionally, and independently control nonnative plants on NPS lands in the Potomac Gorge. The training details the identification and mechanical control methods of 13 nonnative plants, protection of park resources, park visitor education, safety, and emergency management. After an introduction to their adopted area, Weed Warriors head out as NPS VIPs, armed with orange vests, clippers, and saws, and work whenever it best suits their schedules. After each visit, they return an "action report," including details on what plants they treated, treatment methods used, interactions with visitors, and plans to return.

In addition to the successful Weed Warrior program, The Nature Conservancy has worked with both park units in the gorge to organize



The Potomac Gorge, a 15-mile (24 km) river corridor near the nation's capital, has one of the highest concentrations of rare plant species in the nation. Two plant communities here are found nowhere else in the world. One of the greatest threats to this biodiversity is invasion by nonnative plants.

Citizen volunteers aid the National Park Service in controlling exotic vegetation, such as this linden viburnum (*Viburnum dilatatum*) in the Potomac Gorge. This shrub species has spread rapidly through acres of upland forest in Turkey Run Park, and volunteers like Margaret Chatham have dedicated hours of their personal time to help control its spread.



and supervise Weed Buster volunteer workdays to control nonnative plants. Volunteers may participate on these group workdays without prior experience and receive training on the job. Nature Conservancy staff has special training and permission to apply herbicides as needed for woody species cut during the workdays, complementing the manual control work of the volunteers.

As a result of these initiatives, Weed Warrior and Weed Buster volunteers have assisted the National Park Service in the control of 19 nonnative plant species, treating approximately 20 acres (8 ha) of habitat in the Potomac Gorge primarily through mechanical control, often in areas that are difficult to access. Weed Warriors become intimately familiar with their adopted area and provide feedback on the success of control efforts. Alongside the efforts of the National Capital Region EPMT, they have become invaluable in stemming the tide of nonnative plants and strengthening the partnership between the George Washington Memorial Parkway and the C&O Canal National Historical Park to protect biodiversity in the Potomac Gorge. ■

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Multipark program teaches students how to appreciate their rare, fragile backyard

By Bruce Izmirian

SOUTHERN CALIFORNIA is home to more than 17 million people and has an abundance of some of the most diverse plant and animal species found anywhere in the world. Yet many of those who live and recreate in the area lack an awareness of the rare and fragile ecosystem (classified as “Mediterranean”) that is their backyard. This lack of knowledge can make park management more difficult when issues involving research are interpreted to a public that may not understand, or care about, the significance of the research findings.

A citizen science education program called Each One, Teach One is helping remedy this problem. From June 2004 to July 2005, the program helped promote research occurring in three national parks in southern California. Funded by the California Mediterranean Research Learning Center, this program helped scientists from Santa Monica Mountains National Recreation Area, Cabrillo National Monument, and Channel Islands National Park share current research data with a core group of three college interns in a one-week intensive training period. The purpose of the research learning center is to establish a cooperative management, research, and education effort that supports research in the three parks’ ecosystems. It seeks to involve and educate the public in park research through citizen science opportunities.

This program ... helped close the gap between scientists and students ... [and] stands as a template of what successful research learning center programs can achieve.

Research overviews included world and local Mediterranean ecosystems, wildland fire, vegetation, marine ecosystems, wildlife, and cultural history. Each park was assigned supervision duties for one project intern. After the one-week training, interns continued to gain specialized knowledge while working closely with resource management and education staffs at their assigned park.

According to teachers, “average” students had had few opportunities before the program to demonstrate their knowledge and understanding of local ecosystems. Each One, Teach One provided the forum in which students applied and demonstrated what they learned about the scientific method, National Park Service science, and ecosystem preservation. The information gained from this training then empowered the interns to become teachers. Interns shared their knowledge by developing and presenting curriculum-based lessons for Los Angeles, Ventura, and San Diego County high school science classes. They facilitated in-park service learning studies focusing on fundamental concepts about research components and ecosystem challenges. They also shared their expertise with other students and the public through production of an educational video and traveling exhibit.

The response from both teachers and students was extremely positive. Teachers agreed that the program went beyond their expectations in meeting curriculum objectives. Excited about continuing this hands-on program, teachers said that it expanded their students' world, teaching them about the unique ecosystem that is their own backyard. Students agreed that they were more informed about their Mediterranean ecosystem and more concerned about taking care of it. They urged the National Park Service to keep the program going in order to help more students understand the importance of preservation.

Increased public support for NPS efforts in the scientific, education, and preservation fields emerged as a major benefit of this cooperative project. One hundred seventy-nine students and 7,200 park visitors established a foundation on which to base future growth and urban planning decisions in a holistic and scientifically based way. Marketing of the project video for broadcast through community and educational television stations was scheduled for January 2006. Video outreach is guaranteed to exceed the life and funding for the program and requires minimal staff assistance while reaching large audiences.

The project also created preservice training opportunities for student participants. Two undergraduate project interns are currently working for the National Park Service in seasonal and research capacities. Several high school students have expressed a desire to conduct more in-depth work as park interns.

This program, which developed in response to a call for network projects supporting research learning center goals, helped close the gap between scientists and students. It stands as a template of what successful research learning center programs can achieve.

Each One, Teach One helped connect students, teachers, and the general public with the resource. Understanding frequently brings appreciation, and appreciation brings caring and protection. As keepers of America's treasures, the National Park Service is providing a hands-on opportunity for students to learn about their natural and cultural heritage. This program is also building future stewards of a rare and fragile biome that belongs to all. ■

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Debbie Kiner, education volunteer at Santa Monica Mountains National Recreation Area (left), and Pacifica High School students conduct vegetation studies on Santa Cruz Island for the Each One, Teach One science education training program. This program, funded by the California Mediterranean Research Learning Center, highlighted how educating and mentoring students, who then become teachers themselves, on important ecological issues can enhance the management of national park units.



Barbara Collins, student intern at Channel Islands National Park (left), and Pacifica High School students study animal tracks on Santa Cruz Island. Scientists from Santa Monica Mountains National Recreation Area, Cabrillo National Monument, and Channel Islands National Park shared current research data with a core group of college interns in a one-week intensive training program. All participants were engaged in an enhanced awareness and understanding of the complexity of natural resource management.

LaQuincy Arnold, ambassador for national park conservation

By Gillian Bowser

LAQUINCY ARNOLD, a junior at Prairie View A&M University in southeastern Texas, is part of the next generation of conservation leaders and is also a talented student and an outspoken supporter of the National Park Service and several of its conservation partners. He gained interest in the Park Service and its conservation mission in 2004 when he accepted a summer internship at Big Thicket National Preserve, 40 miles (64 km) south of Kountze, Texas, where he grew up. Sponsored by the Student Conservation Association (SCA) and working under the leadership of Acting Chief of Interpretation Leslie Dubey, LaQuincy, who goes by “Quincy,” was involved with a variety of park projects under several divisions, including Interpretive Education, Natural Resource Management, Fire, Maintenance, and Administration. This SCA resource assistant position gave him his first exposure to natural resource management issues. Though he worked primarily on interpretation programs, introducing young people to park natural resources, he also participated on fire and hog management crews and helped maintain park trails.

Quincy is a young and devoted ambassador for the National Park Service and actively shares his work experiences with his peers at Prairie View and other historically black colleges.

The following semester, Quincy came to Texas A&M University as a student intern through Prairie View’s cooperative education program, where he was part of the unique partnership of Texas A&M and the Gulf Coast Cooperative Ecosystem Studies Unit (CESU). In that role he worked directly with Robert Stanton, former NPS director and senior fellow at the university, and Dr. Gillian Bowser, CESU research coordinator and National Park Service liaison, coordinating the Distinguished Lecture Series, arranging field trips to several units of the National Park System, and conducting a literature review on minority issues within Fortune 500 companies and on these companies’ commitment to professional development. He was particularly engaged in this project because he feels strongly about diversity in the workplace and believes that many organizations do not recognize the value of a diverse workforce. In addition, his research enhanced the issues highlighted by Mr. Stanton in his lecture series on parks and environmental justice.

Quincy is a young and devoted ambassador for the National Park Service and actively shares his work experiences with his peers at Prairie View and other historically black colleges. In fact he has personally recruited students to work at the Gulf Coast CESU in cooperative education positions; two of those students went on to work at national parks in 2005 and will be returning for another summer season in 2006. He hopes that by sharing his recent work experiences, he will be able to ignite the interest of other minority students in careers in conservation and the National Park Service.



LaQuincy Arnold holds leadership positions in some of the most respected organizations on the campus of Prairie View A&M University, where he is a junior. His work with the National Park Service demonstrates the value of the Student Conservation Association and Texas A&M University, the host university of the Gulf Coast Cooperative Park Ecosystem Studies Unit, in exposing promising minority students to careers in conservation and with the National Park Service.

Quincy will continue his professional development with the Park Service in 2006 by working on the business plan for National Capital Parks–East in Washington, DC. He will be the only undergraduate on a team of graduate students from leading business schools in the nation. In developing a business plan for the park, the park staff will have compelling supportive documentation for their financial and programmatic decisions, a substantive resource for setting priorities and implementing management strategies, and increased credibility with internal and external stakeholders. Quincy was introduced to the NPS business plan concept in the summer of 2005 while working in the SCA regional office in Arlington, Virginia. There, Senior Vice President Flip Hagood served not only as his supervisor but also as a mentor and role model. Quincy worked with the SCA team to coordinate the annual training session for the Business Planning Initiative held in Yosemite National Park, and attended that training to begin his work with National Capital Parks–East. He is continuing to develop the business plan through the spring 2006 semester based at Texas A&M, then will join the staff of the park and work under the leadership of Superintendent Gayle Hazelwood.

Quincy continues his close relationship with Robert Stanton and Gayle Hazelwood, who have mentored him over the last year and are watching him mature into a true leader. “I have a great deal of respect for the phenomenal mentors and giants in conservation that I have had the privilege of meeting,” Quincy says. “Robert Stanton, Gillian Bowser, Flip Hagood, Gayle Hazelwood, and Leslie Dubey all have been so influential throughout my work experience with the parks.” Quincy is grateful for nonprofit organizations, such as the Student Conservation Association, that provide students with experience and a strong and supportive network that is tremendously beneficial to the success of their careers. He appreciates the opportunities he has had to develop professional skills related to the conservation of national parks and finds them inspiring as he continues his educational development. Quincy is a business management major with a minor in English and has plans to attend law school after completing his undergraduate studies at Prairie View. ■

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“Bridges” helps teachers improve science education in California classrooms

By Debbie Savage

REDWOOD NATIONAL AND STATE PARKS has a secret strategy for encouraging California students to consider careers in science: giving students tangible tools, engaging experiences, and relevant activities that include all learning styles. Bridging the gap between the classroom and future science careers is the goal of “Bridges,” a comprehensive curriculum that connects state and national science education standards with the primary interpretive themes of Redwood National and State Parks. The curriculum allows students to explore resource management methods through hands-on activities. Most classes are not able to travel to the parks, so the staff decided to take the parks to the students. In 2005, park staff completed the curriculum for seventh and eighth graders, which has received an enthusiastic response from both students and teachers.

The curriculum focuses on park animal species that offer a signal of biological changes in the ecosystem, known as indicator species. Northern California steelhead (*Oncorhynchus mykiss*), marbled murrelet (*Brachyramphus marmoratus*), mountain lion (*Puma concolor*), and Roosevelt elk (*Cervus elaphus* subsp. *roosevelti*) allow students to explore the mosaic of habitats within the parks and region. Students discuss how scientists learn about wildlife and their habitats in order to monitor, enhance, and restore them. Because the focus is on investigating resource management techniques, students learn about radio tagging, stream pebble counts, and animal-sighting logs. They also learn how data influence resource management decisions. Park scientists and interpretation staff designed all of the activities in the curriculum in consultation with teachers from the local community. Activities and educational concepts were tested at workshops and in the classroom.

The [teacher’s] guide has 11 units that explore research methods used by the parks’ resource managers and how this research helps determine management decisions and practices.

The materials include a 115-page teacher’s guide and a wheeled resource trunk containing all the necessary supplies for conducting the activities outlined in the curriculum. The guide has 11 units that explore research methods used by the parks’ resource managers and how this research helps determine park management decisions and practices. Six trunks are available for teachers to check out through the school district media centers in Del Norte and Humboldt Counties. The materials include conventional teaching aids like videotapes, books on the redwood ecosystem, and field guides to animal tracks and stream organisms. The trunks also contain unexpected materials, such as animal track and scat replicas, elk and mountain lion skull and tooth replicas, and a copy of a marbled murrelet egg. What seventh or eighth grader would not get excited about scat?



Looking for an innovative way to interest students in science, interpretation staff at Redwood National and State Parks developed a comprehensive resource management curriculum for teachers to present to their seventh and eighth grade students. All of the activities were created in consultation with teachers from the local community and tested at workshops and in the classroom, where they received an enthusiastic response.



Teachers found the trunks very useful too. “The contents of this trunk were interesting, well thought out, and very appropriate to our area. [The curriculum] was both fun and educational, plus it could be used by many different grade levels,” noted Castle Rock Charter School teacher Margie Rouge.

The Bridges curriculum also features activity sheets. Called “Redwood Log” student pages, the sheets provide information, graphs, and charts for students to organize data, and space to record observations. As the activities are completed, students can gather the pages into a personal folder or logbook to serve as a learning assessment tool.

The critical need for innovative solutions to increasing the participation of young people in science is evident in the range of organizations that provided financial support for the project: Exxon Mobil Corporation, Save-the-Redwoods League, National Park Foundation, Parks as Classrooms, and Redwood Park Association.

The Bridges project has introduced local students to the distinct natural history of Redwood National and State Parks. It has also helped build understanding of the importance of a stewardship ethic in protecting the natural environment. Students have learned that science can be relevant and enjoyable, perhaps sparking a lifelong interest in science for some participants. Park staff is also hopeful that one or two of the students will return in the future as park scientists. After all, this project is all about the future. ■

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Volunteers collect dragonfly cast skins for survey along Potomac River

By Richard Orr

Volunteers helped inventory dragonflies and damselflies in a survey along the Potomac River by collecting the skins discarded when larvae become adults. This newly emerged black-shoulder spinyleg dragonfly rests on top of its cast skin at Chesapeake and Ohio Canal National Historical Park.



IMAGINE GROWING BY SPLITTING YOUR SKIN and walking away from the dried husk. Dragonflies grow this way; the skins that are left behind are called “cast skins,” which can often be identified to species. From 2002 to 2004 the National Capital Region of the National Park Service conducted a detailed survey that made use of the cast skins of dragonflies and damselflies of the Potomac River and its adjacent wetlands at Harpers Ferry National Historical Park (West Virginia and Virginia), Chesapeake and Ohio Canal National Historical Park (Maryland and District of Columbia), and the George Washington Memorial Parkway (Virginia). The goal of the survey was to find out which species were present and which might be at risk because of mosquito management for West Nile virus. The parks

were considering spraying an insecticide to control mosquitoes and needed to understand the effects this action would have on other species of insects.

The Potomac River is large and difficult to sample for aquatic insects. Many microhabitats in the river support different insect assemblages. These areas are not obvious when viewed from the shore or surface, making surveys expensive and sometimes dangerous. Fortunately, dragonfly larvae from all parts of the river ultimately end up leaving their cast skins along the shore when the adults emerge. Experts can then examine the skins and determine which species are living there. Damselfly cast skins were also collected occasionally, but they are better surveyed by other techniques.

Maintaining the integrity of native plant communities in Glacier Bay

By Whitney Rapp

The National Capital Region contracted Versar, Inc., to coordinate the survey, with volunteers providing the many hours of labor along the river. Though they have rarely been used for detailed scientific surveys targeting aquatic insects, these citizen scientists were essential for this study, which would not have been possible without their help and dedication.

Over ... three field seasons, 23 volunteers worked 160 field days, contributing 552 volunteer hours ... and collecting more than 4,000 cast skins from which 3,347 were identified to species.

Versar, an environmental consulting company, along with the Audubon Naturalist Society and Partners in Parks, coordinated a workshop early in 2003 to train the NPS volunteers in making the collections and worked out the related program logistics. Over the next three field seasons, 23 volunteers worked 160 field days, contributing 552 volunteer hours to the project and collecting more than 4,000 cast skins from which 3,347 were identified to species.

Park managers were amazed at the number of dragonflies the volunteers collected. In total, 101 species of dragonflies and damselflies were identified from the cast skins. Forty-five of the species are of conservation importance because they are rare in the District of Columbia, West Virginia, Maryland, and Virginia. Many of the records of the rarest dragonflies came from cast skins found by the volunteers.

No immediate management decisions about controlling West Nile virus emerged from this study because the threat of the virus seems to be in abeyance, possibly because the dragonflies themselves are doing such a good job of controlling the mosquitoes. However, data gained from this survey will inform future management decisions when control of mosquitoes or other problem species is called for now that managers know that some of the 101 species of dragonflies and damselflies might be affected. ■

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SPECIES LIKE COMMON DANDELION (*Taraxacum officinale* subsp. *officinale*), red and white clover (*Trifolium pratense* and *T. repens*), and annual bluegrass (*Poa annua*) are ubiquitous across America, just like fast-food restaurants and big-box stores. Unfortunately, these plants are not native to the United States and negatively affect native biota. In remote Alaska, including Gustavus, the gateway to Glacier Bay National Park and Preserve, nonnative vegetation is also establishing itself. The nearest grocery store or fast-food restaurant is a 60-mile (97 km) flight or boat trip away, but aggressive, nonnative plants have made the trip to the wilderness. The distinct and unspoiled quality of Glacier Bay is now in jeopardy from nonnative, or exotic, plants. In 2005, during the first year of a local effort, the invasive plants program surveyed more than 500 acres (203 ha), removed 3,300 pounds (1,500 kg) of nonnative plants, and initiated community outreach and education efforts.

Nonnative plant invasions generally begin in areas of human disturbance, including roadsides, vacant lots, and campgrounds. While only the developed area of Glacier Bay has substantial human disturbance, natural disturbances are common throughout the park and leave it vulnerable to colonization by nonnative species. Consider that two centuries ago glaciers covered the majority of the park now enjoyed by visitors each year. As the glaciers retreat, newly exposed ground is extremely susceptible to invasion by opportunistic plants. One of Glacier Bay's founding missions is to serve as a natural laboratory for studying postglacial plant succession, but this process is dramatically altered with the arrival of nonnative species.

In 2005, the first year of a local invasive plants program in Glacier Bay, nearly 500 acres (203 ha) were surveyed using the protocols of the Alaska Region Exotic Plant Management Team (EPMT). Since the park is the size of the state of Connecticut (3.3 million acres; 1.3 million ha), most of the effort focused on the coastal areas most used by visitors. Twelve new nonnative species were identified, bringing the total nonnative plant species to



Children in Gustavus, Alaska, show their faces painted with native flowers during a public event celebrating the native flora of the area. Several outreach events have targeted the youth of the community in hopes that they will take the message home to their families and their yards.

37. Of these, only 5 have invaded the backcountry. Considering the widespread distribution of nonnative species in other park units, Glacier Bay considers itself fortunate. Accordingly, the park is working proactively through early detection and rapid response to prevent the wilderness landscape from deteriorating and falling prey to the homogenizing influence of aggressive, nonnative plants.

One of Glacier Bay's founding missions is to serve as a natural laboratory for studying postglacial plant succession, but this process is dramatically altered with the arrival of nonnative species.

This year, more than 3,300 pounds (1,500 kg) of nonnative plants were pulled or dug in 127 hours by a crew that included one employee and many volunteers. Control efforts focused on the developed areas of the park to limit future dispersal and targeted the most aggressive species, including reed canary grass (*Phalaris arundinacea*), ox-eye daisy (*Leucanthemum vulgare*), timothy (*Phleum pratense*), and dandelions. In the backcountry, control efforts focused on eradicating disjunct infesta-

tions. Except for dandelions, park staff anticipates that all other nonnative plants will be removed from the backcountry within a few years.

The invasive plants program has initiated community outreach and education efforts aimed at raising awareness. One event was the "Invasive, Exotic Flower Arranging Contest," which was held during the Fourth of July celebration, Gustavus's largest annual gathering. The colorful and creative floral arrangements drew attention to the display where people could learn about exotic species. What could be more patriotic on Independence Day than working to protect our native species? Other outreach events have targeted the youth of the community in hopes that they will take the message home to their families and their yards.

In 2005 the program was supported by funds from three National Park Service sources: the Alaska Region EPMT, the Southeast Alaska Coastal Cluster, and Glacier Bay National Park and Preserve. With continued vigilance and appropriate allocation of resources for inventory, control, and education, the invasive plants program aims to maintain the integrity of Glacier Bay's native ecosystems. ■

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Nonnative plants, including ox-eye daisies, large-leaved lupines, and hawkweed, are arranged on a bike for the "Invasive, Exotic Flower Arranging Contest." Through fun and innovative events like this one, Glacier Bay National Park and Preserve is educating the community about the effects nonnative plant species can have on native ecosystems.

Nonnative common dandelions grow alongside native plants in a meadow at Glacier Bay National Park and Preserve. The same nonnative plants that are displacing the native flora elsewhere in the United States are altering the distinct and unspoiled quality of Glacier Bay.



Visitors fascinated by Canaveral National Seashore's Sea Turtle Watch Program

By Laura E. Henning

EACH SUMMER, SEA TURTLES RETURN to Canaveral National Seashore in Florida to make their nests and lay their eggs, but the turtles are not the only ones drawn here for this event. In June and July 2005, interpreters guided more than 1,600 visitors on nightly walks in a quest to view nesting sea turtles and learn about the national seashore's efforts in sea turtle conservation. Because of its protected status, Canaveral National Seashore is the perfect classroom for observing how sea turtles behave in nature without interference from lights, traffic, or artificial barriers on the beach.

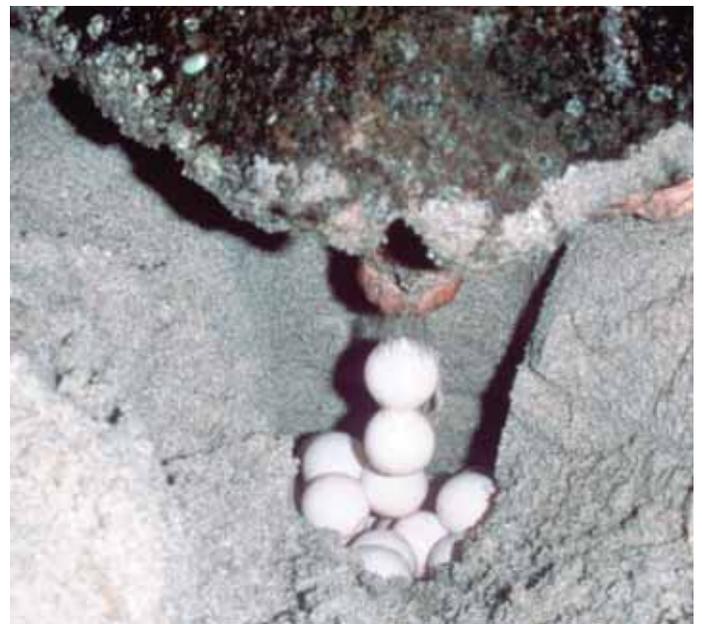
For visitors this shared experience establishes an emotional connection to a species that many know little or nothing about before they come to Canaveral National Seashore.

The experience of the turtle watch is as extraordinary as the nesting process itself. It is resource immersion at its finest. The program begins with a hands-on talk about sea turtles and Canaveral National Seashore's role in their preservation. Tension and excitement mount as the group awaits the call that will take them to the dark beach to see the real thing. The group is quietly led to the nesting loggerhead turtle as she is laying her eggs. The rangers and volunteers use red-filtered flashlights to provide a better view without disturbing the female turtle. Though the group may number up to 30, the volunteers are quiet and awestruck. Whispers about her size and the perfectly round Ping-Pong ball-sized eggs mix with comments of appreciation for what she is going through. When she finishes covering her nest and returns to the ocean, the group breaks into a satisfied round of applause. For visitors this shared experience establishes an emotional connection to a species that many know little or nothing about before they come to Canaveral National Seashore.

During summer 2005, the 22nd season of the sea turtle nesting program, the national seashore was the site of 3,600 nests made by green sea turtles (*Chelonia mydas*), leatherbacks (*Dermochelys coriacea*), and the threatened loggerheads (*Caretta caretta*). Nest numbers have ranged from 1,776 in 1987 to a high of 4,563 in 2000. Volunteers and biotechnicians put in hundreds of hours on the beach collecting data on nests and screening them from predators. Turtle watchers have been concerned that the number of loggerhead turtle nests has declined in recent years, and data collected over the last five years do show a slight downward trend in 2004 and 2005. In the next few summers, program participants will collect crucial data regarding the future of the threatened loggerhead sea turtles that come to nest at Canaveral National Seashore where they provide an unforgettable experience for visitors. ■



(Above) The endangered green sea turtle may not reach reproductive maturity until 30 years of age. Canaveral National Seashore had a record 1,039 green sea turtle nests in 2005. (Below) This loggerhead sea turtle is depositing her eggs and lays between 80 and 150 per clutch.



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Education program targets plant restoration at Santa Monica Mountains

By Jack Gillooly

IN THE SANTA MONICA MOUNTAINS of southern California, a long history of human occupation has left the landscape with a complex variety of natural and disturbed habitats. Native plant communities—coastal sage scrub, chaparral, and oak woodlands—are interspersed with patches and fields of nonnative annual grasses and other invasive species. Erosion can be high and biodiversity low, with little natural recovery of native vegetation. Compounding the problem is the mountain checkerboard of public and private ownership, as backyard plants continue to escape into parklands.

Sounds like a mission for “EcoHelpers,” a successful restoration-education program at Santa Monica Mountains National Recreation Area. Each year, 2,000 diverse high school science students from the Los Angeles area are signed on as park volunteers to pull weeds and plant native vegetation during school field trips. For many it is their first visit to a national park, and comes with a crash course in Gardening 101. The students also receive important lessons in watershed ecology, invasive species, and the wildlife benefits of restoration, qualifying them for “service learning” credit needed for graduation.

The EcoHelpers project is a close partnership between the park’s Resource Management and Interpretation Divisions. Resource



After clearing weeds and learning how to plant native species, students help restore a national parkland. For years to come, they can return and see the fruits of their volunteer labor.



At the restoration site, EcoHelpers coordinator Eli Dickerson guides student volunteers in proper planting and weeding techniques. Training for the program also includes an ecology talk and guided walk. Students learn to identify nonnative plants, discuss their detrimental effects, and discover how native plants benefit wildlife.

Management oversees the restoration planning, including site prioritization, selecting plant palettes, seed collection, and operating the plant nursery. Interpretation takes care of the education elements and guides the field trips. Both divisions enlist adult volunteers and gather funding for the program’s full-time NPS coordinator, equipment, and school buses. The pilot program was funded in 2003 by the California Coastal Commission, with subsequent funding from federal sources: the Cooperative Conservation Initiative, Challenge Cost-Share, and Public Lands Commission.

In 2004 and 2005, EcoHelpers focused on degraded streamside habitat in Solstice Canyon, where a dominant new nonnative species was taking over: *Euphorbia terracina*. After eliminating large patches and replanting 3 acres (1.2 ha), the program will move to Zuma Canyon in 2006 for an attack on mustard, Russian thistle, castor bean, and fennel. Along with euphorbia, these plants are high on the park’s target list, especially when they cover large areas, as in Zuma.

Beyond the habitat benefits of the program, interns and staff have been testing different restoration strategies. New mulching combinations, aftercare techniques, and planting patterns have improved plant survival and helped minimize weed regrowth. Continuous monitoring keeps track of remaining weed seed banks while long-term recovery is charted in photo points.

EcoHelpers has shaved decades off habitat recovery time and is an effective tool in the park’s restoration and education programs. Park staff is happy to share information to help other parks start similar programs. ■

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Colorado State University graduate students improve awareness of Heartland Network's inventory and monitoring activities

By Sara Melena, Chris Mayer, Tawnya Ernst, and Cara DiEnno

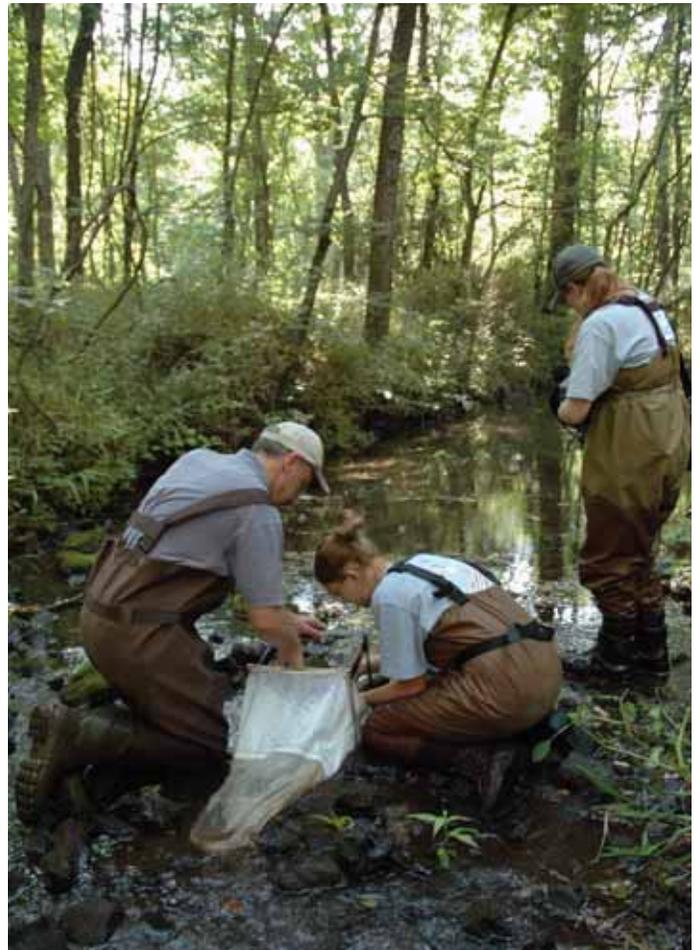
IF A TREE FALLS IN THE FOREST and no one is there to hear it, does it make a sound? More importantly, is park science really relevant if only a handful of scientists are aware of new findings and can understand their implications for park resources? As park management becomes more complex with many management issues spanning park boundaries, communicating new research findings with park managers, visitors, local residents, and others who might have a hand in effecting change and addressing natural resource challenges becomes increasingly important. The Heartland Network Natural Resource Monitoring Program recognized the need to communicate the results of ongoing monitoring and inventory efforts. In 2005 the network enlisted a team of Colorado State University (CSU) graduate students, under the direction of the Natural Resource Program Center's Office of Education and Outreach, to develop strategies for raising awareness about and understanding of the purpose, objectives, and benefits of the network's inventory and monitoring activities.

Heartland Network scientists understand that converting data into compelling stories that illustrate the importance of their research is good for both their program and the parks.

The Heartland Network monitoring program was established as part of the park vital signs monitoring program, which provides park managers with accurate scientific information needed to make sound management decisions about the resources in their care. More than 270 parks with significant natural resources have been organized into 32 networks. Each network conducts long-term monitoring of key indicators of change, or "vital signs." Scientists with the Heartland Network measure the condition of water, air, geologic resources, plants, and animals found within the network's 15 parks.

To improve communication about the value of network parks and new scientific findings, the team of graduate students used research results and examples of adaptive management success stories to create thematic messages and communication products. For example, they developed prairie wildflower seed packets that featured an interpretive message about the negative effects of invasive nonnative plant species. Additionally, radio spots were developed on issues like threatened and endangered species, nonnative plants, and water quality. The short radio announcements were recorded for broadcast on park radio or to be downloaded from the Heartland Network's Web site. One of the spots reminds visitors that they can enjoy many of the same plants and animals encountered by Lewis and Clark during their Corps of Discovery expedition more than 200 years ago, thanks in part to NPS inventory and monitoring activities.

The team also produced a short video presenting a broad picture of the Heartland Network and its monitoring efforts, which was



Scientists at George Washington Carver National Monument, Missouri, one of the Heartland Network parks, sample macroinvertebrates, which are small organisms consumed by fish and an important component of the food web.

made available to internal and external audiences. It supplied templates for interpretive products that can be tailored to the issues and priorities of individual parks. A training presentation, note cards, a brochure, and an electronic newsletter were also products developed by the team.

As graduate students well know, academic research is not considered complete until it has been published, thereby contributing to the larger body of knowledge. Heartland Network scientists understand that converting data into compelling stories that illustrate the importance of their research is good for both their program and the parks. National Park Service scientists also recognize that they have an obligation to provide the American public with useful scientific information. For these reasons, the Heartland Network is expanding its efforts to communicate to a wider audience. Public outreach is emerging as the final step in the research process for good reason: it benefits the national parks and the people who enjoy them. ■



In 2005 the Heartland Network enlisted a team of Colorado State University graduate students to develop strategies for raising awareness and understanding of the purpose, objectives, and benefits of inventory and monitoring activities. The team developed a range of interpretive products.

Scientists with the Heartland Network measure the condition of water, air, geologic resources, plants, and animals found within the network's 15 parks, including Pipestone National Monument, Minnesota. The national monument supports more than 500 native plant species, including the threatened western prairie fringed orchid (*Platanthera praeclara*), which is regularly monitored.



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Putting educational materials about parks in the hands of science teachers

By Bruce Nash and Jim Wood

TWO OFFICES OF THE NATURAL RESOURCE PROGRAM Center in Lakewood, Colorado, have developed digital education materials that support teachers and inform the public about scientific concepts illustrated in national parks. Collaboration between the Geologic Resources Division (GRD) and the Office of Education and Outreach (OEO) has resulted in original, park-focused materials that allow teachers to bring the National Park System into their classrooms. As one user explains, "Each park has its own distinctive features, and when you use science to help explain the features, it makes them even more interesting."

In 2005 the Office of Education and Outreach expanded a program called "Views of the National Parks" through components called "virtual experiences" and "knowledge centers" about wilderness, Grand Canyon-Parashant National Monument, Whiskeytown National Recreation Area, geology of the National Mall, coastal geology, and Tonto National Monument. To broaden the educational opportunities, Views of the National Parks offers multicultural perspectives and examples of how parks have inspired artists, musicians,

The Natural Resource Program Center ... [has] developed digital education materials that support teachers and inform the public about scientific concepts illustrated in national parks.

and writers, using interactive graphics, 360-degree panoramas, natural sound recordings, and digital movies to stimulate interest in national parks and encourage users to extend their exploration. Developers organized the program around two components: virtual experiences take users on a journey of adventure to a single park, and knowledge centers present information on topics that reach across many parks. In addition to working with subject-matter experts at the Natural Resource Program Center, OEO staff worked with a "master teacher" who wrote and evaluated modules and activities, including lesson plans about wildlife in Grand Canyon National Park, Florissant Fossil Beds National Monument, volcanism, wilderness, and coastal geology. During this collaboration they also developed a teacher resource center that provides suggestions on effectively using the program and links to national teaching standards, lesson plans, activities, and other educational resources.

In partnership with the US Geological Survey (USGS) and local science teachers, the Geologic Resources Division developed a teacher resource site in 2005 to provide educational resources for teaching geology with examples from national parks; the site is extensively linked to Views of the National Parks. The Geologic Resources Division asked volunteer educators to comb through NPS Web pages to evaluate educational materials that park staffs had posted. These

volunteers rated the best sites for Earth science education and posted them on a “jumpsite,” which serves as a starting point for teachers and students to probe the labyrinth of NPS pages. Through collaboration with the USGS in Menlo Park, California, GRD staff set up extensive linkages between the NPS and USGS sites, including hundreds of sites about geology in the National Park System and thousands of geologic photos. Over the past year the USGS has greatly expanded its image collection of national parks, including many 3-D images, which users can access via the jumpsite.

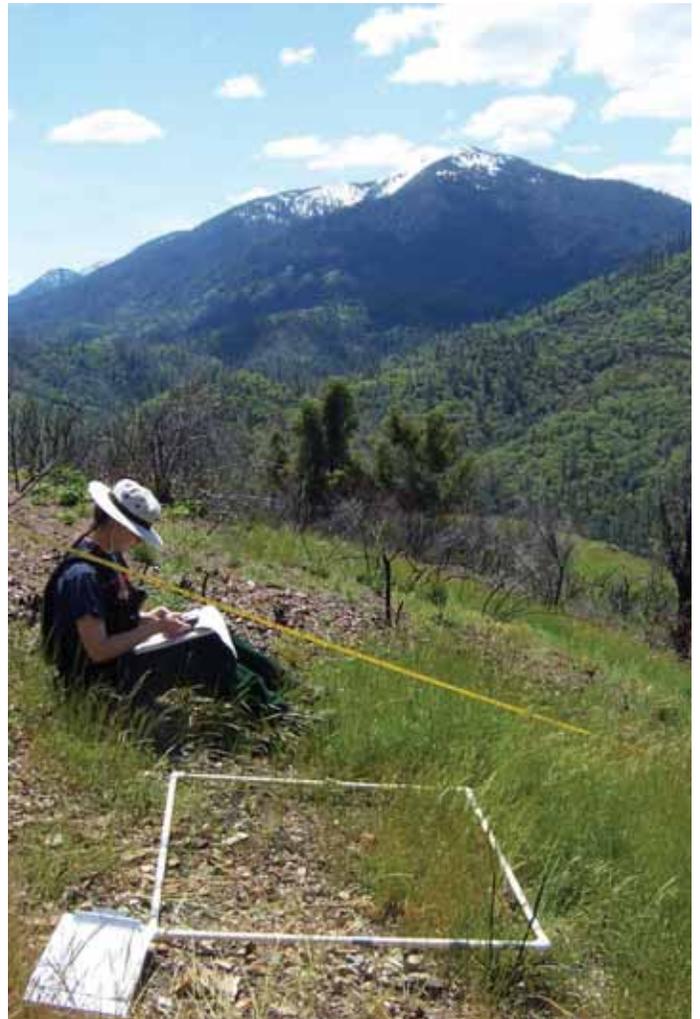
The GRD Web pages are available at <http://www2.nature.nps.gov/geology/education/index.cfm>; Views of the National Parks is available on CD and at <http://www2.nature.nps.gov/views/>. In 2005 many individuals and organizations came to recognize the usefulness of these materials. For instance, SciMaTEC, an education center at the University of Toledo, Ohio, requested 400 Views CDs for distribution at its Northwest Ohio Symposium on Science, Mathematics, and Technology. One physics teacher who received the CD remarked that national parks help stimulate discussion: “We could talk about the physics of geysers in Yellowstone or the way lava flows in the Hawaiian lava fields. Students are interested in these kinds of things, and when you can relate science [to these features], it just is an added bonus.” In addition the Digital Library for Earth Systems Education—a community Web site for educators, students, and scientists working together to improve Earth science education—posted four knowledge centers (volcanism, coastal geology, caves and karst, and glaciers) at <http://www.dlese.org>. This library is another venue for getting scientific information about national parks into the hands of teachers. It appears to be one of the hottest Internet sites for Earth science teachers and is broadly recognized as a good source of information and materials for natural science education. Also in 2005, WGBH Television in Boston selected portions of these four geologic knowledge centers to be posted on its Teachers’ Domain Web site, a National Science Foundation-funded project that uses video, interactive features, primary documents, still photographs, and lesson plans to teach science under national and state K–12 standards. When these knowledge centers go live on the WGBH site in 2006, they will be another avenue for teachers to gather science-related information about national parks. ■

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A biological science technician samples vegetation at Whiskeytown National Recreation Area to assess the response of both native and nonnative vascular plants to a 2004 wildfire. Video of the survey appears in the knowledge centers module on ecology of the Views of the National Parks program and helps illustrate the importance of science in understanding park ecosystems.

Parks, plates, passion, and a professor

By Katie KellerLynn and Judy Geniac

“THE GEOLOGY OF THIS NATIONAL PARK is way too complicated.” This is the occasional refrain of park staffs charged with interpreting sites set aside for their awe-inspiring geology. Bob Lillie’s answer to this comment is “Yeah, but so is a lizard.” Lillie, a professor of geology at Oregon State University, has served as a Geoscientists-in-the-Parks participant in eight units of the National Park System and as a seasonal ranger at Crater Lake (Oregon) and Yellowstone National Parks (Wyoming, Montana, and Idaho). He has taken on the “geologic cause” of training park staffs about geology in their parks. “You get a lot of great talks about bears and flowers, but geology gets ... short shrift,” says Lillie.

Since beginning a yearlong sabbatical in August 2005, he has been collaborating with local experts and NPS geologists and leading a series of 45 geology workshops in parks for interpreters and other interested staff. His geologic-training adventure began in Golden Gate National Recreation Area (California), then shortly thereafter he traveled to Rocky Mountain National Park (Colorado). Lillie’s passion will take him to national parks, monuments, and seashores across the nation; he will spread the word that national parks are places where dramatic geologic events are taking place. For example, as he says in the preface of his new book, *Parks and Plates: The Geology of Our National Parks, Monuments, and Seashores*, “People can go to parks in California to observe changes in the landscape associated with earthquakes. They can see volcanic eruptions and their products in the Pacific Northwest, Alaska, and Hawaii. In national seashores they can see effects of erosion and deposition.”

[Bob] has taken on the “geologic cause” of training park staffs about geology in their parks.

Lillie explains that “the geologic forces that influence our lives are especially vivid in national parks—about half of which were established because of their spectacular geologic features.” *Parks and Plates*, published in 2005 by W.W. Norton, is intended for visitors to the National Park System and for park staffs in interpretation, natural resources, and research. His book is already popular in some of the 150 or so courses on the geology of national parks taught at colleges around the nation. “If we can use the compelling stories of geology in our national parks to hook people into learning more about our natural world, that’s great,” Lillie says.

His dedication is exemplified by a sabbatical committed to training workshops and his book, which presents geology in a way that speaks to a general audience. To Lillie “food analogies are good.” An accomplished Cajun cook, he recalls growing up in Cajun country with his mother’s and grandmother’s cooking. “They always started by making a roux—a mixture of hot oil and flour. The more flour



Professor of geology Bob Lillie at Dream Lake, Rocky Mountain National Park, Colorado.

added, the thicker and more pasty the roux. Magma is similar, only the thickening agent is silica.” He also uses Oreos to explain plate tectonics: the hard cookie representing Earth’s rigid plates and the creamy filling representing the asthenosphere (the “zone of mobility” below the plates where magma is generated, isostatic adjustments take place, and seismic waves are strongly attenuated).

On his way to New Orleans to help in hurricane recovery efforts, Lillie stopped at a conference and accepted awards from the National Park Service. He and his university, Oregon State,

each received a plaque of appreciation for three important ways they have been helping parks: volunteer work, a focus on having graduate students work with national parks to create geology training manuals, and development of a program to certify students in geologic interpretation.

In cooperation with the National Park Service, Bob Lillie saw a need and is on a quest to fill it. “There are major issues affecting society, such as fossil fuel use, earthquakes, pollution, and global warming, that all relate to geology,” he says. “Most park interpretive rangers have backgrounds in biology or social sciences, but rarely geology. The Park Service recognizes the need to do more to tell the geological stories that shape the spectacular scenery of national parks.” Professor Lillie is taking the lead to help NPS staff understand the geology of the park areas they serve. ■

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