

# PARKSCIENCE

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## ASSESSING THE ACCURACY OF WETLANDS MAPS AT SEQUOIA, KINGS CANYON, AND POINT REYES

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## IMPLICATIONS OF BARRED OWL RANGE EXPANSION AT REDWOOD

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## CREATING A DIGITAL PHOTOGRAPHY INVENTORY OF RESEARCH LIBRARY CONTENTS AT DINOSAUR

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NATIONAL PARK SERVICE

# “I’LL BE OUT OF THE OFFICE FROM...”

Most of us who write for and read *Park Science* spend the majority of our time in the office. I suspect that what once attracted us to our professions in park research or resource management was the expectation of working—at least part of the time—in the great outdoors of the national parks, an ideal as potent for some as the calling to preserve the magnificence of the National Park System. In reality, we balance these two worlds, conducting experiments or carrying out resource management projects in the field, and enjoying the productivity afforded by the office environment where we synthesize data from fieldwork, organize staffs for field projects, collaborate with colleagues, advance partnerships, or simply take care of administrative details.



In my job I have the great pleasure of engaging daily in the telling of fascinating stories of research and resource management throughout the National Park System. I cross paths with hundreds of park employees and researchers each year. Yet I do almost all of this work in the office—in front of a computer monitor, beside a phone, next to a row of reference books. Seldom as they are, days that I spend in a national park are vital experiences that deepen my understanding of these special places and strengthen my connection with them.

Late last June I enjoyed a day in the field with more than 100 NPS colleagues from the Natural Resource Program Center and the Office of the Associate Director for Natural Resource Stewardship and Science when we met in Rocky Mountain National Park to assist with several resource management projects. My crew’s task was to remove musk thistle (*Carduus nutans*), an invasive plant species, from a forested area east of the Continental Divide. With the ground soft from a week of rain, we tore after the invaders, and by day’s end had pulled hundreds of the prickly plants from the ground. Although it was only one day in the field, it was a day that produced real results in a short period of time. I felt refreshed to be out of the office working alongside colleagues and new acquaintances and giving the park a boost with a daunting job.

Like my simple outing pulling weeds, the articles in this issue demonstrate tangible results of fieldwork, application of technical skills, and direct involvement with the care of park resources. Yet fieldwork eventually comes to an end, and meaningful articles come about only through the extra effort of the authors, usually made in the office, to distill the results and organize them in a useful format for others to contemplate and absorb. As you read the articles here, I hope you will consider writing up a report of a science-based project, long or short, that’s important to you and the management of your park’s resources and submit it for publication so that others might learn from your experience. Please contact me if you are interested.

I hope you enjoy this issue of *Park Science* wherever you are—in your office or out in the field.

  
Editor

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**ON THE COVER**

Management and protection of wetlands requires knowledge about the locations and vulnerabilities of these important natural systems. In this issue, two resource managers describe their methods for assessing the accuracy of readily available National Wetland Inventory (NWI) maps in Sequoia and Kings Canyon National Parks (page 19), and Point Reyes National Seashore and Golden Gate National Recreation Area (page 34). For example, lakes (like this one at Sequoia) are labeled on the maps for their deep-water areas, although they often have extensive shallow areas. Another problem is illustrated by the photograph in the upper right portion of this page. It shows a wet meadow (called a palustrine emergent wetland or PEM) in front of a palustrine scrub-shrub (PSS) wetland. Although the NWI maps correctly classified these particular wetlands in the Mineral King area of Sequoia National Park, sampling found that 26% of the wetlands classified as PEM on the NWI maps for Sequoia and Kings Canyon were actually PSS and 22% of PSS wetlands were actually PEM.



## COVER ARTICLE

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# HIGHLIGHTS

## Cultural landscape recognized as important wildlife habitat at Eisenhower National Historic Site

At Eisenhower National Historic Site (NHS) in Pennsylvania, amidst the layers of cultural fabric dating from prehistoric times when Native Americans lived there, through Confederate Civil War occupation, and up to modern times where President Dwight D. Eisenhower's home is commemorated, there lives an inconspicuous critter commonly known as the least shrew (*Cryptotis parva*). Classified as an insectivore, the fine velvety-furred shrew inhabits meadows, old fields, and moist woodlands. The least shrew is listed in Pennsylvania as an endangered mammal whose occurrence has been noted only three times in the state since 1962. Bone fragments detected in barn-owl pellets were the first indicators alerting local mammalogists to the shrew's presence in the park. Through subsequent inventories, the shrew was discovered at three locations in Eisenhower NHS. As a result of the shrew's presence, the mammal technical committee of the Pennsylvania Biological Survey has designated the park as an "Important Mammals Area." This designation helps focus voluntary

As a result of the shrew's presence, the mammal technical committee of the Pennsylvania Biological Survey has designated the park as an "Important Mammals Area."



At Eisenhower National Historic Site, agricultural practices are not intensive and allow small mammals like the least shrew to survive by moving to undisturbed fields each season. COURTESY OF JIM HART

efforts on identifying sites critical to wild mammals, rare or common, and to draw attention to these sites as tools for teaching people about the mammals' habitat needs.

Once widely distributed throughout the state, least shrews seem to have undergone a precipitous decline over the last 50 years. The reasons for this are unknown, but the decline may be a result of secondary forest growth following farm abandonment combined with a change in farming practices from small-patch rotational agriculture to large-scale, nonrotational crop monocultures. Agricultural practices at Eisenhower NHS preserve the farming and cattle operations of Eisenhower's time; however, they are not intensive and allow small mammals like the least shrew to survive by moving to undisturbed fields each season. This may be the reason the least shrew populations at Eisenhower NHS have had more success than in other areas across the state. The National Park Service is continuing to study Eisenhower NHS and the adjacent Gettysburg National Military Park for the presence of the least shrew and other species of concern.

In addition, part of Eisenhower NHS has been identified by the Pennsylvania Audubon Society as an "Important Bird Area" (southern Adams County grasslands) because it provides critical habitat to bird species of special concern. Species such as the state-endangered loggerhead shrike (*Lanius ludovicianus*) have been observed using the corridor as a nesting area. And other grassland species not listed but infrequently seen, such as the grasshopper sparrow (*Ammodramus saviarum*) and common bobwhite (*Colinus virginianus*), have been observed by park staff yearly since 1999.

Eisenhower NHS is one example of how a park originally established for its cultural significance has also perpetuated a piece of our natural history. As landscapes across our nation continue to change, even small parks offer habitat where species, common or rare, can persist.

—Zachary Bolitho, natural resource specialist, Gettysburg National Military Park, Pennsylvania; [zachary\\_bolitho@nps.gov](mailto:zachary_bolitho@nps.gov).



## Students help restore Pacific Northwest national parks

Nearly 500 students from inner-city Seattle rolled up their sleeves in summer 2004 to help restore natural ecosystems in North Cascades and Mount Rainier National Parks, and San Juan Island National Historical Park. They collected seeds for the North Cascades greenhouse, where native plants are raised for park restoration projects, and they also removed 7 square meters of a non-native geranium. At Mount Rainier, students removed nonnative plants, brushed trails, and prepared plants for the greenhouse. At San Juan Island they planted grasses and monitored their growth, and also mapped the extent of nonnative blackberry in the park. In addition to their hard work, students learned about the



ecosystems they were restoring through fun, interactive lessons prepared and presented by staff of the nonprofit partner of the National Park Service, EarthCorps, and the North Coast and Cascades Research Learning Network. Through evaluations, students reported that they appreciated the opportunity to make a difference and learn about their national parks. One student asked, “Can we do this in Seattle?”

That question has led Seattle City Parks Community Centers to consider how they can develop this program in students’ home communities. Seattle Parks teen leaders have been working with the national park partner, EarthCorps, to develop restoration and stewardship projects in the city parks.

Thanks to funding from the Public Land Corps, this project evolved into a multilayered partnership among the National Park Service, EarthCorps, the City of Seattle, and numerous other nonprofit youth groups. EarthCorps, a nonprofit Seattle-based

restoration group, has been leading this program for the past three years in partnership with the resource education and natural resources staff at the national parks. EarthCorps has extensive experience leading volunteer groups in restoration work, experience that has been key to the success of this program.

For most of the participants and many of the adult leaders, this visit to a national park was their first. Because this project integrates students’ experiences in national parks and their home communities, it provides a good model for developing a network of local and national program partners who promote stewardship values and understanding.

—Lisa Eschenbach, coordinator for the North Coast and Cascades Research Learning Network; National Park Service; Seattle, Washington; [lisa\\_eschenbach@nps.gov](mailto:lisa_eschenbach@nps.gov).



PHOTOS COURTESY OF EARTHCORPS; USED BY PERMISSION

## High school students participate in inventory and monitoring of bats in the Upper Columbia Basin Network

A group of eight high school science students was brought together for two weeks in July 2004 to study bats in three national monuments in the Upper Columbia Basin Network (UCBN) of the Pacific West Region. The team was organized through collaboration between the network and the Oregon Museum of Science and Industry, in Portland. The team divided its time between the John Day Fossil Beds National Monument (Oregon), Craters of the Moon National Monument and Preserve (Idaho), and Hagerman Fossil Beds National Monument (Idaho). It succeeded in making a significant contribution to the network's inventory and monitoring program and clearly demonstrated that the "tent- and van-" based high school research team model can and should be used in future network inventory and monitoring projects. As UCBN coordinator Lisa Garrett recently remarked, "That science students can have an unparalleled hands-on educational experience and at the same time make real contributions of data and recommendations to NPS resource professionals is really exciting for us."

Students, some of whom traveled from as far away as Texas and Illinois to participate, were trained in the various methods and life history topics required to study bats in the Pacific Northwest. They quickly became proficient at important research tasks, including the setup and



Two bat team students use calipers to measure the forearm length of a long-eared myotis in Craters of the Moon National Monument and Preserve. NPS PHOTO



Oregon Museum of Science and Industry bat research team students demonstrate the Anabat bat call recording equipment to Hagerman Fossil Beds operations chief Fran Gruchy. NPS PHOTO

operation of mist nets, acoustic monitoring equipment, and the identification and measurement of captured bats. Students concluded the program by assembling a final report that was submitted to each of the monuments and the network, complete with tables and maps generated in Microsoft Excel and ArcView GIS.

Notable findings from the team's work include first-time documentation of eight species of bats in and around Hagerman Fossil Beds, including the Townsend's big-eared bat (*Corynorhinus townsendii*), western pip-

istrelle (*Pipistrellus hesperus*), and pallid bat (*Antrozous pallidus*); addition of the fringed myotis (*Myotis thysanodes*) and hoary bat (*Lasiurus cinereus*) to the Craters of the Moon inventory species list; and monitoring results from pallid bat and Townsend's big-eared bat maternity roosts in John Day Fossil Beds and Craters of the Moon. Information from the roost monitoring is being used by the network as it begins to prioritize vital signs and consider

possible protocols for vital signs monitoring.

The Upper Columbia Basin Network is planning to organize a weed and rare plant mapping research team with the Oregon Museum of Science and Industry in 2005.

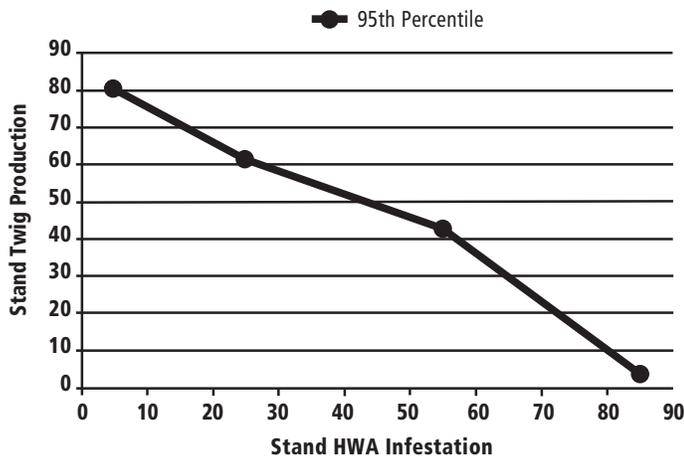
—Tom Rodhouse, ecologist, NPS Upper Columbia Basin Network, University of Idaho; [thomasr@uidaho.edu](mailto:thomasr@uidaho.edu).



## Update on hemlock woolly adelgid and the management of hemlock decline at Delaware Water Gap

Past studies at Delaware Water Gap National Recreation Area (Pennsylvania and New Jersey) have shown that an alien insect, hemlock woolly adelgid (HWA, *Adelges tsugae*), has been causing decline of eastern hemlock forests, leading to the loss of native biodiversity, and opening the way for invasions of alien plants. New and ongoing studies continue to expand our understanding and documentation of these changes. In addition, we are making progress in developing strategies and techniques to address important management issues associated with these changes.

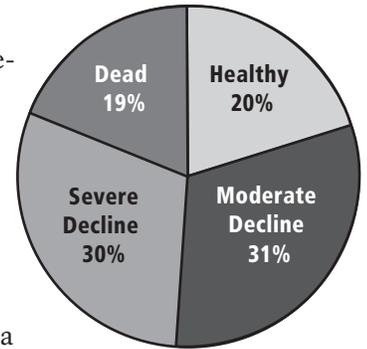
**Monitoring**—Annual monitoring of hemlock forest plots has documented the spread of HWA infestations throughout hemlock stands, and consequent declines in stand health. Initial HWA infestations only occur on a few branches of a few trees in a stand, and have little or no effect on overall hemlock stand health. As infestations increase and spread to more trees, they reduce the annual production of new twigs in the stand, eventually nearly eliminating it (fig. 1).



**Figure 1.** The graph documents decline in hemlock stand twig production with increasing levels of HWA infestation at Delaware Water Gap National Recreation Area during the 10-year period from 1995 to 2004. Data collected from monitoring plots in seven hemlock stands.

**Research**—Dr. Denise Royle, USDA Forest Service, used Landsat Thematic Mapper satellite imagery to quantify and analyze hemlock forest decline on a pixel-by-pixel (30-m x 30-m) basis throughout the national recreation area. This analysis has provided useful information about the spatial distribution, rate, and extent of hemlock decline and indicated that, as of 2002, approximately half

of the hemlocks in the recreation area were dead or in severe decline, and half were healthy or in moderate decline (fig. 2). Forest plot data, collected “on the ground,” indicate similar levels of hemlock decline.



**Figure 2.** The pie chart shows health of hemlock forests in Delaware Water Gap National Recreation Area in 2002, as indicated by satellite (Landsat) image analysis.

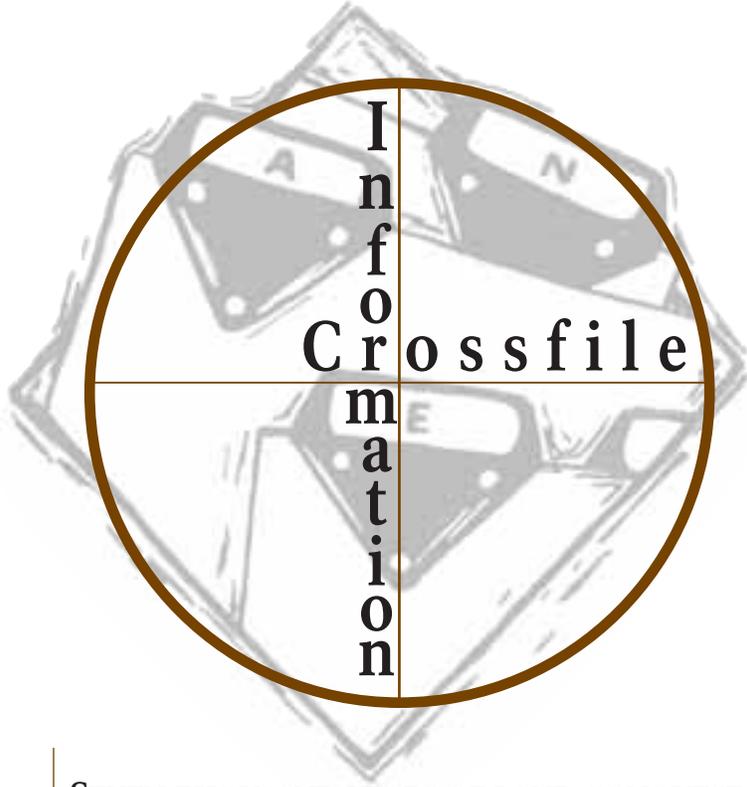
In 2003, Anne Eschtruth, a doctoral student at the University of California–Berkeley, initiated research in the park to determine if and how alien plant invasions are facilitated by hemlock decline, browsing by white-tailed deer, and surrounding alien plant populations. Results indicate that invasive alien plants are much more common and abundant in hardwood stands than healthy hemlock stands, but become more common and abundant in declining hemlock stands.

**Management**—In 2003 the national recreation area hosted an interdisciplinary workshop to gain expertise in developing strategies and techniques to manage declining hemlock forests. The workshop focused on developing (1) management plans for several important visitor use areas already experiencing severe hemlock decline and mortality, and (2) strategic goals and priorities for all of the 140 hemlock stands covering some 2,800 acres (1,134 ha) in the park. The NPS restoration ecologist assisted with the workshop, and representatives from the USDA Forest Service, the states of Pennsylvania and Connecticut, Rutgers University, and The Nature Conservancy contributed expertise in silviculture, plant ecology, landscape management, forest pest management, GIS, and remote sensing. A summary of the workshop, available from the author, was completed, and detailed site management plans are in preparation.

—Richard A. Evans, ecologist, Delaware Water Gap National Recreation Area, Pennsylvania; [richard\\_evans@nps.gov](mailto:richard_evans@nps.gov).

**Editor’s Note:** Readers may find the USDA Forest Service publication “Eastern hemlock forests: Guidelines to minimize the impacts of hemlock woolly adelgid” of interest; it is available at [www.fs.fed.us/na/morgantown/fhp/hwa/pub/guidelines\\_to\\_minimize\\_hwa\\_impacts\\_pub.pdf](http://www.fs.fed.us/na/morgantown/fhp/hwa/pub/guidelines_to_minimize_hwa_impacts_pub.pdf).





## SEVEN THOUSAND YEARS OF LAND CONQUEST AND THE LAND ETHIC

Typically, “Information Crossfile” articles summarize new research, technology, or other information reported in journals that is deemed useful to resource managers. In contrast to this norm, however, two rather old publications are mentioned here and are worth a fresh look. The first one (published posthumously in 1949) is *A Sand County Almanac* by Aldo Leopold. The second, published in 1953 about work conducted in 1938 and 1939, is more obscure (but still available through the Natural Resources Conservation Service): *Conquest of the Land through 7,000 Years* by Walter C. Lowdermilk. Leopold worked for the USDA Forest Service, Lowdermilk for the then Soil Conservation Service, so their experiences as government employees may be familiar to NPS resource managers; however, their perspectives are extraordinary, particularly in light of their pertinence to present-day land management.

Today, the Institute for Scientific Information estimates the duration of a publication’s usefulness by the frequency of citations in published literature. A usual decay curve of citation frequency shows a half-life of approximately six years; that is, after publication, citations build for five or six years then taper off. For *A Sand County Almanac*, however, a contrasting curve appears: almost no citations occurred for more than a decade, then citations have been rising consistently for the subsequent 50 years (Leopold 2004). It is evident, then, that Aldo Leopold’s book is having an impact over a long period of time.

Now consider a passage from Lowdermilk (1953):

A just relation of peoples to the earth rests not on exploitation, but rather on conservation—not on the

dissipation of resources, but rather on restoration of the productive powers of the land and on access to food and raw materials. If civilization is to avoid a long decline ... society must be born again out of an economy of exploitation into an economy of conservation.

Using examples from lands of ancient civilizations and our own civilization, the report calls into question the meaning of progress and development. But it also is a realization that peoples of the past were not somehow better caretakers of Earth’s resources. For example, the first records of salinization caused by irrigation are about 5,000 years old and come from present-day Iraq (ancient Mesopotamia), the crib of all civilization. The present applicability of this 65-year-old soil survey is astounding.

Therefore, the assumption that we humans have lost our intuition about how to care for the land and that primitive peoples were more adept is probably false. We are undoubtedly still learning, and the lessons in Lowdermilk (1953) and the land ethic in Leopold (1949) continue to provide guidance. —K. KellerLynn

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## IN SUPPORT OF BASIC RESEARCH IN NATIONAL PARKS

National parks in the United States have a well-documented history of indifference, if not hostility, in support of basic research. Numerous external reviews have criticized the lack of institutional support for science, blaming it in large part on the traditional emphasis of the National Park Service on tourism and recreation management. However, according to Parsons (2004), recent efforts to improve the support for science in U.S. national parks have been most encouraging. These include a long-sought congressional mandate to support research; a major budget initiative to support scientific understanding and management of park resources, and to improve research facilities; leadership in the establishment of a network of university-based cooperative units; and partnering with private organizations to support programs that fund Ph.D. undergraduate and graduate students, postdocs, and sabbaticals in national parks.



Six programs are particularly noteworthy and highlight, in the words of NPS Associate Director Michael Soukup, “the mutualism between park management and scientists” (Soukup 2004) in attaining the objectives of both “science for parks” and “parks for science.”

#### **Canon National Parks Science Scholars Program for the Americas**

By providing support to Ph.D. students throughout the region (i.e., Canada, the United States, Mexico, the countries of Central and South America, and the countries of the Caribbean), the Canon National Parks Science Scholars Program for the Americas strives to develop the next generation of scientists working in the fields of conservation, environmental science, and national park management. The program is a collaboration among Canon U.S.A., Inc., the American Association for the Advancement of Science, and the U.S. National Park Service. More information is available at [http://www1.nature.nps.gov/canonscholarships/2004\\_App\\_Guide.htm](http://www1.nature.nps.gov/canonscholarships/2004_App_Guide.htm).

#### **Cooperative Ecosystem Studies Units (CESUs)**

As part of a network of cooperative research units established to provide research, technical assistance, and education to park managers, each CESU is structured as a working collaboration among federal agencies and universities. The network provides resource managers with scientific research, technical assistance, and education. More information is available at <http://www.cesu.org/cesu/>.

#### **GeoScientists-in-the-Parks (GIP)**

Facilitated through the GIP Program, experienced earth science professionals and students work with park staffs to understand and protect geologic processes and features in the National Park System. The range of needs that GIPs address are fundamental research, synthesis of scientific literature, mapping, GIS analysis, inventorying, site evaluations, developing brochures and informative media presentations, and educating staffs. More information is available at <http://www2.nature.nps.gov/geology/gip/>.

#### **National Parks Ecological Research (NPER) Fellowship Program**

Through funding from the Andrew W. Mellon Foundation, the National Park Service, National Park Foundation, and Ecological Society of America host the NPER Fellowship Program, which encourages and supports outstanding post-doctoral research in ecological sciences related to the flora of the U.S. National Park System. Each year, up to three fellowships are granted to researchers who have recently completed their Ph.D. More information is available at <http://esa.org/nper/>.

#### **Research Learning Centers**

The National Park Service developed Research Learning Centers to facilitate research efforts and provide educational opportunities for all people to gain new knowledge about national parks. These centers are places where science and education come together to preserve and protect areas of national significance. They have been designed as public-private partnerships that involve organizations and individuals including researchers, universities, educators, and community groups. More information is available at <http://www1.nature.nps.gov/learningcenters/>.

#### **Sabbatical in the Parks**

The National Park Service created the Sabbatical in the Parks program to assist in arranging faculty sabbaticals to conduct research and other scholarly activities in the National Park System. Outcomes are usable knowledge for NPS management and advancement in science and human understanding. More information is available at <http://www1.nature.nps.gov/Sabbaticals/>. —K. KellerLynn

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## **PROTECTING SPECIES IN THE FACE OF CHANGING CLIMATE**

Since the late 1980s, we have commonly heard reports that human activities are increasing the atmospheric concentrations of greenhouse gases—which tend to warm the atmosphere—and, in some regions, aerosols—which tend to cool the atmosphere. Scientists project that these changes in greenhouse gases and aerosols, taken together, lead to regional and global changes in climate and climate-related parameters such as temperature, precipitation, soil moisture, and sea level (Watson et al. 1996). However, how these changes will affect the day-to-day activities of NPS resources managers is just now coming to light.

Resource managers are faced with the significant challenge of protecting species in the face of changing climate. This challenge is particularly formidable because species conservation is generally associated with protection strategies linked to particular pieces of property such as national parks. In the United States and other nations around the world, national parks increasingly are being used to serve critical roles in species protection. However, if global climate change alters the geographic distribution of habitats

and wildlife species, the ability to retain and protect species within designated boundaries is highly uncertain.

Recent empirical studies strongly suggest that wildlife species are already responding to recent global warming trends with significant shifts in range distribution (generally northward) and phenology (e.g., earlier breeding, flowering, and migration). In response to these studies, researchers have begun to use the predictive power of general circulation models (GCMs) to anticipate large-scale and long-term effects of climate change as entire complex communities shift. In the models, predicted gains and losses of species from selected parks were strictly a function of expected vegetation shifts due to climate change (Burns et al. 2003). A species was recorded as potentially present in a park, under the future climate scenario of doubled levels of CO<sub>2</sub>, if acceptable habitat for that species was predicted to occur within park boundaries.

Current models of global climate change indicate that eastern and western ecosystems within the United States will be impacted differentially. Therefore, researchers of this study stratified the United States into eastern and western ecoregions (divided by the Mississippi River) to ensure equitable representation of eastern and western parks. They then chose eight U.S. national parks from the larger pool of parks within these regions: Acadia, Big Bend, Glacier, Great Smoky Mountains, Shenandoah, Yellowstone, Yosemite, and Zion. Three factors constrained their choice of national parks: (1) geographic extent of climate change predictions, that is, the continental United States; (2) the regional availability of parks, that is, more western than eastern U.S. national parks; and (3) the availability of detailed mammalian species lists for each park.

Their results suggest that the effects of global climate change on wildlife communities may be most noticeable not as a drastic loss of species from their current ranges, but as a fundamental change in community structure as species associations shift because of influxes of new species. As shifting species forge new ecological relationships with one another and with current park species, the character of species interactions and fundamental ecosystem processes stands to become transformed in unforeseen ways. For example, an influx of new species may alter existing competitive interactions and influence trophic dynamics with changes in predator-prey interactions. Also, climate warming is likely to result in phenological shifts, including changes in spring breeding dates, flowering, and

bud emergence, which can further disrupt current species associations. In some cases, shifting species assemblages may lead to irreversible state changes, in which the relative abundance of species in different trophic levels can be radically altered. Moreover, the outcome of these new species interactions may be particularly difficult to predict because of the rapid pace of change expected and the potential for nonlinearities that may emerge, for example, as a consequence of altered trophic interactions. —K. KellerLynn

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## TWINKLE, TWINKLE, LITTLE STAR. HOW I WONDER WHERE YOU ARE?

The stars in the nighttime sky are disappearing. One here, one there—a hardly noticeable process that began over large metropolitan areas and is now spreading to nearly every corner of civilization. Even remote areas are being exposed to increased illumination from “sky glow” that appears at night over urban areas and obscures our view of stars and other astronomic phenomena. Investigators predict that the most noticeable effects of light pollution will occur in those areas close to natural habitats (Longcore and Rich 2004). This may be near wilderness

where summer getaways are built, along the expanding front of suburbanization, near wetlands and estuaries that are often the last open spaces in cities, or on the open ocean, where cruise ships, squid boats, and oil derricks light the night.

As faint celestial objects billions of miles away began to disappear from their telescopes, astronomers were the first to notice what we are stealing away from ourselves.

Now other scientists, primarily ecologists, and citizens are realizing the effects of light pollution in deadly ways. The poster child for this issue is probably hatchling sea turtles, which are protected under

**THEIR RESULTS SUGGEST THAT THE EFFECTS OF GLOBAL CLIMATE CHANGE ON WILDLIFE COMMUNITIES MAY BE MOST NOTICEABLE NOT AS A DRASTIC LOSS OF SPECIES FROM THEIR CURRENT RANGES, BUT AS A FUNDAMENTAL CHANGE IN COMMUNITY STRUCTURE AS SPECIES ASSOCIATIONS SHIFT BECAUSE OF INFLUXES OF NEW SPECIES.**



the Endangered Species Act of 1973. These baby reptiles generally break free of their shells under the cover of darkness and then waddle into the surf as soon as possible to avoid predation. Normally they orient themselves by scanning the horizon and heading for celestial lights such as the moon and stars reflecting off the sea. Artificial lighting on beaches and roadways near nesting areas, however, often confuses hatchlings and causes them to crawl inland instead (Schaar 2002). According to Kristen Nelson of the Florida Department of Environmental Protection, thousands of hatchlings are disoriented in this way every year. In 1998, for example, marine turtle permit holders reported 19,970 hatchlings as disoriented (Nelson 2000). Many hatchlings die from dehydration, are eaten by predators such as fire ants and ghost crabs, or are run over by cars if they wander onto nearby roadways. Those that do make it to the water may have a decreased chance for survival because of wasted energy resources.

In addition to causing disorientation, ecological light pollution has demonstrable effects on the behavior of most organisms in natural settings (e.g., insects, migrating toads and salamanders, birds, bats, and fish). Changed behaviors—orientation/disorientation and attraction/repulsion—in altered light environments may in turn affect foraging, reproduction, migration, and communication (Longcore and Rich 2004). Moreover, the cumulative effects of behavioral changes induced by artificial night lighting on competition and predation have the potential to disrupt key ecosystem functions (Longcore and Rich 2004). The consequence of ecological light pollution on aquatic invertebrates illustrates this point. Many aquatic invertebrates, such as zooplankton, move up and down within the water column during a 24-hour period. This regular vertical migration, called “diel vertical migration,” presumably results from a need to avoid predation during lighted conditions; therefore, most zooplankton forage near water surfaces only during dark conditions (Gliwicz 1986). Artificial illumination decreases the magnitude of diel migrations, both in the range of vertical movement and the number of individuals migrating. Researchers hypothesize that this disruption of diel vertical migration may have substantial detrimental effects on ecosystem health. With less zooplankton migrating to the surface to graze, algae populations may increase. Such algal blooms would then have a series of adverse effects on water quality (Moore et al. 2000).

In *Management Policies 2001*, the National Park Service acknowledges the roles that light and dark periods and darkness play in natural processes, and in cooperation with park visitors, neighbors, and local governments, it strives to prevent loss of dark conditions and natural night skies. However, obstacles for the National Park Service include a lack of awareness of light pollution as a

threat to wilderness values and cultural heritage, an absence of baseline formation about this resource, and inefficient facility lighting (Moore and Duriscoe 2002). Possibly conventional wisdom that light reduces crime also serves as a stumbling block. Most crime, however, actually occurs during the day, or inside buildings, and the paucity of data precludes any definitive statement regarding the relationship of lighting and crime (International Dark-Sky Association 1990). Furthermore, “dark campus” programs across the country have shown that darkness actually reduces crime, in particular vandalism, and saves money (e.g., decreased energy costs and reduced repairing and cleaning of damage) (International Dark-Sky Association 2000). On the other hand, studies indicate that lighting decreases the fear of crime; it makes us feel safe outside at night. Yet, the real task for resource and facility managers is to make visitors and staffs not just feel safe, but be safe, for example by providing good lighting for nighttime travelers around headquarters, housing areas, visitor centers, and entrance stations. Yet visitor and staff safety must be achieved while protecting the natural behaviors of wildlife and preserving natural night skies. This means that the National Park Service needs effective and efficient lighting in developed areas. Good visibility is the goal (not just wasting resources on lighting a vacant parking lot or perhaps lighting a criminal’s way), and good lighting can help. Poor lighting compromises human safety, natural wildlife behaviors, and the natural night sky.

The International Dark-Sky Association (1996) provides some solutions that minimize light pollution without compromising safety or utility:

1. Use night lighting only when necessary. Turn off lights when they are not needed. Timers can be very effective. Use the correct amount of light for the need, not overkill.
2. Where light is needed, direct it downward. The use and effective placement of well-designed fixtures will achieve excellent lighting control. When possible, retrofit or replace all existing fixtures of poor quality. In all cases, the goal is to use fixtures that control the light well and minimize glare, light trespass, light pollution, and energy use.
3. Use low pressure sodium (LPS) light sources whenever possible. These are the best possible light sources to minimize adverse effects on astronomical activities and are the most energy efficient light sources that exist. Areas where LPS light sources are especially good include street lighting, parking lot lighting, security lighting, and any application where color rendering is not critical.

*Continued in right column on page 23*

## Chilean conservation of biodiversity in the context of Latin America

Article and photographs, except as noted, by Juan Oltremari Arregui

### Biodiversity and its trends in Latin America

Latin America represents approximately 15% of the world's landmass, containing more than 8.5% of the global human population. Two biogeographic realms represent the region: the Nearctic, containing most of Mexico, and the Neotropical, enclosing the countries of Central America, the Caribbean, and South America.

Latin American is rich in biodiversity at the global level, and a number of Latin American ecoregions are globally outstanding (Dinerstein et al. 1995). The tropical area includes almost 40% of the world's floral species, and South America registers 32% of global avifauna. Latin America also contains a variety of ecosystems: dry lands (Chile's Atacama Desert), humid territories (Colombia's Choco forests), immense tropical forests, the most extensive mountain range in the world (the South American Andes), vast coastal-marine areas, and very old and stable environments, such as the Orinoco, the Amazon, and Patagonia (International Council of Bird Preservation 1992).

Although some Latin American countries still have large, pristine territories, most suffer from severe deterioration, in which biodiversity is seriously threatened. The

annual rate of deforestation reaches 1.2% in Central America and Mexico, 1.7% in the Caribbean, and 0.5% in South America (Food and Agriculture Organization 1999). For the period 1990–2000, the Food and Agriculture Organization of the United Nations (2001) estimated net annual forest area loss to be about 10 million acres (4 million ha) in South America, and future perspectives are pessimistic. The Food and Agriculture Organization (2000) predicts that in the next five years Latin America could experience an annual transformation rate of more than 12 million acres (5 million ha) of virgin forests to agriculture and livestock production. Many countries have adopted this development pattern without thorough consideration of land-use capacity or environmental deterioration.

Facing this situation, protected areas play an important role in preserving biological diversity and minimizing

**Protected areas play an important role in preserving biological diversity and minimizing fragmentation of natural habitat.**

fragmentation of natural habitat (Brandon et al. 1998). Although these areas do not fully guarantee the conservation of biodiversity, they constitute an overwhelming con-

tribution to maintaining unique and representative natural resources and sustainable use of resources compatible with preservation objectives (table 1, page 14).



## Chile in the context of Latin America

As with the rest of Latin America, human activities threaten Chile's biodiversity. The illicit clearing of natural forests, habitat destruction and hunting of wildlife, overgrazing of grasslands, overexploitation of fishing resources, and inappropriate agricultural practices are significant examples. In addition, during the 2001–2002 season, unusual forest fires affected more than 172,000 acres (70,000 ha) (San Martín 2002), causing significant damage to Tolhuaca National Park and Malleco National Reserve. Additional environmental deterioration is the consequence of global phenomena such as depletion of the ozone layer and global warming (greenhouse effect). El Niño–Southern Oscillation, another global phenomenon, also affects biodiversity.

## Origins of protected areas in Chile

The conservationist movement in Chile is not new, particularly with regard to forest protection. In 1859 one of the first legal conservation-oriented instruments was passed, regulating the cutting of Alerce (*Fitzroya cupressoides*) in the fiscal lands of two communes of southern Chile. Later, in 1872 (the same year Yellowstone National Park was established in the United States) the cutting of forests on high slopes and near water resources was also regulated, and in some cases prohibited, both on public and private lands (Gallardo 2002).

The first mention of protected areas in Chilean legislation occurred in 1879. In that year, a strip 6.2 miles (10 km) wide in the Andes Mountains, and another strip 1.6 miles (1.0 km) wide in the Coastal Range, between 38° S and 42° S latitude, were classified as national reserves.

**Table 1. Protected areas of Latin America**

Country	National area in acres (ha)	Total protected area in acres (ha)	Protected area as % of national area	% of total protected area in Latin America
Argentina	686,099,086 (277,664,300)	36,131,114 (14,622,262)	5.27	9.16
Bolivia	271,454,164 (109,857,500)	26,691,250 (10,801,949)	9.83	6.77
Brazil	2,103,278,478 (851,196,800)	80,267,069 (32,484,083)	3.82	20.34
Chile	187,038,053 (75,694,300)	34,898,871 (14,123,573)	18.66	8.85
Colombia	281,420,064 (113,890,700)	24,210,818 (9,798,118)	8.60	6.14
Costa Rica	12,576,970 (5,089,900)	3,128,428 (1,266,075)	24.87	0.79
Cuba	28,298,493 (11,452,400)	16,115,038 (6,521,756)	56.95	4.08
Ecuador	112,553,002 (45,550,200)	28,672,990 (11,603,959)	25.48	7.27
El Salvador	5,155,671 (2,086,500)	12,903 (5,222)	0.25	<0.01
Guatemala	26,905,856 (10,888,800)	5,134,080 (2,077,762)	19.08	1.30
Honduras	27,696,318 (11,208,700)	4,655,888 (1,884,238)	16.81	1.18
Mexico	487,362,244 (197,235,500)	27,602,061 (11,170,554)	5.66	7.00
Nicaragua	36,571,535 (14,800,500)	5,340,746 (2,161,400)	14.60	1.35
Panama	19,046,207 (7,708,000)	4,382,325 (1,773,527)	23.01	1.11
Paraguay	100,506,548 (40,675,000)	3,674,117 (1,486,915)	3.66	0.93
Peru	317,572,276 (128,521,500)	16,852,755 (6,820,310)	5.31	4.27
Dominican Republic	11,969,607 (4,844,100)	3,001,465 (1,214,693)	25.08	0.76
Uruguay	46,188,535 (18,692,500)	82,871 (33,538)	0.18	0.02
Venezuela	225,363,726 (91,204,700)	73,718,599 (29,833,917)	32.71	18.68
Total	4,987,056,833 (2,018,261,900)	394,573,388 (159,683,851)	N/A	100.00

Sources: Ministry of the Environment of Colombia (1998) and National Forestry Corporation (2003), updated for Chile.

The first protected area in Chile was established in 1907: the Malleco Forest Reserve. This initiative was a response to the government's commercial interest in forest products and the resulting serious forest depletion, in order to create more land for agriculture and cattle raising (Oltremari and Faharenkrog 1979, Oltremari and Jackson 1985).

Since the 1930s the government has initiated a strong policy toward the establishment and management of protected areas, as a system composed of different management categories: national parks, national reserves, and natural monuments, administered by the National Forestry Corporation, under the Ministry of Agriculture. Nevertheless, protected areas as a system still did not have legal support until 1984 when law 18.362 established this system.

**Since the 1930s the government has initiated a strong policy toward the establishment and management of protected areas....**

### Characterization of Chile's protected areas

The influence of past glaciation on Chile's territory has not allowed the high levels of biodiversity that are found in more tropical countries. Nevertheless, Chile's isolated conditions have facilitated the evolution of endemic species of flora and fauna, giving special value to Chile's natural patrimony. In addition, Chile has an important diversity of ecosystems, including the desert of Atacama, wetlands of the Andes high plateau, oceanic islands, shrublands of the central and south-central region (fig. 1), rain forests, and the southern ice fields. According to the National Forestry Corporation (1999), 75% of the protected-area system includes a nearly equal representation of native forest, wetlands, and permanent snow and glaciers. The system also contains almost 30% of all of Chile's natural forests. This protected-area system is



Figure 1. Shrublands are poorly represented in Chilean protected areas. Río de Los Cipreses National Reserve, in region VI (see fig. 3, page 16), protects this ecosystem type.

Chile's most significant biodiversity conservation initiative, as it represents almost 19% of the total national area (tables 1 and 2; fig. 2).

The protected areas are spread throughout the country with a notable concentration in the southern "austral" region (table 3 and fig. 3, page 16). This distribution is explained by the original motivation for establishing protected areas: scenic beauty. These areas were long associated with the conservation of scenic forests, lakes, and mountains concentrated here. This original motivation has evolved in the last few decades, to the point where biodiversity conservation has become much more important. In fact, the most recently created protected areas are located in the north and north-central parts of the country, containing arid and semi-arid environments that formerly were considered less important in terms of biodiversity.

Table 2. Management categories and size of Chilean protected areas

Management categories	Number	Area in acres (ha)
National parks	31	21,542,525 (8,718,260)
National reserves	48	13,312,165 (5,387,433)
National monuments	15	44,181 (17,880)
Total	94	34,898,871 (14,123,573)

Source: National Forestry Corporation (2003).



Figure 2. Evergreen forests associated with watershed systems are well-represented natural environments in southern Chilean protected areas. This natural environment, located in region X (see fig. 3), hosts several *Nothofagus* species and is classified as globally outstanding but vulnerable in Latin America.



## Protected areas in Chile: strengths

The main strengths of Chile's protected-areas system are its longevity (for almost a century), areal extent, and diversity (fig. 4). The long-lived conservationist movement in Chile helped maintain biological diversity in protected areas. Because of patrolling activities, threats to biodiversity in protected areas are less significant than on private lands (Naranjo 1993), except for the recent increase in forest fires. Environmental legislation passed in 1993 also contributed to regulation of development activities in the protected areas (Gallardo 2002).

**The main strengths of Chile's protected-areas system are its longevity, ... areal extent, and diversity.**

The protected-area system has undergone reclassification and re-delimitation, which is also considered an important strength. In the 1980s investigators carried out rigorous studies to better classify those areas whose original management category was not correctly applied (Oltremari et al. 1981).

During this period, improvements were made to the boundaries of several protected areas. For example, some areas included private and degraded lands, and had excluded adjacent public lands of high biological value. During this process the system was reordered using scientific and technical criteria.

**Table 3. Geographical localization of protected areas in Chile**

Location	% of the number	% of the area
North and central-north (regions I–V)	24.9	8.2
Central (metropolitan region)	2.2	0.1
Central-south (regions VI–VIII)	15.2	1.0
South (regions IX–X)	26.1	7.0
Austral (regions XI–XII)	31.6	83.7

Source: National Forestry Corporation (2003).

**Figure 3 (left). Chilean protected areas comprise about 9% of the country's land area. Protected areas that are 49,420 acres (20,000 ha) or larger are shown in dark gray; open triangles represent protected areas less than 49,420 acres (20,000 ha). The Roman numerals on the map designate Chilean administrative regions that are like states in the United States of America, although Chile does not have a federal government.**

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**Figure 4. Landscape diversity is an outstanding feature of several national parks in Chile. For example, Villarrica National Park, in region IX (see fig. 3), hosts the active Villarrica Volcano (9,338 ft; 2,847 m).** PHOTO BY AIDA BALDINI

## Protected areas in Chile: weaknesses

Chile's protected-area system still endures some weaknesses, which present challenges for the future. These can be classified into two key categories: (1) inadequate coverage of Chile's biodiversity and representation of its major ecosystems, and (2) institutional and legal constraints.

Several indicators demonstrate the need to improve biodiversity coverage and representation of major ecosystems. Some of the forest types are represented very poorly (fig. 5). Such is the case of the forest type *Nothofagus obliqua*-*Nothofagus glauca*, which is represented in only 0.5% of their distribution, and the shrublands of central Chile and the forest type *Nothofagus obliqua*-*Nothofagus alpine*-*Nothofagus dombeyi*, represented in 2% and 2.8%, respectively.

This weakness is also notable when considering the representation of Chile's vegetative associations (Benoit 1991). The protected-area system only preserves 54 of the 83 vegetative associations described for the country (36% lack representation). Additionally, 264 species of flora and fauna are considered threatened (National Forestry Corporation 1987, National Forestry Corporation 1989).

However, several recent initiatives reduce these deficiencies. The National Forestry Corporation and the University of Concepción (1993) carried out a comprehensive study to identify priority sites for conservation of biodiversity not properly represented in the system. Results of this activity have been very useful in guiding the establishment of new protected areas during the last decade (fig. 6).

Certain institutional and legal constraints also are recognized weaknesses. The lack of personnel is evident: only 450 park rangers (called "guards" in Latin America), including both seasonal and permanent personnel, manage and protect the total amount of protected areas—approximately one guard for each 74,130 acres (30,000 ha). However, this figure should only be considered as an indicative reference, as the real need for guards should be associated with the extent of management programs, number of visitors, and accessibility of the areas. As an

example, in 2001, protected areas located in the most southern region of Chile (regions XI and XII, see table 3 and fig. 3) received only 18% of the total visitors to the national system, although 84% of Chile's protected area is located there.

Chile, as with many Latin American countries, has insufficient funding to satisfy the needs of protected areas. The annual budget for the whole system is about \$5 million, including salaries, goods and services, and capital expenditures. Capital expenditures are considered the major constraint as they have only reached an average of 10 to 15% of the annual budget during the last decade.

Chile lacks systematized legislation to support the national system of protected areas. The laws on protected areas are dispersed and legal contradictions are frequent. While some laws promote the establishment and management of protected areas, others are focused on enhancing traditional productive activities incompatible with environmental protection within protected areas. Mining is a primary example. In this context, the need to improve legislation, increase institutional capacities, and search for innovative financing mechanisms are the major challenges for Chile's protected areas.

## New perspective and conclusions

As a fundamental criterion for the establishment of protected areas, Latin American countries are using the conservation of representative samples of biological diversity. In this context, national parks and other protected areas are achieving increasing relevance and importance. Moreover, the national institutions administering protected areas, and society as a whole, are delegating a more complex role to these areas. Several countries now

plan protected-area systems as part of the surrounding landscape through a bioregional planning process. By means of this approach, strict protected areas, like national parks, are considered as core zones linked by buffer zones and biological corridors.

This new perspective involves serious challenges. The active participation of the private sector is essential in the



**Figure 5. The Sclerophyll Forest Ecologic Subregion is one of the most seriously threatened ecosystem types in Chile. The subregion is dominated by the espino (*Acacia caven*), and other sclerophyllous shrubs, such as *Lithraea caustica*, *Quillaja saponaria*, and *Cryptocaria alba*. The espino is a native species spread by the introduction of domestic livestock and clearing of the matorral for firewood.**



**Figure 6. Mountain Sclerophyll Forest of central Chile risks extinction because of overgrazing and agricultural activities. Preserving this forest type is a major priority in establishing new protected areas.**



operation of some management activities, such as eco-tourism, inside and outside protected areas. Society also can play an important role through the establishment of private protected areas that provide vital connections between and surrounding the areas.

As a consequence, governmental institutions administering protected areas need to strengthen their normative role regarding the participation of other interested organizations. The coordinated efforts of public institutions with local communities, the private sector, and the growing number of nongovernmental organizations are crucial. The government cannot delegate the responsibility for guaranteeing environmental protection. Rather it must assume a protagonist role in coordinating alliances among interested and affected stakeholders.

At present in Latin America, society in general is more sensitive to environmental conservation than in past decades, and national parks and other protected areas are now receiving substantial attention and support. The cultural values of the indigenous and rural communities associated with protected areas are also receiving important attention. As a result, a new challenge has arisen: democratizing the planning and management of protected areas to improve management activities. Participatory planning is increasingly being used to reduce conflicts between environmental protection and traditional land use, and to promote viable solutions for the problems of poverty of local communities.

As with other Latin American countries, Chile is facing the new challenges of improving management of existing protected areas, and of increasing the coverage and representation of those environments not yet well protected. Overall, Chile needs to develop innovative financing mechanisms to enhance institutional capabilities to manage protected areas and to create legislation that will guarantee the stability of decisions that conserve biological diversity.

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# Accuracy assessment of National Wetland Inventory maps at Sequoia and Kings Canyon National Parks

By Harold W. Werner

## Introduction

Both long-term planning and daily management of wetlands require knowledge of where wetlands exist and their vulnerabilities. For example, uncontrolled visitor use or poorly located facilities can damage wetlands, many of which, like marshes, are obvious, but identifying other types of wetlands requires technical skills. The National Park Service's policy of "no net loss of wetlands" mirrors a policy that originated with the National Wetlands Policy Forum in 1987 (Mitsch and Gosselink 1993), which strives to avoid and minimize wetland impacts wherever practicable and to compensate for unavoidable impacts through restoration of degraded wetlands (National Park Service 2001).

The U.S. Fish and Wildlife Service produces National Wetland Inventory (NWI) maps that provide information on the characteristics, extent, and status of wetlands and deep-water habitats (U.S. Fish and Wildlife Service 2003a). Maps that included Sequoia and Kings Canyon National Parks, California, were produced in 1996. This information is in the public domain and is important for planners, managers, and scientists. We used these maps because they provided the most readily available information on wetland types and their locations.

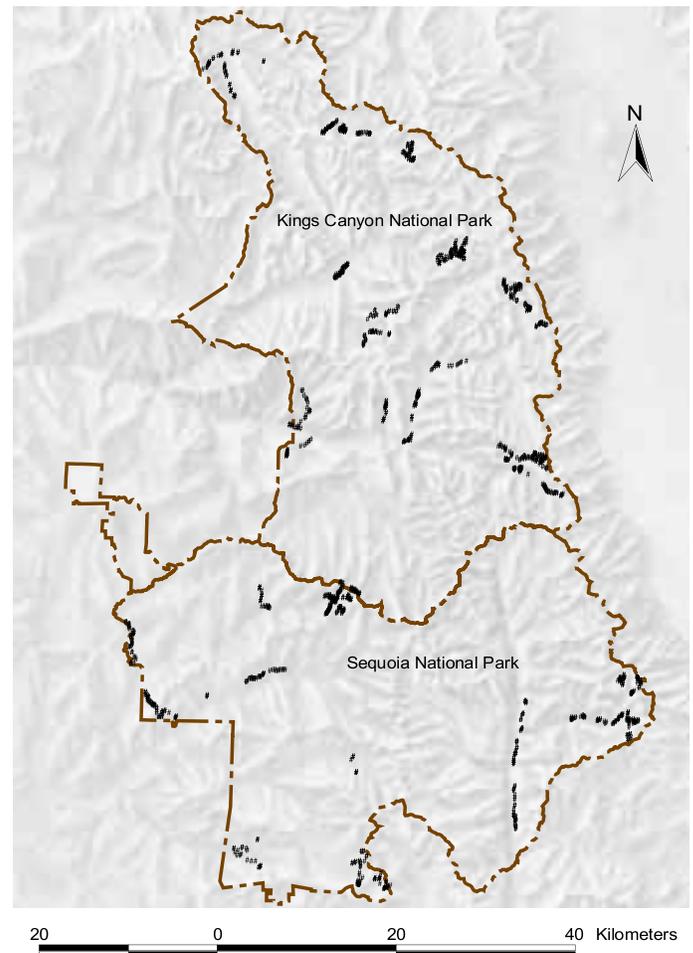
The NWI maps do not replace the accuracy of on-site wetland delineation, but they should provide meaningful data about the wetlands of an area. Our field surveys were not intended to characterize the parks' wetlands; rather, our purpose was to assess the accuracy of the NWI maps for Sequoia and Kings Canyon National Parks. We classified all sites on the basis of definitions and descriptions in Cowardin et al. (1979) and used NWI map codes (U.S. Fish and Wildlife Service 2003b).

## Methods

We performed fieldwork during summer in 2000 and 2001. The work resulted in two basic data collection strategies: (1) field verification of a sample of NWI sites for identifying errors of commission (in this case where wetlands were misclassified or upland areas were classified as wetlands) and (2) sampling along transects for identifying errors of both omission and commission. We

selected "verification sites" with the fullest range of NWI wetland taxa available and "transect sites" to represent the spatial extent and diversity of landscapes in the parks (fig. 1). The field crew, consisting of two biological science technicians, surveyed all wetlands encountered (mapped and unmapped) along selected transects.

The NWI maps show 23,091 wetland sites within Sequoia and Kings Canyon National Parks. The crew surveyed 900 wetland sites, which included 294 verification



**Figure 1.** To assess the National Wetland Inventory maps, investigators selected validation sites that represented the fullest range of wetland taxa available, and surveyed transects representing the spatial extent and diversity of landscapes in Sequoia and Kings Canyon National Parks. Surveyed sites are marked in black on the figure.

sites, encounters with 596 sites along transects, and 10 incidental encounters of unclassified sites during validation. Of the 900 wetland sites examined, 620 were on the NWI maps. These 620 sites included all of the verification sites and 326 transect sites. All 620 sites were used for evaluating the accuracy of the points, lines, and polygons delineating wetlands on the digital GIS layer representing the NWI maps. Our classification scheme allowed for one taxon per site; therefore, crew members classified each of the 900 sites on the basis of the dominant taxon. Because some sites contained multiple wetland taxa, field investigators made 1,257 taxonomic determinations at the 900 sites.

The crew classified wetlands to subclass and estimated hydrologic regime. For each site they identified the location using Universal Transverse Mercator (UTM) coordinates, elevation, slope, aspect, adjacent substrate, average feature width, vegetation type, and predominant vegetation.

## Results

### Validation of NWI wetland sites

Of the 294 NWI wetland sites that the field crew validated, only one was an upland. On the NWI map, investigators had classified it as Palustrine Emergent Wetland (PEM, see table 1). This is an error of only 0.34% (3.4 per thousand) for misclassifying upland as wetland.

Few discrepancies occurred between the NWI maps and field surveys for the Lacustrine data (fig. 2). Putting subsystem differences aside (e.g., L1 vs. L2, see table 1), the field crew determined that 97% of the sites identified as Lacustrine on NWI maps were correct. They determined that 3% were Palustrine (PUB, see table 1).

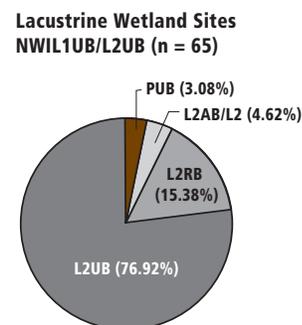
Our survey found considerably more problems at the NWI Palustrine sites than at the Lacustrine sites. At the system level (see table 1), 6% of the Palustrine sites identified on NWI maps were not actually Palustrine. At the class level (see table 1), only 67% of the sites identified as Palustrine Emergent Wetland (PEM) were identified correctly (fig. 3). Twenty-six percent of the Palustrine Emergent Wetland were actually Palustrine Scrub-Shrub Wetland (PSS). Only 64% of the Palustrine Forested Wetland (PFO) were correct. Sites classified erroneously as Forested Wetland (PFO) were primarily meadows (PEM) or Scrub-Shrub Wetland (PSS). Sites classified as Palustrine Scrub-Shrub Wetland were correct 66% of the time. Twenty-two percent of the Palustrine Scrub-Shrub Wetland sites were meadows (PEM), and 8% were forested (PFO). In general, a two-thirds probability exists that sites identified as Emergent Wetland, Scrub-Shrub Wetland, or Forested Wetland on the NWI maps are correct, but there is a 96% likelihood of the site being one of these three. National Wetland Inventory maps incorrectly

classified 55% of the Palustrine Unconsolidated Bottom (PUB) sites. Twelve percent were ponds, but either with Rock Bottom (PRB, 8%) or vegetated bottoms (PAB, 4%); 23% were lakes; 13% were meadows; and the remainder (7%) was Scrub-Shrub Wetland, Palustrine Unconsolidated

**Table 1. Wetland classification terms used in text**

System, subsystem, and class	Symbol	Example
<b>Palustrine</b>		
<b>Pond or emergent vegetation</b>		
Emergent Wetland	PEM	Wet meadow
Unconsolidated Bottom	PUB	Pond with mud/sand/cobble/gravel bottom
Scrub-Shrub Wetland	PSS	Willow stand
Forested Wetland	PFO	Alder or riparian forest
Aquatic Bed	PAB	Pond with vegetated bottom
Unconsolidated Shore	PUS	Pond shore of mud/sand/gravel/cobble
Rock Bottom	PRB	Pond with bedrock/boulder bottom
<b>Lacustrine</b>		
<b>Lake</b>		
Limnetic	L1	Lake area >2 m deep (deep open water)
Unconsolidated Bottom	L1UB	Lake margin with mud/sand/gravel/cobble bottom
Littoral	L2	Lake area <2 m deep (shallow, usually near shore)
Rocky Shore	L2RS	Lake shore of bedrock or boulders
Unconsolidated Bottom	L2UB	Lake with mud/sand/gravel/cobble bottom
Rock Bottom	L2RB	Lake with bedrock/boulder bottom
Aquatic Bed	L2AB	Lake with vegetated bottom
<b>Riverine</b>		
<b>River or stream</b>		
Upper Perennial	R3	High gradient, fast permanent flow
Unconsolidated Bottom	R3UB	Stream with mud/sand/gravel/cobble bottom
Rock Bottom	R3RB	Stream with bedrock/boulder bottom
Intermittent	R4	Seasonal flow
Streambed	R4SB	Any intermittent stream

Source: Cowardin et al. (1979) and U.S. Fish and Wildlife Service (2003b).



**Figure 2. Few discrepancies occurred between NWI maps and field surveys for Lacustrine sites. Ninety-seven percent of the Lacustrine sites were correct. The remaining 3% were Palustrine (ponds).**

Shore (PUS), or Upper Perennial (R3) stream. Twenty percent of the sites classified as Palustrine Unconsolidated Shore (PUS) were correct. Most sites were either Lacustrine Littoral Rocky Shore (L2RS, 40%) or Palustrine Emergent Wetland (40%).

The classification of Riverine systems on the NWI maps also had many problems (fig. 4). The crew found only half (51%) of the NWI Riverine sites actually to be Riverine. The remaining misclassified sites were actually Palustrine, primarily Scrub-Shrub Wetland (22%), meadow (PEM, 16%), and forested (PFO, 9%). Only 45% of the sites labeled Upper Perennial streams with Rock Bottom (R3RB) were correct (fig. 4). Eight percent were Upper Perennial streams with Unconsolidated Bottom (R3UB), 3% were Intermittent Streambed (R4SB), and the remainder was Palustrine (44%). The only Riverine site labeled as Unconsolidated Bottom was a meadow (PEM). Less than

Overall, 45% of the sites encountered on transect surveys were not on NWI maps.

one-third (29%) of the sites labeled as Rocky Shore (L2RS) were re-classified correctly. The remaining misclassified sites were actually Riverine Rock Bottom (14%) or Palustrine (primarily PEM, 57%). Only 37% of the sites labeled on the NWI maps as Intermittent Streambed (R4SB) were correct. Six percent were Upper Perennial Rock Bottom (R3RB) and the others were Palustrine (57%).

*Wetland transects*

Overall, 45% of the sites encountered on transect surveys were not on NWI maps. This suggests that about half again as many wetlands and deep-water habitats may exist in the parks as are displayed on the NWI maps. Few (5%) of the omissions were found to be Lacustrine systems. Most omissions were Palustrine and Riverine (fig. 5, page 22).

Forty-two percent of surveyed Palustrine wetlands were not on the NWI maps. More than half of these were meadows (PEM, 55% of unmapped Palustrine wetlands). The remainder was primarily Scrub-Shrub Wetland (PSS, 21%) or forested (PFO, 20%). A few ponds (either PUB or PRB, 4%)

**Palustrine Wetland Sites**

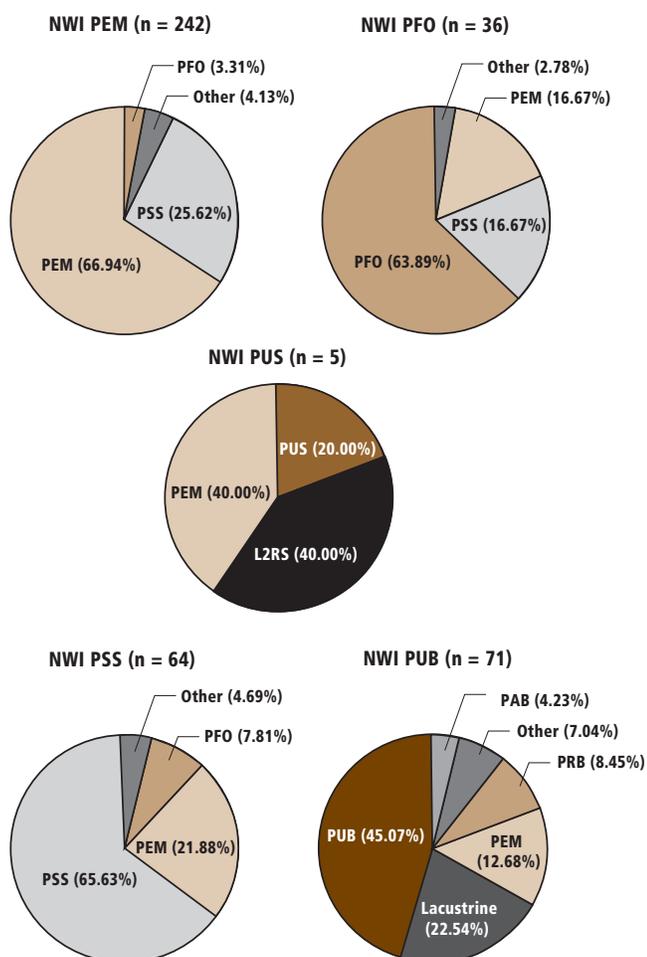


Figure 3. Field investigations revealed considerable problems with Palustrine sites shown on NWI maps. For example, of the 242 Palustrine Emergent Wetland (PEM) sites classified on the NWI maps, only 67% of the sites were classified correctly at the class level.

**Riverine Wetland Sites**

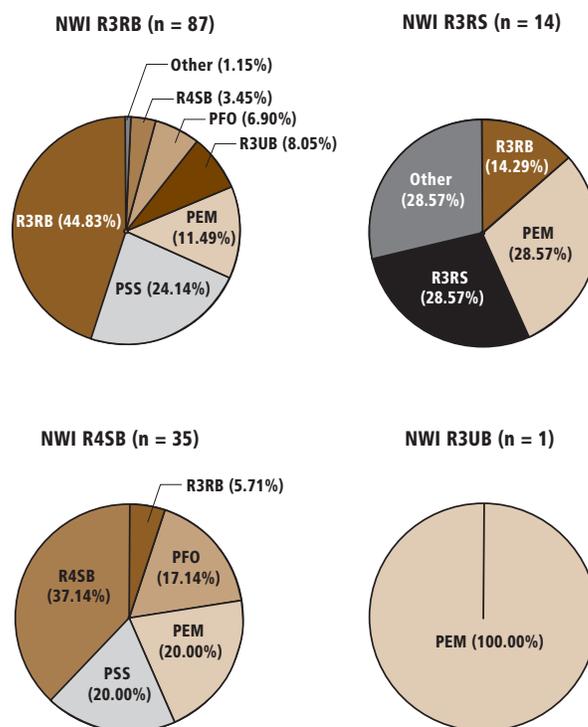
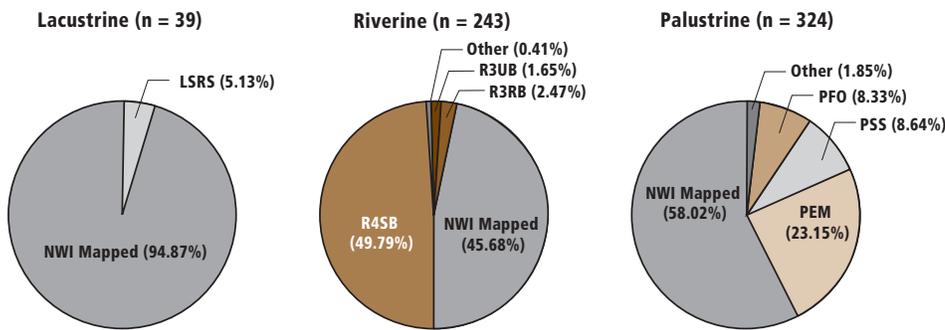


Figure 4. Field surveys revealed the greatest errors in classifying Riverine wetlands. Comparing all four Riverine classes combined, only half (51%) of the sites classified on the NWI maps were correct. The pie charts show what was actually observed in the field for each of the Riverine classes. For example, on the NWI maps used for the survey, Riverine Unconsolidated Bottom (R3RB) was correct about 45% of the time.



## Errors of Omission



**Figure 5.** Surveys along wetland transects showed that about half again as many wetlands and deep-water habitats may exist in the parks as are displayed on the NWI maps. The pie charts show for each system the proportion of wetlands mapped during the National Wetlands Inventory compared to newly identified sites during field surveys. Most sites not included on NWI maps were Palustrine and Riverine.

and some Unconsolidated Shore (PUS, 1%) also occurred.

Wetlands in the Riverine system had the highest frequency of not occurring on NWI maps. Fifty-four percent of the Riverine wetlands surveyed were not on NWI maps. Ninety-two percent of these were Intermittent Streambed (R4SB), which are probably the most cryptic and ubiquitous of the Riverine classes. The remainder was Upper Perennial somewhat evenly distributed between Rock Bottom and Unconsolidated Bottom.

### Water regime

The NWI maps include water regime in addition to wetland taxa. Water regime is a difficult parameter to estimate without long-term knowledge of a site. However, a site's water regime does have indicators: floristic community, fauna, current condition for time of year, soil, and high-water marks.

The NWI maps and field determinations concurred best for the wettest and one of the driest water regimes, with 81% agreement for "permanently flooded" sites ( $n = 208$ ) and 56% agreement for "temporarily flooded" sites ( $n = 46$ ). Of the other predominant water regimes, only 35% of the NWI sites labeled "seasonally flooded" matched field observations ( $n = 161$ ). Many were "temporarily flooded" (20%) or "seasonally flooded/saturated" (16%). Only 17% of sites ( $n = 156$ ) labeled as "saturated" actually were. Most "saturated" sites were "seasonally flooded/saturated" (22%), "temporarily flooded" (19%), or "seasonally flooded" (17%). The greatest disparity existed with sites labeled "semipermanently flooded" with only 11% agreement ( $n = 28$ ). Most of them were "permanently flooded" (36%) or "seasonally flooded" (21%).

**Our findings are not necessarily applicable to other localities, and may have declining relevance outside the southern Sierra Nevada.**

## Discussion

The discrepancies between NWI maps and our field investigations need to be considered within the context of where, when, and how they were measured. Our findings are not necessarily applicable to other localities, and may have declining relevance outside the southern Sierra Nevada.

Temporal change may have induced some errors. These NWI maps are based on aerial photography that was flown primarily in August 1985, 15 years before we initiated this assessment. Fires, floods, and succession could have caused some of the differences. Furthermore, our field crew had a distinct advantage over personnel

working from 1:58,000-scale aerial photography. The NWI investigators classified the sites on the basis of what taxonomic attributes were available to them on film, which were calibrated with some field investigations. Members of our field crew saw and measured features that probably were not visible on the photographs (fig. 6), particularly where canopy obscures the

sites. Some errors may reflect differences in the interpretation of definitions in Cowardin et al. (1979). However, inconsistencies should be minimal because the definitions are very explicit.

Although we found considerable discrepancies between the NWI maps and our field observations, I continue to find the NWI maps useful. For example, where wetlands were indicated, they typically existed, and the taxonomy was generally correct. The NWI maps provide a quick representation of the types and distribution of wetlands to be expected.



**Figure 6.** Investigators on the ground often observed far more complexity than was evident on the NWI map. Here a small Riverine unit (R3UB) flows through a wet meadow (PEM) after emerging from a stand of willows (PSS). This Riverine unit was not on the NWI map. NPS PHOTO

## Recommendations

1. Users of the NWI maps should trust that the wetlands and deep-water habitats shown probably exist. However, they should expect that the maps may have omitted nearly half as many additional wetlands.
2. Users should be suspicious of the accuracy of taxonomy on the maps. However, the Lacustrine sites are the most trustworthy.
3. For applications where accuracy is critical, such as planning of research or monitoring projects or preparing for Section 404 compliance of the Clean Water Act, on-site delineation or evaluation is essential. The maps should be used only as an indicator of what to expect.
4. Managers wishing more detailed information about this survey should see Werner (2003).

## Acknowledgments

Pat Lineback initiated this project and secured funding from the NPS Water Resources Division. Sylvia Haultain, Jennifer Akin, and Julia Evans provided field oversight and support for the crew. Elizabeth Van Mantgem, Allison Roll, Cheryl Bartlett, and various members of the vegetation mapping crew collected the data. Joel Wagner provided valuable suggestions for improving this manuscript.

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4. Avoid development near existing observatories, and apply rigid controls on outdoor lighting when development is unavoidable. —K. KellerLynn

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## REPORTS AVAILABLE ONLINE

Two new reports on recently completed inventories are posted on the Web site for the Northeast Region: "Comprehensive inventory of birds and mammals at Fort Necessity National Battlefield and Friendship Hill National Historic Site" and "Inventory of intertidal habitat: Boston Harbor Islands, a national park area." These can be viewed at and downloaded from <http://www.nps.gov/nero/science>. —B. Blumberg



# RANGE EXPANSION OF BARRED OWLS INTO REDWOOD NATIONAL AND STATE PARKS: MANAGEMENT IMPLICATIONS AND CONSEQUENCES FOR THREATENED NORTHERN SPOTTED OWLS

BY HOWARD SAKAI

The northern spotted owl (*Strix occidentalis caurina*) (fig. 1) is a federally listed threatened species that inhabits old-growth and mature second-growth forests. During surveys of known spotted owl territories in Redwood National and State Parks (California) investigators encountered barred owls (*Strix varia*) (fig. 2). Barred owls are known to displace and hybridize with spotted owls, which could have a negative impact on the genetic makeup of northern spotted owls as hybrids develop (Hamer et al. 1994). This article provides a brief synopsis of survey results within the parks and briefly discusses some management implications relative to these findings.

**Figure 1 (background photo).** The northern spotted owl is a federally listed threatened species that inhabits the old-growth and mature second-growth forests of Redwood National and State Parks.

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**Figure 2.** The generalist nature of barred owls in selecting habitats allows the species to populate a variety of forests and riparian areas.

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## Range expansion of barred owls

Historically, barred owls ranged from south-central Mexico north through the southern and eastern United States. Westerly range expansion occurred over the past several decades whereby barred owls became common in southwestern British Columbia, and western Washington and Oregon. Biologists from Olympic National Park (Gremel 2003, 2001) and Crater Lake National Park (M. Brock, chief of Resource Management Division, Crater Lake National Park, phone contact, October 2001) have documented barred owl encroachment into spotted owl territories.

The expansion of barred owls is probably a function of their generalist nature in using a variety of habitats in both disturbed and undisturbed conditions (Hamer 1988). Barred owls are known to successfully colonize a variety of forest and riparian habitats, including old-growth and mature forests that spotted owls also inhabit. The extensive amount of disturbed forests impacted by human activities such as logging throughout the Pacific Northwest probably facilitated their expansion.

Barred owls are slightly larger and known to be more aggressive than spotted owls, so the probability of competition with spotted owls and the likelihood that barred owls will displace spotted owls from their established territories are relatively high. Their aggressiveness may even lead to the predation of spotted owls. For example, in 1997 researchers noted an incident of a possible predation of a spotted owl by a barred owl within Redwood National and State Parks (Leskiw and Gutierrez 1998).

## Spotted owls surveyed

In fall 1993 we embarked upon a three-year federally funded project to survey and monitor northern spotted owl territories throughout the 106,000 acres (42,898 ha) of the parks. We divided the linear-shaped park complex into three zones (southern, central, and northern) to facilitate survey coverage of all suitable spotted owl habitats, which totaled 97,000 acres (39,000 ha). We initiated surveys in the southern portion of the park complex and expanded northward in 1994 and 1995.

Investigators located 36 northern spotted owl territories during the three-year survey and monitored each for occupancy, nesting status, and reproductive success. Each year since 1996 we continued monitoring all spotted owl territories during the spotted owl breeding season. In 2002 we switched our survey efforts to monitor 20 known functioning activity centers (defined as being occupied by one or more spotted owls within the previous three years) and inventoried a subset of the remaining 16 “inactive” centers. We inventoried inactive sites within a 1-mile (1.6-km) radius centered on the last-known (historical) spotted owl activity center location. The objective of resur-

veying inactive sites is to determine the current status of the original spotted owl occupants. Between 1993 and 1995 we banded many of the spotted owl adults and fledglings with colored leg bands. We discontinued this practice because of budget constraints and low frequency of re-sight information from banded birds.

## Observations

During the 11 years of spotted owl surveys, we detected barred owls, including five spotted owl–barred owl hybrids (three in 1995 and two in 1996). The barred owls responded audibly to spotted owl vocal lure surveys throughout most of the park complex (fig. 3, page 26). Detection of barred owls ranged from 2 to 42 observations between 1993 and 2003 (fig. 4, page 26). The 42 barred-owl detections in 1995 may reflect expanded survey efforts in the northernmost portion of the park complex where barred owls may occur in highest densities (fig. 3). Alternatively, this result could be attributed to repetitive counts of barred owl individuals or pairs. To date, we have detected barred owls at an estimated 32 independent sites that include 17 spotted owl territories within Redwood National and State Parks (Schmidt 2004). Barred owl sites are locations where at least one barred owl has been detected at least once and are 1 mile (1.6 km) or more away from another such site. This distance is comparable to the average radius of the home range of barred owls in Washington (Hamer 1988, Kelly 2001).

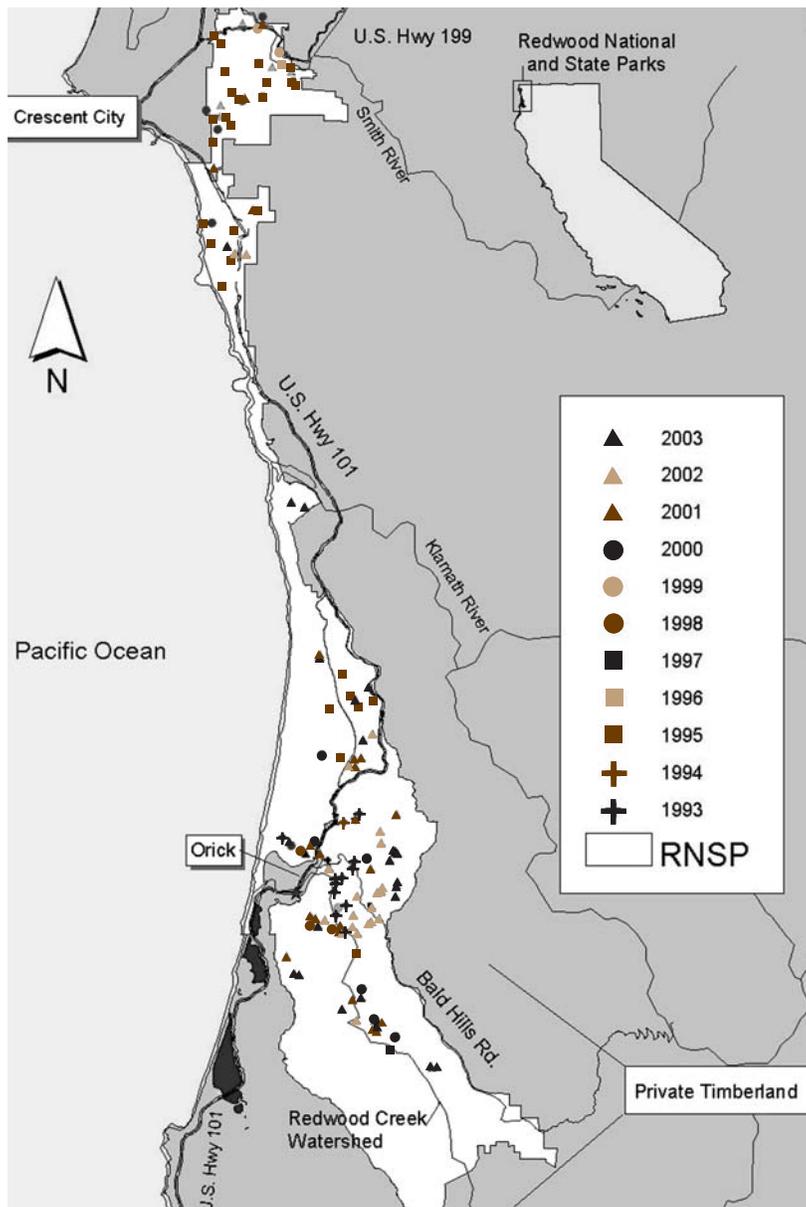
At Redwood National and State Parks what was perceived to be displacement of a known spotted owl territorial pair by barred owls may not be as clear as originally noted. In 1993 we found the South Fork Little Lostman Creek spotted owl pair. Barred owls immigrated into the spotted owl territory in 1996, and both species coexisted there until 1999 when the spotted owl pair vacated their historical nest site. Since 1999 this historical spotted owl activity center has been either vacant or occupied by barred owls. In 2002 two spotted owls of opposite sex were detected about a mile (1.6 km) from the known historical spotted owl site, which was occupied by a pair of barred owls (Schmidt 2003). A single male spotted owl was detected there in 2003 but no barred owls.

Resurveying 8 of 18 known inactive spotted owl territories in 2003 resulted in one spotted owl pair detection within 1 mile (1.6 km) of their historical nest site (Schmidt 2004).

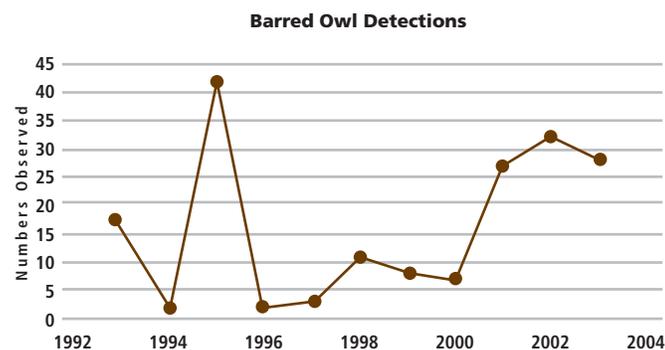
## Is range expansion of barred owls natural dispersal?

Within the scientific community, different views persist regarding the possible causes of barred owl range expansion in the Pacific Northwest, from increased forest frag-





**Figure 3.** Investigators encountered barred owls at the locations depicted on the map during the surveys of known spotted owl territories (1993–2003). Barred owls are now distributed throughout most of the park complex except in the southeastern portion of the Redwood Creek watershed.



**Figure 4.** Detection of barred owls during the 11-year monitoring program ranged from 2 to 42 observations.

mentation (i.e., disturbed forests) (Johnson 1992; Hamer 1988; R. J. Gutierrez, Professor, University of Minnesota, phone call, November 2001) to other anthropogenic influences (e.g., establishment of riparian forests or planting trees) (Knopf 1994). Some scientists view barred owl range expansion as a natural event based on the species, expansion into a variety of habitats, not just old-growth and mature, undisturbed forests (Hamer 1988; Dunbar et al. 1991; Johnson 1994; Kelly et al. 2003). These different views highlight the complexity of and the need for additional research on the species' life history (including distribution), ecology, and habitat requirements.

### Consequences of barred owl expansion

The lack of baseline information about barred owls has managers at Redwood National and State Parks in a quandary as to the appropriate action to take regarding potential adverse impacts that barred owls may have on spotted owls. Park managers have discussed their concerns with U.S. Fish and Wildlife Service (USFWS) regulatory staff in Arcata and researchers (Eric Forsman, research wildlife biologist, USDA Forest Service Pacific Northwest Research Station, October 2001; R. J. Gutierrez, Professor, University of Minnesota; and A. Franklin, Research Associate, Colorado Cooperative Fish and Wildlife Research Unit, phone contacts, November 2001) regarding barred owl range expansion, displacement of spotted owls, and whether anything can or should be done to manage for this invasive species. Although *NPS Management Policies 2001* and guidelines for natural resources of threatened and endangered species (NPS-77) provide the possible foundation for action, park managers must decide whether to endorse and pursue such an endeavor. Without credible, science-based information on barred owls, managers at Redwood National and State

Parks and other agencies with spotted owls do not have the knowledge to fully address this issue or make effective decisions relating to the conservation and recovery of spotted owls.

Researchers and USFWS staffs are aware of this issue but make no recommendation except that more research on barred owls is needed. Whether barred owls are indeed impacting spotted owls (e.g., reducing reproductive success and suitable habitat) or whether anything can be done to reverse the situation is unknown and needs addressing. In the meantime, the ongoing USFWS five-year review petition for spotted owls may give some direction or useful information for managers. The pur-

pose of the five-year review, as required for all listed species under the Endangered Species Act, is to determine if a change in listing status is warranted. The evaluation will use all existing and current information to make an assessment of how the spotted owls have fared since they were listed for protection in the early 1990s.

## Implications and recommendations

The question managers may want to ask is whether prevention of barred owl expansion into spotted owl territory or intervention into already established barred owl territory is warranted in order to maintain viable populations of northern spotted owls. A significant factor in the decision of whether to intervene and control the further expansion of barred owls into Redwood National and State Parks may be that barred owls are already quite common throughout most of the park complex. Of interest to park management is whether the progression of barred owls into the southern portion of the park will continue eastward through old-growth forested parklands within the Redwood Creek drainage and eventually into adjacent managed private timberlands (fig. 3) where currently only two barred owls have been reported (Schmidt 2003).

Restoration goals of the National Park Service usually focus on restoring ecosystem processes rather than managing a specific (single) species. However, the federally listed northern spotted owl is an important component of Redwood National and State Parks' old-growth redwood forest ecosystem and, therefore, is a consideration in management decisions. Another factor is the feasibility and practicality of any planned action, which may be controlling or eradicating an invasive species or sterilizing a target species, in this case barred owls. In addition, the participation, cooperation, and support of other agencies and landowners throughout the range of the northern spotted owl are factors in the success of any management endeavor, as barred owl range expansion is a regional issue in the Pacific Northwest.

If park managers decide to pursue an invasive control or eradication program, objectives of the program should include public education as a means of addressing the potentially controversial nature of the decision. Public education presentations and materials should anticipate potentially negative public attitudes with clear objectives and scientific evidence.

Managers may also want to consider whether (1) the chosen action is cost-effective because costs could be in the hundreds of thousands of dollars or more, (2) participating agencies and landowners are willing to commit to a long-term program, and (3) sufficient biological knowledge is available on the target species (i.e., barred owls).

The sterilization of barred owls currently is not a viable technique and is still experimental for birds, especially

raptors (K. Fagerstone, research program manager, USDA Animal and Plant Health Inspection Service, phone call, November 2003). A major concern with this type of program is choosing an effective mode of delivering the sterilizing agent to the target species (e.g., injecting it into a food source or into a captive target species) without affecting any non-target species (e.g., the spotted owl). Unfortunately, unlike spotted owls, barred owls are not caught easily as they do not respond well to proven spotted owl techniques used to lure them into mist nets and entice them to retrieve handheld mice as bait and be captured by hand (A. Franklin, research associate, Colorado Cooperative Fish and Wildlife Research Unit, phone call, November 2001; E. Forsman, research wildlife biologist, USDA Forest Service Pacific Northwest Research Station, phone call, October 2001). Therefore, barred owls may not be good candidates for injection unless capture of the species becomes more reliable.

My overall assessment of the current knowledge of barred owls and the practicality and potential cost of implementing and maintaining an invasive species program is that such programs presently are unrealistic and infeasible. However, in the near future, sterilization of barred owls may prove to be viable. Until that time, I recommend that park managers:

- Continue to seek assistance from subject-area experts and the U.S. Fish and Wildlife Service to address this issue.
- Obtain funds to conduct a regional inventory and research on barred owls within the parks and on other public lands.
- Enlist interagency and public cooperation to address the potential threat of barred owls to spotted owls across their range, including support to develop public education programs and materials with clear scientific evidence on this issue.
- Continue discussion with the U.S. Fish and Wildlife Service on the potential impact of luring barred owls into spotted owl territories using their recommended spotted owl survey protocol. Discussions could lead to changes in the protocol that may lessen encounters with barred owls within spotted owl territories.

## Conclusions

Distribution of barred owls, occurrence of hybridization with spotted owls, and potential displacement of spotted owls from known territories within Redwood National and State Parks indicate a potential threat that could change diversity of species, including the northern spotted owl—a federally listed threatened species—within the parks' old-growth forest ecosystem. Although observations of barred owls were made incidental to monitoring

*Continued in right column on page 50*



The 46,000-acre (18,630-ha) Timucuan Ecological and Historic Preserve (the preserve) in Duvall County, Florida, was authorized as a National Park System unit in 1988. Unlike typical National Park System units, much of the lands within its boundaries are public lands (state and city parks) or private lands (more than 300 private and corporate owners). The multiple ownership of the preserve requires a management approach that relies greatly on outreach and partnerships, including the management of birds.

Consisting primarily of estuarine ecosystems such as salt, fresh, and brackish waters; marshes; coastal dunes; maritime shrub/scrub; and maritime hammocks, the preserve provides habitat to a diverse array of organisms, including resident and migratory birds (figs. 1 and 2). Birds comprise a major segment of the vertebrate fauna of the biologically diverse preserve, interact at many levels with the estuarine ecosystems, and influence many ongoing resource management activities. The preserve is within the southern breeding limit of many northern bird species and offers habitat for wintering and migrating birds. It also provides refuge for many birds that are increasingly threatened by land development, recreational activities along coastal areas, and other factors.

Preliminary inventory and monitoring projects have been initiated to manage birds and their habitats. (Eakes 1996, Tardona et al. 1997, Tardona et al. 1999). The monitoring of bird species has important implications for the preserve and broadly aids in data collection on migratory species for other agencies and bird observatories. In addition to the benefit gained from the data gathered, the involvement of preserve partners from regional and local communities strengthens and expands support for the preserve's goals.

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# Monitoring painted buntings in the Timucuan Ecological and Historic Preserve:

## p r e l i m i n a r y r e s u l t s

By Daniel R. Tardona

### Painted buntings (*Passerina ciris*)

The Timucuan Preserve contains important habitats for breeding and migratory birds, including painted buntings (*Passerina ciris*, fig. 3). The eastern population's breeding habitat consists of scrub communities and the edges of maritime hammocks adjacent to salt marshes. John James Audubon called this bird "nonpareil" because he viewed it as having no equal. Male painted buntings have a beautiful, tropical-looking, multicolored plumage; female plumage is less multicolored but nonetheless a striking two-tone green. This bunting species is an important bird to monitor in the preserve because some birders visit just to observe this bird. Because it is conspicuous in the pre-



Figures 1 (left) and 2 (above). Timucuan Ecological and Historic Preserve is a vast expanse of salt marsh grasses and waterways, and quiet wooded islands.



Figure 3. Male painted bunting (*Passerina ciris*).

serve, the painted bunting is “showcased” during public educational and interpretive programs focused on the importance of preserve lands for migratory bird species. Nevertheless, this species is listed by Partners in Flight as a species of special concern (Sykes personal communication with author, August 2002; Kaufman 1996) and has been declining at about 4% annually since 1966 based upon breeding bird survey data (Hunter et al. 1993a, Sauer et al. 1997). The cause or causes of this decline are not known but may be associated with fragmentation of eastern forest habitat into isolated patches (Robbins et al. 1989); loss or significant alteration of optimum breeding habitat (Askins et al. 1990, Askins 1993); brood parasitism by the brown-headed cowbird (*Molothrus ater*) (Brittingham and Temple 1983, Trail and Baptista 1993);

predation by domestic cats, snakes, or rodents; problems on wintering grounds (cage bird trade in Cuba and possibly southern Florida); or other undetermined causes. The survival rate of the southeastern coastal population of the painted bunting is currently unknown. The habitat needs of the painted bunting along with other animals need to be considered when making natural and cultural resource decisions in the preserve.

## Methods

A six-year study of the southeastern population of the painted bunting extending from near Camp Lejeune, North Carolina, along the immediate coast to the St. Johns River in northern Florida is currently in its fifth



year. The principal investigator is Paul W. Sykes, Jr., of the U.S. Geological Survey, Patuxent Wildlife Research Center, in Maryland. The object of this study is to determine annual survival by age and sex using trapping/retrapping and sightings of banded painted buntings throughout the Atlantic coast breeding range. The preserve participates by providing four study sites with two baiting stations at each site (a total of eight feeding stations). Two baiting stations are south of the St. Johns River, one at Ft. Caroline National Memorial and one at the Ribault Monument (fig. 4). All sites were located in prime painted bunting habitat at the interface of salt marsh and maritime hammock forest. Six other baiting stations are north of the St. Johns River—two at Little Talbot Island (part of the Little Talbot Islands State Parks but within the preserve), two on Fort George Island near the grounds of the Kingsley Plantation, and two at Cedar Point. These sites were chosen based upon likelihood of painted bunting presence (prime habitat) and accessibility, and because they were on public lands, thereby better protected and less likely to be disturbed. The bait stations were filled and maintained by preserve staff just before the start of the bunting breeding season each year. The bait stations were removed at the end of each breeding season.

Mist nets are erected surrounding the baiting stations and monitored at each site for half a day. During the breeding season of each year the preserve study sites are systematically sampled in coordination with all the sites along the southeast Atlantic coastal breeding range. Buntings captured in the mist nets are quickly leg-banded with unique color band combinations. Birds are released at the net sites after banding, and age and sex data are recorded. (For more details on the broader project and methods see Sykes, Kendall, and Meyers 2002). Annual survival rates are calculated based on recaptures the following year and on resightings.

## Preliminary results and discussion

Preliminary results of this study show a decreasing trend in captures of painted buntings in the preserve for the past four years. Table 1 shows data for each study area for the years 1999 through 2003. Figure 5 depicts the total counts of individual captured birds in the preserve by year, as well.

The total set of information collected will be essential in determining the demographics for the species in the southeastern United States. These data suggest an apparent decline of the painted bunting population in the preserve and greater region. This information complements other data being collected on reproductive success and

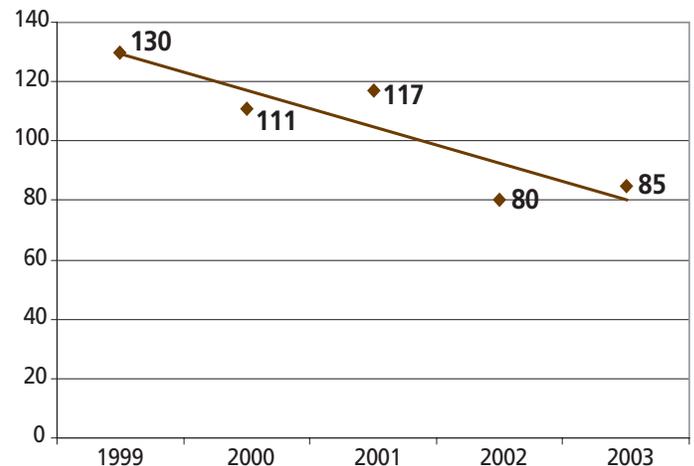


**Figure 4. Bait station located at the edge of a maritime hammock woods and marshland near grounds of Fort Caroline exhibit.**

NPS PHOTO BY DAN TARDONA

**Table 1. Numbers of captured painted buntings in the preserve by year and study area**

Year	Study Areas				Total
	Fort Caroline/ Ribault Monument	Little Talbot Island	Fort George Island	Cedar Point	
1999	4	59	49	18	130
2000	14	49	40	8	111
2001	7	65	27	18	117
2002	3	42	14	21	80
2003	11	25	19	30	85
Total	39	240	149	95	523



**Figure 5. Counts of captured painted buntings in the preserve by year.**

the characteristics of local habitat conditions. All of these data potentially offer clues that facilitate the maintenance of viable populations and assist land managers in making land use and other resource-related decisions. Data gathered by this research will provide opportunities for resource interpreters and educators to provide the public with information about painted buntings and other birds, their habitat, and the threats to their survival. Such education is an important resource management tool.

## Conclusion

Habitats for the painted bunting must be maintained in the preserve because rapid development outside the boundaries is causing habitat to be degraded or lost completely. Data collected from the research project, though preliminary, can be easily and clearly used in public educational programs as well as for management planning and with preserve partners. The monitoring of the painted bunting will continue in the preserve, and data collected may be important to consider in various future preserve management decisions, such as setting priorities for exotic species removal, feral cat control, and other land use decisions. For example, one of the cultural resource areas of the preserve is the Kingsley Plantation on Fort George Island. The Kingsley Family structures and 26 tabby cabins that were the homes of enslaved Africans who worked the plantation are a significant cultural resource. Much of the island was cleared for planting cash crops during the plantation period, but has since been reclaimed by nature. When preserve managers develop a cultural landscape plan, natural habitat, including bunting habitat, may be an important consideration in deciding the extent of landscape change, if any, to some portion of land between the Kingsley Family structures and the slave cabins. Any thinning or clearing of the landscape, if deemed appropriate to approximate the historic landscape, might require sacrificing some painted bunting habitat. Considering the apparent declining population of buntings and the unclear reasons for their decline, how much of an impact, if any, would a landscape restoration have upon bunting habitat and overall population? Weighing and balancing natural and cultural resource values is typically a complicated and difficult task. More data allows for more informed resource management decisions. The preserve's participation in research as outlined in this article is an important contribution to both local and regional resource management planning and public education.

## Acknowledgment

I thank Paul W. Sykes, Jr., for permission to use some of his preliminary findings from his research on the painted bunting in the preserve.

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# Capulin Volcano National Monument

## inventory reveals insect range extensions

By Robert R. Parmenter

**C**apulin Volcano National Monument in northeastern New Mexico is a 59,000-year-old volcanic cinder cone that rises 1,148 feet (350 m) above the grasslands of the western Great Plains (Sayre et al. 1995). During 1996 and 1997, biologists from the University of New Mexico's Department of Biology conducted a field survey of the monument. This was a search for listed and category (now called candidate) species of plants, mammals, birds, reptiles, amphibians, and invertebrates (Parmenter et al. 2000). The survey was funded in 1995 by ONPS (Operation of the National Park Service) for \$12,372.

The team made visual observations and systematic surveys, conducted livetrapping exercises, and collected arthropods in the spring, summer, and autumn. Based on the results of the field research, they found no listed or category species of plants, vertebrates, or invertebrates residing on the monument. These results were primarily because of (1) the soil types found on the monument (basaltic soils with cinder gravels), which have not been found to support any listed or category plant species in this part of New Mexico; (2) the limited availability of substantial cliff faces for nesting raptors; (3) the lack of natural freshwater sources (springs, streams, ponds); and (4) the relatively small size of the monument. However, different habitats (high cliff formations and limestone



**Figure 1. The Capulin Volcano National Monument, a volcanic cinder cone, rises above the grasslands of the western Great Plains.** ROBERT R. PARMENTER

outcrops) exist to the west of the monument on private lands, and these may support such listed species as peregrine falcons, and perhaps some listed plants that would normally inhabit limestone outcrops. Whether associated with neighboring lands or not, certain wideranging animal species (notably raptors) occasionally pass through the monument during migration or while foraging.

In the case of invertebrates, while no currently listed or category species were observed, investigators noted some range extensions and a rarely observed subspecies of butterfly. The field sampling included the use of pitfall traps, sweep-netting, and hand collecting in the three main habitat types found in the monument: grassland, pinyon-juniper woodland, and cinder cone/lava escarpments.

Beetles, grasshoppers, and crickets comprised the most commonly sampled arthropods at Capulin Volcano National Monument. Thus far, 48 species of beetles,

44 species of grasshoppers, and 8 species of crickets from the monument have been identified by Richard Fagerlund, an entomologist at the University of New Mexico. Although they were not collected in abundance, four of the beetle species are new records for New Mexico, and their known ranges suggest that the region of Capulin Volcano National Monument may be a transitional area for a variety of arthropod taxa. For example, the soldier beetle, *Belotus abdominalis* LeConte (Cantharidae), was known to occur in Texas; its appearance on

**Four of the beetle species are new records for New Mexico, and their known ranges suggest that the region of Capulin Volcano National Monument may be a transitional area for a variety of arthropod taxa.**



**Figure 2. Inventory scientist Dave Lightfoot and an assistant of the University of New Mexico install a pitfall trap on the volcano slope.**

ROBERT R. PARMENTER

the monument represents a range extension of 250 miles (432 km) to the northwest. Similarly, the presence of the hide beetle, *Trox foveicollis* Harold (Trogidae), represents a range extension westward from Arkansas. In contrast, the new record of the ladybird beetle, *Hyperaspis quadrivittata* LeConte (Coccinellidae), indicates a southern range extension from Wyoming, while the presence of the minute fungus beetle, *Sericoderus lateralis* (Gyllenhal) (Corylophidae), represents a southeasterly range extension from the Pacific Northwest. None of the grasshoppers or crickets represented new state records or unusual occurrences for the region. The four new state records for beetles were not surprising because few surveys for arthropods have been conducted in this part of the state. These findings suggest that there may also be undescribed species of arthropods in the Capulin Volcano region and at Capulin Volcano National Monument.

Based on known distribution, the only known invertebrate that may be considered regionally rare at the park is the Capulin subspecies of the Alberta Arctic butterfly (*Oeneis alberta capulinensis* Brown). This butterfly is known only from the crater rim of Capulin Volcano National Monument, along with two other areas in northeastern New Mexico and one other location in southern Colorado (New Mexico State Parks Division, S. Cary, personal communication, 9 July 2002). However, the subspecies is neither state nor federally listed, nor is it a category species. Investigators observed several individuals of this butterfly during each spring and early summer field trip to the north rim of the crater. Consequently, even though this butterfly can be considered rare in the region, it appears to be common in the park.

The larvae of this butterfly species are known to feed on grasses, particularly bunch grasses in the genus *Festuca*. The host plant of the Capulin subspecies is not known, but it is probably a native species of bunch grass such as Arizona fescue (*Festuca arizonica*), or *Poa* sp. The butterfly species occurs as local populations on isolated mountains in the southern Rocky Mountains region. The limited distribution of the Capulin Alberta Arctic may mean that it is genetically distinct from other populations. Future research may determine that the Capulin Alberta Arctic butterfly is a genetically significant population of a species with a wider geographic distribution. Consequently, park management could make monitoring this butterfly a high priority in order to facilitate the protection of this subspecies. At the time of the study, the grass habitats on the Capulin volcano appeared to be well preserved and protected from human impacts.

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# Enhanced wetlands mapping and inventory in Point Reyes National Seashore and Golden Gate National Recreation Area

By Dave Schirokauer and Amy Parrauano



Examples of various wetlands at Point Reyes National Seashore: (left) Drake's Estero at low tide; (middle) wetlands mappers Scott Willis and Laura Castellini conducting field work in a cattail (*Typha latifolia*) marsh; and (right) Tomales Bay mudflats at low tide.

California has lost a greater proportion (more than 90%) of its original wetland area than any other state, and much of the remaining acreage is degraded (Dahl 1990). Point Reyes National Seashore, California, was established “to save and preserve, for the purpose of public recreation, benefit and inspiration, a portion of the diminishing seashore of the United States that remains undeveloped.” The seashore protects a range of wetland habitat types including salt, brackish, and freshwater marshes; riparian wetlands; wet meadows; and seasonal ponds. The seashore has high quality, diverse wetlands, which are particularly rare in coastal California. Wetlands are extremely important resources to the seashore, and to meet the enabling legislation and other legal requirements, wetlands must be preserved, protected, and restored where practicable.

**Past land-use practices have degraded many of the wetlands.**

The wetlands in Point Reyes National Seashore and Golden Gate National Recreation Area (the parks) are designated critical habitat for the federally threatened red-legged frog (*Rana aurora draytonii*) and support several federal and state-listed plant, vertebrate, and invertebrate species (table 1). These wetlands also provide critical wintering grounds for tens of thousands of migratory waterbirds and shorebirds along the Pacific flyway.

Currently, hazardous material spills, failing septic systems, mariculture (cultivation of marine organisms), beef and dairy operations, and construction and maintenance of facilities threaten the parks' wetlands. Past land-use practices have degraded many of the wetlands. Without adequate reference information on the location, extent, and type of wetlands, managers cannot evaluate and prevent wetland degradation or loss, or design and prioritize restoration prescriptions. Therefore, beginning in 2000, we began a mapping and inventory project to acquire accurate and current information on our wetland resources to help guide management decisions and to serve as reference data for future monitoring and research. The map and inventory resulting from this project also will facilitate compliance with Section 404 of the Clean Water Act, the Coastal Zone Management Act, the NPS Organic Act, the National Environmental Policy Act, and the NPS Director's Order #77-1 (the policy directive addressing wetland protection in the National Park System).

## Methods

We divided the project into two phases. Phase one included: (1) assessing the accuracy of data gathered during the U.S. Fish and Wildlife Service's National Wetlands Inventory (NWI), specifically looking for areas that are wetlands but were not detected during NWI (errors of omission) (USFWS 1991) and (2) testing the applicability of using the parks' draft vegetation map (Environmental Systems Research Institute 2000) to detect wetlands throughout Point Reyes National Seashore (about 71,000 acres; 28,734 ha) and the north district of Golden Gate National Recreation Area (about 15,000 acres; 6,071 ha).

In phase two we conducted detailed mapping and an inventory to accurately delineate, describe, and classify

wetlands in the Abbotts Lagoon watershed (about 4,000 acres; 1,619 ha) (fig. 1, page 36). We also collected data on wetland function and threats during phase two. Later, after completing phase two, we used the detailed map of the Abbotts Lagoon watershed as a point of reference for comparing and evaluating NWI data and the parks' draft vegetation map.

### Phase one

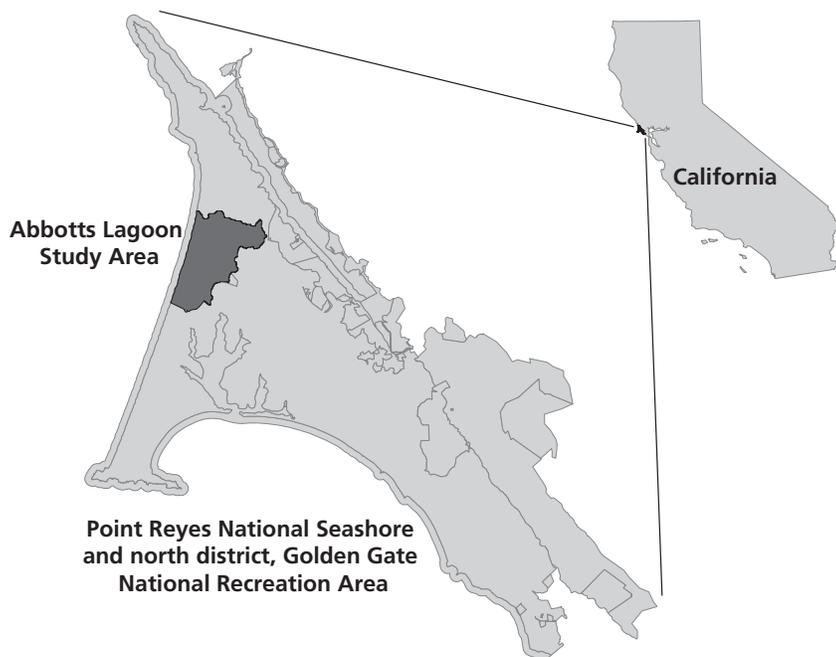
The parks' draft vegetation map and data from NWI maps served as the foundation in choosing sampling locations for the wetland inventory during phase one. The U.S. Fish and Wildlife Service created the NWI digital maps (1:24,000) using photo-interpretation of color

**Table 1. Rare wetland plant and animal species at Point Reyes National Seashore and the North District of Golden Gate National Recreation Area**

Common name	Scientific name	Status	Presence
<b>Invertebrate</b>			
Myrtle's silverspot	<i>Speyeria zerene myrtleae</i>	E	Permanent
California freshwater shrimp	<i>Syncaris pacifica</i>	E	Permanent
<b>Fish</b>			
Tidewater goby	<i>Eucyclogobius newberryi</i>	E	Permanent
Coho salmon	<i>Oncorhynchus kisutch</i>	T	Seasonal
Central California steelhead	<i>Oncorhynchus mykiss</i>	T	Seasonal
<b>Amphibian/reptile</b>			
California red-legged frog	<i>Rana aurora draytonii</i>	T	Permanent
<b>Bird</b>			
California clapper rail	<i>Rallus longirostris obsoletus</i>	E	Seasonal
Brown pelican	<i>Pelecanus occidentalis californicus</i>	T	Seasonal
Western snowy plover	<i>Charadrius alexandrinus nivosus</i>	T	Permanent
<b>Mammal</b>			
Point Reyes jumping mouse	<i>Zapus trinotatus orarius</i>	State SOC	Permanent
Salt marsh harvest mouse	<i>Reithrodontomys raviventris</i>	T	Permanent
Pacific harbor seal	<i>Phoca vitulina richardii</i>	MMPA	Permanent
<b>Plant</b>			
Sonoma Alopecurus	<i>Alopecurus aequalis</i> var. <i>sonomensis</i>	E	Permanent
Sonoma spineflower	<i>Chorizanthe valida</i>	E	Permanent
Robust spineflower	<i>Chorizanthe robusta</i>	E	Permanent
Marsh milkvetch	<i>Astragalus pycnostachyus</i> var. <i>pycnostachyus</i>	State-1B	Permanent
Swamp hairbell	<i>Campanula californica</i>	State-1B	Permanent
Point Reyes bird beak	<i>Cordylanthus maritimus</i> ssp. <i>palustris</i>	State-1B	Permanent
San Francisco gum plant	<i>Grindelia hirsutula</i> var. <i>maritima</i>	State-1B	Permanent
Gairdner's yampah	<i>Perideridia gairdneri</i> ssp. <i>gairdneri</i>	State-4	Permanent
Marin knotweed	<i>Polygonum marinense</i>	State-3	Permanent
Point Reyes checkerbloom	<i>Sidalcea calycosa</i> ssp. <i>rhizomata</i>	State-1B	Permanent

Note: T = federally listed as threatened; E = federally listed as endangered; State 1B = rare, threatened, or endangered in California and elsewhere; State 3 = more information about this plant is needed (Review List); State 4 = limited distribution (Watch List); State SOC = species of concern; MMPA = Marine Mammal Protection Act.





**Figure 1.** The study area at Point Reyes National Seashore and north district of Golden Gate National Recreation Area.

infrared aerial photography (1:56,000) flown in April 1984. They did not field-verify any of the data. Environmental Systems Research Institute (ESRI) under contract with Point Reyes National Seashore created the draft vegetation map interpreted from true-color aerial photographs (1:24,000), which delineates 79 plant communities. Along with the draft vegetation map, they provided a plant community classification and key, based on an ordination analysis of 366 highly detailed vegetation plots. Using the wetland indicator status of dominant plants (Reed 1996), we considered as highly likely to contain wetlands: nine freshwater, brackish, or saltwater communities; four willow communities; and one alder plant community (Sawyer and Keeler-Wolf 1995) (table 2).

**Table 2.** Plant communities with high and moderate potential to occur in wetlands

Map code	Alliance or association	Typical plant species in alliance or association	Wetland indicator status of dominants
7060	Willow super alliance**	<i>Salix ludica</i> , <i>S. lasiolepis</i> , <i>S. leavigata</i>	OBL-FACW
7070	Red alder**	<i>Alnus rubra</i>	FACW
7071	Red alder/salmonberry/red elderberry**	<i>Rubus spectabilis</i> , <i>Sambucus racemosa</i>	FACW-FAC
7072	Red alder/arroyo willow**	<i>Alnus rubra</i> , <i>S. lasiolepis</i>	FACW
24063	Coyotebrush/sedge/rush**	<i>Baccharis pilularis</i> , <i>Carex</i> sp., <i>Juncus</i> sp.	FACW-UPL
32080	Arroyo willow**	<i>Salix lasiolepis</i>	FACW
46022	Pacific reedgrass/sedge/rush**	<i>Calamagrostis nutkaensis</i> , <i>Carex</i> sp., <i>Juncus</i> sp.	OBL-FACW
51010	Saltgrass**	<i>Distichlis spicata</i>	FACW
52030	Rush/sedge/bulrush**	<i>Juncus</i> sp., <i>Carex</i> sp., <i>Scirpus</i> sp.	OBL-FAC
55020	Bulrush/cattail**	<i>Scirpus</i> sp., <i>Typha</i> sp.	OBL-FACW
56010	Cordgrass**	<i>Spartina foliosa</i>	OBL-FACW
64030	Pickleweed**	<i>Salicornia virginica</i>	OBL
64032	Pickleweed/saltgrass/Jaumea**	<i>Salicornia virginica</i> , <i>Distichlis spicata</i> , <i>Jaumea carnosa</i>	OBL-FACW
64031	Pickleweed/arrowgrass**	<i>Salicornia virginica</i> , <i>Triglochin</i> sp.	OBL
1012	California bay/sword fern*	<i>Umbellularia californica</i> , <i>Polystichum munitum</i>	FAC-FACU
20010	California wax myrtle*	<i>Myrica californica</i>	FAC+
30050	Salmonberry*	<i>Rubus spectabilis</i>	FAC+
47030	Introduced perennial grassland*	<i>Holcus lanatus</i> , <i>Lolium perenne</i> , <i>Festuca arundinacea</i>	FAC-UPL
52040	Tufted hairgrass*	<i>Deschampsia caespitosa</i>	FACW

Notes: Wetland indicator status follows Reed (1996).

\*\* indicates high potential.

\* indicates moderate potential.

OBL = obligate, always found in wetlands (>99 percent of the time).

FACW = facultative wetland, usually found in wetlands (67–99% of the time).

FAC = facultative, equal in wetlands or non-wetlands (34–66% of the time).

FAC+ = subcategory of facultative, equal in wetlands or non-wetlands (50–66% of the time).

FACU = facultative upland, usually found in non-wetlands (1–33% of the time).

UPL/NI = upland/no indicator, not found in local wetlands (<1% of the time).

We also used data from soil surveys of Marin County (Kashiwagi 1985, U.S. Department of Agriculture 1992). The portion of the digital soil surveys that occurs in the study area did not contain any hydric (characterized by an abundance of moisture) soils, but did contain some soils that were known to have small unmapped inclusions of persistently moist soils. We included the five plant communities with a moderate potential to support wetlands (see table 2) only when they occurred over soils described as containing hydric inclusions.

Staff at Point Reyes National Seashore assessed the draft vegetation map for accuracy. Although significant errors exist in the parks' draft vegetation map, with respect to the wetland plant communities, the vast majority of the errors are confusion with other wetland types (table 3). Therefore, even though the vegetation mappers mislabeled many of the plant communities, when considering wetland plant communities as a whole, the parks' draft vegetation map is quite accurate. This feature makes our vegetation map highly suitable for locating areas likely to contain NWI wetlands.

**Table 3. Accuracy of wetland plant communities in the draft vegetation map**

Plant community type	% correctly classified at the plant community level	% correctly classified as a wetland
Upland	90	NA
Cold wet forest form	0	100
Willow super alliance	23	93
Red alder alliance	76	96
Coyote brush sedge	58	75
Arroyo willow alliance	65	87
Pacific reedgrass-sedge	71	90
Intro perennial grassland	33	65
Saltgrass alliance	43	100
Rush superalliance	35	81
Tufted hairgrass alliance	25	25
Saturated grass form	0	100
Bullrush alliance	50	90
Cordgrass alliance	50	100
Saturated forb form	0	100
Pickleweed alliance	57	100

Based on the wetland plant communities (table 2) and soil data, we selected a total of 1,084 individual land-cover polygons within the study area from the draft vegetation map. Because a primary objective of this phase of the project was to identify wetlands potentially missed in the NWI effort, we included all polygons representing wetland plant communities from the draft vegetation map that did not have overlapping boundaries with NWI polygons. This selection of polygons yielded a total of 484 locations as potential errors of omission in the NWI data.

Field crews visited 210 of these localities. We used the existing boundaries of the polygons on the vegetation map as the assessment area for wetland determination and classification. Field crews applied the same criteria during phase two to determine whether the polygons contained wetlands.

### **Phase two**

The polygons selected during phase one identified potential locations within the Abbots Lagoon watershed to initiate the detailed mapping and inventory in phase two. We performed a wetland assessment at each of 259 sites to make an initial wetland determination, identify and map wetland boundaries, classify the wetland type using Cowardin et al. (1979), collect vegetation composition and cover data, and assess wetland function.

To determine whether a site is a wetland, as defined by Cowardin et al. (1979), one of the following criteria must be present: (1) the land supports more than 50% cover of hydrophytic (living in water-logged conditions) plant species (as listed in Reed 1996) at least periodically during the growing season, (2) the substrate is predominately undrained hydric soil, or (3) the substrate is a non-soil and is annually saturated with water or covered by shallow water at some time during the growing season. We collected and evaluated hydrophytic vegetation (criterion 1) and hydrology data (criterion 3) in making this determination. We evaluated hydric soil (criterion 2) if uncertainty existed in the other two criteria.

The hierarchical structure of the classification system we used is composed of three levels: system, subsystem, and class (Cowardin et al. 1979; see also table 1, page 20). The systems are subdivided into five subsystems: marine, estuarine, riverine, lacustrine (e.g., lakes and ponds), and palustrine (e.g., marshes and wet meadows). Dominant plant life-form and composition of the substrate determine the class. Water regime modifiers describe specific hydrologic conditions that affect the periodicity and duration of inundation. Special modifiers describe wetlands that have been created or highly modified by human activities. This includes wetlands that are diked or impounded, excavated, farmed, drained or ditched, grazed by cattle, filled with artificial substrate, or dammed by beavers.

Classifying systems, subsystems, and classes is straightforward and precise. However, the extent and duration of saturation or inundation (water regime modifier) was often difficult to determine during drier summer months. To determine whether hydrology sources are perennial,



seasonal, or ephemeral often required a second field visit to verify the water regime designation immediately following winter rains.

The criteria for wetland polygon boundary delineation were determined by changes at any level in the Cowardin classification. Wetland boundary mapping was performed mainly by on-screen digitizing, using multispectral high-resolution (11-ft<sup>2</sup>, 1-m<sup>2</sup>) ortho-imagery acquired in October 2001, and 10-ft (3-m) contour data derived from 3.2-ft<sup>2</sup> (0.3-m<sup>2</sup>) ortho-imagery. We used GPS receivers to map wetland boundaries when they were not easily discerned on the imagery. The minimum field-mapping unit (MMU) was 0.24 acres (100 m<sup>2</sup>). We reduced the MMU to 0.002 acres (9 m<sup>2</sup>) for wetlands in coastal dune swales to support an ongoing dune restoration project. We documented seeps and springs, which fell below the MMU, as “point features” because they are often main water sources for wetland systems and provide pertinent wetland classification information.

We digitized wetland line and polygon shape files using ArcView GIS 3.2 software. We converted shape files into coverages and edited using ArcInfo software. Our GIS data and the associated metadata record are available at [www.nps.gov/gis/park\\_gisdata/california/pore.htm](http://www.nps.gov/gis/park_gisdata/california/pore.htm).

## Results and discussion

### Phase one

We found 146 locations (70%) of the sampled polygons to support wetlands (table 4). We classified 80% of the polygons as palustrine systems (117 polygons) and 20% as estuarine systems (29 polygons). We found no marine, riverine, or lacustrine systems. Of the three wetland criteria, the first one (“at least periodically the land supports predominantly hydrophytes”) was met most often.

**Table 4. Sampled sites found to support wetlands in each alliance or association**

Alliance or association	# polygons sampled	Indicator status	Indicator category	% wetlands
Cordgrass alliance	2	OBL	1	100
Pickleweed alliance	15	OBL	1	100
Slough sedge alliance	9	OBL	1	100
Arroyo willow association	8	FACW	2	88
Pacific reedgrass association	12	OBL/FACW	2	92
Red alder alliance	6	FACW	2	100
Red alder/arroyo willow association	5	FACW	2	100
Rush super alliance	20	OBL/FACW	2	95
Saltgrass alliance	9	FACW	2	100
Tufted hairgrass alliance	1	FACW	2	100
Scirpus/spikerush association	3	OBL/FACW	2	100
Willow super alliance	16	OBL/FACW	2	93
Coyote brush/sedge/rush association	7	FACW/UPL	3	57
Red alder/salmonberry/red elderberry association	12	FACW/FAC	3	100
Salmonberry alliance	2	FAC	3	50
California bay/sword fern association	12	FAC/FACU	4	33
California wax myrtle alliance	3	FAC+	4	100
Coyote brush alliance	19	FAC/UPL	4	16
Coyote brush/Rubus weedy association	6	FAC+/UPL	4	17
Grassland (annual, weedy) alliance	4	FAC/UPL	4	25
Grassland (perennial, weedy) alliance	21	FAC/UPL	4	19
Water, mudflat	2	--	--	--
Poison oak association	1	--	--	--
Unclassified	15	--	--	--
Total	210	--	--	70*

Note: Indicator status and indicator category follow Reed (1996).

\*Among all the alliances or associations combined, 70% were wetlands.

OBL = obligate, always found in wetlands (>99 percent of the time).

FACW = facultative wetland, usually found in wetlands (67–99% of the time).

FAC = facultative, equal in wetlands or non-wetlands (34–66% of the time).

FAC+ = subcategory of facultative, equal in wetlands or non-wetlands (50–66% of the time).

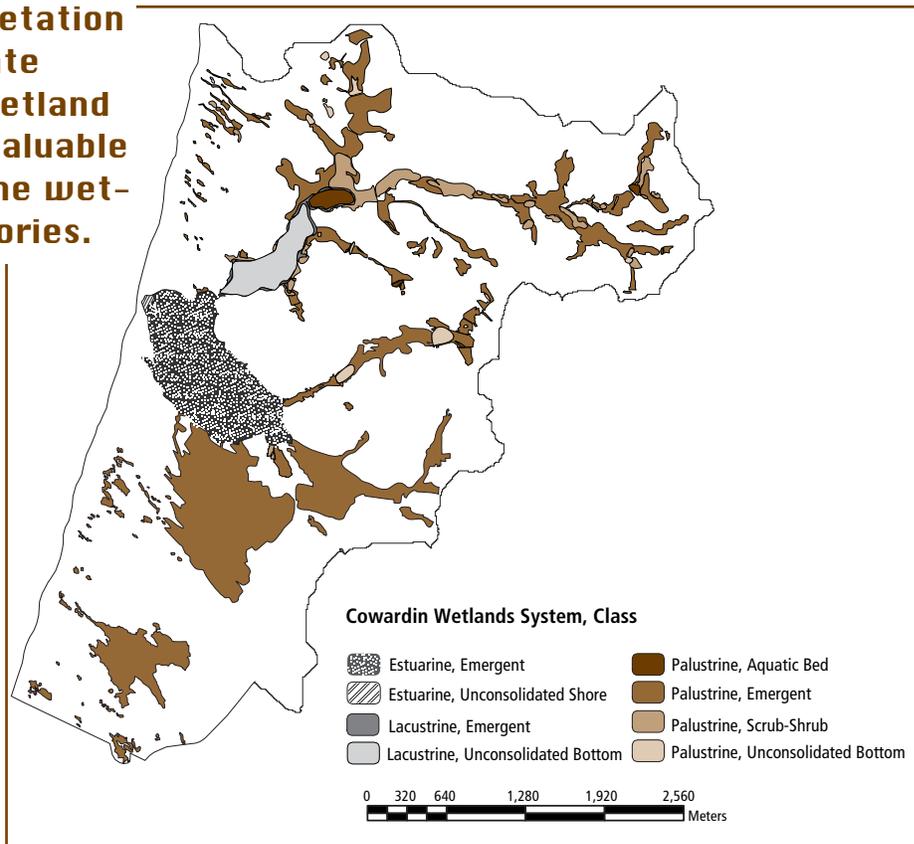
FACU = facultative upland, usually found in non-wetlands (1–33% of the time).

UPL/NI = upland/no indicator, not found in local wetlands (<1% of the time).

During sampling, we found sites that supported wetlands in each alliance or association (table 4). Plant communities dominated by plants that only grow under wet conditions (wetland obligates),

such as pickleweed, were wetlands 100% of the time, compared to 33% for vegetation types dominated by plant species that tolerate wet or drier conditions (facultative species), such as California bay. The pattern of incremental decrease in the likelihood of a polygon on the vegetation map to contain a wetland, with respect to how dependent the dominant plant species is on wet conditions (table 4), follows a pattern similar to the U.S. Fish and Wildlife Service (Reed 1996) wetland indicator categories. This shows that using a vegetation map to locate potential wetland areas is a valuable tool to refine wetland inventories.

**Using a vegetation map to locate potential wetland areas is a valuable tool to refine wetland inventories.**



**Figure 2a.** The exhaustive field survey mapped 989 acres (400 ha) of wetlands within 259 polygons. Field investigators identified 53 different classes of wetlands based on the Cowardin system.

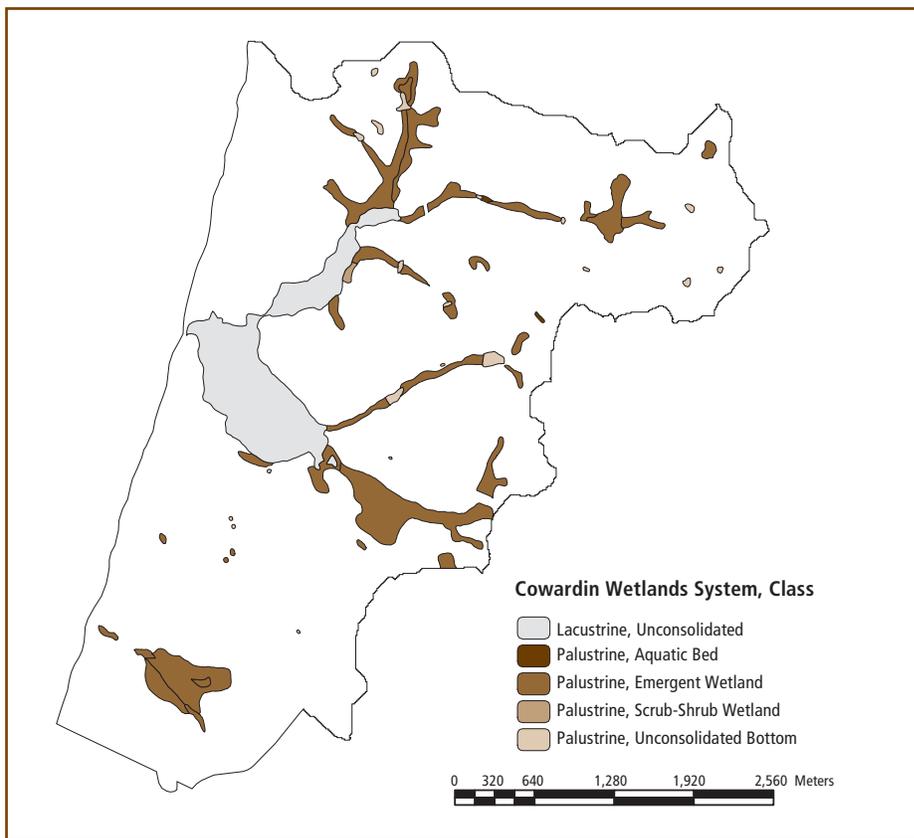
**Phase two**

**Exhaustive Field Survey**

Field crews conducted an exhaustive inventory and GPS-based mapping of Abbotts Lagoon watershed (fig. 2a). They mapped a total of 989 acres (400 ha) of wetlands within 259 polygons and classified a total of 53 different types of wetlands, when displayed at the water regime modifier level. We considered this to be the “ground truth” when comparing these results with published NWI data and with the parks’ vegetation map.

**NWI Data**

National Wetlands Inventory’s aerial photo interpreters mapped 550 acres (223 ha) of wetlands within 61 polygons (fig. 2b). When compared with the exhaustive field map of the Abbotts Lagoon watershed, 429 acres (174 ha) (44.5%) of wetlands were not identified on the NWI maps. Furthermore, nine different types of wetlands appeared on the NWI maps compared to 53 types detected by field staff, when considered at the special modifier level.

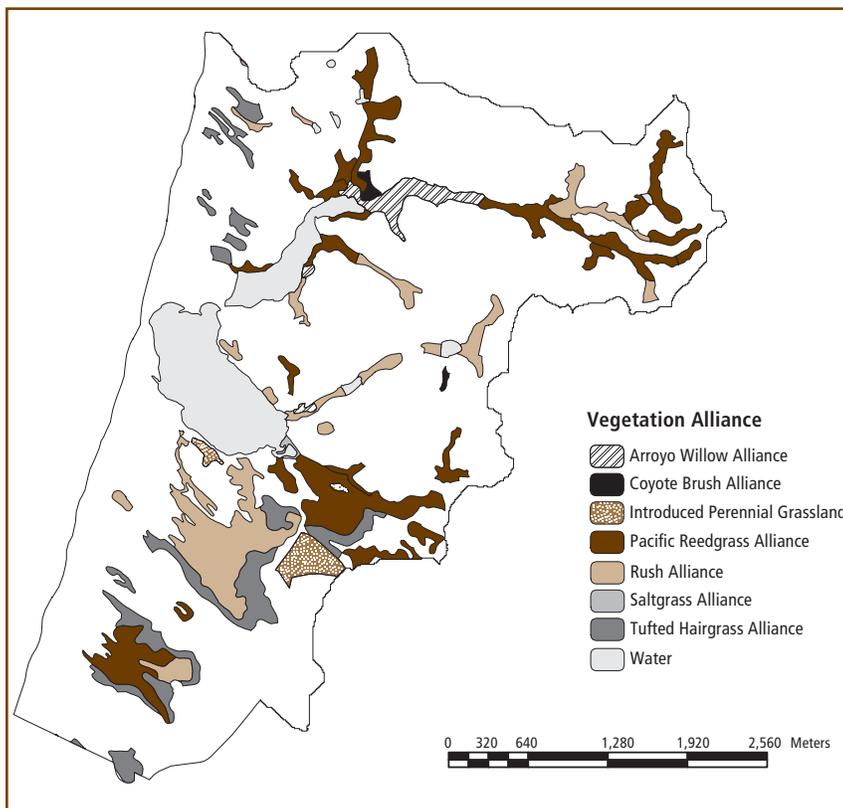


**Figure 2b.** National Wetlands Inventory (NWI) investigators mapped 550 acres (223 ha) within 61 polygons and identified nine Cowardin wetland types. The NWI data underestimated the wetland area by 44.5% when compared to the exhaustive field-based maps.



## Vegetation Map

The draft vegetation map contains 1,046 acres (423 ha) of wetland vegetation within 82 polygons. From this, we selected 14 plant communities as highly likely to contain wetlands and five plant communities as moderately likely to contain wetlands (fig. 2c). We extracted these polygons from the draft vegetation map. The vegetation map overestimated wetlands by 81 acres (33 ha) (8.4%) when compared with the exhaustive field map of the Abbotts Lagoon watershed. The draft vegetation map identifies eight plant communities (associations), significantly less than the 53 wetland types that our field crews mapped in the study area. The vegetation map did a good job of delineating wetlands but without the thematic resolution of the field-based GIS data.



**Figure 2c.** The parks' plant community map contains 1,046 acres (423 ha) of wetlands within 82 polygons and identifies 5 of 19 wetland plant communities. The plant community map overestimated wetlands by 8.4% when compared to the exhaustive field survey.

## Conclusions

Many units in the National Park System where wetlands are an important natural resource could benefit from the enhanced wetlands mapping approach implemented at Point Reyes National Seashore and the north district of Golden Gate National Recreation Area. Clearly managers should carefully evaluate existing NWI data before using them as an inventory of a park's wetland resources. In some areas, small isolated wetlands contribute significant-

ly to species richness and may harbor species of concern. Maps created during the National Wetlands Inventory typically miss such wetlands because of the scale at which they are created. A systematic field effort is necessary to adequately inventory and map wetlands. Current vegetation maps, such as our draft vegetation map, may focus field efforts and provide a broad picture of where wetlands are likely to occur.

**A systematic field effort is necessary to adequately inventory and map wetlands.**

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# BURROWING MAYFLIES (*Hexagenia*) as indicators of aquatic ecosystem health at Sleeping Bear Dunes National Lakeshore, Michigan

By Thomas A. Edsall  
and William E. Phillips

## Background

The National Parks Omnibus Management Act of 1998 encourages the development of programs to help protect natural resources throughout the National Park System by inventorying and monitoring those resources and establishing baseline information that can be used to provide status and trend information on their condition. Various studies have been conducted in recent years that contribute to the information base needed to protect and manage park resources, but the environmental status of most inland waters of the National Park System units in the Great Lakes Monitoring Network is still poorly known (Whitman et al. 2002) (fig. 1, page 42).

Major external threats to the inland waters of these parks include accelerated or “cultural” eutrophication caused by human activities that elevate, above natural or historic levels, the phosphorus in precipitation, surface runoff, and tributaries entering the parks. These elevated levels of phosphorus stimulate the excess production of algae, which removes oxygen from the water when the algae die, sink to the bottom, and decay. The effect of this excess algae production can be most severe in park inland lakes that stratify thermally in summer (see sidebar).

The effects of cultural eutrophication in Platte Lake (fig. 2, page 43), including excess algae blooms, and lowered water transparency, were the basis for legal actions brought by area property owners who wanted the nutrient loading to the lake from the Michigan Department of Natural Resources (MDNR) fish-rearing station to be reduced (Whelan 1999). In Loon Lake (see fig. 2), the effects of cultural eutrophication are not as apparent, suggesting that Platte Lake may be trapping much of the phosphorus carried by the river. The level of total phosphorus measured in Loon Lake in 1998 and 1999 (Whitman et al. 2002) was consistently low in water (0.03 to 0.04 parts per million), but varied seasonally and was much higher in lakebed sediments (80 to 478 parts per million), suggesting cultural eutrophication was occurring. The nitrogen:phosphorus ratio was 31.5 and very near the point (29.0) where the production of undesirable blue-

Elevated levels of phosphorus stimulate the excess production of algae, which removes oxygen from the water....

## Thermal Stratification

Summer thermal stratification occurs when the sun warms the lake’s surface and the warmer surface water becomes less dense than the colder, deeper water. These density differences cause three thermally distinct layers to form in the lake. The uppermost or surface water layer is uniformly warm; the mid-depth layer or thermocline is a zone of rapid transition where the temperature decreases rapidly as water depth increases; the deepest or bottom water layer is uniformly cold.

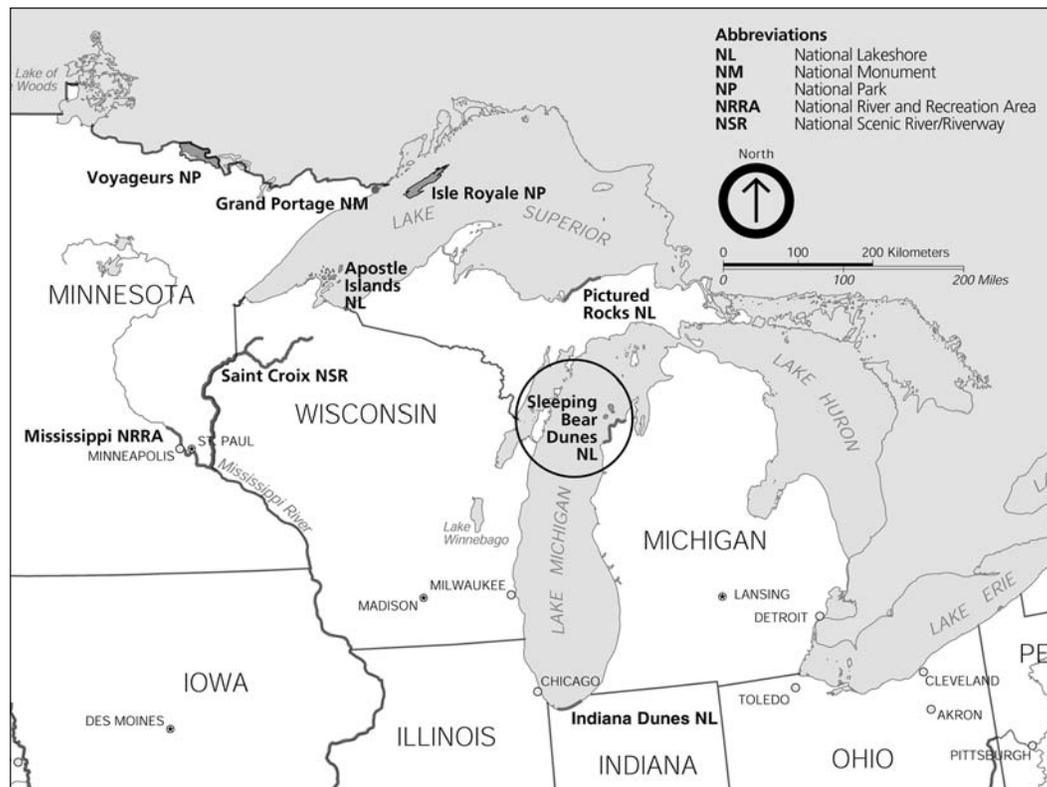
The density differences that cause the thermal stratification also inhibit mixing of the layers. The surface water layer, which is well mixed by the wind, is oxygen-rich. The dissolved oxygen concentration in the thermocline and bottom water layers reflects a balance between the oxygen demand by decaying algae and the dissolved-oxygen-bearing capacity of the water, which varies inversely with temperature. Thus, if the oxygen demand is high during summer thermal stratification, the dissolved oxygen concentration in the thermocline and bottom waters may become too low to support fish and invertebrate organisms, including *Hexagenia* nymphs.

green algae is favored over that of beneficial diatoms and green algae (Wetzel 1975); this further suggests that cultural eutrophication was occurring in Loon Lake. The absence of dissolved oxygen in the lake’s deeper waters in August and September 1998 and 1999 (Whitman et al. 2002) is additional evidence that cultural eutrophication was occurring and suggests that phosphorus mobilization and release from the sediment during episodes of low dissolved oxygen might be sufficient to periodically lower the nitrogen:phosphorus ratio in water and trigger the production of blue-green algae. Earlier records describing dissolved oxygen levels in Loon Lake’s bottom waters are not available, but Brown and Funk



(1940) reported that conditions in the bottom waters were adequate to support fish, including cisco (*Coregonus artedii*) and trout, which are cold-water fishes that typically would occupy these waters and require high levels of dissolved oxygen for survival. A more recent survey (Kelly and Price 1979) found only warm-water fishes were present. The apparent loss of resident ciscoes and trout suggests that low levels of dissolved oxygen developed between the early 1940s and the late 1970s and that cultural eutrophication was the responsible agent.

The present study describes the provisional use of burrowing mayflies (*Hexagenia* [Ephemeroptera: Ephemeridae]) as an indicator organism to assess and monitor the health of the Loon Lake and lower Platte River ecosystem within Sleeping Bear Dunes National Lakeshore, Michigan (figs. 1 and 2). The indicator approach (Edsall 2001, Environment Canada and the U.S. Environmental Protection Agency 2001) was promoted at international State-of-the-Lake Ecosystem Conferences in 1996, 1998, 2000, and 2002, and results from applying the indicator approach are being used to inform the United States and Canadian governments and the public about progress toward restoring and maintaining the chemical, physical, and biological integrity of the Great Lakes ecosystem, as required by the Great Lakes Water Quality Agreement (Environment Canada and the U.S. Environmental Protection Agency 2003). *Hexagenia* was selected as an indicator because it (1) was historically abundant in unpolluted, near-shore, soft-bottomed habitats throughout the Great Lakes; (2) was intolerant of and was extirpated by cultural eutrophication, which caused anoxic conditions in many of those habitats in the 1940s and 1950s; (3) has shown the ability to recover almost completely in one of those habitats, western Lake Erie, following nutrient reduction (Edsall et al. 1999); (4) is ecologically important in the food chain because it eats detritus and in turn is eaten preferentially by trout, bass, walleye, yellow perch, lake sturgeon, and other desirable food and game fish; and (5) has abundant, highly visible mating swarms of winged adults that, by their presence, can send a message to the public that the water body supporting the nymphal population is not suffering from the effects of cultural eutrophication.

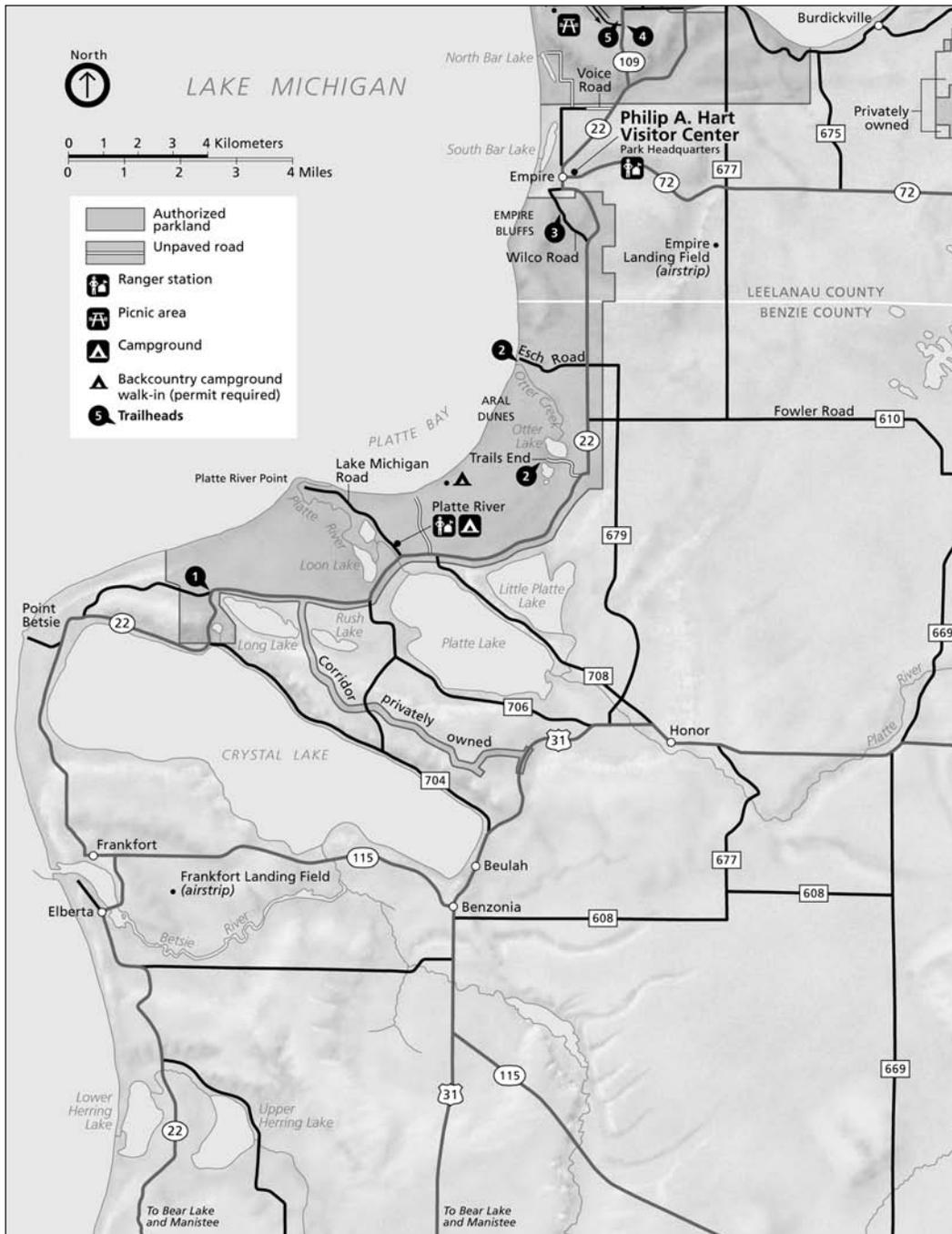


**Figure 1. National Park System units in the Great Lakes Monitoring Network. The study area is circled.**

## Methods

We conducted this study in Loon and Platte Lakes in the Platte River drainage and in two “reference” areas—Crystal Lake and Frankfort Harbor (Betsie Lake)—in the adjacent Betsie River drainage (fig. 2).

Sampling and measurements were made from a 17-foot-long (5.2 m) boat powered by a small outboard motor and equipped with a depth sounder, which continuously reported water depth to the nearest 0.1 foot (4.0 cm). We used a Petite Ponar grab sampler with a 0.25-square-foot (2.0 cm<sup>2</sup>) jaw opening to collect *Hexagenia* nymphs burrowed in the lakebed substrate. We collected at least two grab samples with the Petite Ponar at each station where the first grab sample revealed that the substrate was suitable for *Hexagenia* nymphs. Suitable substrate for *Hexagenia* is typically soft enough to permit the nymphs to burrow in it and cohesive enough to prevent the burrow from collapsing (Wright and Mattice 1981). In the present study, suitable substrates were mud or mud and fine sand. Each grab sample with suitable substrate was dumped into a sieving bucket in which the bucket bottom had been replaced with one-eighth-inch mesh hardware cloth. The sediment portion of the sample was washed through the hardware cloth by partly submerging the bucket alongside the boat and moving it up and down several times. The nymphs retained in the bucket were counted and released.



**Figure 2.** The study area, including portions of Sleeping Bear Dunes National Lakeshore, showing the Platte and Betsie Rivers, Loon, Platte, and Crystal Lakes, and Frankfort Harbor.

In Loon, Platte, and Crystal Lakes we collected Petite Ponar grab samples over a range of depths extending from the shallow, near-shore waters at depths of 10 to 20 feet (3.1 to 6.1 m), toward the offshore waters at depths of 37 to 49 feet (11.3 to 14.9 m) (table 1, page 44).

Sampling was conducted around the perimeter of Loon Lake, near the outlet of Platte Lake, and at the eastern end of Crystal Lake. In Frankfort Harbor, we sampled at a depth of 5 feet (1.5 m) near the mouth of the Betsie River and at 20 feet (6.1 m) at the eastern end of the navigation channel. We attempted to sample *Hexagenia* in Little Platte Lake and the lower Platte River below Loon Lake,

but the substrate was sand or flocculent marl-like material, which was unsuitable for *Hexagenia*. We used a YSI Model 55 dissolved oxygen and temperature meter with a 50-foot (15.3-m) cable connecting the meter to its sensing probe to measure temperature to the nearest 0.1°F (0.06°C) and dissolved oxygen to the nearest 0.1 parts per million. The sensing probe was attached to a weighted line with 1-foot (0.3-m) markings, lowered to the bottom, and then retrieved to preselected depth intervals to provide data that would permit construction of dissolved oxygen and temperature profiles for each water body. Profiles extended from the surface of the water to depths of 42 to 50 feet (12.8 to 15.3 m) in Loon, Platte, and Crystal Lakes and to 20 feet (6.1 m) in Frankfort Harbor. The dissolved oxygen and temperature data for each water body were collected near the deepest site sampled with the Petite Ponar grab. A Garmin GSPMAP 76 chartplotting global positioning system was used to record sample and data collection locations to the nearest 0.1 second.

The protocol for using *Hexagenia* as an indicator of ecosystem health (Edsall 2001) specifies sampling the nymphal population in the

spring before the older, mature nymphs—which are the major biomass component of the population—emerge as winged subadults in early summer. Unfortunately, logistical constraints in 2002 prevented us from sampling until 24–26 July. As a result, we simply counted the nymphs we collected in each sample and did not attempt to obtain biomass data from them. This approach allowed us to describe the general distribution of the nymphal population and to examine the potential for using *Hexagenia* as an indicator of ecosystem health in the study area, but did not provide biomass data that could be used for trend monitoring following the protocol in Edsall (2001).



## Results and discussion

Sampling with the Petite Ponar grab for *Hexagenia* nymphs in Loon, Platte, and Crystal Lakes revealed coarse and fine sand substrates extended from the shoreline out to depths of between 10 and 20 feet (3.1 and 6.1 m) in Loon Lake, 20 and 25 feet (6.1 and 7.6 m) in Platte Lake, and 14 and 17 feet (4.3 and 5.2 m) in Crystal Lake (table 1). Mud and fine sand was the substrate at 20 to 42 feet (6.1 to 12.8 m) in Loon Lake and 25 to 49 feet (7.6 to 14.9 m) in Platte Lake; mud was the substrate at 5 and 20 feet (1.5 and 6.1 m) in Frankfort Harbor. Nymphs were collected only from mud or mud and sand substrates, but were absent from mud and fine sand substrates at 30 to 42 feet (9.2 to 12.8 m) in Loon Lake and at 36 to 49 feet (11.0 to 14.9 m) in Platte Lake.

We collected no large, mature nymphs in Loon and Platte Lakes, indicating emergence probably had already occurred there. While sampling in Crystal Lake, we found windrows of floating *Hexagenia* exuvia (the outer body covering that nymphs shed at the surface of the water as they emerge as winged insects), indicating that an emergence had occurred during the previous evening. In Frankfort Harbor we collected several large, mature nymphs with black wing cases, indicating that some of the population there had not yet emerged. These observations indicate that sampling to establish trend information for the *Hexagenia* populations in the study area should be done in June when both density and biomass data can be collected as described in Edsall (2001).

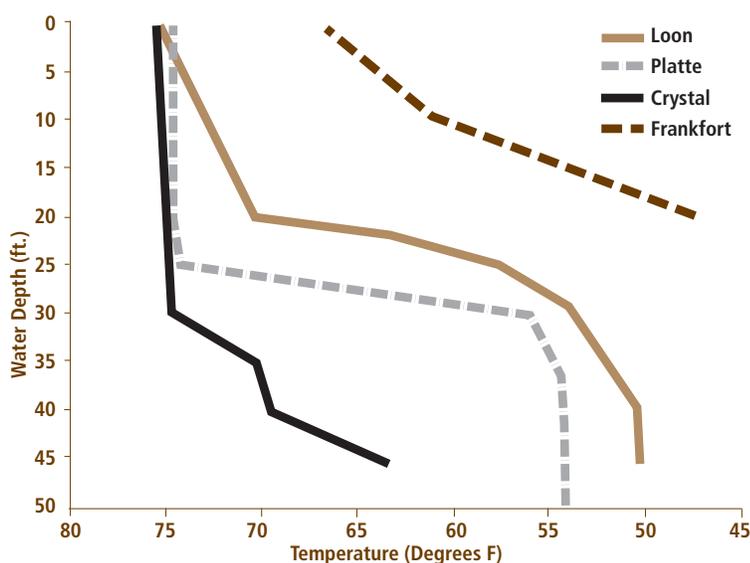
The waters of Loon, Platte, and Crystal Lakes were strongly thermally stratified during our study (fig. 3). Surface temperatures were similar in all three lakes (74.5 to 75.7°F; 23.6 to 24.3°C) and the thermocline extended from about (slightly deeper than) 20 feet (6.1 m) to about 40 feet (12.2 m) in Loon Lake, about 25 to 40 feet (7.6 to 12.2 m) in Platte Lake, and about 30 to 45 feet (9.2 to 13.7 m) in Crystal Lake. The temperature in the surface layer immediately above the thermocline was 70.3°F (21.3°C) in Loon Lake, 74.3°F (23.5°C) in Platte Lake, and 75.2°F (24.0°C) in Crystal Lake. The waters of Frankfort Harbor were also strongly thermally

**Table 1. Water depth, substrate, and catch-effort data for *Hexagenia* nymphs in Loon, Platte, and Crystal Lakes, and Frankfort Harbor, 24–26 July 2002**

Location	Water depth (ft)	Substrate type	No. grab samples	No. nymphs
Loon Lake	10	Coarse and fine sand and clay	3	0
	20	Mud and fine sand <sup>a</sup>	5	3
	30	Mud and fine sand <sup>a</sup>	6	0
	40	Mud and fine sand <sup>a</sup>	3	0
	42	Mud and fine sand <sup>a</sup>	2	0
Platte Lake	20	Coarse sand and small shells (snails and fingernail clams)	2	0
	25	Mud and fine sand <sup>a</sup>	2	6
	36	Mud and fine sand <sup>a</sup>	2	0
	49	Mud and fine sand <sup>a</sup>	2	0
Crystal Lake	14	Coarse sand	1	0
	17	Mud and fine sand <sup>a</sup>	2	7
	20	Mud <sup>a</sup>	2	9
	25	Mud <sup>a</sup>	2	8
	29	Mud <sup>a</sup>	2	1
	37	Mud <sup>a</sup>	2	1
Frankfort Harbor	5	Mud <sup>a</sup>	2	10
	20	Mud <sup>a</sup>	2	2

<sup>a</sup>Substrate suitable for habitation by nymphs.

stratified, but the warm surface layer seen in Loon, Platte, and Crystal Lakes was absent and the harbor's water temperatures were similar to or lower than those within the thermocline in Loon, Platte, and Crystal Lakes. The temperature in Frankfort Harbor declined almost linearly from 66.4°F (19.1°C) at the surface to 64.1°F (17.8°C) at 5 feet (1.5 m) and 47.5°F (8.6°C) at 20 feet (6.1 m). The absence of a layer of warm surface water probably reflected the direct connection of the harbor with Lake Michigan and the flushing of the harbor by a wind-driven



**Figure 3. Temperature–water-depth profiles in Loon, Platte, and Crystal Lakes and Frankfort Harbor, 24–26 July 2002.**

mass of cold Lake Michigan water. *Hexagenia* nymphs were only collected immediately above the thermocline in Loon and Platte Lakes, immediately above and within the thermocline in Crystal Lake, and only within the thermocline in Frankfort Harbor. The temperatures where nymphs were collected were 70.3°F (21.3°C) in Loon Lake, 74.3°F (23.5°C) in Platte Lake, 75.2 to 54.1°F (24.0 to 12.3°C) in Crystal Lake, and 64.1 to 47.5°F (17.8 to 8.6°C) in Frankfort Harbor.

In Loon and Platte Lakes, the dissolved oxygen concentration was 7.3 and 7.5 parts per million, respectively, at the surface, 7.5 parts per million immediately above the thermocline, and 0.6 and 2.8 parts per million, respectively, at the bottom of the thermocline (fig. 4).

In Crystal Lake, the dissolved oxygen concentration increased from 7.9 parts per million at the surface to 8.0 parts per million just above the thermocline, to 11.5 parts per million at 45 feet (13.7 m). In Frankfort Harbor, the dissolved oxygen concentration increased with depth, from 8.9 parts per million at 5 feet (1.5 m) to 11.8 parts per million at 20 feet (6.1 m). Nymphs were only present in grab samples where the dissolved oxygen in the overlying water was 7.5 parts per million or greater.

Thus, in summary, nymphs were (1) found only in mud or mud and fine sand substrates; (2) present on mud and fine sand to a depth of 37 feet (37.3 m) in Crystal Lake, but absent from that substrate at depths greater than 20 feet (6.1 m) in Loon Lake and 25 feet (7.6 m) in Platte Lake; (3) collected only at 70.3°F (21.3°C) in Loon Lake and 74.3°F (23.5°C) in Platte Lake, but found at 75.2 to 54.1°F (24.0 to 12.3°C) in Crystal Lake, and 64.1 to 47.5°F (17.8 to 8.6°C) in Frankfort Harbor; and (4) present only where the dissolved oxy-

gen concentration was 7.5 parts per million or greater. Collectively, these results indicate that the absence of *Hexagenia* nymphs in grab samples collected in the thermocline and bottom waters at depths of 30 to 42 feet (9.2 to 12.8 m) in Loon Lake and at 25 to 49 feet (7.6 to 14.9 m) in Platte Lake, where the substrate was mud and fine sand, was primarily due to low concentrations of dissolved oxygen. These results together with other information describing changes in the historical composition of the fish fauna in Loon Lake (Brown and Funk 1940, Kelly and Price 1979) and excess algae production and related water quality problems in the Platte River watershed (Whelan 1999, Whitman et al. 2002, McMacken 2003) suggest that the low concentrations of dissolved oxygen in the deeper waters of Loon and Platte Lakes during summer thermal stratification are the result of cultural eutrophication in the Platte River watershed.

### Management recommendations

Our study was largely exploratory and not designed to pinpoint the nutrient sources that are contributing to eutrophication of the Platte River system. However, it seems clear from our study results and the other supporting information that there is a basis for concern about nutrient input to and eutrophication of Sleeping Bear Dunes National Lakeshore waters, and that the most significant nutrient sources lie outside the boundaries of the

park. Thus, effectively addressing the threat to park waters posed by cultural eutrophication will need to focus not only on conditions within the park, but also in the Platte River and watershed outside the park. Additional study of the condition of the habitats and the populations of *Hexagenia* in Loon and Platte Lakes, and comparison with

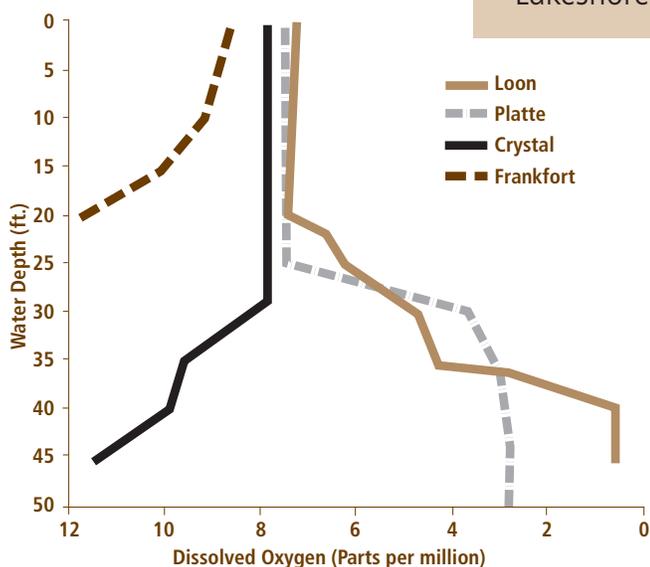
those in the headwater lakes in the Platte River system would more precisely identify the major sources of nutrient enrichment to the system. Additional study would also better establish a more rigorously quantitative basis for trend monitoring in the Platte River system, using burrowing mayflies as an indicator of ecosystem health. Once a formal monitoring protocol for Loon Lake is established, monitoring can readily be carried out annually by park staff to provide trend information needed to develop short- and long-term nutrient management strategies.

### References

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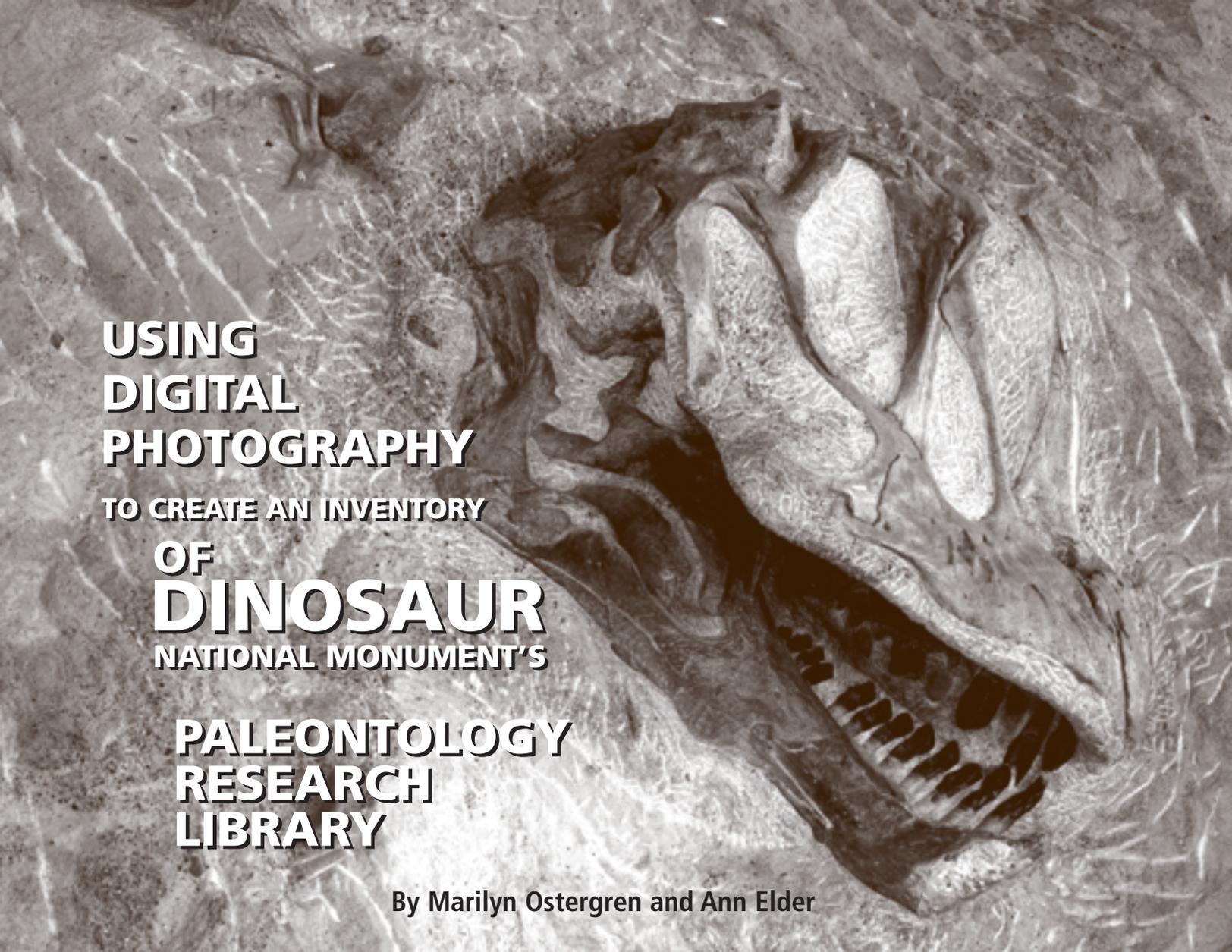
*Continued in right column on page 48*

There is a basis for concern about nutrient input to and eutrophication of Sleeping Bear Dunes National Lakeshore waters....



**Figure 4.** Dissolved oxygen concentration–water depth profiles in Loon, Platte, and Crystal Lakes and Frankfort Harbor, 24–26 July 2002.





# USING DIGITAL PHOTOGRAPHY TO CREATE AN INVENTORY OF DINOSAUR NATIONAL MONUMENT'S

## PALEONTOLOGY RESEARCH LIBRARY

By Marilyn Ostergren and Ann Elder

Literature inventoried as part of this project helps support research on fossils such as this *Camarasaurus* skull (DINO 2580), which can be viewed and enjoyed by the public in the rock wall in the Quarry Visitor Center at Dinosaur National Monument. NPS, DINOSAUR NATIONAL MONUMENT

**T**he paleontology research library at Dinosaur National Monument, Colorado, is a significant research collection that contains material dating back to the late 1800s. The research documents, primarily journal articles, are grouped by subject and author and are stored in document boxes on shelves. A relatively small number of references in this collection describe park resources and should be listed in NatureBib, the comprehensive NPS library catalog; however, the bulk of the collection is not park-specific. Most of the references at Dinosaur are relevant generally to the park's paleontological resources and are important to researchers working with the park's fossil collection. The park's goal is to improve access to the collection to better meet the needs of park staff and researchers who come to study this internationally significant fossil collection.

### Inventing an alternative strategy

The first step toward this goal was bringing a team of professionals (an archivist, two curators, and a librarian) together at the park to make recommendations for this collection (in addition to other library resources, the archives, and the museum). Because this library did not have an up-to-date catalog, we could not do a standard library inventory (which is done by comparing what is in the catalog with what is on the shelves). We needed an alternative strategy to identify and document the contents of the collection for accountability and to support a later complete cataloging effort. We came up with the idea of photographing one or more pages of each document with a digital camera—an efficient way to conduct an inventory with additional value and potential (discussed under “Benefits” later in the article).

## Setup for taking digital images of documents

Our tools consisted of a digital camera with a 125-image capacity, three to four sets of rechargeable batteries, a camera copy stand, a standard gray exposure card, two lamps, a laptop computer loaded with the camera software, and the numbers “2,” “3,” and “4” printed on small squares of paper reinforced with contact paper. We attached the camera to the copy stand, arranged the lamps to illuminate the platform, and placed the gray card on the surface that would be photographed (fig. 1).

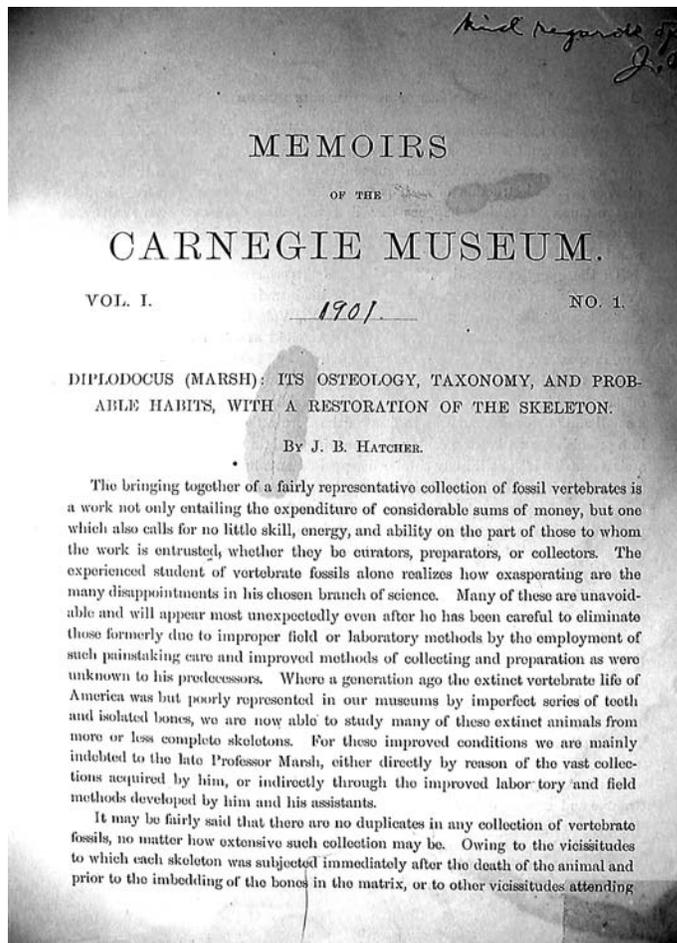


**Figure 1.** Librarian Marilyn Ostergren sets up a digital camera in preparation for photo-inventorying the paleontology research library collection at Dinosaur National Monument. In two weeks of work, she and Ann Elder, the park's museum curator, inventoried more than 4,900 research documents in the park's library.

We photographed the documents box by box. For each document we took the following steps:

1. Set the camera exposure while focused on the gray card to give an accurate reflection of the ambient light. (Because the documents are primarily white, the camera's automatic exposure setting will underexpose the image in its effort to compensate for the intense light reflected from the white surface. The gray card corrects this). We concentrated on getting a good image of the information and were not concerned with the color cast presented by fluorescent or incandescent lighting.

2. Arranged the document. (The camera had a small LCD screen on the back that allowed us to be sure that the document was positioned correctly without having to lean over and look through the viewfinder.)
3. Took the picture (fig. 2).



**Figure 2.** A sample photo from the digital paleontological research library inventory.

For cataloging purposes we wanted the images to contain citation information (title, author, date, etc.) and also wanted them to convey a sense of the document's content. To do this, we sometimes took more than one image of a single document. For example, for a book we often needed to take a photo of the title page (to record author and title information), the back of the title page (where information including the date of publication is often found), and the table of contents. In these cases, we placed numbered cards on the subsequent pages to indicate that this was the second, third, or fourth picture of the same document. We needed two pictures in about 30% of the cases, but rarely needed a third or fourth.

After completing a box of documents, we plugged the camera into the computer, downloaded the images into a

folder or directory labeled with the box name, deleted the images from the camera, and moved on to the next box. At the end of each day we backed up the images on another computer.

Our productivity level was low for the first few days as we worked out the procedure and checked our work to be sure the images were of adequate quality. By the fourth day, our routine was set. In that eight-hour day we processed 600 documents or about 100 documents per hour. This included the time spent making backups, taking breaks, and handling phone calls and other business. Altogether, in a two-week period we created an inventory of 4,902 documents in the library, detailed in 7,002 images on six CDs.

## Benefits of a photo inventory

The digital photos are useful for the following purposes:

1. Browsing the collection—A user can scroll through the images to see, for example, what documents are stored in the boxes labeled “Crocodilia.”
2. Cataloging the collection—The images contain enough information for basic cataloging (e.g., author, title, date, subjects). This could be done at the park, or the CDs could be sent to a cataloger elsewhere. Eventually the documents will be alphabetized by the last name of the first author, but for now they remain grouped by subject and author.
3. Enhancing the catalog—When a catalog is created, the images can be included in the catalog record, allowing the searcher to view pages from any document that is retrieved by a search.

We welcome inquiries about the project.

## About the authors

Librarian **Marilyn Ostergren** has been working with research-resource management collections in national parks since 1993. She is currently working under contract for the Denver Service Center library and Channel Islands National Park and can be reached at [marilyn\\_ostergren@contractor.nps.gov](mailto:marilyn_ostergren@contractor.nps.gov).

**Ann Elder** is a paleontologist who has worked for Dinosaur National Monument since 1984; she is currently the park's museum curator and can be reached at 435-781-7704, or [ann\\_elder@nps.gov](mailto:ann_elder@nps.gov).



“Burrowing Mayflies” continued from page 45

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# TRIBUTE

## Remembering Brian Lambert, a special natural resource specialist

NPS PHOTOS (2)



NPS PHOTO BY BRIAN LAMBERT

By Betsie Blumberg

Brian Lambert was the first natural resource specialist to work at Valley Forge National Historical Park, a small and very popular cultural park in the highly urbanized Philadelphia metropolitan area. He served in that position from 1986 until November 2003 when, after a short illness, he died at age 62. Valley Forge has lost an unusually insightful, quietly determined advocate, extraordinarily devoted to managing the park's resources both to enhance the cultural landscape and to serve the hundreds of thousands of visitors annually who use the park for recreation in a region where Valley Forge is one of the largest open spaces.

Brian was fascinated by, and a dedicated steward of, the natural resources he found in the midst of this intensely developed landscape. He saw the city as a resource for the park and encouraged interested scientists from the nearby universities to do research there. The neighbors, likewise, see the park as an important resource and have always been very concerned about whatever goes on there. Kristina Heister, now inventory and monitoring coordinator of the Mojave Network, worked as a biological technician under Brian for several years. She recalls that "everything you do at Valley Forge starts with a public relations campaign." Brian was the right man for a park in that situation and the right person in the right place can get a lot done.

The restoration of Valley Creek is a case in point. The park is at the bottom of the Valley Creek watershed. When Brian came to the park, intensive development upstream was creating excessive stormwater flooding,

(Left) Brian Lambert pauses in a cave entrance following an enjoyable and productive survey at Valley Forge in 1987. (Middle) Brian as integrated pest manager. (Right) Valley Creek at flood stage.

sending so much sediment down the creek that aquatic life was being degraded, the stream banks were eroding, and archeological resources were being lost. The problem required mitigation throughout the watershed.

To become the creek's advocate in this larger community, Brian devoted himself to learning all about stormwater management, consulting experts and relevant authorities, and attracting a coalition of concerned local environmental groups. As Superintendent Arthur Stewart put it, "We had '100-year floods' a couple of times a year and Brian did more than any single person to make that fact known and to encourage a plan to do something about it." With his expertise, his contacts, his eloquence as a grant writer, and his quiet power of persuasion as a speaker, Brian became an effective presenter for Valley Creek's case.

Years of organizing by the coalition and innumerable meetings with five different townships and two counties finally succeeded in persuading the state, in 1993, to change its designation of Valley Creek to an "Exceptional Value Stream," thereby requiring municipalities to permit development only if there will be no degradation to the creek. This triumph was followed by a successful appeal for post-construction regulation requiring that runoff be no greater than it would have

been if the site were an undisturbed meadow. Largely for his efforts to protect Valley Creek, Brian won the National Park Service's annual Trish Patterson-Student Conservation Association Award for Natural Resource Management in a Small Park in 2002.

**"Everything you do at Valley Forge starts with a public relations campaign." Brian was the right man for a park in that situation and the right person in the right place can get a lot done.**



He loved his park, arriving at dawn and staying late. In 1999, when Hurricane Floyd washed over Valley Forge, the staff took cover, but Brian was missing. He was finally spotted up on Mt. Joy. He had wanted to see how the hurricane affected Valley Creek. This was a 500-year flood and Brian was out there taking pictures as the storm raged. The park now has rare photos of Valley Creek at hurricane flood stage (see photo on right, page 49).

Creating tallgrass meadows from the lawns was another of Brian’s big projects. When Brian came to Valley Forge, all the grounds, except for the forested area, were mowed. He had a different vision for the park. Brian argued that tallgrass meadows would be more like the landscape that George Washington found when he chose Valley Forge for the 1777–1778 winter encampment, and that borders mowed around the meadows could define the boundaries of the original farms, adding interpretive value. The meadows would also invite wildlife. This time, instead of finding many allies in the community, Brian had to convince the community, and the park staff as well, that eliminating some of the lawn would not make the park look neglected. He started with a small area, and when that was accepted, more lawn became meadow. Now there are 925 acres (375 ha) of meadow and such diversity of habitat that the National Audubon Society is considering part of the park for designation as an “Important Birding Area.” The number of birds, especially raptors and ground-nesters, and the populations of herpetofauna and other wildlife have all greatly increased.

The scourge of many parks, exotic invasive plants, is rampant at Valley Forge. Brian knew that they can never be completely removed, but he worked tirelessly to control them. Kristina Heister remembers him very often bent under a pesticide backpack (middle photo, page 49) spraying the mile-a-minute weed, a seemingly endless job.

Brian Lambert understood that history happens in a place because of the attributes of that place. At Valley Forge those attributes were in the landscape. His advocacy for the resources within that landscape has broadened the park’s natural and cultural resources management goals. Brian’s knowledgeable and supportive presence is missed by very many friends and colleagues in the park and in the community, who have proposed naming a tributary of Valley Creek after him and informally renaming the stretch of Valley Creek that runs through the park “Lambert’s Reach.” His monuments survive: a clear and serene creek; tall grass meadows busy with wildlife; a community cadre of concerned, active advocates for Valley Creek; and the rich legacy of the many projects he initiated and accomplished at Valley Forge.

#### About the author

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for spotted owls at known territories, these observations identify the need to conduct research on barred owls and gather data on the species, life history (including distribution), ecology, and habitat requirements. This potential threat also gives credence to continued monitoring of spotted owls and expanding the survey of spotted owl habitat to include areas not occupied currently by spotted owls. In addition to gathering valuable information about barred owls, the survey would help validate the current status of spotted owls in those areas.

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# Meetings of Interest\*

**March 14–18, 2005** The George Wright Society will convene its biennial conference on parks, protected areas, and cultural sites in Philadelphia to explore the theme “People, Places, and Parks: Preservation for Future Generations.” This event integrates all fields of natural and cultural resource management pertinent to park and protected area management. It draws a cross-section of high-level park managers, researchers, administrators, field personnel, academics, representatives from nongovernmental organizations, and others. Participants will be able to choose among a broad range of intellectual offerings, including thought-provoking keynotes, paper and panel presentations, exhibits, computer demonstrations, side meetings, and on-site and field-based workshops. The conference program is keyed to four areas: the role of natural, cultural, and social sciences and scholarship in enhancing our understanding and management of park resources and visitors; practical aspects of park preservation and management, including the application of new technologies; issues of equity in the use, understanding, and enjoyment of parks and civic engagement in park management; and the educational functions of parks and protected areas to build public appreciation for park resources. Further information is available at <http://www.georgewright.org/2005.html>.

**March 16–19** Sponsored by the Wildlife Management Institute, the 70th North American Wildlife and Natural Resources Conference will take place in Arlington, Virginia, and explore the theme of “Elevating the Priority of Natural Resource Conservation.” Presentations will expound on six topic areas: (1) with coming retirements and possible outsourcing, who will manage our natural resources? (2) a case study of long-term landscape use and abuse in relation to sage-grouse conservation; (3) a continental perspective of conservation across borders; (4) managing the wildlife disease–human health interface; (5) advancing the cause of integrated bird conservation; and (6) stemming the tide of nonnative, invasive plants. Additional concurrent meetings are planned. Further information is available at <http://www.wildlifemanagementinstitute.org/pages/TOC.html>.

**September 12–18** The Society for Ecological Restoration International will host “Ecological Restoration: A Global Challenge” to explore the ways ecological restoration can integrate scientific and technical fundamentals with economic opportunities, social needs, and political realities, and how to apply this integration to projects under way on every part of the planet. Participants will meet in Zaragoza, Spain, to discuss social and cultural aspects of global ecological restoration; the economy of ecological restoration; approaching ecological restoration at the landscape scale; the ecological restoration of ecosystems, threatened populations, and urban zones; and technical tools for ecological restoration. More information is available at <http://www.ser.org/content/2005Conference.asp>.

**September 25–29** The Wildlife Society is planning its 12th annual conference to be held in Madison, Wisconsin. The gathering will feature symposia, workshops, and a special poster session that focus on topics of wildlife science, management, education, and policy under the general theme that guides the society: excellence in wildlife stewardship through science and education. Further information is available at [www.wildlife.org](http://www.wildlife.org) under the heading “conferences.”

\*Readers with access to the NPS Natural Resources Intranet can view a longer listing of upcoming meetings, conference, and training courses at <http://www1.nrintra.nps.gov/NRMeet/>.



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