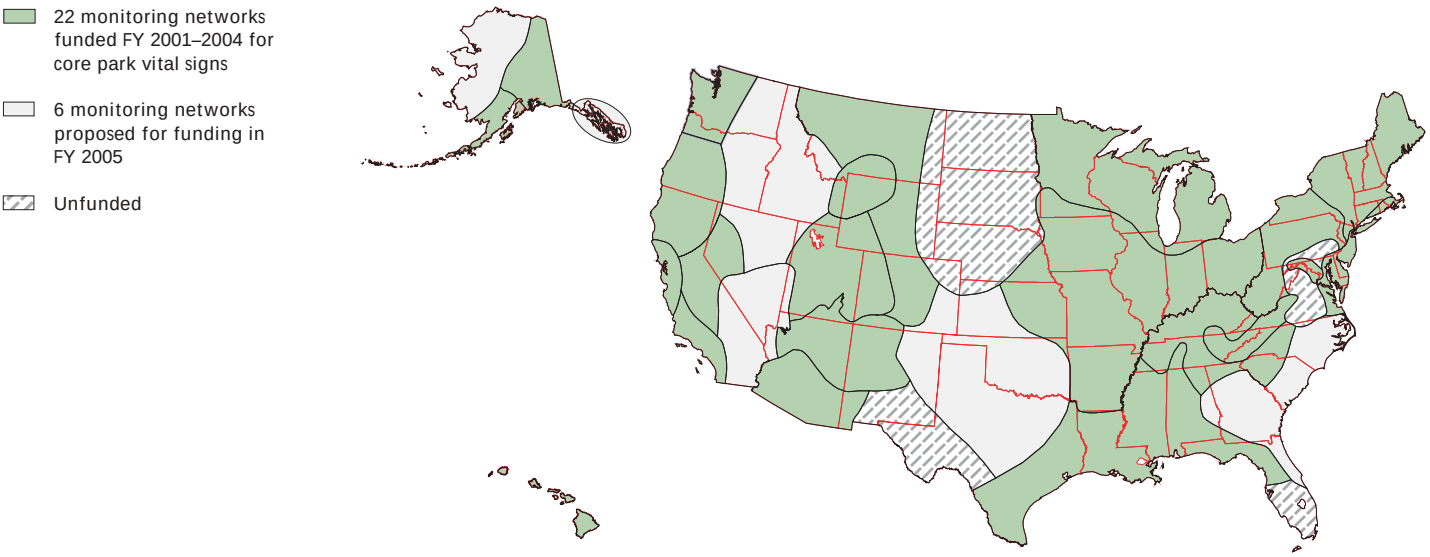
Inventory and Monitoring Charges Ahead

"One of the best weapons for addressing complex management problems is good scientific information. This requires good research…. [and] a tight linkage between research and management."

—David L. Peterson
National Parks and Protected Areas: Their Role in Environmental Protection

In its infancy a decade ago, the Inventory and Monitoring Program flourished in 2003. It has developed from inadequately funded inventories in numerous parks and pilot monitoring focused on just 22 parks to a thriving program that encompasses all national parks—some 270 (called I&M parks)—that have significant natural resources. It owes its success in large part to the organization of the I&M parks into 32 networks designed to document the status and trends of natural resources. Using this strategic approach, parks in the various networks share funding and professional staff, obtained through the Natural Resource Challenge, and partner with hundreds of universities and federal and state agencies to complete basic park resource inventories and monitor the condition of selected resources. The program emphasizes the development of modern database and GIS systems to build institutional knowledge by documenting and organizing the resource information needed for effective science-based, managerial decision making and resource protection. The articles that follow exemplify how parks are benefiting from inventory information and how many parks in the 22 networks funded for monitoring are charging ahead to meet the information and resource protection goals. The next step is to complete all 32 I&M networks, so that, like those in operation, the 10 networks that are not funded can develop the long-term informational tools needed to safeguard the health and integrity of these parks for the future.

PARK VITAL SIGNS MONITORING NETWORKS STATUS FY 2004

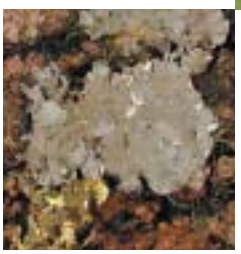


Developing institutional knowledge of biodiversity

By Mark A. Wotawa

NPSpecies database

The NPSpecies database is the new, authoritative repository of information about the biodiversity of organisms found in the National Park System. The information tool is comprehensive, detailing the biodiversity of native and nonnative species, plants and animals, vertebrates and invertebrates, and other life-forms occurring in the parks.



PRESERVING AND PROTECTING our natural heritage require "institutional knowledge" that is readily accessible. Until recently, detailed knowledge of park resources usually resided solely with park researchers and other park staff. The information was lost, having not been integrated into a sustainable format, as key staff members moved on in their careers. NPSpecies—the NPS database for biodiversity, which contains species lists and associated scientific evidence and serves as the core of a larger, integrated information system—changes this situation with respect to biodiversity. NPSpecies will help build institutional knowledge by housing biodiversity information indefinitely for parks, scientists, and the public. NPSpecies also makes the information available for applications beyond immediate park management purposes.

Institutional knowledge in this context results from the collection, organization, and verification of raw field data and their subsequent integration, analysis, and dissemination to produce usable scientific knowledge. Developing institutional knowledge of biodiversity in the National Park System is especially challenging because of the ecologically and physically diverse environments of the national parks, the dynamic nature of biodiversity in a world of changing landscapes, and constant change in taxonomic systems. Also, the many disparate programs and projects that contribute to the information base of biodiversity demand extensive human resources and fiscal support. A system like NPSpecies, which incorporates the information-sharing capabilities of the Internet, helps develop and preserve institutional knowledge of biodiversity efficiently and effectively.

The development of NPSpecies began in 1999 with the conversion of existing data, and later the entry of new data acquired primarily from field surveys of vertebrate animals and vascular plants through the Inventory and Monitoring Program. In 2003, with enhancements to NPSpecies for quality assurance, NPS staff began to conduct formal review and verification of each newly completed field survey. Biologists and taxonomists from numerous NPS partners participated in efforts to collect, organize, review, and verify NPSpecies data, including those from other federal and state agencies (e.g., the U.S. Geological Survey), universities, Cooperative Ecosystem Studies Units, and nongovernmental organizations such as NatureServe and natural heritage programs.

NPSpecies examples include (from top to bottom, left to right) marine and terrestrial animals such as batstar (*Patiria miniata* at Point Reyes National Seashore, California), island fox (*Urocyon littoralis santacruzae* at Channel Islands National Park, California), angel shark (*Squatina california* at Point Reyes); nonnative plants and animals such as invasive chinaberry (*Melia azedarach* at San Antonio Missions National Historical Park, Texas), python (*Python* sp. at Everglades National Park, Florida), and leafy spurge (*Euphorbia esula L.* at Devils Tower National Monument, Wyoming); and a new species of lichen (*Leioderma* sp.) discovered as part of the All Taxa Biodiversity Inventory at Great Smoky Mountains National Park, Tennessee and North Carolina, a newly discovered fern (*Schizea pennula* at Big Cypress National Preserve, Florida), and endemic *Rugelia nudicaulis*, which occurs only in Great Smoky Mountains in high-elevation areas.

Major advances to integrate NPSpecies information, both within and outside the National Park Service, occurred in 2003. In addition to previous integration with the natural resource bibliography (NatureBib), NPSpecies was combined to varying degrees with other NPS information systems. These include the Exotic Plant Management Team's Alien Plant Control and Monitoring (APCAM) database, the Fire-Effects Program Fire Ecology Assessment Tool (FEAT) database, the Natural Resource Management Assessment Program (NRMAP) database, the natural resource metadata database with its associated GIS map and data archive (NR/GIS Metadata), the Incident Management Analysis and Reporting System (IMARS), and the Automated National Catalog System (ANCS+) of the NPS Museum Management Program.

Outside the National Park Service, the National Wildlife Federation directly integrates verified species lists from NPSpecies and interpretive information in their eNature database to produce park-specific interpretive field guides that will be available over the Internet. Through an online, interactive tool, park staff will be able to tailor the generic multimedia information, including pictures, sounds, maps, and text. In a related cooperative venture with the ALL Species Foundation and Discover Life in America, the interpretive field guides will showcase species previously unknown to science that were discovered in parks, and other significant finds, such as range extensions and new populations. Having this knowledge available in a central location on the Internet (anticipated early 2004) will provide interpreters and educators with a tool to greatly enhance the experience of park visitors.

The U.S. Fish and Wildlife Service has recognized the potential for NPSpecies to document the biodiversity of the National Wildlife Refuge System. In 2003, NPS staff began discussing how the two agencies could use NPSpecies for information exchange. A partnership arrangement that uses NPSpecies would save human and fiscal resources and provide a common tool for scientists and managers to collaborate on solutions to similar natural resource issues in both parks and refuges.

The final, all-important step in developing institutional knowledge is making the information widely available to all NPS constituents for scrutiny. Development has begun on the public, online version of NPSpecies, with the anticipated sharing of appropriate and verified information starting in 2004. Tools to produce comparative summary statistics for analysis currently are available in NPSpecies, and geospatial tools to integrate products from other inventories, such as vegetation maps, are in development. Making the same information available to scientists and natural resource professionals throughout the world will result in ongoing analyses of information that contributes to the management and protection of natural resources in parks.

The National Park Service continues to support other programs that assist in documenting biodiversity, including the All Taxa Biodiversity Inventory. An oceans program that would help record the biodiversity of marine organisms for 70 coastal parks is on the horizon. NPSpecies has the capability to integrate, analyze, and disseminate information from all of these programs and to ultimately fulfill the vision of accurately and systematically developing institutional knowledge of biodiversity in the National Park System. ■

mark_wotawa@nps.gov
Ecologist–Biological Inventory Coordinator, Natural Resource Information Division; Fort Collins, Colorado

award-winner

Brian Carey honored for successfully integrating natural resource management in a "cultural" park

Brian Carey, chief of Resource Management and Visitor Protection at Lyndon B. Johnson National Historical Park (Texas), is the winner of the 2002 Trish Patterson–SCA Award for Natural Resource Management in a Small Park, awarded in 2003. This park was established to preserve cultural resources, including the Texas White House during its namesake's presidency. Before coming to this park in 1995, Brian worked at three other national parks, but this is his first "cultural" park. Brian's natural resource management activities, such as treating the 55-acre (22-ha) pecan grove using integrated pest management and partnering to remove invasive species from the prairie plots, reflect his belief that preserving and interpreting cultural resources also require understanding and stewardship of the natural landscape in which they occur.

Balancing the preservation of cultural resources with natural resources can be tricky. For example, at Lyndon Johnson a historic cattle herd has traditionally been pastured and watered along the banks of the Pedernales River, posing two natural resource–related problems: cattle trails along the river are eroding the banks, and movement of the river channel is changing the historical boundaries of the pasture. Which is the most important resource to preserve in this cultural landscape? In this case, under Brian's leadership, the banks of the Pedernales River are being protected with electric fencing; the cattle are being watered at troughs; and native, stabilizing, riparian vegetation is thriving. Whether to restrict the meandering river or to dampen the effects of three old dams in this reach of the Pedernales River is still being decided.

Beyond his park, Brian has played an important role as co-coordinator of the Southern Plains Vital Signs Monitoring Network. The 11 parks in this network are primarily cultural and recreational units with limited natural resource budgets and staff. Brian has taken the lead in attracting partners and implementing agreements in order to survey the parks and update staff who are unfamiliar with inventory techniques.

Although Brian was a biology major in college, he considers himself a generalist. He says, "I enjoy getting involved with all aspects of the parks. What is especially interesting here is that Lyndon Johnson was so attached to this land rooted in the Texas hill country. You can see that reflected in the natural resources legislation he promoted throughout his career." ■

Making fuels and vegetation data available for fire management

By David Pillmore and Pat Stephen

HOW WILL A FIRE BURN given particular conditions such as wind speed, slope, and humidity? Fire technicians can readily and accurately measure these parameters for input into a model, but two other variables, fuels and vegetation, require a concerted mapping effort and management of data for easy access. In 2003, data managers and fire technicians in the NPS Natural Resource Information Division, Rocky Mountain National Park, and Grand Teton National Park joined forces to design a tool for capturing and transferring information on fuels and vegetation that makes these data readily available for fire management. Their approach is promising and adaptable far beyond high-elevation mountain parks.

The need for such a tool emerged during the development of models for managing fire risk. The vegetation map that fire managers in Rocky Mountain National Park were using as a basis for developing their models was created in 1988 using methods that are outdated by today's standards. Although managers estimated its accuracy at 80% to 85%, the fuel parameters assigned to the various vegetation associations had never been tested in the field.

The efforts behind the prototype fuels-vegetation mapping project involved gathering field and remotely sensed data from 547 plots, which are representative of larger biophysical units that combine vegetation and geographic attributes. Notably, field crews simultaneously recorded fuels and vegetation data, streamlining the mapping process. Field documentation also included numerous photographs from each plot. Aerial photo interpretation, map development, and field testing for accuracy are ongoing.

"The design is flexible.... [and] provides a means for easily exporting data to fire and fuels management applications"

The backbone of the prototype fuels-vegetation mapping project is the management of data through the fuels-vegetation mapping application. Starting with the NPS standard database, Microsoft Access, the application is well designed using standard data models and formatting. Project designers incorporated models such as the Anderson Guide fuel models and Burgan and Rothermel fuel inventories into the database. They followed a standard structure and template, developed by the Inventory and Monitoring Program, to be used for all resource-related studies and created a layout that is compatible with data entry forms used by vegetation mapping crews, which facilitated both data entry and quality control. The application makes plot information and more than 3,000 plot-related photos available for review digitally. A linkage allows the photos to be viewed by querying the plot from within the GIS, enhancing the ability to compare map layers with photographs of the surrounding terrain.

Along Bear Lake Road in Glacier Gorge, Rocky Mountain National Park, field crews inventoried plot #406, simultaneously mapping fuel types and cover with vegetation for input into fire-fuel models. Among the 16 species identified are the conspicuous quaking aspen (*Populus tremuloides*) and eagle fern (*Pteridium aquilinum*).

The design is flexible. For example, repeat visits to build time-series data, for tracking changes over time, can be included and different habitats can be incorporated. The design also provides a means for easily exporting data to fire and fuels management applications like Fuels Management Analyst (FMA) and Forest Vegetation Simulator (FVS). In short, the prototype fuels-vegetation mapping application is a tool for capturing information on fuels and vegetation that can be used for developing better models and testing assumptions about forest growth, fire behavior, and fire-risk analysis.

Managers in Rocky Mountain and Grand Teton National Parks developed similar prototypes in 2003. Many reasons exist for other fire and network data managers with vegetation mapping projects to adopt these prototypes for use in their parks: the application is public domain, the design and database structure are established, the code is written, the links for exporting information into other programs are set, and the electronic forms are in place. Saving time and money, of course, is another factor. In addition, the potential for sharing data through the same data structure and the ease of communication about a similar database make the prototype fuels-vegetation mapping application a powerful starting point for collaboration. ■

david_pillmore@nps.gov
Computer Technician, Rocky Mountain Network; Estes Park, Colorado

pat_stephen@nps.gov
Prescribed Fire Technician, Rocky Mountain National Park, Colorado

Remote sensing makes widespread contributions to vital signs monitoring

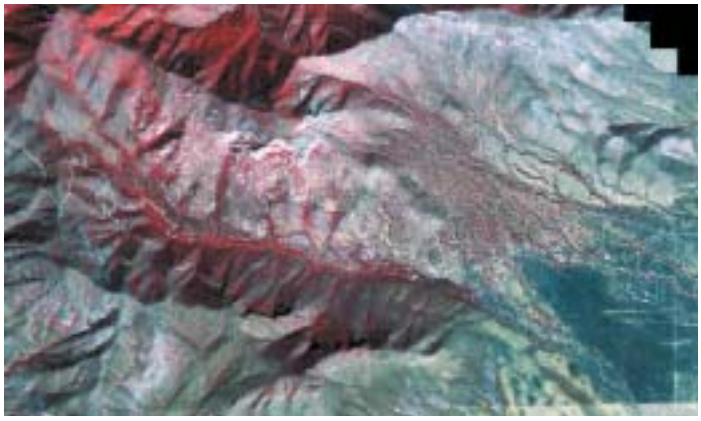
By John Gross

LOGISTICAL DEMANDS REQUIRED to monitor natural resources frequently challenge the networks of parks that have been established for inventory and monitoring. Areas of concern may be large, rugged, remote, or even submerged, and physically collecting data may be expensive, dangerous, and sometimes impossible. Furthermore, ecologically important processes—including fire, windthrow, and vegetation change—can occur on such vast, landscape scales that ground-based monitoring is simply not practical. To address these needs, monitoring networks are rapidly integrating remotely sensed data into monitoring programs and collaborating with partners to develop novel techniques to better use "data from space." In 2003 alone, at least eight networks used remote sensing to aid in managing fires, creating vegetation-fuels maps, and monitoring the effects of invasive plants and changes in land use.

Mitigating the spread of invasive plants depends on up-to-date information about distribution and abundance. Resource managers routinely have used high-resolution, remotely sensed data to identify woody weeds, where structural (rather than spectral) attributes contributed to easy identification. Distinguishing between species of herbaceous plants is usually not possible from remotely sensed data, but researchers from the U.S. Geological Survey (USGS) collaborated with staff in Canyonlands National Park (Utah) to combine spectral signatures and temporal patterns to identify and map the occurrence of cheatgrass (*Bromus tectorum*), a highly invasive, nonnative species. The ability to identify and map cheatgrass will vastly improve the efficiency of monitoring efforts by reducing the area that needs to be examined through ground-based sampling. Remotely sensed data also provide a means to extend routine monitoring, based on satellite imagery, to much larger areas in the extremely rugged and remote parks on the Colorado Plateau.

"The Sonoran Desert Network is examining the use of high-resolution IKONOS satellite imagery to detect and map human impacts on desert environments."

Another important application of remotely sensed data is the evaluation of changes in land use. Scientists have repeatedly identified changing land-use patterns as one of the most important long-term threats to park resources. Five Inventory and Monitoring networks are collaborating with universities and the USGS to develop protocols using remotely sensed data to monitor and evaluate consequences of land-use change in and near more than 50 units of the National Park System. In the Northeast the smaller size of parks and higher intensity of land use justify analyses based on high-resolution satellite data. In other areas where the scales of analysis are broader, lower-resolution satellite imagery (e.g., LandSat, Modis, ASTER) will be an important component of integrated analyses that combine imagery with spatially explicit databases that include information on population size, home density, and other indicators of land use. When integrated, these sources provide a rich picture of the changing landscape in which parks are embedded.

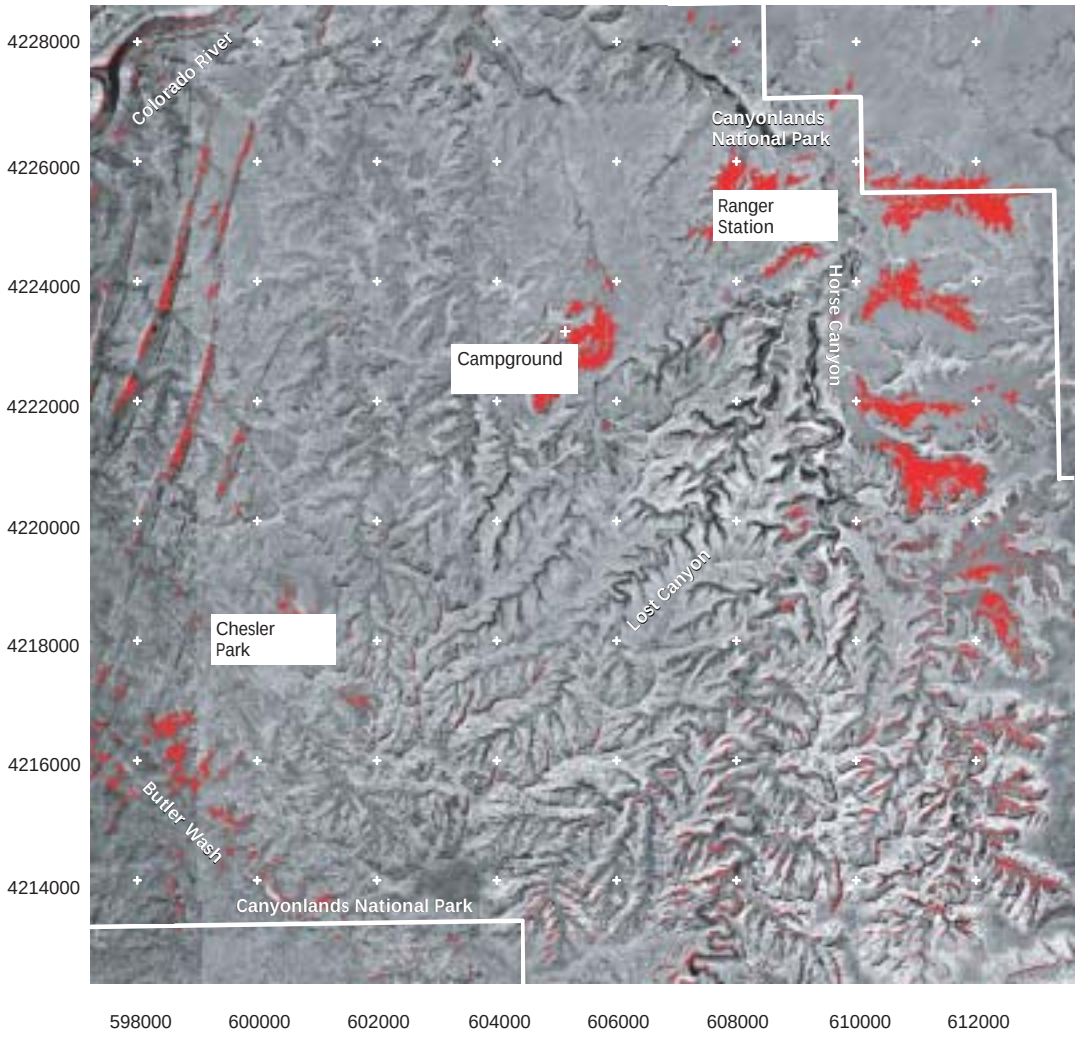


This IKONOS satellite image of Coronado National Memorial, Arizona, reveals variation in plant species distribution and density that results from environmental differences in slope, aspect, soils, and land management practices. The sharp angle near the top and the horizontal line near the bottom of the image reflect much higher grazing pressure from cattle outside the fenced memorial boundary. Many of the roads near the right edge of the image were created by illegal immigration and smuggling. Information from remotely sensed images is valuable for assessing the natural resource impacts of illegal transit through the park from Mexico, fire management planning, vegetation mapping, and evaluating land uses along park boundaries that may affect park resources.

Natural Resource Year in Review—2002 (see page 57) documented a smaller-scale change in land use within parks: the impacts of large numbers of illegal immigrants and smugglers moving through parks on the U.S.-Mexican border. This problem is especially acute in Organ Pipe Cactus National Monument (Arizona), where impacts include trails, off-road vehicle tracks, and construction of temporary shelters. Dangers posed during confrontations with smugglers limit the ability of the National Park Service and its partners to conduct field surveys to identify travel routes and impacts. In collaboration with researchers from the University of Arizona and with support from the NPS Mexican Affairs Office, the Sonoran Desert Network is examining the use of high-resolution IKONOS satellite imagery to detect and map human impacts on desert environments. Field investigators have confirmed accurate identification of paths, temporary shelters, and unauthorized roads on satellite imagery. Comparisons with images from the mid-1990s have clearly revealed a dramatic increase in resource damage over a period when changes in law enforcement led to propagation of travel through remote park locations.

POTENTIAL CHEATGRASS INFESTATIONS IN CANYONLANDS NATIONAL PARK, UTAH

Satellite remote sensing is being used to detect areas potentially infested by invasive cheatgrass (*Bromus tectorum*), shown in red, in Canyonlands National Park, Utah. For this image, researchers compared Landsat 7 Enhanced Thematic Mapper data collected on April 15, 2001, when cheatgrass was green, with those gathered on July 4, when the grass was brown. The vegetation growth cycle of cheatgrass contrasts with that of native vegetation on the Colorado Plateau, which facilitates identification of cheatgrass-infested areas. The background image is derived from digital orthophotos.



In collaboration with the NPS fire program, managers extensively use aerial photographs and satellite imagery to simultaneously map vegetation and collect data on fuel loads (see article on page 37). Furthermore, the fire program uses contemporary aerial photographs and satellite data to map the extent of fires, estimate burn severity, and evaluate recovery rates over short and long periods.

Remotely sensed data are used throughout the National Park System for inventory and monitoring applications to address key information needs in natural resource management. This information will be increasingly important to monitoring programs as the quality of data improves and the price to acquire them decreases. ■

"Monitoring networks are rapidly integrating remotely sensed data into monitoring programs and collaborating with partners to develop novel techniques to better use 'data from space.'"

john_gross@nps.gov
Ecologist, Inventory and Monitoring Program; Fort Collins, Colorado

LIDAR in paradise: An alternative method for coral reef mapping and monitoring in the U.S. Virgin Islands

By Matt Patterson and Britton Wilson

SHALLOW CORAL REEFS in the Caribbean Sea were once dominated by elkhorn coral (*Acropora palmata*), but in the 1980s and 1990s, white disease nearly wiped out the genus. This species was generally found atop the reef crest where its massive branches helped protect coastlines by reducing wave impact from approaching storms. These structures also provided refuge to many species of reef creatures and created excellent opportunities for snorkelers to experience thriving coral reef ecosystems.

For several years the species has been attempting a comeback in several of the U.S. Virgin Islands national parks, where coral reef scientists have documented nearly 4 inches (10 cm) of growth per year. Ironically, the growth of the delicate branches has thwarted scientists' efforts to monitor change in the colony. As they grow, the branches fuse, creating a lattice of living creatures that is easily disturbed. Fortunately, a new mapping and monitoring method has emerged that does not disturb sensitive reef species and that increases the information available to resource managers.

Researchers based at NASA's Wallops Flight Facility (Virginia) and the USGS Center for Coastal and Watershed Studies (Florida) have developed a new airborne sensor, the NASA Experimental Advanced Airborne Research Lidar (EAARL), which assists scientists and managers of these precious resources. The sensor uses **lidar** (light **d**etection **a**nd **r**anging) technology to rapidly survey elkhorn coral colonies, determining total area and mapping the microtopography of the sites. The technique also documents the surrounding terrestrial and marine resources. The NASA EAARL instrument is attached to a fixed-wing aircraft and continuously transmits laser pulses, capturing the time-amplitude history of their reflections. The resulting "laser wave forms" are used to map the elevation of the ocean substrates and to generate three-dimensional information on vegetation canopies. In 2003 the South Florida/Caribbean Network coordinated with the USGS and NASA to collect lidar data from many of the network parks with coral reef resources.

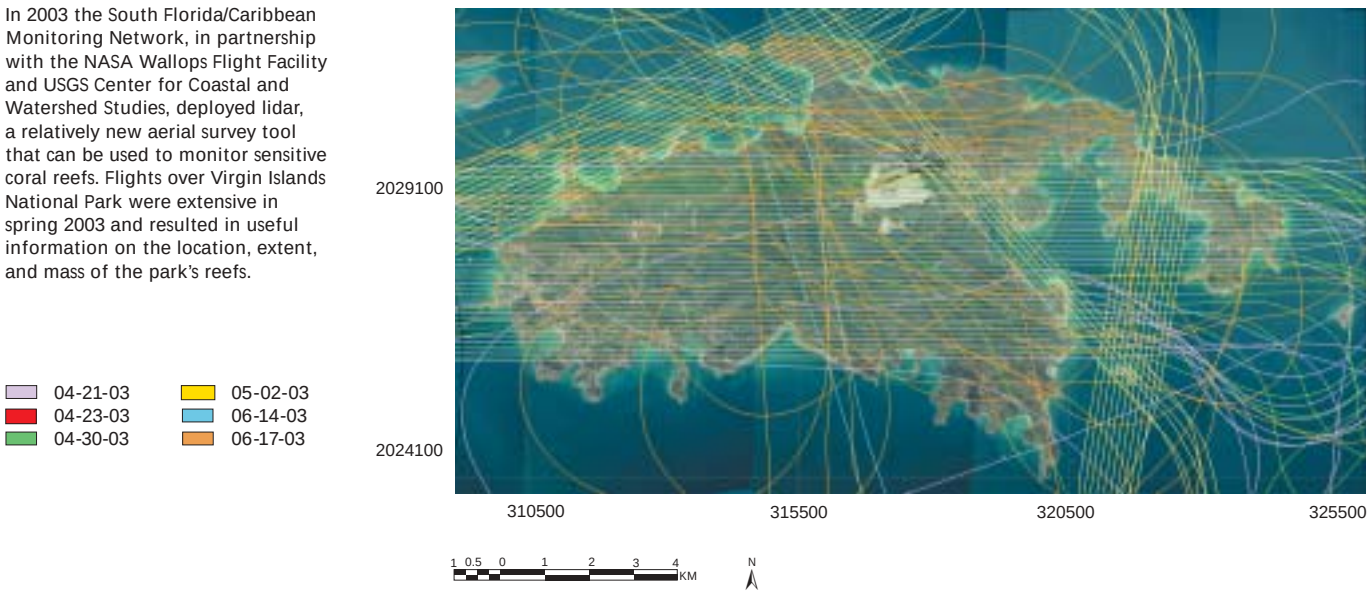
By combining the lidar data with ground-based research findings, scientists are able to gain new information. A larger-scale application is comparing the mass of a complex coral reef with a barren seafloor. First, park resource managers collect location data for coral reefs using global positioning systems. They then combine the information with 1-meter-resolution lidar data to approximate the mass of an individual coral species for a park. Whereas measuring the mass of thousands of individual coral colonies could take months, this combination approach provides results in much less time. This baseline information will be critical to network parks as they begin to monitor the species' recovery and evaluate the impacts of future storms on this key marine resource. ■

matt_patterson@nps.gov
Monitoring Coodinator, South Florida/Caribbean Monitoring Network; NPS Southeast Regional Office, Homestead, Florida

britton_wilson@nps.gov
Data Manager, South Florida/Caribbean Monitoring Network; NPS Southeast Regional Office, Homestead, Florida

SPRING 2003 EAARL FLIGHTS OVER ST. JOHN, U.S. VIRGIN ISLANDS

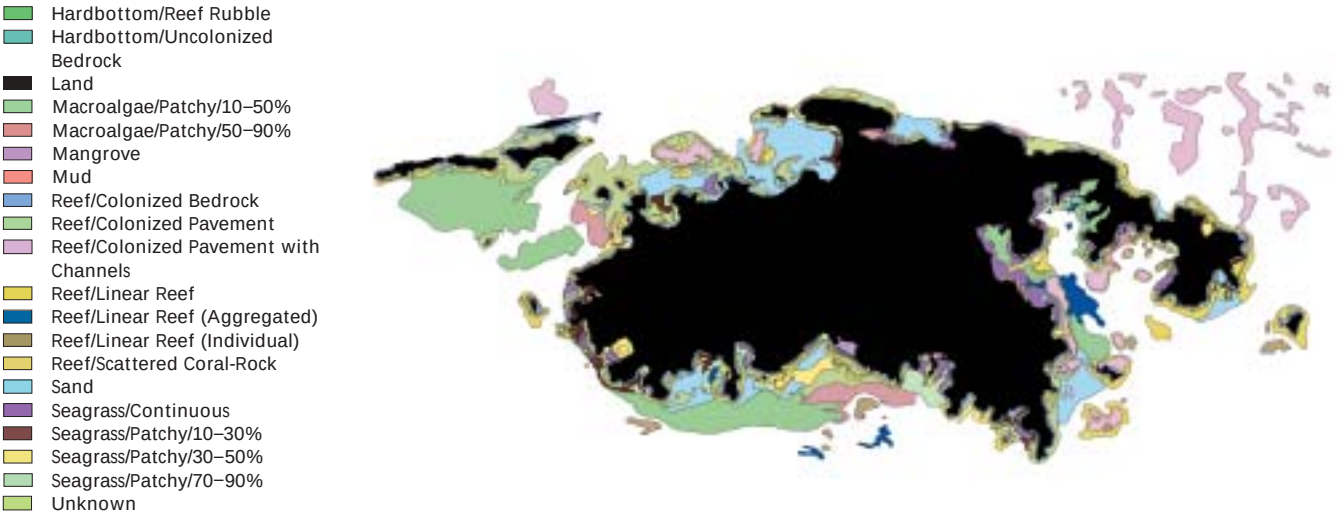
In 2003 the South Florida/Caribbean Monitoring Network, in partnership with the NASA Wallops Flight Facility and USGS Center for Coastal and Watershed Studies, deployed lidar, a relatively new aerial survey tool that can be used to monitor sensitive coral reefs. Flights over Virgin Islands National Park were extensive in spring 2003 and resulted in useful information on the location, extent, and mass of the park's reefs.



Marine inventory to pay monitoring dividends in Caribbean parks

By Jim Petterson

HYPER-SPECTRAL IMAGE OF BENTHIC HABITATS AROUND VIRGIN ISLANDS NATIONAL PARK, ST. JOHN



AN AMBITIOUS MARINE inventory program in the Caribbean national parks is paving the way for the development of an integrated fish monitoring program throughout the South Florida/Caribbean Monitoring Network. The inventory is being conducted cooperatively by staff of Virgin Islands National Park, the recently authorized (2001) Virgin Islands Coral Reef National Monument, Buck Island Reef National Monument, the National Oceanic and Atmospheric Administration (NOAA) Biogeography Program, and the Caribbean Field Station of the USGS Biological Resources Division.

The project is ongoing and builds on results from an extensive fish inventory of the waters around St. John that began in 1995 with the establishment of the prototype Long-Term Ecological Monitoring Program at Virgin Islands National Park. These efforts demonstrated that accurate marine habitat maps were needed in order to monitor fish for the long term, and in 1998, NOAA undertook efforts to produce habitat maps of the ocean floor surrounding Puerto Rico and the U.S. Virgin Islands. The maps were based on aerial photos and hyper-spectral imaging, which is rich in detail. The staff at Virgin Islands National Park, Buck Island Reef National Monument, and the USGS played integral roles in the subsequent accuracy assessments of the maps. Their efforts required scuba-diving visits to randomly selected sites to describe biotic habitat features and topographic complexity. At the same time they sampled macroinvertebrates and reef fish using transect and point count techniques.

To date, approximately 450 sites have been characterized in Virgin Islands National Park (see map) and Buck Island Reef National Monument. The accuracy of the habitat maps has been verified and valuable information pertaining to the biodiversity and health of the parks is available. Particularly noteworthy is the documentation of the extremely diverse and healthy coral reef communities in the deeper water regions of Virgin Islands Coral Reef National Monument and previously unidentified high-diversity patch reefs hidden among seagrass beds at Buck Island Reef. The inventory staff selected sample sites randomly from the two dominant marine communities—reef hardbottom and seagrass beds—both inside and outside park and monument boundaries. This sampling strategy will allow comparisons between the no-take areas in the monuments and the adjacent waters outside the designated marine protected areas, where harvesting is permitted, to test for differences in habitats and biotic communities.

The next step, which the network partners began in 2003, is to use the fish population sampling data to develop a robust reef fish monitoring protocol that can be applied to all the marine parks in the South Florida/Caribbean Monitoring Network. ■

jim_petterson@nps.gov
Ecologist and Data Manager, Virgin Islands National Park, U.S. Virgin Islands

Seals and sea lions: Indicators of marine ecosystem condition at Point Reyes

By Sarah Allen

PARK RESOURCE MANAGERS are identifying species that can give them insights into the condition of natural systems in the nation's parks through the Inventory and Monitoring Program, a major component of the Natural Resource Challenge. Changes in populations of top predators, for example, provide early warning signals of disruptions in natural systems. Seals and sea lions, as the apex predators of Pacific Ocean marine ecosystems, were selected in 2003 by the San Francisco Bay Network as indicators for ecosystem condition at Point Reyes National Seashore.

Seals and sea lions, known as pinnipeds, are excellent indicators because the protocols for monitoring these animals are well established and easily implemented. Additionally, other marine parks and agencies, including Channel Islands National Park and the National Oceanic and Atmospheric Administration, monitor pinnipeds, providing opportunities for regional collaboration on analysis. These animals also have special status under the Marine Mammal Protection Act because of special requirements for their protection and, in some cases, because of the precarious status of species.

"At Drakes Estero… park managers detected a decline in population numbers and determined that increased kayak use was disturbing the breeding seals. In response the park instituted a seasonal closure of the area to kayaking, and the recovery of the colony was documented in subsequent breeding seasons."

Monitoring at the seashore focuses on the two breeding species of pinnipeds, harbor seals (*Phoca vitulina richardii*) and northern elephant seals (*Mirounga angustirostris*), although six species of pinnipeds occur there. The topographic and hydrographic complexity of the coastal zone of Point Reyes National Seashore provides diverse habitats for seals and their prey. Harbor seals are the dominant and most widespread pinniped in the park, hauling out throughout the year at nine terrestrial sites. Point Reyes National Seashore is also the northernmost breeding colony for northern elephant seals.

Since 1976, researchers have monitored seal colonies at Point Reyes National Seashore to detect changes in population numbers and reproductive success and to identify factors that might affect population trends. During surveys, staff and trained volunteers collect demographic data, including the total number of animals by sex and age class and number of pups. Information is also collected on environmental factors (e.g., weather, shoreline changes) and human disturbances (e.g., sources of disturbance impacts on seal behavior).

Northern elephant seals (left and right) congregate to breed at Point Reyes National Seashore, California, home of the northernmost colony of these animals. Six species of seals and sea lions, federally protected marine mammals, occur at Point Reyes. Park managers are monitoring seal colonies to detect changes in natural systems and to adaptively manage park resources and activities to benefit seal populations.

Biologists have determined that populations of both species have increased significantly within the seashore over the past 20 or more years; however, individual colonies have experienced uneven recovery rates depending upon human activities. Point Reyes National Seashore has responded with various adaptive management strategies. At Drakes Estero, for example, park managers detected a decline in population numbers and determined that increased kayak use was disturbing the breeding seals. In response the park instituted a seasonal closure of the area to kayaking, and the recovery of the colony was documented in subsequent breeding seasons.

Monitoring several colonies has allowed biologists to distinguish broad-scale environmental effects, such as climate variability from human-caused disturbances, on individual colonies. Researchers may also detect regional or global trends by linking regional pinniped monitoring data with other indicators such as water quality, weather, and marine fish populations. The scientific information obtained through monitoring gives park managers a better understanding of how to sustain and restore species like the seals of Point Reyes National Seashore. ■

sarah_allen@nps.gov
Science Advisor, Point Reyes National Seashore, California

NPSFACT

Visitors to the approximately 270 national park units that are considered to have **significant natural resources** (I&M parks) numbered 231.6 million in 2002, or **84% of total visitation** in the National Park System. Visitation at the I&M parks dropped 0.6 million from 2000 to 2002 compared to an overall decline in National Park System visitation of 8.6 million for the same period.

Channel Islands National Park seeks expert recommendations to enhance monitoring programs

By Kathryn McEachern

Channel Islands National Park (California) was one of the first four parks to obtain funding to create a Prototype Ecological Monitoring Program. Prototype programs serve as "centers of excellence," conducting more in-depth monitoring and information gathering to benefit all of the approximately 270 parks with significant natural resources. Important elements of prototype programs are the evaluation of monitoring efforts and the development of better sampling and assessment methods for parks in each of 10 major biomes. With this in mind the U.S. Geological Survey–Biological Resources Division (USGS-BRD) in 2000 initiated an expert review of the vegetation and land bird monitoring programs of Channel Islands National Park. Suggestions from the review were implemented in 2003.

The USGS-BRD Channel Islands Field Station convened a panel of experts to review more than a decade's worth of data and the programs' monitoring protocols in 2000. The panel provided comments and recommendations to the National Park Service that are designed to improve the effectiveness and efficiency of the monitoring programs. Program revisions based on the findings are being designed and tested by USGS-BRD and NPS scientists. For example, transect sample efforts, which have been extensive in the past, are being strategically redesigned to free resources for other monitoring needs identified by the review, such as vegetation mapping. Similarly, the land bird monitoring program has been changed to place emphasis on analyses of bird abundance by habitat for all five of the park's islands. Another change is improvement of both monitoring programs' databases to enable better integration of information across habitats and to streamline annual report preparation. Improving and deepening the information available to park managers allow them to better respond to the changes affecting park natural resources. ■

kathryn_mceachern@usgs.gov
Senior Plant Ecologist, U.S. Geological Survey–Biological Resources Division; Channel Islands Field Station, California

Resource managers monitor a coastal scrub plant community transect at San Miguel Island, Channel Islands National Park. In 2003 the National Park Service began to implement recommendations from a scientific review of the park's vegetation and land bird monitoring programs.

Repeating history: Vertebrate inventory in Yosemite National Park

By Leslie S. Chow

Jim Patton, project leader and curator of mammals at the UC Berkeley Museum of Vertebrate Zoology, weighs a mouse (*Peromyscus maniculatus*) live-trapped from the Merced Grove of giant sequoias.

HOW OFTEN do we get to repeat important historic moments? In the summer of 2003, scientists from the University of California–Berkeley Museum of Vertebrate Zoology and the U.S. Geological Survey (USGS) had the opportunity to repeat some of the historical vertebrate surveys conducted by Joseph Grinnell in Yosemite National Park. The first broad survey of Yosemite National Park wildlife in more than 80 years was made possible through a cooperative effort with both organizations and the National Park Service's Inventory and Monitoring Program.

Joseph Grinnell and the university's Museum of Vertebrate Zoology conducted vertebrate surveys from 1914 to 1920 along a transect that ran from the Central Valley of California, through Yosemite National Park, to the Great Basin Desert near Mono Lake. The Grinnell Survey collected more than 4,000 specimens, recorded 2,001 pages of handwritten field notes, and took nearly 1,400 photographs. The resulting report, "Animal Life in the Yosemite," remains the most comprehensive documentation of Yosemite's vertebrates.

In 2003, scientists revisited five of the original Grinnell sites in the park. Preliminary results suggest that the distribution of several species has changed. One of the most common shrew species recorded by Grinnell in Yosemite Valley appears to have been replaced by another shrew during the intervening years. Golden-mantled ground squirrels no longer appear to inhabit the Merced Grove of giant sequoias as they did in Grinnell's time, although they were found at higher elevations. And two chipmunk species thought to be relatively common have yet to be found. Whereas some species may have been displaced, others have appeared in surprising locations. The western harvest mouse (*Reithrodontomys megalotis*), not previously known in the park, was caught in Yosemite Valley, and a low-elevation woodland mouse (*Peromyscus truei*) was found at Mount Lyell (10,600 ft, 3,233 m) and Glen Aulin (7,800 ft, 2,379 m).

Although it is not yet clear why these changes have happened, possible factors include warmer average temperatures and the increased density of vegetation from fire suppression. To better understand the changes occurring in Yosemite National Park, museum staff and USGS biologists will continue the survey for the next two years thanks to a grant from The Yosemite Fund. ■

les_chow@usgs.gov
Research Wildlife Biologist, USGS-WERC Yosemite Field Station, California

Documenting species and sites through bird inventories

By Carol Beidleman with Nikki Guldager, Stephen Fettig, David Mizrahi, and Robert Kuntz

BIOLOGICAL INVENTORIES are a critical first step in effective management of park resources. Protecting species that do not use national park habitats throughout the year, such as migratory birds, presents a special challenge. Given the decline in migratory bird populations, documenting their presence and use of park habitats is important for ensuring the survival of these species.

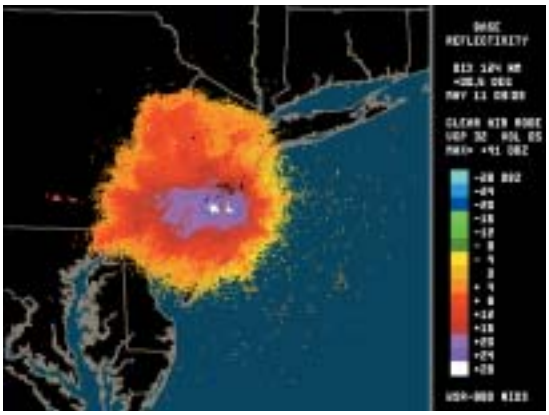
Bird inventories are 1 of 12 core inventories being conducted in approximately 270 parks with significant natural resources. The goal of these inventories is to document 90% of the species that occur in the parks, to document abundance and distribution for selected groups of high-priority species, and to form the basis for developing effective long-term monitoring programs for these species.

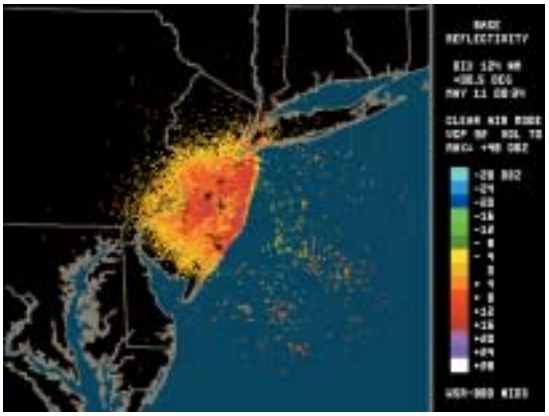
"Protecting species that do not use national park habitats throughout the year, such as migratory birds, presents a special challenge."

Inventory efforts may focus on species or sites used by species. Several examples come from the Park Flight Migratory Bird Program, which works to protect migratory bird species and their habitats in U.S. and Latin American national parks and protected areas through bird conservation and education projects and technical exchange.

In Gates of the Arctic National Park and Preserve (Alaska, photo, page 46), the Park Flight Program and the National Park Service Inventory and Monitoring Program provided support to conduct land bird and shorebird inventories. Gates of the Arctic includes 8.2 million acres (3.3 million hectares) in the central Brooks Range, an extensive and largely unsurveyed landscape with important nesting habitat for numerous migratory bird species. At the park level, baseline information can be used to assess impacts of potential management issues and natural disturbances on species distribution and habitat. Inventory data will also be incorporated into the statewide bird monitoring program developed by Partners in Flight, which focuses on regional trends in population abundance and distribution throughout Alaska. At the global level, many migratory species face widespread loss of habitat in critical feeding and staging areas along migration routes and in wintering areas, and impacts of these threats may be detected first through changes in bird abundance and distribution on breeding grounds. Data from the shorebird inventories, which are conducted by the Alaska Science Center, will be shared with a new Park Flight project in Argentina where some of these species winter.

In New Mexico, a Park Flight project conducted a species inventory through participation in a statewide Breeding Bird Atlas. This project, involving Bandelier, Aztec Ruins, Capulin Volcano, and Fort Union National Monuments, and Pecos National Historical Park,



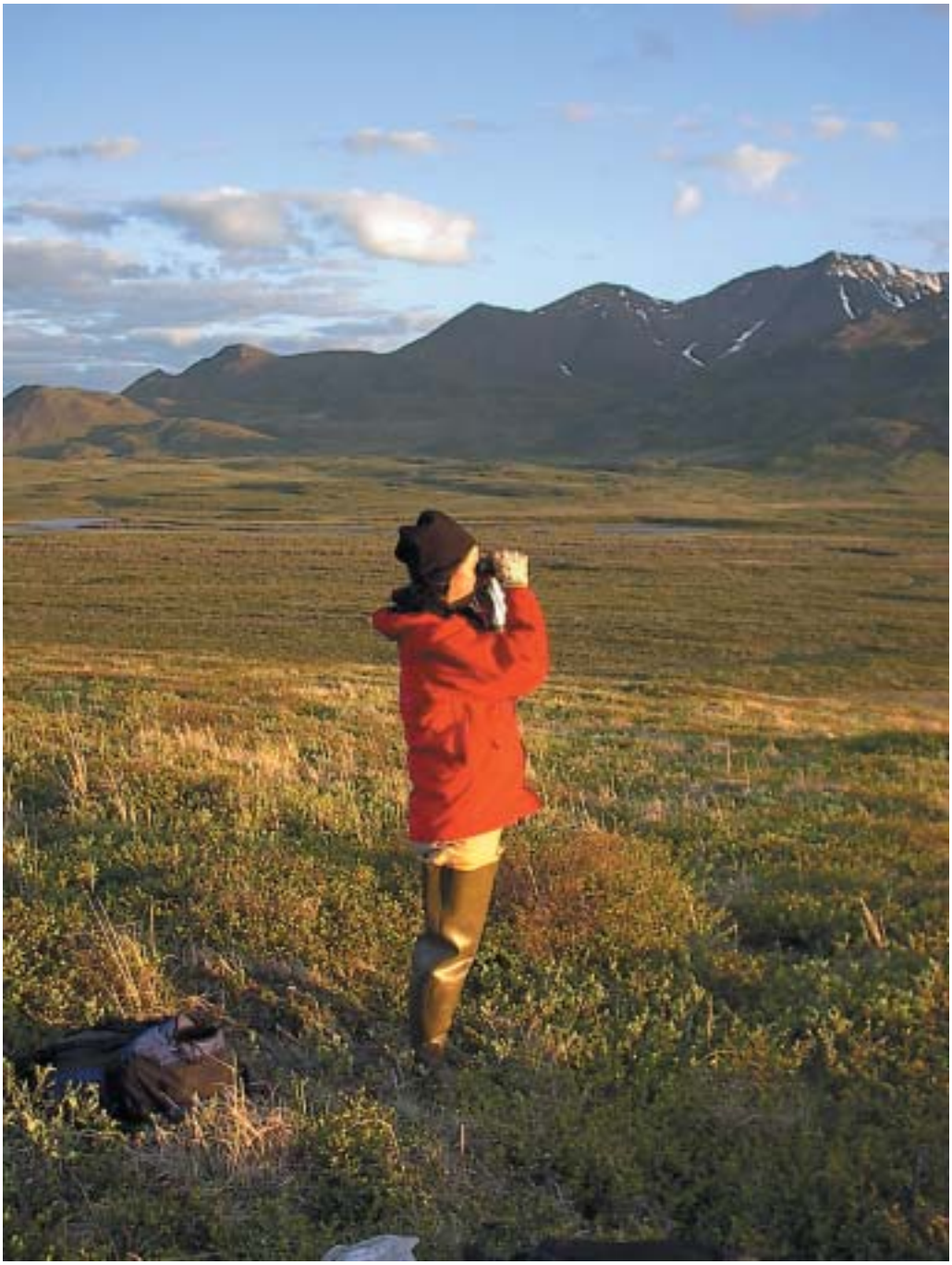


The New Jersey Audubon Society is using an innovative approach for monitoring stopover areas used by nocturnally migrating songbirds. Every night during spring and fall migration they evaluate National Weather Service Doppler radar (NEXRAD) data to determine if a migration is under way. If it is (top image, made May 10, 2001, at 11:03 p.m. EDT), then they examine data collected as migrants depart on the same evening (bottom image, made about three hours earlier), to determine areas they occupied before their exodus. By identifying these sites, the society can recommend land acquisition priorities or encourage conservation practices where other land uses might prevail.

is a reminder that national park units established to protect cultural resources still have natural resource management responsibilities and play an important role in the conservation of migratory birds. Breeding Bird Atlas information, which documents breeding status, is a key component in basic understanding of ranges and trends of breeding birds and a key building block in any statewide bird conservation effort. Including national park areas in an atlas is critical for evaluating potential causes for bird population trends, because changes to parklands are often minor compared with development or habitat destruction on nonpark lands.

Another Park Flight project, at the New Jersey Coastal Heritage Trail Route, focuses on developing an inventory of important migratory bird stopover sites. This unit works through partners, such as the New Jersey Audubon Society, to promote resource awareness

Wildlife Biologist and Park Flight Manager Nikki Guldager surveys birds during an inventory in the Killik River area of Gates of the Arctic National Park and Preserve, Alaska. The goal of the inventories is to assess avian species diversity, density, and habitat within the park and to develop a monitoring plan.



and protection. New Jersey is a major thoroughfare for large numbers of Neotropical songbirds during spring and fall migration. The availability of suitable stopover habitats that provide the food resources necessary for birds to accumulate energy quickly and safely is essential. National Weather Service Doppler radar is an effective approach for identifying stopover habitats (see image pair, page 45) because it can monitor bird movements at spatial and temporal scales and provide information about site-use frequency and bird density at particular sites. Combining radar data with land-use and land-cover data in a Geographic Information System leads to determining the use of specific habitat types by migratory birds during stopovers. This information is crucial for ranking the importance of particular sites and for making sound land management decisions regarding the conservation of habitats used by songbirds during migration stopovers.

A different kind of migratory bird site inventory has taken place at North Cascades National Park (Washington) as part of a broader regional effort. Here the focus was on the black swift, a species that is not effectively surveyed by standardized approaches for broad-scale landscape- or habitat-based monitoring, such as the roadside Breeding Bird Survey. The black swift is a Partners in Flight Continental Watch List Species, a priority species in the Northern Pacific Rainforest Bird Conservation Region, and a priority species in Bird Conservation Plans for Oregon, Washington, British Columbia, and Alaska. Prior to this project, no survey of this species had ever been conducted in the Cascade Range of British Columbia and Washington. Because black swifts breed on steep canyon walls close to waterfalls, a special protocol is required to determine their distribution and abundance. Roberto Quintero-Dominguez, a Park Flight international intern from Mexico, was part of a team of NPS employees and North Cascades Institute graduate students who conducted these physically challenging inventories of selected waterfalls in North Cascades. The high percentage of swifts observed at waterfalls and the large number counted on individual surveys suggest that falls within the park are extremely important nesting habitat for this species. ■

"National park units established to protect cultural resources … play an important role in the conservation of migratory birds."

beidlemanc@aol.com
Park Flight Migratory Bird Program Coordinator, University of Arizona, working with the NPS Biological Resource Management Division; Fort Collins, Colorado

nikolina_guldager@nps.gov
Wildlife Biologist, Gates of the Arctic National Park and Preserve, Alaska

stephen_fettig@nps.gov
Wildlife Biologist, Bandelier National Monument, New Mexico

dmizrahi@njaudubon.org
Vice President for Research, New Jersey Audubon Society

robert_kuntz@nps.gov
Wildlife Biologist, North Cascades National Park, Washington

Understanding land bird diversity in the Klamath region

By Daniel A. Sarr, Nat Seavy, John D. Alexander, and Paul Hosten

What drives bird diversity in the Klamath region in the Northwest? Scientists are learning that fundamental conservation questions such as this often must be addressed through landscape-scale analyses. Therefore, network Inventory and Monitoring programs, other federal agencies, and nonprofit conservation organizations are partnering to consider regional needs through development of consistent inventory data sets across park and agency boundaries. For example, scientists who analyzed data collected during field inventories of land birds in three federal conservation preserves believe environmental conditions, such as climate and habitat, may be important drivers of bird diversity patterns in the Klamath region.

Yellow-rumped warbler, a species that prefers high elevations, is abundant at Crater Lake National Park (high elevation), less common in Cascade-Siskiyou National Monument (middle elevation), and nearly absent from Whiskeytown National Recreation Area (low to middle elevation).

In 2003, scientists from the National Park Service (NPS) Inventory and Monitoring Program, the Bureau of Land Management (BLM), and the nonprofit Klamath Bird Observatory jointly studied bird diversity in Crater Lake National Park, Oregon (administered by NPS); Cascade-Siskiyou National Monument, Oregon (BLM); and Whiskeytown National Recreation Area, California (NPS). Crater Lake National Park, which has diverse and pristine habitat but a cool climate, supported a lower diversity of birds (38 species recorded) than the warmer, lower-elevation parks. Whiskeytown National Recreation Area, the lowest, warmest preserve, however, was apparently no richer in species than Cascade-Siskiyou National Monument, which occupies intermediate elevations (70 vs. 78 bird species recorded, respectively).

Cascade-Siskiyou straddles the crest of the Cascade Range and has exceptional variability in climate and vegetation, which may explain its high bird diversity. Most bird species showed peak abundance in either Crater Lake or Whiskeytown, suggesting that many bird species have preferences for either high or low elevations during their breeding season. However, each of the three preserves supports distinctive and complementary bird species, suggesting they play different roles in the conservation of regional land bird diversity. ■

dan_sarr@nps.gov
Inventory and Monitoring Coordinator, Klamath Network; Ashland, Oregon

nes@klamathbird.org
Ornithologist, Klamath Bird Observatory; Ashland, Oregon

jda@klamathbird.org
Executive Director, Klamath Bird Observatory; Ashland, Oregon

paul_hosten@blm.gov
Plant Ecologist, Bureau of Land Management; Medford, Oregon