PARK SCIENCE
Integrating Research and Resource Management

Volume 15 – Number 1 National Park Service • U.S. Department of the Interior Winter 1995

The Reconstruction of Kenilworth Marsh
The Last Tidal Marsh in Washington, D.C.

A partnership with the U.S. Army Corps of Engineers, and other agencies, leads to restoring a regionally important wetland

By Stephen W. Syphax and Richard S. Hammerschlag

Kenilworth Marsh is a 77-acre freshwater tidal marsh and swamp forest located adjacent to the historic Kenilworth Aquatic Gardens along the Anacostia River in Washington, D.C. National Capital Parks–East, a unit of the National Capital Region of the National Park Service, manages the marsh.

This marsh, along with hundreds of other acres of tidal wetlands, had flanked the Anacostia River into the Twentieth Century (figure 1, page 16). However, during the 1920s-40s, the U.S. Army Corps of Engineers dredged and channeled the Anacostia River from the Potomac River up to Bladensburg, Maryland (approximately 9 miles), to improve navigation. The dredge spoil was used to create *upland* within the adjacent wetlands. Much of the newly created land became Anacostia and Kenilworth parks. In 1940, the marshes at Kenilworth were dredged, ostensibly to create a recreational lake (figure 2, page 16). However, the lake developed into a shallow bowl, which at low tide simply became an extensive unvegetated mud flat (-0.6 to 0.1 feet mean sea level[1]) having minimal habitat value (figure 3, page 16). Wild rice (*Zizania aquatica*) and other emergent plants, which once dominated the Anacostia marshes and were major food sources for wildlife, had practically disappeared.

Before (top) and after (bottom) reconstruction of mass fill area #1 at Kenilworth Marsh. A tidal gut, or channel, *was also installed in the restoration effort and shows in the bottom image of the completed marsh.*

Recognizing Potential

NPS documents from as early as 1963 recognized the potential of Kenilworth Marsh as an important natural area and wildlife sanctuary. In 1980, the Kenilworth Park and Aquatic Gardens Development Concept Plan promoted the interpretation and study of this natural area (that nearly surrounds the historic gardens). For the area to meet interpretive objectives, improve water quality, and certainly to meet the goal of being a viable wetland habitat, the wetland would have to

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[1]Mean sea level is the average ocean surface level for all stages of the tide over a recent 19-year period; twice daily tides range above and below mean sea level.

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Integrating Research and Resource Management
Volume 15—No. 1 • Winter 1995

PUBLISHED BY
The National Park Service
U.S. Department of the Interior

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Park Science (ISSN-0735-9462) is a quarterly science and resource management bulletin that reports recent and ongoing natural and social science research, its implications for park planning and management, and its application in resource management. The bulletin is published in January, April, July, and October for distribution to interested parties. Please advise the editor of address changes.

The editor welcomes submissions of case studies and feature articles. See volume 14, number 4, page 13 for complete submission criteria or contact the editor at:

National Park Service
Natural Resources Publication Office
P.O. Box 25287 (WASO-NRPO)
Denver, CO 80225-0287
Phone (303) 969-2147
Printed on recycled paper

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IN THE NEXT ISSUE. . .

Coinciding with spring migration, look for several articles detailing research and resource management projects on birds in our spring 1995 edition. We anticipate running stories on spruce grouse research in Acadia National Park, Maine, piping plover habitat protection at Cape Cod National Seashore, Massachusetts, and Alaskan national parks peregrine falcon migration tracking by satellite. Also expect a summary of recommendations from the Assistant Secretary Frampton ad committee for the future of resource management under the NPS reorganization plan.

New Year, New Look

With the coming of the new year, we launch the inaugural issue of the fifteenth volume with a new appearance. Part of the transition in moving this publication from the Pacific Northwest to Denver has been to renegotiate printing and distribution contracts and to reevaluate the *Park Science* design while maintaining its always useful content.

You may first notice a difference in the publication subtitle. Now, "Integrating Research and Resource Management," my hope is to portray the role of the publication more accurately by broadening the subtitle to include research and resource management, and to show at a glance the relationship between the two disciplines. Our focus has always been this, so why not say so right on the front page?

You may also find *Park Science* to be a little easier to read. The lines of text are spaced a little broader and the pages are a little more open, creating a more inviting appearance. I hope that creative arrangement of text, graphics, and other design elements will delight the eye as much as the words have always delighted the mind.

A new year celebration often prompts us to look at where we have been and plan for where we are headed . Is it any wonder that the indexes to volume 14, published in the last pages of this issue, indicate that last year a very common topic for *Park Science* articles was the National Biological Survey? We dealt with change on a huge and painful scale, not only in planning for our own reorganization, but also in mourning the loss of our scientists. Now we have begun to accept these realities and are beginning to feel more optimistic about our new relationship with our sister agency. Our point of view seems to be shifting toward one of cooperation and ingenuity in getting the work accomplished. To this end, plans for 1995 include publishing a profile of a NBS research center, along with examples of some of the first research products to come from our fledgling relationship. As always, I encourage contributions of all kinds for the coming year, but especially examples of success between us and the National Biological Survey and other cooperators. Our cover story on restoration of Kenilworth Marsh and the visitor study at Rocky Mountain National Park are perfect examples of the kinds of partnerships we are capable of forming.

This year and in the future, we may also see continued growth in the number and diversity of articles dealing with ecosystem management or landscape ecology research. This edition contains a paper on breeding population dynamics of Isle Royale National Park loons and serves as an example of this important trend toward expressing research and its application in more holistic ways. Growth in this area has been gradual for more than a decade, and I expect that *Park Science* will publish more and more research and resource management project papers that link or have utility in ecologically similar parks.

Whereas last year challenged us to come to grips with sweeping changes in our science program, this year will likely require adjustments to our internal organization. Once our proposed system support offices are up and running and regions have been replaced by the field director offices, we should be able to sort out any changes in our in-park resource management programs and make most of the necessary minor adjustments. While surprises always occur, it seems that 1995 is likely to be more stable and may even begin to show growth and continued professionalization for resource management in the parks.

One indicator for growth is the great progress achieved in garnering support for a long-term increase in resource management staffing as a result of recommendations from the Vail Agenda, the Strategic Plan for Improving the Natural Resource Program of the National Park Service, and the Natural Resource Management Assessment Program (NR-MAP). NR-MAP has proven to be good enough in assessing our natural resource operational workload that Director Kennedy, in a September memorandum, vowed to double park personnel involved in natural resource management by the year 2000! Parks have already begun to plan for these increases through participation in a fiscal year 1997 initiative to compete for the first staff increases.

Another positive indicator will be reported next issue regarding the Assistant Secretary Frampton recommendations for strengthening resource management under the NPS reorganization plan. While specifics are few at this point, NPS participants to the Frampton ad hoc committee gathering last November in Washington, D.C., indicated that support for resource management is running high within the department.

To check up on how well we meet your needs in communicating cutting-edge resource management activities, research, its application in parks, news, and other concerns, we plan to survey readers again in 1995. Conducted first in 1985, the reader survey told us about our audience and your use of the publication. This reader survey will repeat some of the same questions and will give you the opportunity to identify strengths and weaknesses and make suggestions for improving *Park Science*. This bulletin has always been strongly rooted in serving its readers, and the upcoming survey should help strengthen our level of service and keep us pointed in the direction that is most useful to you. We will also update addresses of recipients to improve delivery.

Much can be made out of something that has not yet occurred. Momentum appears to be building again, albeit slowly. Let us get on board and work to make the ride productive this year.

Regional Highlights

Midwest

Winter surveys from 1994 have confirmed the presence of 57 wolves in the Michigan Upper Peninsula (up from 31 the previous year) with a minimum of 7 breeding pairs. Several sightings in and around Pictured Rocks National Lakeshore indicate occupation of the area by more than 1 wolf, with a possibility of a breeding pair utilizing the area for at least part of the year. The Michigan Department of Natural Resources, U.S. Forest Service, U.S. Fish and Wildlife Service, and National Park Service will be working to learn more about the status of the wolf and to complete the state wolf recovery plan.

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The Pictured Rocks resource report series has printed another volume recently. "Late Wisconsin history of Pictured Rocks National Lakeshore and vicinity," by William L. Blewett of Shippensburg University, Pennsylvania, reinterprets theories of the origin of glacial highland features in the Michigan Upper Peninsula. You can obtain copies of the report from the park.

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Researchers surveyed Pipestone National Monument, Minnesota, for western prairie fringed orchid *(Platanthera praeclara)* and found 19 flowering individuals. Although they made no systematic effort to search for juvenile plants, the researchers located 2. Tall vegetation surrounding the orchids made them especially difficult to locate. A Minnesota Department of Natural Resources researcher visited the site and indicated that the actual population (juveniles and adults) could be two to three times the number of flowering plants found in a given year. The fringed orchid was reported at Pipestone twice in the 1980s, but was not confirmed by park staff until last year.

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Indiana Dunes National Lakeshore hosted the second annual meeting of the central states task force on declining amphibians on September 10-11. The following day, the National Park Service sponsored another gathering to discuss formulating a research design for assessing trends in amphibian populations nationwide. Altogether, approximately 50 people attended the presentations of 25 papers on subjects related to amphibian and reptile monitoring.

One presentation discussed the use of a lampricide in streams throughout the Great Lakes region in efforts to control sea lamprey (*Petromyzon marinus)* by killing their larvae. Although managers have generally regarded lampricide as being specific only to lamprey larvae, research has shown that mud puppy (*Necturus maculosus*) populations decline significantly following a lampricide treatment. In some cases where multiyear treatments have been made, mud puppies have been extirpated from the area. A review of literature indicates that the lampricide also affects some genera of mayflies, tadpoles, native lampreys, darters, suckers, and yellow walleye.

Reporting on a research effort in Cuyahoga Valley National Recreation Area, Ohio, a researcher described the use of a portable automated sound recording system to assess the population status of toads and frogs. This method matched or exceeded the performance of traditional sampling techniques used a decade ago in a multiyear study. For approximately $2,000 in supplies, a researcher can build the animal call recording system. Gary Sullivan has a list of the equipment and assembly instructions. If interested, give him a call at (402) 221-3994.

Task force members at the conference recommended a new book entitled, *Measuring and Monitoring Biological Diversity, Standard Methods for Amphibians,* edited by W. Ronald Heyer, et al. In the book, nearly 50 herpetologists recommend ten standard sampling procedures for measuring and monitoring amphibian populations. Included is a detailed protocol for implementing each procedure, a list of necessary equipment and personnel, and suggestions for analyzing the data. The book is published by the Smithsonian Institution Press and can be ordered from Smithsonian Institution Press, Department 900, Blue Ridge Summit, PA 17294-0900, telephone (800) 782-4612 or (717) 794-2148. $49.00 cloth, $17.95 paper.

• • •

Guided by the Saint Croix Zebra Mussel Response Plan, staff at the Saint Croix National Scenic Riverway in Wisconsin contacted over 66,000 individuals between May 15 and October 10, 1994, to discuss National Park Service efforts to slow the spread of the mussel to the unit. Among those contacted were crews of seven vessels harbored on the Saint Croix River and reported to have been operating in zebra mussel-infested waters during the summer. No adult populations of zebra mussels were found on these vessels.

Southeast

Resource managers are developing an integrated pest management (IPM) plan to control a black rat population on three islands at Dry Tortugas National Park in the Gulf of Mexico, 70 miles from Key West, Florida. The rats prey on sooty tern nests on Bush Key and are a threat to this avian colony that is regarded as a wildlife resource of outstanding international significance. Predation of loggerhead and green turtle nests by the rats on Loggerhead Key is another concern. Recent monitoring by snap traps indicates a high rat population. Furthermore, the rats appear to be able to migrate across the channel following tern nesting season to Garden Key where food and harborage are ample. Doug DeVries, IPM coordinator at Everglades National Park, is seeking input from rodent experts and assistance (volunteers) with control implementation.

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One of numerous issues being addressed by resource management personnel at Biscayne National Park in South Florida is resource damage resulting from boats that anchor in live coral. Up to 1,000 boats per day utilize the park on weekends during peak season, and many of these either visit the outer reef tract or the extensive system of patch reefs.

The park schedules anchor surveys during peak visitor use periods and conducts them with a two-person crew. While one crew member explains to a boat captain the damage that occurs when boats are anchored to corals, a snorkeler checks the actual location of the anchor. The snorkeler then relays the position of the anchor to the partner on board the boat–in sand, seagrass, hardbottom, or live coral. If the anchor is found to be in coral, the anchor is moved to an alternate location, and any significant impact to the resource is documented on camera.

Staff have checked anchor locations of over 400 boats and have found that 26% rested in live coral. With boater use of park waters

on the rise, resource managers expect the number of anchors to be placed in live coral to rise accordingly. The cumulative impacts of this practice over time will result in severe degradation of the park coral reef resource.

By continuing these anchor surveys, the resource management staff hope to educate the public on the damage caused by anchoring in coral. They also hope to document and monitor the damage and identify areas that require the installation of additional mooring buoys for resource protection.

WESTERN

The potential life span of the island fox *(Urocyon littoralis),* a threatened species in California, has been documented for the first time during the past two years through terrestrial monitoring at Channel Islands National Park. During pilot studies in the mid-1980s designed to test mark-recapture techniques, scientists on San Miguel Island collared these small relatives of the mainland gray fox *(Urocyon cinereoargenteus)* with individually numbered steel cable collars. Surprisingly, they recaptured several of the animals during the summers of 1993 and 1994.

After examining the original data, which included the estimated ages of the animals at initial capture, the researchers were able to determine that several are currently at least nine years old. Previously, the life span of island fox had been estimated to be only five or six years and was based on tooth wear models from gray fox research.

This discovery demonstrates the importance of monitoring not only for tracking species abundance, but also for acquiring basic information regarding the natural history of long-lived species. Staff are currently marking the island fox on San Miguel Island with passive integrated transponders for continued long-term monitoring.

• • •

Mary Ann Madej of the National Biological Survey, and Vicki Ozaki, Redwood National Park, presented a paper at the annual meeting of the Geological Society of America in Seattle, Washington, in October 1994. Entitled, "Changes in channel morphology following passage of a sediment wave," the paper was part of the special session On the Geological Basis of Wild Salmon Ecology. The talk described the decline and partial recovery of pool habitat in Redwood Creek, northern California, following a large flood and associated high erosion, and the subsequent effects of these habitat changes on the distribution of steelhead populations.

SOUTHWEST

The Southwest Regional Office, in conjunction with the University of Colorado and the NPS Water Resources Division in Fort Collins, Colorado, has initiated a water infiltration study at Carlsbad Caverns National Park in New Mexico. Several years ago, cave specialists became concerned about runoff from parking lots and the possibility of sewage leaks from park facilities. In fact, recent videography of existing sewerlines indicates that the lines may have been leaking for many years. This is a servicewide concern, since the majority of NPS-administered caves, Carlsbad Caverns among them, are solution caves. That is, they are formed by water dissolving away limestone. The geologic features, such as joints, bedding planes, and faults, which facilitated water flow to create these caves, can become the routes of travel for other pollutants, as well.

Scientists have made several discoveries from the research and inventory trips to Carlsbad Caverns. Fecal coliforms have been found in an undeveloped section of the cavern which is associated with drippings from the cave ceiling. Additionally, researchers have noticed unusual molds and fungi growing on walls and ceilings of the cave in remote areas. The water infiltration study will examine the possible correlation of the discovery of fecal coliforms and the molds and fungi to these sewage leaks.

• • •

After two full seasons of fieldwork, the inventory phase of the Montezuma Castle National Monument, Arizona, inventory and monitoring project is now completed. This multidisciplinary effort of researchers from Northern Arizona University and the Colorado Plateau Research Station (National Biological Survey Cooperative Parks Studies Unit) has been supported by small park Natural Resources Preservation Program (NRPP) funds. Some important results of the inventory include: 1. characterization and mapping of the desert riparian and associated upland vegetation communities, 2. discovery of additional new aquatic invertebrate species from the unique limestone sink spring at Montezuma Well, 3. documentation of state listed sensitive fish species (desert sucker and Sonoran sucker) in stream habitats at the park, 4. detailed description of the bird community in the area, which includes nesting common black-hawks and yellow-billed cuckoos, and 5. documentation of the loss of several native mammal species from the area in historic times, probably due to long-term habitat change.

Montezuma Castle and the Western Regional Office are providing funding to begin long-term monitoring, concentrating on riparian and associated habitats. The inventory and monitoring effort at the park has received the continued support and commitment of the superintendent and staff, and also regional office staff (Southern Arizona Group, and the Western Regional Office). This sustained commitment is crucial to any extended project, and is particularly important as we move into the long-term monitoring phase which will begin in spring 1995.

NORTH ATLANTIC

The regional office Division of Natural Resources and Research has recently published a series of technical reports. Those focusing on Acadia National Park, Maine, include, "Acadia National Park geographic-based fire and natural resource management simulation system (AGEOFRSS)," by S.L. Garman; "Elemental mass balance, and episodic and ten-year changes in the chemistry of surface waters," by R H. Heath, J. S. Kahl, S.A. Norton, and W.F. Brutsaert; and "Nutrients in Somes Sound and the associated watershed, Mount Desert Island, Maine," by P.H. Doering and C.T. Roman. Cape Cod National Seashore, Massachusetts, reports include, "Ecology and monitoring of white-tailed deer on Cape Cod National Seashore," by W.F. Porter, D.L. Garner, W.F. Seybold; and "Modern limnology of the Provincelands Ponds for comparison with recent changes in the biota of Duck and Bennett Ponds adjacent to the Prov-incetown Municipal Landfill," by M.G.

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Winkler. Finally, two reports apply to Gateway National Recreation Area, New York. They are, "Inventory of submerged natural resources and review of key issues," by J. Muzio, F. Rubel; and "Seeps investigation at Fountain Avenue Landfill," by R. Ahlert and C.Rugge.

ROCKY MOUNTAIN

Last issue, we reported that wolf restoration in Yellowstone National Park (and central Idaho) was imminent and that no lawsuits were expected to delay the carefully researched and planned project. In late November, however, after the *Park Science* fall release, the American Farm Bureau Federation filed suit in U.S. District Court, delaying the reintroduction effort.

The lawsuit contends, in part, that Yellowstone and central Idaho are outside the "probable historic range" of the Canadian wolves that would be introduced there and that translocating a species outside of its probable historic range is in violation of the Endangered Species Act. The lawsuit requested a temporary restraining order to prevent the release of the wolves until after the suit is heard. Federal officials have agreed not to import any wolves into the United States until after January 1, 1995. The U.S. Fish and Wildlife Service, however, can continue to capture wolves in Alberta, to fit them with radio collars (necessary for follow-up study after reintroduction), and to turn them loose for later tracking. By the time this issue of *Park Science* has been circulated, the lawsuit will likely have been settled.

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The Rocky Mountain Region established a natural resource management team in 1994 to focus on field problems and needs. Not an advisory group, this team of park resource specialists and regional office staff will emphasize performing services for parks. Another responsibility of the team is to improve communications among the natural resource management professionals in parks and the regional office. The team's first assignment was to review the natural resource program at Zion National Park, Utah. Requested by the park resource management division, the in-depth review took place last September.

Team members and leaders will change on a rotating basis, and regional office staff will not serve as team leaders. Working on the team also offers opportunities for professional development. The team presently consists of Cheryl Clemmensen, Grant-Kohrs Ranch National Historic Site, Montana; Chip Jenkins, Black Canyon of the Gunnison National Monument, Colorado; Ralph Moore, Zion; Sue Consolo Murphy, Yellowstone National Park, Wyoming; Bruce Rogers, Canyonlands National Park, Utah; Jim Tilmant, Glacier National Park, Montana; and Bob Moon, Monta-Glea Trebilcock, Janet Wise, and Tom Wylie of the Rocky Mountain Regional Office.

• • •

The regional office and the NPS Water Resources Division cohosted a water resource planning workshop in Denver, Colorado, during November 1994. The workshop provided an overview of the water resource management planning process and focused on the development of resource management plan project statements, scoping documents, and water resource management plans. These documents support the decision-making process related to the protection, use, and management of park water resources.

The group first discussed case studies of water resource management programs before beginning a problem-solving session. Park representatives presented the water resource issues facing their parks and then received individual technical assistance from staff in developing strategies and documents.

This was one in a series of workshops that have proved to be beneficial to participating parks. Park resource managers interested in initiating additional water resource planning workshops should contact their respective regional water resource coordinators.

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In cooperation with the Environmental Protection Agency Region 8, the Rocky Mountain Region is initiating a Colorado Plateau ecosystem partnership for the development of an information database. The focus of the database development, storage, and retrieval activities will be the National Biological Survey field unit led by Charles van Riper III at Northern Arizona University in Flagstaff. Data sets will be structured at two different scales, one for comprehensive plateauwide data, and a second providing more detailed data for specific parks.

ALASKA

After 18 years of concentrating on its cultural resources, the Klondike Gold Rush National Historical Park Resource Management Division expanded this year to include a natural resource program. First-year efforts included conducting a native and exotic plant inventory, developing a herbarium collection, assessing a campground for limits of acceptable change in preparation for upcoming state centennial celebrations, achieving a trail survey and assessment, creating a wildlife observation database, and developing both short-term and long-term program goals.

Initial surveys reveal a park that, although small in size by Alaskan standards (approximately 13,000 acres), is rich in biodiversity and special in geographic character. The park lies in the driest and northernmost section of southeastern Alaska, stretches from sea level to the summit of a coastal mountain, and links the moist marine climate of the southeast to the dry interior climate of the Yukon. With so much landscape and species diversity within such a compact area, we anticipate another exciting season of discovery.

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The Alaska Region has completed a draft natural resource strategic action plan that will serve as a regional resource management plan and more! It should help to improve our science management capabilities by identifying region-based needs in resource management.

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We are planning a resource management workshop for the end of February in or near Anchorage. The gathering will combine a work group session with an informational meeting format for discussing changes. The highlights of technical workshops will be summarized in the next *Park Science*.

• • •

Gary Vequist attended an interagency Alaska ecosystem management team meeting that might have been termed more appropriately a *design* team. This is because the team designs pub-

lic involvement approaches to ecosystem management. Ecosystems are complex and require more interdisciplinary expertise, or as we say in Alaska, "more brains per acre." This approach to ecosystem management combines not only the interdisciplinary expertise of the agencies, but also that of the public and other organizations. Past planning and decision-making processes often created adversarial relationships, because resource management decisions were made *for* the public. Using the new ecosystem management design, decisions are made along *with* the public.

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Several articles of relevance to regional parks have been published during the last several months. They are: "Succession on regraded placer mine spoil in Alaska in relation to initial site characteristics," by R.V. Densmore, 1994, and published in *Arctic and Alpine Research* 26:60-69; "Stream and floodplain restoration in a riparian ecosystem disturbed by placer mining," by K.F. Karle and R.V. Densmore, 1994, and published in *Ecological Engineering* 3:121-133; "Stream and floodplain restoration in Glen Creek, Denali National Park and Preserve," by K.F. Karle and R.V. Densmore, 1994, and published in *Technical Report NPS/NRWRD/NRTR-94/17,* 33 pp; and finally, "Functional response of wolves preying on barren-ground caribou in multi-prey ecosystems," by B. Dale (NPS), L. Adams (NBS), and T. Bowyer (University of Alaska), 1994, and published in the *Journal of Animal Ecology.*

Pacific Northwest

Over the past two years, resource managers at Craters of the Moon National Monument in Idaho developed several partnerships for the purpose of rehabilitating an abandoned mine site within park boundaries. Before rehabilitation, Martin Mine, a gold and silver mine dating from the 1920s, was about an acre in size and consisted of four tailings piles totaling 1,850 cubic yards (1,415 cubic meters) of material. The site was of concern, because it is located in the drainage of a creek that is the sole source of monument drinking water; a preliminary baseline water quality study had indicated that mine tailings were impacting the stream, predominantly by surface erosion and sediment transport processes.

The first step we took in the reclamation effort was to evaluate the mine under the Comprehensive Environmental Response and Liabilities Act (CERCLA, also known as Superfund) process. A preliminary site assessment conducted by the NPS Water Resources Division concluded that our site was not eligible for clean up under the act.

Next, resource management staff solicited technical assistance from the NPS Mining and Minerals Branch, who agreed to develop a reclamation design and oversee the implementation of the project. The selected design included: 1. placing the tailings below grade in dry, stable areas, 2. covering the tailings with a minimum of 36 inches of topsoils salvaged from adjacent roadfill, 3. reconstructing the surfaces to restore original contours and surface hydrology, and 4. mulching and seeding the area with native pioneering species. Mining and Minerals staff plan to publish a technical case study of this reclamation effort in a future edition of *Park Science.*

Finally, the Natural Resource Division of the Pacific Northwest Regional Office agreed to fund the reclamation effort. In order to stretch funding, resource management staff at the park approached our neighboring Bureau of Land Management district to ask for their assistance. Through a contract, they provided a bulldozer and an operator for the work.

The park completed the project in late September following a full week of hard work. Staff from the Mining and Minerals Branch were on hand to oversee heavy equipment operations. An archeologist from Hagerman Fossil Beds National Monument, Idaho, was also on-site to provide expertise on the protection of any cultural resources that might have been discovered (none were unearthed). Finally, a local Boy Scout troop along with resource managers handled the reseeding and mulching of the site.

The many cooperators involved in the project are to be commended for their efforts. Without them, rehabilitating this mine site at Craters of the Moon never would have occurred.

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Fossil finds, some of worldwide significance, continue to spring up all over Hagerman Fossil Beds National Monument. In December 1993, NPS staff excavated a fossil log that was not mineralized. That is, the original wood was still present despite the age of the specimen. The log is the second oldest of its kind in the world (the oldest is found in Greenland), and more of it is still present in the cliff face. The remainder will be excavated when funds become available.

In the spring 1994, a geology graduate student from Idaho State University discovered the skull of a fossil camel. What is really exciting about this find is that it was discovered in a geologic formation that had not been known to contain fossils, whatsoever. The camel skull is on display in the park visitor center.

During the dog days this past summer, we excavated several mastodon bones from a quarry in a remote section of the monument. While these bones were not in good condition, as we were prospecting around the area, we found an articulated fossil beaver skeleton! We have cast this skeleton in a plaster jacket for safekeeping and hope that the National Guard will provide us the service of a helicopter for its removal.

• • •

The regional director recently recommended a policy of no recreational harvest of edible mushrooms in Pacific Northwest parks. While the *Code of Federal Regulations* permits a superintendent to designate fruits, berries, nuts, and unoccupied seashells to be gathered for personal use, the provision also stipulates a restriction. The regulation states that gathering is only allowed upon a written determination that the activity will not adversely affect wildlife, reproductive potential of a plant species, or otherwise adversely affect park resources. The memo included a summary of ecological considerations related to the harvest of mushrooms and recommended that superintendents not authorize the harvesting activity until they can demonstrate that mushroom collecting is not detrimental to park resources.

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INFORMATION CROSSFILE

BIODIVERSITY AND COMPLEX webs of interactions are commonly discussed in ecological circles; however, Peter Kareiva points out in three articles of the September 1994 issue of *Ecology* (Special Feature, *Ecology* 75 (6), 1994, pp. 1527-1559) that this is not the focus of recent ecological research. Kareiva reviewed every paper published in the journal between January 1981 and December 1990 and found that greater than 60% of the papers dealt with at most two species and a single pairwise interaction. Reductionist ecologists have been so focused on simple experiments that they have developed new terms to describe more complex situations, such as higher order interactions. Kareiva expresses concern that interaction modifications (direct interaction of two species altered by the presence of a third) are often not considered in much of the ecological research dealing with higher order interactions. Ecologists have tended to write papers that marvel at the discovery of these interactions, neglecting the effects of these interactions on the interpretation of results.

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The presence of introduced fish populations may substantially alter the community structure of native species within a body of water and complicates fisheries management. The widespread management practice of fish stocking has also added considerable confusion in regard to the distribution of native fish populations. Consequently, a basic question that NPS biologists often need to address is the native status of fish populations.

Similar questions are being asked about the status of lakes in Canadian national parks. A recent study by S. Lamontagne and D.W. Schindler (*Canadian Journal of Fisheries and Aquatic Sciences* 51(6), 1994, pp. 1,376-1,383) determined the historical status of several lake fish populations in Jasper National Park by interpreting the abundance of subfossil remains of *Chaoborus spp.* (a diptera) from sediment cores. *Chaoborus* species are sensitive to the presence of planktivorous fish, with the largest of the species, *Chaoborus americanus,* being the most vulnerable and rapidly extirpated when fish are present. Another related study by B. Miskimmim and D.W. Schindler (*Canadian Journal of Fisheries and Aquatic Sciences* 51 (4), 1994, pp. 923-932) used sediment cores to reconstruct a 50-year record of the invertebrate community structure in three lake basins. This study was done to assess the invertebrate community response to past toxaphene treatments and subsequent trout stocking.

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Do lists of endangered, threatened, and sensitive species compiled by federal and state wildlife agencies accurately reflect known or suspected population declines? Using federal and state lists of endangered or sensitive species, Jonathan Atwood, in his article, "Endangered small landbirds of the western United States" (published in *A Century of Avifaunal Change in Western North America. Studies In Avian Biology No. 15,* J.R. Jehl, Jr., and N.K. Johnson editors), compared these lists with the results of three recent monitoring studies assessing regional trends in western bird populations.

Of the 135 species of small western landbirds currently indicated as needing conservation concern, 78 (58%) occur either peripherally in the West or as peripheral populations in those states where they appear on official lists. Of the remaining species, none exhibited declining population trends that were detected by two or more of the monitoring studies. Additionally, the monitoring studies identified 27 species of landbirds that are absent from federal or state lists of species of conservation concern. Six of these species (band-tailed pigeon, olive-sided flycatcher, Swainson's thrush, Wilson's warbler, chipping sparrow, and black-throated sparrow) were found to be declining by at least two monitoring sources. Though some differences in Atwood's analysis may be trivial, merely reflecting limitations in population monitoring techniques, clearly they do not explain the failure of government agencies to incorporate results of recent scientific findings into their listing process.

In conclusion, Atwood notes, "inconsistent and poorly defined terminology, failure to systematically incorporate current scientific data, and overemphasis on protection of peripheral populations that show no evidence of widespread declines have created a vague and confusing system that has minimal value to scientists or conservationists." Increasing threats to bird populations make it imperative that we improve the processes used to identify species in need of special conservation.

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The Academy of Natural Sciences of Philadelphia and the American Ornithologists Union have combined their resources to begin publishing an encyclopedic reference series featuring accounts of the biology of each of the 700+ species of birds known to breed in North America. *The Birds of North America* summarizes what is known or unknown about the biology and status of each North American bird. The standard profile format emphasizes key aspects of ecology and conservation. Each profile, authored by a recognized expert or team of experts, includes information on distribution, population status and trends, habitat needs, and management recommendations. An excellent bibliography is also included with each account. To date, approximately 80 species accounts have been published and the editors plan to publish an additional 80 accounts per year over the next eight years. Each account costs approximately $7. If you have planned a project that involves specific species, this is an excellent starting point from which to gain reference material. For more information call 1-800-345-8112.

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A new quarterly journal, *Urban Ecosystems,* will be launched at the Seventh National Urban Forestry Conference to be held in September 1995 in New York City. The journal will foster the application of ecosystem science principles to understanding the dynamics of urban systems, and link urban ecosystem science and urban ecosystem management. The journal will primarily contain peer-reviewed investigations of the function and dynamics of urban ecosystems. A significant portion of the journal will also discuss management and policy implications of the articles and offer dialogue between urban ecosystem scientists and managers. The journal will include an editor's summary, invited commentaries from urban ecosystem managers, and a letters section. For more information, write to the Urban Forestry Department. American Forests, P.O. Box 2000, Washington, D.C. 20013.

Contributors included Reed Glesne and Bob Kuntz of North Cascades National Park.

BY JOHN G. DENNIS

THE U.S. MAN AND THE Biosphere Program (MAB) of the United Nations Educational and Scientific Organization is alive and well, despite any lack of information about it over the past few issues of *Park Science*. The Washington Office has changed, along with everyone else–Bill Gregg, former Mr. MAB in the National Park Service, is now Mr. MAB in the National Biological Survey; Nape Shelton, former author of MAB Notes, has retired and is touring the United States or world; and I have replaced Bill Gregg as the (acting, of course) associate director's (acting, of course) staff support for NPS MAB.

MAB, itself, has a new chair of the national committee. He is Dean Bibles, currently Staff Assistant to Secretary Babbitt as director for policy on land tenure. An ex-Bureau of Land Management state director, I believe he also is the first land manager to become national committee chair, an event that I think will greatly benefit the biosphere reserve component of the MAB program, while not jeopardizing the existing strength of the research component.

These MAB Notes will report on some of the key events of the last two national committee meetings–the July 29 meeting of the U.S. National Committee for MAB and the November 3 meeting of the Executive Committee of the U.S. National Committee for MAB.

The July meeting continued support for high latitude, human-dominated systems, tropical ecosystems, and temperate ecosystems directorate core projects and initiated support for the marine and coastal ecosystem directorate core project. While all directorate projects have value to parks and biosphere reserves in general, the human-dominated, temperate, and marine and coastal projects specifically relate to one or more park-based biosphere reserves and attempt to bring an integrated, natural and social science, focus to their activities. Although the human-dominated project includes New Jersey Pinelands, Virginia Coast Reserve, and South Florida, its focus to date has been South Florida, where it is stirring the pot of thought by bringing together natural, social, economic, and legal specialists to stimulate new ways of thinking about sustaining both natural and human economic livelihoods in South Florida. Contact Mark Harwell, University of Miami, 305-361-4157 voice, 305-361-4077 fax, or "harwell@rcf.rsmas.miami.edu" on the Internet.

The temperate ecosystems project, which involves comparisons of land ownership-land use characteristics in the Olympic Peninsula of Washington and Southern Appalachians regions, discovered that it had to invest a great deal of time and effort in teaching natural scientists and socioeconomic scientists how to communicate with each other and learn each others' definitions of common words used very differently. Contact Bob Naiman, 206-543-6920 voice, 206-543-3254 fax, "cssuw@u.washington.edu" for more information.

The marine and coastal ecosystems project will stimulate the interaction of ecologists, sociologists, economists, and resource managers to assess effectiveness of existing marine management systems and develop information useful for building partnerships for developing, initiating, and operating marine and coastal resource protection in areas where management systems will undergo change within the next few years. Although the directorate proposed four areas, there likely will be only enough funding to focus on two, the Florida Keys and Channel Islands, California, both of which contain NPS interests. Contact Michael Crosby, 301-713-3155 voice, 301-713-4011 fax.

Of much more immediate interest to many nation park system areas, the July meeting broke new ground for the MAB program by adopting a strategic plan for the U.S. biosphere reserve program, by adding a biosphere reserve directorate chair to the national committee, and by allotting $120,000 of fiscal year 1994 funds to the biosphere reserve directorate. The essence of the strategic plan is to help ". . . each U.S. biosphere reserve . . . become a full partner in the process of integrating conservation and sustainable development locally, and in sharing information and experience to help address regional and global problems." In putting the biosphere reserve directorate chair onto the national committee, the national committee implemented a strategic plan goal of integrating the biosphere reserve program as an essential component of the MAB program. In allocating the first formal funds to the biosphere reserve directorate, the national committee supported development of a biosphere reserve selection guidelines, review of the biosphere reserve network, regional meetings of biosphere reserves, development of regional feasibility partnerships, an annual managers workshop, a biosphere reserve brochure, and U.S. participation in a EuroMAB meeting of managers.

The November executive committee adopted a new mission statement for MAB and approved proposed RFPs for biosphere reserve catalytic grants and the tropical ecosystems directorate small grants program. They also addressed the need for a biosphere reserve directorate coordinator and how such a need might be filled by a detailed staff person from a MAB agency. Finally, they established an ad hoc commission to review the structure, orientation, and substance of the MAB Program, and received a report on the EuroMAB managers meeting.

The new mission statement is short and sweet: "The mission of the United States Man and the Biosphere Program is to foster harmonious relationships between humans and the biosphere through domestic and international cooperation in interdisciplinary research, education, biosphere reserves, and information exchange."

The biosphere reserve catalytic grants program is intended to support workshops and partnership-building activities. It is to be a competitive process that focuses on projects that produce short-term tangible results. As scheduled at the meeting, it would require applications for available funds to be submitted by January 15, 1995, and would announce awards in the spring 1995.

The ad hoc commission likely will conduct its deliberations through the 1994-95 winter and provide a draft report to the national committee by March 1995. The purpose will be to reexamine MAB in terms of the new context presented by both domestic and international changes that have occurred. These changes include complexities of managing large-scale land-

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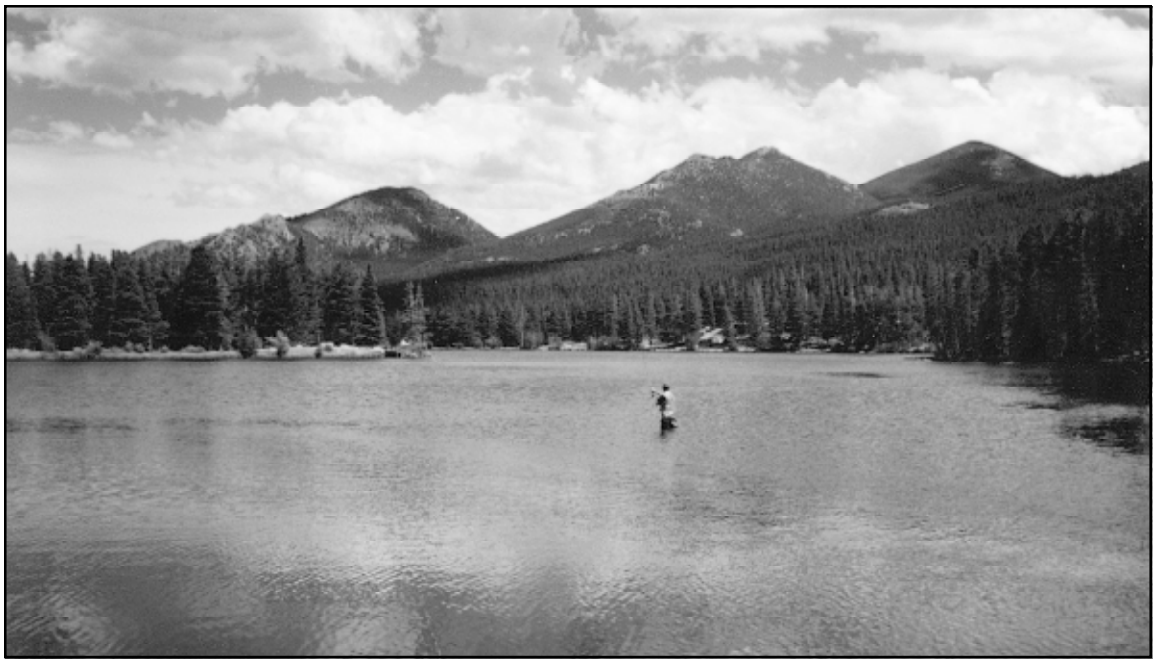

Figure 1. Water resources proved among the most important to a positive visitor experience in Rocky Mountain National Park as evidenced by this visitor-produced photograph.

Visitor Employed Photography at Rocky Mountain National Park: A Valuation Technique

by Jonathan G. Taylor, Natalie R. Sexton, and Kenneth J. Czarnowski

Recently, the National Park Service and the National Biological Survey joined forces to clarify and quantify visitor values of resources in Rocky Mountain National Park in Colorado. During the summer and fall 1993, 197 park visitors participated in a *photo survey* in which we asked them to photograph features of the park (figure 1).

For this study, we were particularly interested in the importance of water and water-related resources to the visitor experience. Researchers at the National Biological Survey were investigating public knowledge and appreciation of riparian ecosystems. Rocky Mountain National Park resource managers needed to establish the importance of water resources to the park visitors, in part because of the many competing demands on park water. By not revealing that our primary research focus was the perceived values of water and water-related resources, we could objectively assess how important these resources were to the visitors by counting the relative frequency at which these features occurred as the subject of the photographs.

Park volunteers distributed single-use cameras to park visitors (figure 2), and instructed them to, "photograph the 12 scenes, features, or situations within Rocky Mountain National Park that have the most important effect (either positive or negative) on your experience of the park." In addition to the cameras, visitors were given *photo logs* in which they recorded the subject and location of each photograph, whether it was a positive or negative scene, and their reasons for taking the photo.

The specific technique used in this study, termed *visitor employed photography* (VEP), has been utilized by other researchers (see, for example, Cherem 1973, Cherem and Traweek 1977, Cherem and Driver 1983). The study technique involves distributing cameras to visitors to an area and asking them to photograph elements indicated by a specific research objective. This allows the researcher to "see through the eyes of the beholder" (Cherem 1973).

This technique has several advantages for measuring human perceptions of environment. First, visitor employed photography captures important scenes or landscapes pictorially, so researchers can see what is valued, firsthand. Second, the method can leave the specific research focus unstated, thus allowing a more objective measure of the importance of a specific resource of interest. Third, the results come directly from participants, rather than being prompted by the researchers. Fourth, the method is an unobtrusive means of measuring elements important to a recreation experience, and fifth, this method does not rely upon after-the-fact recall, which can be quite inaccurate (Bradburn et al. 1987).

Figure 2. A volunteer distributes cameras and questionnaires and explains the study to a prospective participant.

Traditionally, the National Park Service has used visitor-use surveys and observations to obtain visitor opinion and park-use information. Those surveys are primarily conducted as personal interviews at park entrances or exits. The VEP technique is distinct from these surveys in both the way it is administered and the research objectives it is designed to achieve. In visitor employed photography, we are interested in measuring human perceptions and preferences as they relate to critical natural resources and ecosystems. The demographic data collected in the follow-up survey is used to search for explanatory human characteristics and to cross-check with other surveys to ensure a representative sampling of park visitors.

We stratified the target sample of 200 park visitors to include a broad range of park users. Half of the cameras were distributed in July, during the peak summer season, and half in September, during the fall colors and elk bugling period. Cameras were distributed throughout a full week during both periods. In addition, we split those subsamples evenly among four levels of use intensity: drive-through visitors, campers, day-hikers, and backcountry users. From start to finish, this study was a full collaboration between resource managers and social science researchers, sustained by significant volunteer contributions of time, effort, and materials.

Visitors accepted the photo challenge with enthusiasm. Ninety-one percent of the respondents completed the assignment and returned the cameras. We then sent each respondent a complimentary set of his or her photographs, accompanied by a follow-up survey. The surveys were designed to obtain demographic data, more information on each respondent visit, and the values they held for the park water and water-related resources. Eighty-five percent of the photo recipients returned their follow-up surveys. Rates of return for the cameras and surveys are quite high (Dillman 1978).

Results

Features captured in the 2,060 resulting photographs ranged from pristine mountain lakes to park shuttle buses. From the photographs, we identified 12 main categories of features (figure 3). Of these, mountain vistas, water bodies, wildlife, and management features (e.g., maintained trails, buildings, and picnic sites) were photographed most often. Only a smattering of the features photographed were reported to have had negative effects on the visitor experience. The majority of the negative features were human impacts on the park (e.g., crowding, litter, and horse manure on trails), plus a few management features, such as road closures and inadequate facilities.

We identified several important differences between user groups. Campers found management features to be more than twice as important as any other user category (figure 4), but they did not photograph park water features nearly as often. Drive-through and backcountry visitors, groups that had greater access to the mountainous terrain via Trail Ridge Road or high country trails, photographed mountain vistas more often than others. The fact that backpackers took proportionately fewer pictures of wildlife may be explained, in part, by their getting away from heavily traveled areas, where wildlife is habituated to human presence.

Preliminary analyses suggest that water and water-related ecosystems are very important to the visitor experience of Rocky Mountain National Park. Water bodies were the second most photographed category in the park and were the main focus of 17% of the 2,060 photographs. Over 75% of the respondents photographed at least one water feature within the park. When asked in the follow-up survey how a one-third reduction in water and water-dependent plants and animals would affect their experience, 82% of the respondents said it would negatively affect their experience of the park. On a 1 = "negatively affect" to 10 = "positively affect" scale (figure 5), the response mode was 1 and the median was 2 for all three reductions: water, water-dependent plants, and water-dependent animals. Respondents also reported their willingness to pay to preserve the park water resources (figure 6). Nearly two-

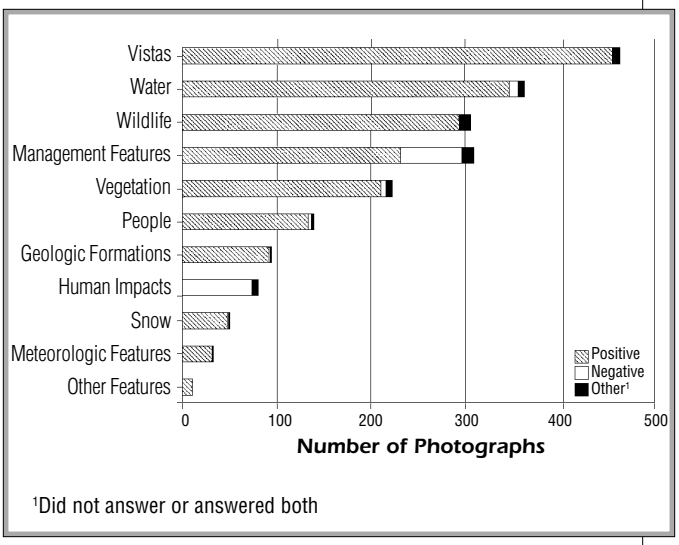

Figure 3. Number of photographs taken by survey respondents of park features by category; participants indicated whether feature effect was positive or negative.

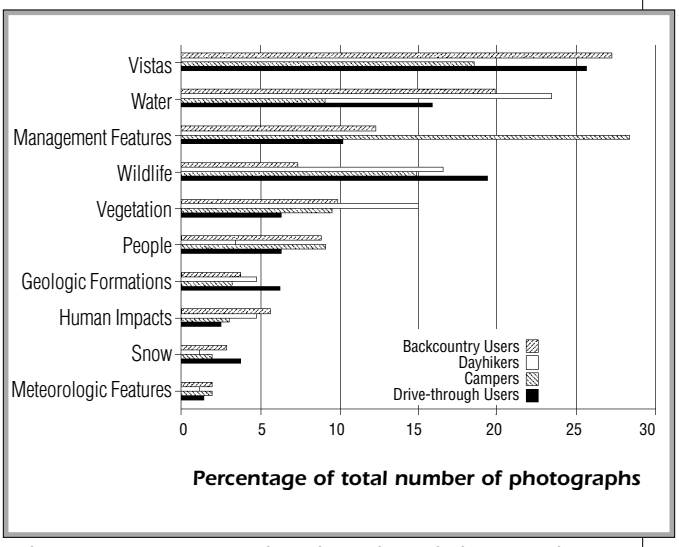

Figure 4. Percentage of total number of photographs comprised of categorized park features photographed by the four user group subsamples in the study.

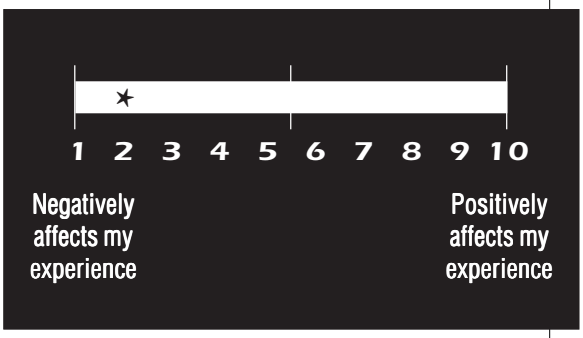

Figure 5. Median rating given by respondents of the effects of reducing park water or water-dependent resources by one-third.

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thirds (63%) stated that they would pay an additional $2 or more in entrance fees to preserve the Rocky Mountain National Park water resources .

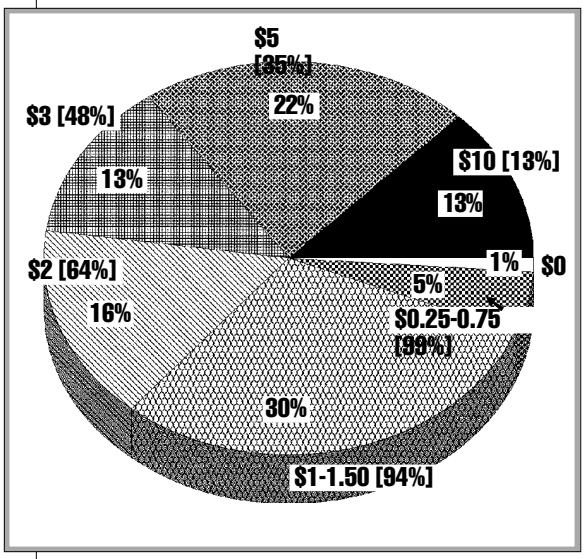

Figure 6. Visitor willingness (by percentage) to pay to protect Rocky Mountain National Park water resources. Numbers in brackets are cumulative percentages: willing to pay $X or more.

An important part of the data analysis involved the use of a geographical information system (GIS) to record the location from which each photograph was taken. Volunteers from the Colorado Mountain Club were able to determine location coordinates for almost all of the photographs by reading the location information provided by respondents in the photo logs, looking at the photographs, and comparing this information to their detailed knowledge of the park environs. With the GIS coordinates in this system, it is possible to determine locations of negative features, areas essential to the park visitor experience, water features most often photographed, and other critical park resources.

Management Implications

The application of visitor employed photography to Rocky Mountain National Park had practical, on-the-ground management utility. During the time that the survey was being conducted, the U.S. Department of Justice, on behalf of Rocky Mountain National Park, was presenting claims for federal reserved water rights for the park in State Water Court. These claims held that all water unappropriated as of the date of the reservation was necessary for maintaining the park in its natural condition. Park managers believe that the many water-dependent values, both physical and biological, found in Rocky Mountain National Park, require an undetermined amount of water to prevent impairment. However, until this study, the values of water-dependent features held by visitors had been largely unknown.

Data from the study suggest that water and water-dependent features are extremely important to a visitor experience to the park. A large majority of all respondents (78%) took pictures of water features, comprising 17% of all photos. Many anticipated that the results of this study would be presented to the water court to help bolster the park claims. However, this was not necessary because of a recent favorable ruling by the court granting the park its claimed federal reserved water rights.

In order to attach a general monetary value to water resources, the study asked respondents how much money they would be willing to pay, in the form of increased entrance fees, to protect the park water resources. Over 90% indicated they would be willing to pay $1 or more to protect these resources.

These results are important to park managers in making decisions to fund protection of water-related resources. Recently, Rocky Mountain National Park has acquired the right-of-way for a failed dam. This study affirms that managers are allocating funds in a manner that is in concert with values held by the visiting public. Further development in the form of high elevation storage for irrigation, hydroelectric generation, and continued trans-basin diversion of water for a growing Front Range populace are issues facing park management that will require the continued attention of all park visitors.

Preliminary results of the study show a general support for the park management policies. In particular, the management objectives of protecting wetlands; preserving lakes, rivers, streams, and other water courses; and restoring riparian areas appear to be well justified. The park general maintenance practices, the architectural style of the buildings, and the quality of service provided by park staff were the features most often praised by study participants. However, they identified other issues as negative, including wildlife feeding, general crowding, conflicts with horse use, closure of certain facilities, and the lack of solitude. These results help park managers focus their attention on issues of concern to the visitor-public.

How society values natural resources differs greatly from one resource to another and from one public to another; these values also change over time. Valuation research has demonstrated that, quite often, resource managers value the resources for which they are responsible in a manner different from the society at large (Peterson and Lime 1973). Visitor employed photography is a potentially important research tool for the study of resource values and environmental perceptions of the user-public. Results from the use of this study technique can help validate, for the resource manager, the need for resource protection or impact mitigation. Park managers can use this information when making decisions about resources, knowing that the views of those who use the park are included in that process. Visitor employed photography helps managers to be more responsive to visitors and to manage resources more effectively. §

Jonathan Taylor is a Research Social Scientist with the National Biological Survey, Midcontinent Ecological Science Center in Fort Collins; Natalie Sexton is a Publications Editor with the National Telecommunications and Information Administration in Boulder; Kenneth Czarnowski is Park Hydrologist, Division of Resource Management, Rocky Mountain National Park--all in Colorado. Taylor's address is MESC/NBS, 4512 McMurry Ave., Fort Collins, CO 80525-3400, phone (303) 226-9438.

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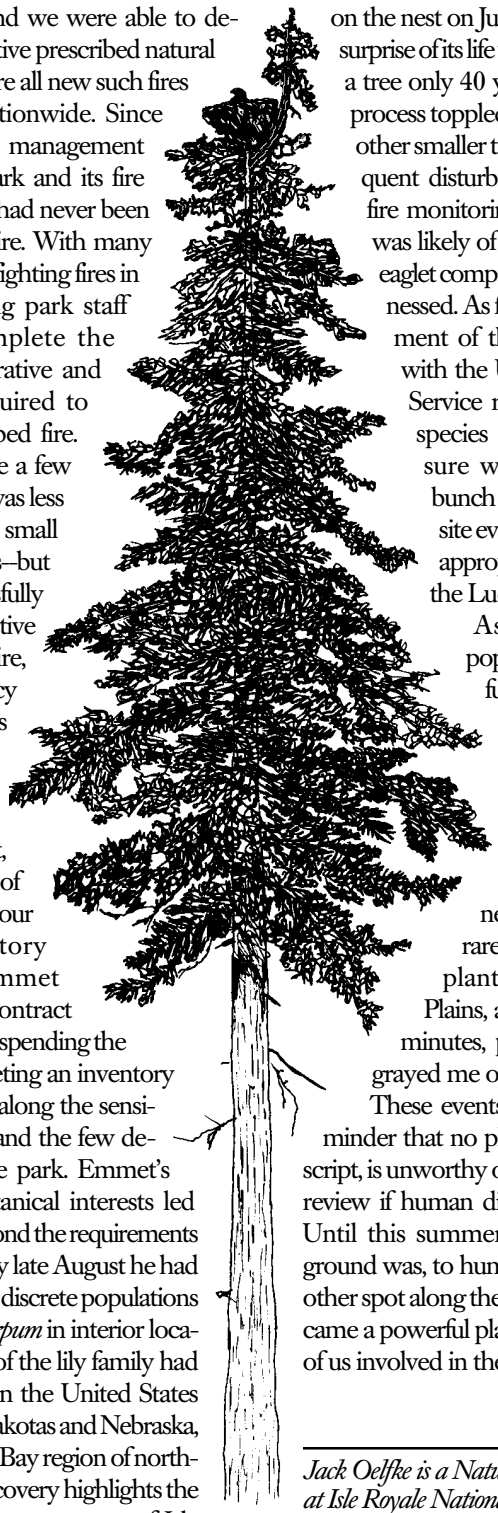
An Isle Royale Story

by Jack Oelfke

Sometimes, events happen that make us pause and lead us to a sense that, indeed, our professional efforts are all worthwhile. Amid the crush of paperwork, reports, fieldwork, and daily crises, episodes occur that help us realize the special nature of the areas in which we work. I have a brief story from the summer 1994 on Isle Royale that has provided a spark of wonder to keep me going. A series of events occurred that individually were significant to the park, but more importantly the setting in which they occurred led to one of those head-shaking, "ain't-that-amazing" feelings.

The first event began in early May when a small team of university and NPS personnel, livetrapping wolves on Isle Royale, accidently discovered an active bald eagle nest. The nest was in an area of the park in which eagles had not nested for decades, and it was to become one of six active bald eagle nests for the summer. Including this discovery, the nests produced the most breeding pairs of eagles the park had seen in 30 years or more. Unfortunately, the new nest was located in a tall white pine just 40 yards off a popular hiking trail. The park quickly closed the trail, recognizing that the action would disrupt visitor use for most of the summer season. However, the closure was essential, and because of it, the adults successfully raised one eaglet, which later fledged. This was the first major public use closure ever enacted by the park to protect resources during the summer season, and it was a success. The public also supported the closure.

The next event began in late July, when a thunderstorm moved through the park and lightning ignited a small fire by striking a large white pine. Ninety-five percent of park lands lie in a prescribed natural fire zone, wherein a lightning-caused fire can be permitted to run its course within certain parameters. One part of the process in approving a fire as a prescribed natural fire includes reviewing the national fire situation to ensure that adequate resources are available to assist on the fire, particularly if a later suppression effort should be required. The national fire situation late last July was extreme, and we were able to declare the fire as an active prescribed natural fire just one day before all new such fires were prohibited nationwide. Since adopting a new fire management plan in 1992, the park and its fire policy and response had never been tested by an active fire. With many key personnel away fighting fires in the West, remaining park staff scrambled to complete the myriad of administrative and technical tasks required to manage the prescribed fire. Rains doused the fire a few weeks later when it was less than 1 acre in size–a small fire by any standards–but the park had successfully dealt with its first active prescribed natural fire, under the new policy and with a bare-bones staff.



The final piece of the puzzle fell into place in late August, near the culmination of the field season for our rare plant inventory project. Dr. Emmet Judziewicz, under contract with Isle Royale, was spending the entire season completing an inventory of rare plant species along the sensitive rock shorelines and the few developed areas in the park. Emmet's enthusiasm and botanical interests led him to areas well beyond the requirements of his contract, and by late August he had discovered five small, discrete populations of *Disporum trachycarpum* in interior locations. This member of the lily family had never been located in the United States east of the western Dakotas and Nebraska, or south of the James Bay region of northern Ontario. This discovery highlights the unusual climate and remoteness of Isle Royale that permit many disjunct populations to survive.

So why tell this story, for surely other parks experience such events each year? The kicker is that each event–the new eagle nest, the lightning-caused fire, and the rare plant population discovery–occurred within 50 yards of each other! The young eaglet sitting on the nest on July 24 probably got the surprise of its life when lightning blasted a tree only 40 yards away and in the process toppled it and burned several other smaller trees nearby. The infrequent disturbance from occasional fire monitoring by NPS personnel was likely of minor concern to the eaglet compared to what it had witnessed. As for the actual management of the fire, we consulted with the U.S. Fish and Wildlife Service regarding endangered species protection, and I am sure we were the quietest bunch of fire personnel on-site ever to manage a fire. We appropriately dubbed the fire the Lucky Eagle fire.

As for the *Disporum* population, we were blissfully ignorant of its presence until after the fire was out and the eaglet had fledged. The possibility that the fire could have easily burned a new eagle nest, its occupant, and a rare handful of *Disporum* plants east of the Great Plains, all in a matter of a few minutes, probably would have grayed me overnight.

These events provided a clear reminder that no place, however nondescript, is unworthy of protection or careful review if human disturbance is planned. Until this summer, that little patch of ground was, to human eyes, truly just another spot along the trail, but it quickly became a powerful place of inspiration to all of us involved in the projects.

Jack Oelfke is a Natural Resource Specialist at Isle Royale National Park. His address is 800 E. Lakeshore Drive, Houghton, Michigan 49931-1895. The park phone number is (906) 482-0986.

Figure 1. Volunteers backpack PUF kits into remote installation site; Figure 2. The PUF kit before breaking inner bag to mix with contents of outer sack; Figure 3. Installer builds support for PUF plug.

Polyurethane Foam Applications in the Closure of Abandoned Mine Openings

By John Burghardt

The National Park Service established a servicewide Abandoned Mineral Land (AML) program in 1984 with five major objectives related to mineral development sites on park lands:

- inventory all AML sites within the national park system
- eliminate safety and health hazards
- eliminate or mitigate resource impacts
- preserve culturally and historically significant sites
- manage sites for special wildlife habitat

Today, the NPS Mining and Minerals Branch has collected data on 2,421 abandoned mine sites that include 10,692 mine openings. These numbers will increase dramatically as we inventory the numerous AML sites in the recent California desert additions to the national park system.

In realizing the objectives of the AML program, we have employed numerous methods to close and reclaim mine openings, depending on the specific conditions and needs at each site. Among these is the use of rigid polyurethane foam (PUF) for plugging openings where the mine does not provide significant wildlife habitat (in the case of bats, for example), where the objective is to reclaim the site, and where conditions preclude an earthen backfill. This article summarizes general PUF closure concepts and various methods of applying foam, and highlights one of those methods that is ideal for remote sites where heavy equipment access and major ground disturbance are not permissible. A comprehensive paper on the comparative advantages, disadvantages, and costs of various PUF application methods is available through our office. A future edition of *Park Science* will carry a follow-up article that describes a method of preserving the bat habitat in mines, while closing them off and making them safe for people.

Basic Application

PUF is produced by mixing two liquid reagents, a resin and catalyst. This mixture is then poured on top of a lightweight form constructed near the mine entrance out of materials such as lumber, plastic sheeting, cardboard, and plywood. A rapid exothermic reaction occurs generating foam that expands to fill all voids and cracks in the mine opening. Within 15-30 minutes, the foam hardens to create a rigid plug firmly bound to the rock. The last several feet of the opening is then *backfilled* with dirt and rock.

The National Park Service has tested four different methods of applying PUF to close abandoned adits and shafts (horizontal and vertical mine openings, respectively). Where vehicular access is permissible, a truck-mounted proportioning unit fed by 55-gallon drums of reagents is the easiest, most economical application method. Where vehicular access is not an option, we have employed three portable systems: a hand-mixed application from bulk product packaged in 5-gallon buckets, prepackaged units including two reagent tanks with hose and nozzle application systems, and a hand-mixed application using plastic bag kits. A cubic yard of PUF is fairly expensive, but the cost is offset by the limited amount of material and time required to plug an opening.

The chemistry of the reagents can be varied to produce different densities of foam. Typical foam density is about 2 pounds per cubic foot, resulting from a 30-fold expansion in volume from the original components. This means that large openings can be sealed using small quantities of material, which is advantageous where insufficient material is available for a total backfill, or where equipment access and ground disturbance are unacceptable. PUF, therefore, offers a good, low-impact closure alternative for AML sites in sensitive,

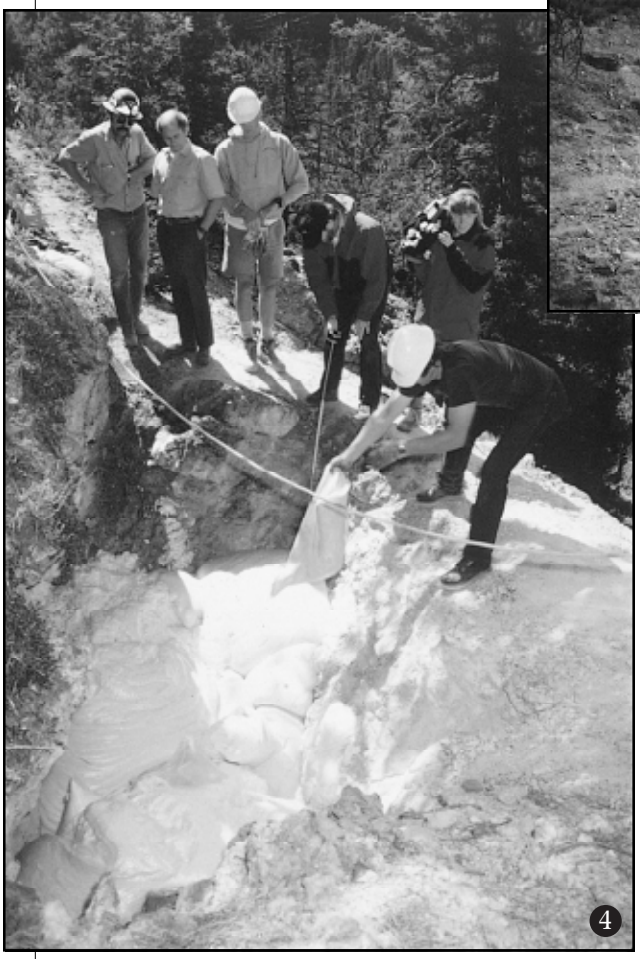


Figure 4. Installer directs expanding PUF foam into desired areas; Figure 5. The completed closure following earthen backfill.

historically significant, or wilderness areas typical to many units of the national park system.

Physical Properties of PUF

Polyurethane foam is inert and will not react with acid mine drainage common to many AML sites. PUF easily cuts with a knife, decays when exposed to ultraviolet light, and is flammable, but the dirt and rock used to fill the remainder of the opening above a PUF plug protects it from vandalism, sunlight, and fire. Although the compressive strength is low (typically 10-15 pounds per square inch for standard foam), it is adequate for plugging mine shafts in areas where heavy vehicles will not traverse the plug. One square foot of standard PUF can support 1,440 pounds in compression. The shear strength for a typical 7-foot plug covering a 5 foot by 5 foot vertical shaft can be calculated at about 100 tons, although its overall strength would be limited to 18 tons by compression failure. When properly backfilled with dirt and rock to the surface (photo 5), however, the compression forces from above are transferred to the walls of the shaft, effectively bridging the plug and enhancing the overall strength of the closure. The closed-cell structure of PUF prohibits the release of mine gases if the plug achieves a good seal. Drainage bypass tubes are installed in closures where water from inside or outside the mine could threaten plug integrity. Most PUF products require a minimum temperature of 50°F for proper foam generation, especially portable systems with hose and spray nozzle applicators.

Environmental and Safety Concerns

PUF is commonly used to insulate ice chests, thermos jugs, refrigerators, and buildings. Home owners may be most familiar with it in aerosol cans available at the hardware store; they use it commonly to seal around window casements and door jambs to prevent air and thermal leaks. PUF releases carbon monoxide and traces of hydrogen cyanide when burned, but in mine closures, backfilling with dirt and rock precludes combustion by isolating the plug from an oxygen source. Some products used at sites where fire is a concern also contain flame retardant additives. Although one of the two liquid components used to make PUF is a toxic isocyanate, neither requires Department of Transportation red tag identification for shipping. Once combined, the isocyanate is complexed into a stable, nontoxic form. The solid foam end product can be discarded in a sanitary landfill without restrictions. When mixing the reagents, any liquid PUF that contacts skin or clothing is nearly impossible to remove. The installer requires adequate ventilation, a dust cartridge respirator, gloves, protective clothing, and protective eyewear for safety.

Case Study: Hand Mixed Application from Plastic Bag Kits

In July 1994, in conjunction with the Colorado Division of Minerals and Geology, we arranged a demonstration of plastic bag PUF kits designed and installed by a private contractor. The test site is a patented mining claim with one adit and one shaft in the Arapaho National Forest just outside Idaho Springs, Colorado. Volunteers backpacked PUF kits one-half mile to the site over steep terrain (photo 1). Lightweight forms of 2 inch by 4 inch lumber and nylon-reinforced utility tarp were constructed approximately 10 feet inside both openings (photo 3). In this application, a lightweight plastic bag of catalyst is stored within a heavyweight plastic bag containing resin (photo 2). The installer ruptures the catalyst bag into the larger bag of resin, which remains intact. The two components are then mixed together by kneading the large bag. When the components are thoroughly mixed, the entire kit is placed in the opening and the foam expands until the outer bag ruptures, releasing foam into the opening. The installer can avoid splash from the rupturing bag and can direct the PUF flow more precisely by cutting the mixed bag before its internal pressure builds, and pouring the mixture where needed (photo 4). After 30 minutes, the PUF has cured sufficiently to backfill with dirt and rock the remainder of the mine opening (photo 5).

Foam bag kits preclude the need for placement equipment, and are not hindered by malfunctioning hose and nozzle systems encountered with other products that we tested. Since the reagents are premeasured and mixing is a simple matter of kneading the bag, proper proportioning is virtually guaranteed. All waste materials may be enclosed in the foam plug (photo 3). This foam product is water based and does not contain chlorofluorocarbons used in other PUF products. The different chemical composition enables the installer to use this product at much lower temperatures than other PUF products, which

Continued on page 28

be restored. The site also provided one of the last opportunities to reconstruct a wetland representative of the once extensive Anacostia River tidal marshes.

Investigations Begin

Initial NPS investigations focused on water and sediment quality and wildlife feeding as factors that limited wetland plant growth at Kenilworth Marsh. Contaminants such as heavy metals and pesticides are not unusual to such urban watersheds, but are of particular concern at this location, since the Kenilworth Marsh is adjacent to an old sanitary landfill that was capped and reclaimed for recreational land in 1972. The potential of toxins to leach from the landfill established an additional possibility for the lack of wetland vegetation growth in the marsh.

During the early studies, the National Park Service confirmed the presence of toxic substances such as lead, chromium, copper, PCBs, and chlordane in the marsh sediments; however, the levels were not considered to be limiting plant growth. Moreover, the University of the District of Columbia conducted bioassays in which Asian clams (*Corbicula fluminea*) demonstrated successful larval development in laboratory tests after having been exposed to the same sediments. In addition, biologists observed that the few residual benches of emergent wetland vegetation at the marsh were growing well, apparently unaffected by any water or sediment quality problems.

In 1988, the Metropolitan Washington Council of Governments and the District of Columbia Department of Consumer and Regulatory Affairs joined the National Park Service by targeting special Chesapeake Bay program funds for projects in the Anacostia River watershed. We used the funds to study the potential for tidal marsh restoration at Kenilworth.

In the spring and summer 1991, we tested the hypothesis, supported by preliminary field studies, that limited plant growth in the marsh was caused primarily by a sediment elevation that was too low relative to tidal inundation. Biohabitats, Inc., a contractor, adapted a bioengineering technique that had been used in the Mississippi River Delta in which 20 foot by 20 foot containment cells were constructed using materials such as brush bundles (tightly bound pine tree branches) or straw bales. We filled the containment cells to varying elevations with bottom sediments and planted them with 10 emergent wetland species.

Figure 1. Kenilworth area, 1927, before dredging and channelization.

Figure 2. Kenilworth Marsh, 1948, following dredging and filling activities that resulted in a recreational lake.

Figure 3. Kenilwo October, 1990, pr reconstruction. A marsh became an mud flat.

Altogether, we constructed some 30 cells, located in two areas of Kenilworth Marsh; elevations ranged from near mean sea level to plus 2 feet. This effort determined the sediment elevation to be near mean high tide for optimal plant growth, and helped us develop a list of native plants with good growth potential. This level was about 2.1 feet above mean sea level during the summer, the same elevation as that of the vestigial benches of wetland vegetation.

The resulting restoration design, possibly involving redistribution of sediments within the marsh, had potential for creating 15 acres of emergent marsh. While we considered the plan workable, funds were not available for its implementation. We also recognized that although bringing in external dredge material, instead of dredging internally, would be feasible for raising elevations, it would likely be too expensive.

Return of the U.S. Army Corps of Engineers

We were very excited to learn that the U.S. Army Corps of Engineers intended to dredge the upper Anacostia River for maintenance purposes and quickly recognized the potential to link the marsh reconstruction project with the dredging project. Although the U.S. Army Corps of Engineers had already identified upland disposal sites in Maryland, staff from the park and the National Capital Region and its Center for Urban Ecology began to explore the feasibility of using dredge material for reconstructing portions of Kenilworth Marsh. If the quality of the Anacostia River sediment was suitable (in levels of contaminants and particle size), we could possibly reconstruct far more than the 15 acres of wetlands detailed in the initial plan. The savings derived from eliminating upland disposal costs would also certainly make the project attractive to the U.S. Army Corps of Engineers. Furthermore, they would be able to demonstrate a beneficial use of dredge material in creating new wildlife habitat in the nation's capital–at a location near their national headquarters!

The Corps accepted the proposal and soon joined the Kenilworth Marsh restoration team. They agreed to perform analyses of the river sediments to be dredged, produce the environmental assessment, and fund the wetland building and planting phases.

The Plan

This new larger scale restoration effort required that we modify the methods described in the Biohabitats, Inc., plan. We decided to reconstruct 32 acres of emergent wetland through the establishment of

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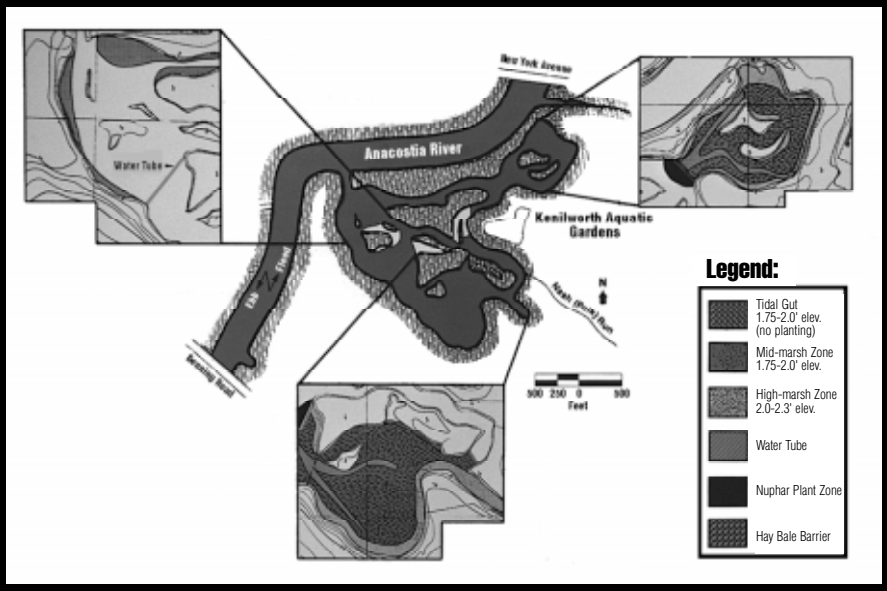


Figure 4. Kenilworth Marsh Restoration Plan.

Figure 5. The reconstructed marsh—Sept. 1993. Note greening *of mass fill areas #1 and #2 where the newly established marsh can be seen.*

two mass fill areas (#1 and #2), 10 and 15 acres respectively, and smaller fringe areas (#3) totaling some 7 acres (figure 4).

Our plan was to temporarily separate mass fill areas #1 and #2 from the tidal marsh (and river) using large water tube devices. Once positioned, the water tubes were pumped full with marsh water. When full, the tubes proved effective at damming fill placement areas and containing sediments released during the filling operations. Similarly, we established fringe marsh areas using the straw bale containment perimeter approach. Straw bales were also installed to protect the few remnant emergent wetland areas that were adjacent to the mass fill sites. We had learned from the demonstration phase that building the brush bundles was too labor-intensive, and the energy regime of the marsh did not require them.

In October 1992, we installed a floating boom with an attached sediment curtain at the marsh inlet-outlet, and the hydraulic dredge barge Blue Ridge (owned and operated by Cottrell Engineering Corporation) began removing sediment from the upper Anacostia riverbed. Through a system of 12-inch diameter pipes, the dredge material was pumped to selected areas of the Kenilworth Marsh. Areas of coarse sandy material in the river, which had been identified during preliminary sampling, were dredged first and used as a foundation for the water tubes.

Once the water tubes were stable, we filled the selected restoration areas to the approximate target elevations. The intent was for roughly two-thirds of reconstructed marsh to be mid-marsh (with elevations approximately 2.1-2.4 feet above mean sea level). We placed additional material around the perimeter of mass fill #1 and #2 such that the elevations would be slightly (several inches) higher to create a high-marsh zone (elevations about 2.5-2.8 feet above mean sea level). A D-4 track bulldozer graded the perimeter edge fill areas, and we surveyed the sites to record initial sediment placement elevations.

We determined that further dewatering (draining) and consolidating would result in the target elevations of about 2.5 feet above mean sea level for high-marsh and 2.1 feet for mid-marsh. A low-marsh zone, planted with spatterdock (*Nuphar advena*), was planned to provide the transition and stabilization between the mass fill areas and the adjacent unfilled areas of Kenilworth Marsh. These elevations reflect the mean high tide levels during the summer, which average some 6 inches higher than winter, due to solar gravitation. We knew the elevations would change from subsidence during dewatering and from displacement and compaction of unconsolidated sediments. We used calculations based on sediment characteristics performed by the Army Corps of Engineers to achieve the final target elevations.

The mass fill areas were allowed to dewater, settle, and consolidate from January 1993, to the time planting began in May 1993. We achieved dewatering by constructing adjustable outlet weirs on one side of each of the two main water tubes.

Planting Begins

On May 17, 1993, work crews from Ecological Restoration and Management, Inc. (a subcontractor to the Army Corps) began planting mass fill #1 with 16 native and local species (table 1, page 18).

Even before planting, the fill areas were being colonized by several *volunteer* plant species (table 2, page 19), particularly mass fill #1. Many of these species were 6 inches tall and had carpeted the area by the time planting began. These plants, however, did not colonize depressions, or low spots in the mass fill areas that contained a residual inch or two of pond water as rapidly as the higher, drier areas. We did not expect the magnitude of volunteer plant growth to be so high, but welcomed it overall. The volunteer vegetation also *absorbed* some of the feeding pressure from Canada geese and ducks.

We performed planting by creating patches of plant species on 2-foot centers; the number of plants in a flat (about 40) controlled the patch size. Placement of plant species was often arbitrary, although we directed high-marsh species to the higher elevation areas.

Continued on Page 18

Following planting, an 8-inch hydraulic dredge barge with a 10-foot wide cutter head, known as a Versi-Dredge Model 308, re-created tidal channels in the two mass fill areas. The channels had been staked previously and were not planted. The new channels were cut approximately 3 feet deep and 10 feet wide and their locations approximated those of the original tidal channels. The sediment cut out of the channel was used to raise the remaining low areas (bottom photograph, front page).

Mass fill #1

Mass fill #1 averaged 2.5 feet above mean sea level in elevation and was the first area to be planted. Volunteer plants colonized this fill area more quickly than mass fill #2, presumably because we planted it earlier and it was higher in elevation. Subsequently, mass fill #1 contained more undesirable plants, as well (species on table 2 marked with an asterisk).

Rice cutgrass *(Leersia oryzoides)* dominated mass fill #1 with dense growth. Because of its potential to outcompete other wetland plants, purple loosestrife (*Lythrum salicaria*) was a particular concern. Of similar regard were a few small clumps of the aggressive phragmites (*Phragmites australus*). Between the fall 1993 and winter 1994, we made attempts to manually eradicate both species, and we will continue to suppress these two potential pests.

A primary observation on the revegetation process was that depressions, or low spots containing a residual inch or two of water, did not green up like the other portions of this area. Apparently, the seeds of potential volunteer species were not nearly as likely to germinate in the puddles as opposed to the drier areas. Perhaps oxygen availability is a controlling factor.

Mass fill #2

We began planting mass fill #2 in early June. Although later in the season, volunteer plants had not invaded to the same degree as they had at mass fill #1. Mass fill #2 supported a diversity of mid-marsh species. Presumably, this is due to the elevational differences, averaging approximately 2.1 feet mean sea level in mass fill #2–some 4 inches lower than mass fill #1.

Table 1. Species Planted in the Kenilworth Marsh Reconstruction

Scientific Name	Common Name	Quantity
High Marsh		
Cephalanthus occidentalis	buttonbush	2,148
Hibiscus mosheutos	marsh hibiscus	2,148
Leersia oryzoides	rice cutgrass	14,362
Saururus cernuus	lizard tail	14,362
Mid-Marsh		
Alisma plantago-aquatic	water plantain	5,122
Carex stricta	tussock sedge	5,122
Iris versicolor	blue flag	5,122
Peltandra virginica	arrow arum	64,815
Polygonum sp.	smartweeds	14,362
Pontedaria cordata	pickerelweed	4,840
Sagittaria latifolia	duck potato	64,815
Scirpus americanus	common three-square	14,362
Scirpus validus	soft stem bulrush	64,815
Sparganium americanum	lesser bur-reed	5,122
Sparganium eurycarpum	giant bur-reed	5,122
Low-Marsh		
Nuphar advena	spatterdock	4,840

The volunteer plants appeared only at the higher areas near the perimeters where water did not pond significantly. Volunteer plants seemed to become more prevalent when standing water was reduced. A noticeable green up occurred when the water tube was removed and tidal channels were cut. Additionally, volunteer plant growth occurred during June and July when growing conditions were optimal.

Fringe Areas

We planted fringe areas as we had the others, except that we used only mid-marsh species. The plan was to create fringe elevations that matched those of mass fill #2. However, after the dredge material was in place, the final elevations of the fringe areas were lower than those in both mass fill #1 and #2. As a result, the fringe areas supported volunteer plant growth only minimally. Similarly, planted species did not establish themselves nearly as vigorously in the fringe areas as they did in mass fill #2.

Summary

Overall, Kenilworth Marsh revegetated extensively and vigorously. During the first year, at least 90% of mass fill areas #1 and #2 was covered with dense plant growth averaging several feet in height (bottom photograph, front page and figure 5, page 17). This may be attributable to several factors: the surrounding berms and islands protected the vegetation from fetch, volunteer plants established themselves prevalently, the newly deposited sediments provided dissolved oxygen and nutrients, sediment levels were near and just above the high tide elevation, wildlife feeding was limited, we planted native species, and we timed planting to coincide with optimal growing conditions.

Follow-up Monitoring

As a prototype, the Kenilworth Marsh restoration project pioneered methods that may be useful in restoring other freshwater tidal wetlands (including others within the Anacostia watershed such as Kingman Lake). The project also raised numerous questions concerning the quality and impacts of the wetlands being produced. Consequently, the agencies involved in restoring the marsh (National Park Service, U.S. Army Corps of Engineers, Metropolitan Washington Council of Governments, District of Columbia Department of Consumer and Regulatory Affairs, Environmental Protection Agency, U.S. Fish and Wildlife Service, the University of the District of Columbia, and the Interstate Commission on the Potomac River Basin) felt strongly that the project be monitored for several years to determine its degree of success. Together, we formed the Kenilworth Marsh monitoring committee for the purpose of

Table 2. Volunteer Plants

Scientific Name	Common Name
Acer rubrum	red maple
Bidens sp.	beggar-ticks
Carex sp.	sedges
Eleocharis sp.	spike rush *
Leersia oryzoides	rice cutgrass
Lythrum salicaria	purple loosestrife*
Phragmites australus	phragmites*
Polygonum sp.	smartweeds
Populus deltoides	cottonwood
Sagittaria latifolia	duck potato
Salix sp.	willow
Typha angustifolia	narrow-leaved cattail
Typha latifolia	broad-leaved cattail
Zizania aquatica	wild rice

*Potential pest species

identifying, promoting, sponsoring, and conducting monitoring studies to document the results of the project.

The studies have examined the project from its first year, 1993, and will continue for many years to come. They will assess levels of toxicants, such as chlordane, in sediments, pore water, and the biotic food chain of the marsh. They will also monitor the effectiveness of wetland vegetation reestablishment; the productivity of wildlife habitat and habitat use (including grazing) by wildlife; the stability of sediment and development of soil, and hydrologic patterns; and water quality. Finally, they will inventory plankton, aquatic macro-invertebrates, mammals, birds, and fish. We have assembled a report for 1993 consisting of several data sets and anticipate writing annual reports and preparing a synoptic report after five years.

Stephen W. Syphax is the Resource Management Specialist for National Capital Parks–East. His address is 1900 Anacostia Drive, S.E., Washington, D.C. 20020, and he can be reached by telephone at (202) 690-5185.

Richard S. Hammerschlag is the Chief of the Center for Urban Ecology, National Biological Survey. His address is 4598 MacArthur Blvd., N.W., Washington, D.C. 20007, and he can reached by telephone at (202) 432-1443.

Regional Highlights continued

Presently, too little is known about the ecological effects of mushroom harvesting to suggest that no ecological effects occur from the activity. To the contrary, scientific evidence indicates that repetitive mushroom harvesting and certain collecting practices can damage the soil.

• • •

The National Marine Fisheries Service has received three petitions to list several populations of salmon comprising four biological species of Pacific salmon from Puget Sound and the Olympic Peninsula, and to designate critical habitat under the Endangered Species Act of 1973. The agency found that the petitions present substantial scientific information indicating that the listings may be warranted. Therefore, they began conducting a status review on these stocks this fall to determine if listing is, indeed, warranted. At the same time, they started comprehensive status reviews for populations of Pacific salmon and anadromous trout not presently undergoing status reviews in Washington, Oregon, Idaho, and California. These species are pink salmon, sockeye salmon, chum salmon, chinook salmon, and sea-run cutthrout trout.

• • •

The report of the National Performance Review (the Vice President Gore reinventing government report, 1993) contains recommendations for a series of environmental actions concerning "environmentally and economically beneficial practices on federal landscaped grounds," as entered recently into the *Federal Register*. One action is to increase environmentally and economically beneficial landscaping practices at federal facilities and federally funded projects. The recommendations, to be incorporated into our landscaping programs and practices by February 1996, specify that agencies should use regionally native plants while employing landscaping practices that conserve water, reduce energy consumption and the use of pesticides, and prevent pollution.

• • •

Biological control agents that have passed the pesticide review process outlined in NPS-77 (Natural Resources Management Guideline) may be used in parks as part of an Integrated Pest Management Program. The review process usually involves quarantine, lab or field tests, and receipt of a permit from the U.S. Department of Agriculture Animal and Plant Health Inspection Service (APHIS) indicating release of the agent.

However, park managers should be aware that APHIS currently has no process to regulate the quality of producers and distributors of biocontrol agents. A private distributor can, for example, import agents directly from the International Biocontrol Institute in Switzerland and sell them to parks without APHIS approval. Until a revised approval process is adopted that also examines more carefully the production and distribution of the agents, NPS managers should proceed cautiously. When biocontrol agents are to be integrated into a park pest management regime, it is prudent to first ensure that the distributors and producers are reputable. You can do this by contacting your state plant protection and quarantine officer, APHIS, the U.S. Department of Agriculture (USDA), or by purchasing biocontrol agents only through APHIS.

NPS IPM program leaders, along with the USDA and the International Biocontrol Institute, are also working toward resolving the following additional concerns regarding biocontrol agents: effects of the biocontrol agent on nontarget species and biodiversity, adherence to the National Environmental Policy Act process, and long-term monitoring issues.

Erratum

In our last issue, the Jean Matthews cover article on the Sequoia Pulse Study (page 5, third paragraph, last sentence) reported a newly discovered depth of 500 centimeters (16.5 feet) for some roots of the giant sequoia tree that was in error. Researcher Pat Halpin of the University of Virginia clarifies this point by saying that he has found *soil* exceeding 400 centimeters (13 feet) in depth around the big trees. Halpin's soil depth measurements are, however, much deeper than the previous soil survey depth estimates of around 150 centimeters (5 feet) in this particular grove of giant sequoias. While this discovery is important in itself for the enhanced water storage capability of soils near the big trees to offset effects of drought (as reported by Matthews), Halpin did not measure root depths. Finally, he points out that the relationship of deep soils to root depths may not be direct, but deep soils at those sites demonstrate that the trees are not impaired from tapping deeper layers if they are physiologically able.

Isle Royale Loons

A multiyear landscape ecology research project begins to answer basic population ecology questions of this wilderness bird

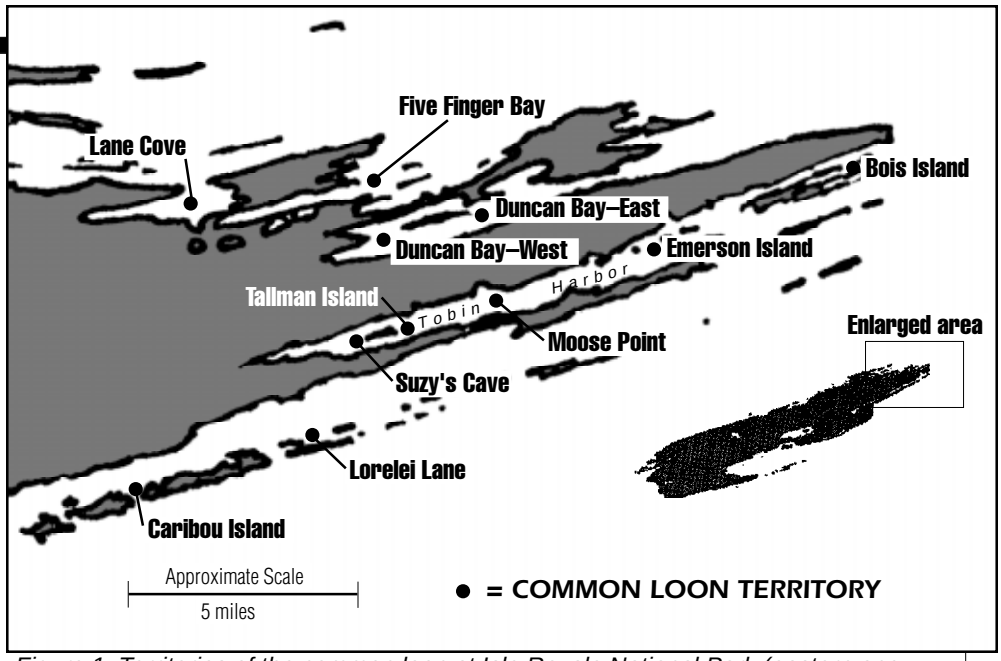


Figure 1. Territories of the common loon at Isle Royale National Park (eastern one-third of island).

By David C. Evers

The common loon *(Gavia immer)* and gray wolf *(Canis lupis)* are symbolic wilderness creatures of Isle Royale National Park, Michigan. This Lake Superior island is well-known for its moose-caribou studies, but also happens to be an ideal site to investigate loon population ecology and contaminant parameters.

Investigators first surveyed Isle Royale loons in 1985 and again in 1990 in order to monitor loon breeding populations every five years. The 1990 numbers indicated that nesting pairs producing young had declined from 1985. These initial results, combined with complexities of the nesting population on the shores of Lake Superior, prompted us to complete annual loon censuses since then to detect changes.

Loons are well-known as residents of large water bodies, but because frequent and intense wave action reduces the already limited suitable nesting habitat, few areas in the Great Lakes can physically support successful breeding. The few areas with nesting pairs are rarely occupied long-term. If loon nests are spared by storm-produced waves, seiches (periodic surface fluctuations unrelated to storms) of up to 6 feet (2 meters) usually severely reduce hatching success rates.

Isle Royale is unusual, for it harbors protected coves, some of which are 5 miles (8 kilometers) long. Although infrequent seiches are enhanced within these coves, these waters are calm enough to allow around 20 territorial pairs (figure 1) to regularly produce young. Surveys of these Lake Superior loon territories show that there is *not* a short-term decline and that productivity is normal, annually varying around one chick per pair.

Since 1990, we have accomplished more than surveys. We participated in a regional biomonitoring project that started in 1989 and also began to identify individuals through vocal-tagging in 1990. This voice recognition technique uses recordings of elicited loon yodels to identify individuals (see photo). Only male loons produce this distinctive territorial song known as a yodel, and studies indicate that the yodel of each bird is unique and constant over time.

In 1991, we expanded this passive marking program to include capturing and color-banding adults and juveniles. Although vocal-tagging provided information on the return rates of males to their territories, the technique was limited in its ability to help us determine other factors related to population dynamics. For example, we were unable to sample females, whatsoever. By color-marking loons with unique combinations of leg bands, we could monitor individuals over time, and could gather information on pair bond types, site faithfulness, turnover rates, recruitment, seasonal and daily movements, and wintering locations. Also, while in hand, we could take blood and feather samples to investigate contaminant loads, genetic makeup, and physiological parameters.

Results and Discussion

Since 1991, we have captured and color-marked with leg bands 22 adults and 20 juveniles. The ensuing 82% annual rate of return for the adults (27 of 33 return possibilities) is higher than the 75% Great Lakes average. Nearly all of the returnees have appeared back at the territory where we originally captured them, exhibiting a high level of philopatry. Actually, within the Great Lakes study area, only six cases of individuals switching territories have been documented. Since adults are rarely captured unless accompanied by chicks, nearly all of these cases represent successful breeding pairs for the prior year.

We are now beginning to gather new and interesting population ecology information that indicates a higher incidence of territory switching. Five pairs of loons occupy territories in Tobin Harbor (figure 1). In 1994, the female from the Moose Point territory (banded in 1991) switched to the adjacent Emerson Island territory and paired with that male (also banded in 1991). Both these loons produced chicks in 1991 and 1992 in the territories where they were originally captured and marked. In 1993, the banded female from Moose Point was displaced by an unbanded female. The banded female was observed once on May 22 on a nearby bay but disappeared for the remainder of the year. The new Moose Point female (unbanded) successfully produced young with the banded Moose Point male. The Emerson Island banded pair also produced chicks in 1993.

Switching mates among successful territories would seem inefficient for a population-optimal reproduction rate. The risk of abandonment and the disruption of a previously proven pair relationship seems to outweigh any short-term reproductive advantages of developing a new pair bond. However, genetic variability, competition for highest quality habitats, and alternative breeding strategies may be long-term issues that are of higher importance for these long-lived birds. In our example, the Moose Point pair produced one chick while the Emerson Island pair nest failed. Interestingly, the female that produced chicks with the Emerson Island male from 1991-93 was found in her territory in late May, but was not observed with the territorial male.

Two other cases of within-year mate switching at Isle Royale are recorded. These and observations from other sites researched in the project have shown that the common loon is not lifetime monogamous and, although strongly faithful to a territory, both sexes do change breeding areas, even after a productive year.

Documenting the return of banded loons gives us an understanding of the turnover and recruitment dynamics. However, the yearly result of returning adults is not a reflection of the mortality rate. In many cases, including one on Isle Royale, adult loons disappeared for an entire breeding season and then reappeared as territory holders.

THE RECRUITMENT DYNAMICS OF LOONS banded as chicks remains unclear. A small sample at the Seney National Wildlife Refuge, Michigan, and the Turtle-Flambeau Flowage, Wisconsin, shows some natal site fidelity. In 1994, however, we did not observe on the island any of the loons banded as juveniles in 1991 (n=8). Since young loons acquire their breeding plumage after their third winter and only return at that time to the breeding grounds (the first 2½ years are spent on the ocean for over 95% of this cohort), following their movements is difficult. Add to this their late probable first-breeding age of six to seven years and the need to study loons over the long-term becomes clear.

Loon banding also provides information on their seasonal movements. Two Isle Royale loons have been recovered outside of the Great Lakes. An individual banded as a juvenile on August 3, 1991, on Five Finger Bay was found dead on March 15, 1993, at Surf City, North Carolina. Other records of Great Lakes subadults that oversummer in this region also exist. The other, an adult female from the Duncan Bay-west territory, was banded on July 1, 1993, and was found dead on March 29, 1994 at Englewood Beach, Florida.

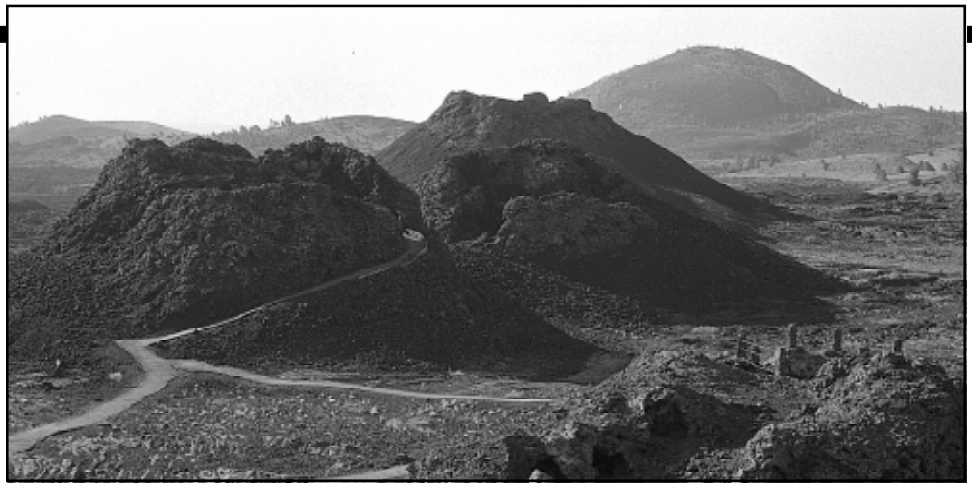
Project assistant Dan Cristol (right) and NPS resource manager Steve Fettig record loon yodels using a parabolic microphone. The recordings are used later to identify individual loons for subsequent field study.

Other recoveries indicate a west-to-east migration of upper Great Lakes loons through the Finger Lakes region of New York to the Chesapeake Bay by mid-November. By early December, most of the adult loons will have probably arrived on their wintering grounds in North Carolina continuing south, along the Florida Coast, and into the Gulf of Mexico to the Texas-Mexico border. In mid-to-late March, the birds begin their northward spring migration; most Great Lakes loons probably leave the northern Gulf of Mexico and arrive on their northern Michigan territories immediately after the ice melts in mid-to-late April.

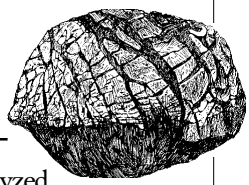
Another important component of the Isle Royale common loon monitoring program is tissue (blood and feather) sampling for contaminant and genetic analysis. Preliminary analyses show feather mercury (Hg) levels ranging from 5.7 to 26.4 parts per million–ppm–(n=5), with corresponding selenium (Se) values of 4.46 to 4.93 ppm for Isle Royale loons. Since selenium offsets the toxicity of mercury in a bird's system, it is the mercury-selenium ratio (molecular ratio is 2.54) that is most indicative of the bird's health. One adult male from Rock Harbor-Lorelei Lane territory had a ratio of 5.69 (26.4 ppm of Hg/4.64 ppm of Se), over double the mitigating impact of the selenium. Many trace elements (n=22) are being analyzed from the feather and blood samples. We are currently emphasizing mercury, although we are closely monitoring the levels of other non-essential heavy metals that probably have an anthropogenic origin, like lead and cadmium. We will soon learn the impacts of organochlorines and PCBs.

This biomonitoring project will need to continue on a long-term basis to provide specific answers on the health of the common loon population and on the quality of the environs within Isle Royale National Park. Plans for the next three years include continuing this biomonitoring scheme, and investigating water quality, prey base, and other piscivores in Isle Royale, Pictured Rocks, and Apostle Islands national lakeshores.

Evers is a conservation biology Ph.D. student with the University of Minnesota, Department of Fisheries and Wildlife and is a visiting researcher at Isle Royale working on population ecology of the common loon. Isle Royale is but one of his many study sites, which also include areas in Minnesota (Voyageurs National Park), Wisconsin, New Hampshire, Maine, Alaska, and, in winter, Florida. He is part of a large, interagency, landscape ecology project that is being supported by federal, state, private, and nonprofit funds. He can be reached at 200 Hodson Hall, Saint Paul, MN 55108, (612) 624-3600 (until mid-March) and (906) 492-3359 (from mid-March through August), then back at the first number in September.



The study area at Crater's of the Moon includes ever-widening trails to popular sites such as cinder cones. The illustration depicts a once common, often collected lava feature known as a bomb. Monitoring will lead to improved protection of these resources.



Geologic Features Monitoring Begins at Craters of the Moon National Monument

By Kathryn A. Diestler

As recently as 2,000 years ago, volcanism along the Great Rift of the Snake River Plain in Idaho produced a spectacular landscape of cinder cones, spatter cones, lava rivers, lava tubes, and tree molds that are now preserved within Craters of the Moon National Monument. Since establishment in 1924, managers have been concerned with visitor impacts to these volcanic features. Over the years, collecting, vandalism, and offtrail hiking have led to damage in many of the high use areas. The once black, glassy crust of the lava flows now appears red and broken in many places, and *bombs* that once littered the cinder cones are now scarce (the watermark depicts a bomb). Lava Snake, a 35-foot long lava tube at Devil's Sewer, was completely destroyed by collection and vandalism. Unfortunately, only another eruption can replenish these otherwise nonrenewable resources.

In order to recognize persistent impacts and threats to the volcanic features before damage occurs, the monument initiated a geologic monitoring program in July 1994. Its purpose is to gain a better understanding of visitor impacts to the features, which will aid us in their protection in the future.

While we have not neglected monitoring the features in the past, visitation increases and time have been required to disprove a misconception that rocks are indestructible. Also, the monitoring itself ran into problems, because of the difficulty in trying to use quantitative techniques. For example, we were unsuccessful in measuring the rapid rate at which a trail leading up a cinder cones was widening (photograph). In 1985, we placed wooden stakes on the trail; the next year, unfortunately, all of the stakes were missing, either lost within the loose cinders or taken by visitors. Staff then planted metal stakes and later used a metal detector to relocate them, but this was also unsuccessful. We realized that the predominantly loose and irregularly shaped volcanic features present a problem in designing a stationary measuring technique and also affect the accuracy of the measurements. We recognized from these experiences that we needed a more comprehensive and consistent method of monitoring impacts.

As a first step, we evaluated the volcanic features in order to determine which ones to monitor. We selected those features that met high visitor use and significance criteria. Significance was based on integrity (most of the feature still in existence), rarity, and susceptibility to damage. Next, we established photo-monitoring points and took photographs of the selected features. We plan to rephotograph the features on a periodic basis in the future to document evidence of accelerated erosion in high visitor use areas.

We selected the photo-monitoring technique for a number of reasons, one of which was strictly administrative. The resource management division at Craters of the Moon has only two permanent employees. Since both our budget and staff are small, the monitoring program needs to be simple enough that any available help can follow the procedures and produce accurate results. Additionally, a simple geologic monitoring process has a greater chance of being continued. Other reasons include universal application of the method to all the features in the program, the ease with which the data can be analyzed and impacts identified, and its flexibility. Furthermore, we can add a variety of other components to supplement the program as it evolves over time.

We had hoped to compare these photographs with similar ones taken early in monument history so that we could assess impacts over time. Unfortunately, only a few early pictures exist depicting significant features that we can use as a baseline. In the future, when time and money allow, we will attempt to track down other early photographs from other collections that could pertain to this project. Until then, the baseline for many features will have to be current conditions.

Resources cannot be protected unless threats to them can be recognized. We believe this program will help us recognize threats and enable us to take action to protect these resources. Without such an early warning system, the opportunity to be proactive does not exist. Additionally, we can use the monitoring program to assess the effectiveness of our mitigation measures, providing us with a tool to evaluate our success in protecting our geologic resources. We realize this program will not prevent damage to these resources, but recognize that it is a step in the right direction.

Geologist Kathryn A. Diestler developed the monitoring program for the park over a 14-week period last summer. Diestler is a graduate of Washington State University and had learned about the opportunity through the Environmental Careers Organization, a firm that places entry level professionals in environmentally oriented positions with federal, state, and local governments. Craters of the Moon hired her specifically to develop the monitoring project, because they do not have a staff geologist. Chief of Resource Management Vicki Snitzler-Neek has further details of the project and can be reached at (208) 527-3257.

Preparing for Dune Swale Wetland Restoration at Indiana Dunes National Lakeshore

By Eddie L. Childers, Charlotte P. Wolfe, and Greg A. Olyphant

This scene west of Derby Ditch exhibits typical present-day conditions within the Great Marsh. The predominance of cattails indicates that water levels are below the historic target levels sought in the restoration effort at nearby Derby Ditch.

Extensive wetlands once occupied interdunal swales in the Calumet region of northern Indiana, on the southern shore of Lake Michigan. The Great Marsh within present-day Indiana Dunes National Lakeshore is a good example of this distinctive ecosystem type.

During the late 1800s, the Great Marsh was drained, filled, dredged, and then dissected by railways, highways, and industrial and municipal development. Originally stretching 34 miles (55 kilometers) with a total area of 1,336 acres (3,300 hectares), the wetland has been reduced to 607 acres (1,500 hectares). Nevertheless, it is an outstanding natural area and provides an opportunity for NPS and NBS staff to test a landscape-based restoration .

The Great Marsh is made up of several distinct watersheds that drain into Lake Michigan: one containing the natural Dunes Creek, and two containing constructed ditches (Derby Ditch, and Kintzele Ditch) that cut through sand dunes. High fecal coliform levels in all three drainages have caused the park to close intermittently several popular swimming beaches. Research on wetlands has shown that increased water retention in wetland areas decreases bacteria levels that flow out of the system. Restoration of a more natural hydrologic regime would increase the time it takes for bacteria-laden waters to flow through the Great Marsh into Lake Michigan, theoretically allowing the bacteria to decompose before reaching swimming beaches. Additionally, changes in the hydrologic regime, fire frequency, and water quality in disturbed areas of the Great Marsh have caused displacement of native sedges and bluejoint grass by cattails and woody shrubs.

Dunes Creek is the least impacted of the Great Marsh watersheds, although minor ditching has occurred in some sections of its drainage. Still, it contains a state nature preserve with an extremely diverse array of plant communities and is the best available model for restoration of the marsh within the Derby and Kintzele Ditch watersheds.

The park has targeted the Derby Ditch watershed for wetland restoration first. In assessing impacts of the restoration, national lakeshore staff are monitoring hydrology and vegetation here. This enables us to determine the variance of present conditions at Derby Ditch from the target conditions at Dunes Creek that we hope to emulate.

We also want to determine the impacts of water level changes on roads and structures. We estimated these impacts using the GIS at the national lakeshore. We noted that a 1-foot water level increase above the present Great Marsh water level, as simulated using digital elevation models, resulted in minimal detrimental consequences to roads, houses, and national lakeshore property.

After one year of premanipulation monitoring, we plan to install a water control structure on Derby Ditch or one of its tributaries. This structure will enable us to gradually raise water levels while monitoring hydrologic and vegetative changes and impacts to roads. We hope to accomplish the hydrologic monitoring through the use of automated water level recorders and soil moisture sensors.

We will use the results of this experiment to calibrate a predictive computer model for the response of the entire Great Marsh ecosystem to hydrologic changes. The model will allow simulation of both short- and long-term land use and weather-climate scenarios that would result in specific water levels, allowing us to predict the effects of these conditions on the biological communities. The model will do this by providing estimates of the amount of time that parts of the watershed are saturated.

The model will be flexible and interactive and will be interfaced with the park GIS. The eventual goal is direct communication between the GIS and the monitoring network via telephone modem connections. The model will be capable of operating on a real-time basis; given current initial conditions (as indicated by the monitoring network), we will be able to predict the hydrologic response to forecasted weather conditions. The hydrologic response to storms could be monitored from the research station as it occurs in the field sites. This capability will allow us to avoid impacts to roads and private property.

In addition to computer modeling, GIS analyses, and vegetation and hydrology monitoring in the present-day Great Marsh, we are interpreting aerial photographs and other historical information to provide an early picture of the Great Marsh. Examining past and present environmental conditions will enable better estimation of the hydrologic and other management conditions necessary to achieve the desired plant communities and reduce bacteria discharges. By restoring the Great Marsh, we hope that Indiana Dunes National Lakeshore will support safer swimming opportunities for the public while increasing the size, quality, and biological diversity of a significant wetland ecosystem.

Childers is the GIS Specialist at Indiana Dunes, phone (219) 926-7561, ext. 331. Wolfe is an Ecologist at the park, ext. 332. Olyphant is Associate Professor of Geological Sciences and Geography at Indiana University in Bloomington, Indiana, (812) 855-5154.

CRAIG S. JOHNSON, 1971-1994
SCOTT D. SHULL, 1968-1994

IN THE LAST ISSUE OF *PARK SCIENCE*, MY M.S. STUDENT, CRAIG Johnson, and I published an article entitled, "Captive Cougars May Aid Florida Panther Project." It is my sad duty to report the tragic deaths of Craig, technician Scott Shull, and pilot Jonathan Saunders while radio-tracking panthers in Big Cypress National Preserve, Florida. Craig, Scott, and Jonathan were collecting radio-telemetry data on Saturday, October 8 when, at about 10:30 a.m., their Cessna 172 went down about 4 miles north of Highway 41 at Big Cypress in an area of pine and cypress trees. All three were killed instantly.

Craig Johnson

As we explained in our article, the telemetry work was part of a four-year effort to determine the effects of public use at the preserve on the endangered cats. Craig and Scott were flying nearly every day to obtain intensive data on location of the panthers and to collect activity data for those analyses.

The wildlife profession has lost two very bright, promising young men. Craig had graduated cum laude with a B.S. degree in wildlife and fisheries science from Tennessee Tech University. While at Tennessee Tech, he was president of his fraternity, president of the student chapter of The Wildlife Society, and was the recipient of the National Elk Foundation Award. I had advertised nationally for a M.S. candidate and was deluged with applications from all over the world. It was only a coincidence that Craig comes from east Tennessee (Greeneville); he was clearly the most outstanding prospect among all the applicants.

Scott Shull (holding black bear)

Craig was a quiet, motivated student who got along well with people and who had the ability to acquire and assimilate information at a rapid rate. I was amazed at his ability to tackle complex problems and process the information into simple, comprehensible terms. The work that he was doing with the captive cats in Knoxville was truly innovative and should prove to be extremely beneficial; it has dispelled many of the myths commonly held concerning tip-switch activity sensors. Craig was a good friend and he will be missed.

I first met Scott Shull in 1989. We had hired him as a technician on a bear project in the Ozark Mountains of western Arkansas. Scott was from Poplar Bluff, Missouri, and had received a B.S. degree from Southwest Missouri State. Scott was an able field technician and demonstrated considerable talent and dedication while trapping, immobilizing, and radio-tracking bears. His efforts paid off and he was offered a M.S. assistantship at the University of Arkansas to look at the effects of mark and release on nuisance bears. During that project, Scott developed an excellent rapport with state game officials, the public, and the academic community alike thanks to his calm demeanor and amiable personality. Scott completed his thesis in 1994. I had hired him for the panther project in August because he was a capable field technician and had accumulated considerable experience with aerial radiotelemetry. Scott was a great person to be with in the field. He was extremely capable, had good *woods sense*, and his wit and humor made the time spent there a real joy. Scott was a close friend of mine; I will take with me many fond memories of him crawling into bear dens, staying up all night radio-tracking bears, and our many lighthearted discussions.

I take great comfort in knowing that Craig and Scott loved what they were doing and were extremely committed to the work in South Florida. They had made many friends there and, both being mountain boys, were beginning to appreciate the beauty and vulnerability of the South Florida ecosystem. My plans are to continue our research there; I think that is how Scott and Craig would have wanted it.

Joseph D. Clark
University of Tennessee Field Station
National Biological Survey
October 31, 1994

Forget-Me-Not: Remembering Park Ranger and Alpine Botanist Carl Sharsmith

By Laura J. Sefchik

Carl W. Sharsmith, famous Yosemite ranger-naturalist, died peacefully in bed in his San Jose, California, winter home on October 14, 1994, at the age of 91. As the angel chorus sang to welcome Carl into paradise on that morning, the heavens were sending snow down on his beloved Tuolumne Meadows, furnishing a blanket for his alpine plants. The flowers rest early this year.

Carl may be remembered as the oldest and longest serving national park ranger, as an expert alpine botanist, as professor emeritus of botany at San Jose State University, as discoverer of previously unclassified wildflowers, or for establishing the herbarium at the university, which now bears his name, but he will be best remembered as Tuolomne Meadows' best-loved naturalist. Carl was an inspiration to all and has influenced thousands of children and adult visitors to Yosemite. I am one of those, having first met Carl on his meadow walk in June 1987. He was magical and delightful while encouraging all of us to develop a greater appreciation for wilderness. Carl's love for the flowers and the mountains defined his life, which he joyfully shared with all park visitors and friends.

Photo by Jim Long

Ranger Carl Sharsmith, 1903–1994

Wallace Stegner, Pulitzer prize-winning author, once said, "A place is not fully a place until it has had its poet. Yosemite and the Sierra Nevada have had two great poets, Muir and Adams." The third great poet of Yosemite is Carl Sharsmith. He looked on Tuolomne Meadows and its high country peaks with reverence and had been delighted with the white blossoms of sweet cassiope, and exhilarated by continually learning nature's secrets.

Tuolomne Meadows in Yosemite National Park had been Carl's summer home since 1931. He was its first ranger-naturalist and its best friend since John Muir. Carl was greatly influenced by Muir having first discovered his writings as a boy. Carl noted, "I always knew about Yosemite because I knew the writings of John Muir by heart; and I was all prepared to see what I saw. Studying at the Yosemite Field School in 1930 was just the most wonderful thing I could do; and it led to an invitation to become a ranger-naturalist."

For decades, Carl led park visitors on ranger programs that engendered love for these mountain places. Consequently, he gained a good following to help protect park resources. He also understood what motivates people to learn, saying, "I find people are not interested in facts. The greater appeal is to the heart." In the Robert Redford film, "Yosemite: The Fate of Heaven," we can see Carl's playfulness, his romance with nature, his wisdom, and his heartfelt desire that, "we bring back the primitive, primeval condition that formerly existed in the park." Carl's nature writings from 1931-1978, to be published soon in the book, "A Naturalist in Yosemite," encourage us to experience the joy of observation and investigation into nature's beauty in much the same way his nature walks delighted us.

Like Muir and Adams, Carl will have a peak named for him soon, perhaps the Tuolomne Meadows region peak, Peak 12,002', his "sundial." He already has several wildflowers named for him. One is the beautiful forget-me-not flower, *Hackelia sharsmithii,* which grows only in the shadow of the rocks in the Mt. Whitney area. But Carl, the poet, and venerable ranger-naturalist who obtained extreme delight in explaining the life of the meadows, would want us to honor him by having each one of us develop a greater appreciation of the wilderness to which he had dedicated his life.

Working in Tuolomne Meadows is how Carl spent his last summer. "What else would I do? Tuolomne Meadows is home to me, so to speak. It is the happiest place in the mountains. God blessed this place. This is the place that holds; this is the place that charms," he said. He told me that in Tuolomne Meadows, his spirit had found its home.

Laura J. Sefchik lives in Yosemite and works for the Sierra Club Le Conte Memorial in Yosemite Valley. She leads children and their parents on nature hikes and presents evening slide programs. She plans to publish Sharsmith's nature writings this spring. Her phone number is (209) 372-4101.

A Society of Wolves: National Parks and the Battle Over the Wolf, by Rick McIntyre

Reviewed by Timmothy J. Kaminski

Wolves have long captured the imagination and attention of peoples of many cultures. Fear and admiration are commonly cited from within the many treatises about wolves, stemming from human-wolf encounters that include the past and present. That there is realism in each of these human emotions contributes to the rich literature that spans the experiences of people and wolves. *A Society of Wolves: National Parks and the Battle Over the Wolf* by Rick McIntyre is among the most recent additions to a long list of technical, historical, and personal accounts.

A Society of Wolves is introduced with commentary by Senator Ben Nighthorse Campbell of Colorado, a Native American Indian, and by Jay D. Hair, President, National Wildlife Federation. The book is laced with outstanding photographs that portray wolves in their natural environment, many of which appear to be from Alaska. Book chapters are organized to assist the reader in understanding basic life history and ecology of the wolf; their relation to Old and New World peoples, beliefs, and settlements; persecution of wolves by European arrivals to North America; and finally their current status and the ongoing efforts to restore this native carnivore to portions of its former range.

At a glance, this book appears to be similar to the many coffee table books designed for the casual or moderately interested reader in the behavior and ecology of gray wolves throughout North America. The focus of recent books, like this one, addresses the status and recovery of gray wolves in national parks of the Rocky Mountains and particularly, Yellowstone National Park. Among the features that set this book apart are that it is well-researched, and that it is written as a tome of personal experience. McIntyre has succeeded in producing a well-written account that will be of value to any with interest in the evolution of our thinking about the role of carnivores and their importance to national park conservation.

Rick McIntyre

Wild Alaskan wolf belonging to the East Fork pack, the same pack biologist Adolph Murie studied in the 1930s-40s.

This book is easy to read, draws considerably from the many experts in the field, pans beautifully a broad spectrum of wolves in their natural surroundings, and captures the reader's interest through personal accounts by the author. McIntyre supplies a section (called Season of the Wolf) that is an accurate, if general, account of our collective knowledge of the ecology, behavior, and threats to long-term conservation of the species. The text is seldom leading and is carefully written to emphasize the dynamic nature of what has been learned over better than 30 years of wolf research and its interpretation by experts. McIntyre has also made a considerable effort to incorporate information from historical accounts through investigations of his own, and has condensed what already was written into an easy-to-read-and-understand documentary. He gives credit to others where appropriate, and acknowledges the many field biologists that he learned from and with whom he spent time. Many of the experiences gleaned while with these experts are described throughout the text.

The organization of the book is a weakness, however, and is at times choppy enough to be annoying, particularly for a reader perusing the chapters from beginning to end. An added shortcoming is that sections on the status of recovery efforts in the national parks (for example, Great Smoky Mountains, Yellowstone, Glacier) and areas where wolves are returning on

their own are overly condensed. In fairness, the book contains inserts or sidebars that concisely summarize recovery efforts and may be entirely appropriate for the coffee table reviewer; however, they could still have been improved upon by adding detail and altering their placement in the text.

McIntyre has carefully watched and experienced wolves in their natural environments, a complement to his writing style that adds greatly to the appeal of his book. Among the most appealing portions are his own experiences and his recounting of them. While interpretations in a few instances are anthropomorphic and subject to question (for example, "vindication" by the wolf Rags the Digger), his introduction, the account of Bill Caywood versus the wolf Rags the Digger, his portrayal of the East Fork (Toklat River) alpha male in Alaska (a return to Murie's time observing the East Fork den about which Murie also wrote in his 1944 account of the Wolves of Mt. McKinley–now Denali), his epilogue to the spirit of the wolf, and finally his revisit to Colorado bring these experi- ences to life for the reader.

McIntyre's time spent as a naturalist, particularly his years in Alaska and in other parks, serves as the basis for this account, more personal than a thorough documentary of the long-standing efforts dedicated to returning gray wolves to North America, especially select national parks of the United States. His insights and photos lead to an accurate and positive image of the wolf and its rightful place in these remaining vestiges of available habitat.

It is not a shortcoming of this book that the story of the tremendously costly and highly political efforts to obfuscate the return of wolves to our national parks has been waged for nearly two decades, and still has not been told. Few would understand from his account, for example, that efforts formally began in 1975 to restore wolves in Yellowstone, that the recovery plan, approved in 1987, sat on a bureaucrat's desk for more than two years following completion by a group of dedicated scientists in 1984, or that a 70-year old visionary played a tremendous role in commencing efforts underway today; the American public is deserving of a more full account. To this end, A Society of Wolves, like other books that will follow, is an important volume that will extend an important dialogue on the ecological role of large predators not readily gleaned from scientific publications. This book stands out among those that similarly describe the plight of wolves in our national parks. McIntyre is to be commended for a fine effort and a valuable contribution to the general public and those interested in learning more about wolves in our past and we hope, our future.

The book is available from Voyageur Press; Stillwater, Minnesota, (800) 888-9653.

It contains 116 photographs, 128 pages. ISBN 0-89658-194-2. $29.95 hardcover.

Timm Kaminski produced a M.S. thesis on the wolves of central Idaho in the early 1980s. He is presently a Wildlife Biologist for the Targhee National Forest. His address is P.O. Box 208, Saint Anthony, ID 83445, (208) 624-3151.

Author Rick McIntyre is working his thirty-sixth season with the National Park Service this winter as a Park Ranger (naturalist) at Big Bend National Park, Texas. In 20 years with the agency, he has served in Glacier, Death Valley, Joshua Tree, and Denali, among other units. This past summer, McIntyre specialized in interpreting wolves and the reintroduction effort at Yellowstone where he also raised all the funding for his own position. His second book on wolves, The War Against the Wolf: America's Campaign to Exterminate the Wolf *(Voyageur Press), is due in March. This book is a 500-page anthology documenting the evolution of American attitudes toward the wolf.*

New Publications

The following natural resource publications are available from the Natural Resources Publications Office:

1. Mammals of the Indiana Dunes National Lakeshore. J.O. Whitaker, Jr., J. Gibble, and E. Kjellmark. NRSM-94/24.
2. Mountain goats in Olympic National Park: biology and management of an introduced ungulate. D. Houston, E. Schreiner, and B. Moorhead. NRSM-94/25.
3. 1993 Highlights of natural resources management. L. Fox, ed. NRR-94/13.
4. Proceedings of the third conference on fossil resources in the National Park Service. R. Benton and A. Elder, eds. NRR-94/14.
5. An introduction to selected laws important for resources management in the National Park Service. N. Shelton and L. Fox. NRR-94/15.
6. 1993 inventory of research in the national parks (by region and park (NRSR-94/10) or by field of study (NRSR-94/11)).

Submit order to Publications Coordinator, National Park Service, Natural Resources Publication Office, P.O. Box 25287 (WASO-NRPO), Denver, CO 80225-0287.

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The National Register of Historic Places Office of the National Park Service has arranged with the U.S. Government Printing Office to sell reprints of the popular book, *Presenting Nature: the Historic Landscape Design of the National Park Service, 1916-1942.* In this 314-page study, author Linda Flint McClelland documents the rich legacy of scenic roads, trails, picturesque park villages, campgrounds, picnic areas, and scenic overlooks built by craftsmen in the national parks using naturalistic design techniques. She describes a wonderful period in NPS history when park designers met the challenge of developing parks for visitor enjoyment while ensuring resource preservation through the evolution of a naturalistic ethic. She also examines the master planning process of the era. The book is available at a cost of $20 from the Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954, (stock number 024-005-01140-4).

Morristown to Assess Water Quality and Threats Through National Partnership

By Bob Masson

Morristown National Historical Park is a 1,685-acre park located largely within the upper reaches of the Great Swamp watershed in north-central New Jersey. During two critical winters--1777 and 1779-80--the area served as quarters for the Continental Army. The National Park Service manages both the 1,320-acre Jockey Hollow Encampment Area and 321-acre New Jersey Brigade Encampment Area of the park to maintain not only the historic context of the scene, but also to protect the natural characteristics, including the existing high water quality.

A year-and-a-half ago, we became partners with the U.S. Geological Survey to protect national water resources through our participation in their National Water Quality Assessment Program. Known as NAWQA, this program documents the quality of national surface and groundwater resources and defines current trends in the quality of these waters in order to produce long-term, consistent water quality information that will be useful to managers and policy makers at national, state, and local levels.

In assessing national water quality, the U.S. Geological Survey has divided the country into 60 study units that include most of the major rivers and aquifers in the nation. Morristown National Historical Park is in the Long Island-New Jersey coastal drainage system study unit.

We participate in the process by attending study unit meetings that are held every six months over an eight-to-ten-year period. At the first of two meetings held thus far, we determined and prioritized surface, groundwater, and aquatic ecology issues within the study unit. At the second meeting, we defined available water quality data and discussed how agencies will map water quality study areas. Plans for the future include compiling and analyzing available data, designing study approaches, conducting intensive sampling for a wide array of physical, chemical, and biological characteristics, beginning low-level sampling, and completing reports on the intensive sampling data. The NAWQA program is proving to be a useful approach for us to monitor our water resources at Morristown.

While planning to continue with NAWQA, we also hope to take advantage of a recently completed memorandum of understanding between the National Park Service and the U.S. Geological Survey to locate sampling sites within national park system units if the sites will be useful to the study of water quality. Through our participation in NAWQA and the possible location of a sampling site within the park, we hope to enhance our ability to monitor long-term water quality trends in the park.

Bob Masson is a Resource Management Specialist at the historical park. He learned about the NAWQA program through a water resource scoping report written for the park by the NPS Water Resources Division in Fort Collins, Colorado. Masson recognized that the park really did not know much about its water quality and that it would probably not be able to investigate properly water quality questions on its own. The NAWQA program and the interagency agreement to locate study sites in parks are proving to be good, inexpensive solutions. Masson's phone number is (201) 539-2016.

The national liaison for the NPS-USGS memorandum of understanding is Bill Walker of the Water Resources Division, (202) 219-3386. Barry Long and Gary Rosenlieb of that office provide technical assistance in implementing the cooperative NPS-NAWQA studies. They can be reached at (303) 225-3518.

Polyurethane foam continued

is helpful in northern latitudes or at high altitudes where temperatures fluctuate greatly throughout the day and warm seasons are short.

This kit produces rigid foam that is more granular and less resilient than the other PUF products we tested, but is thoroughly capable of supporting the loads anticipated over a mine opening. A 22-pound bag generates 11 cubic feet of foam. The bags are conveniently sized and are easily carried in a conventional backpack (photo 1). Bag placement for the shaft closure was much easier than for the adit, however, and the installer got fairly covered with PUF on the adit closure, emphasizing the need for protective clothing and gloves. We recommend rubber gloves duct taped to a Level D disposable Tyvek® hazmat suit. With more practice and experience, the installer may have fewer problems. Each 22-pound bag kit is available for $130, which amounts to approximately $350 per cubic yard of foam generated. Discounts are available for bulk orders.

Conclusion

Each application of PUF has merits, and choosing which method or product to use must be based on factors of site accessibility, availability of products and contractors, cost, and job size. PUF has proven to be a useful material for closing mines especially in remote areas, at sites with access and disturbance restrictions, or where adequate backfill material is not available. For the detailed paper summarizing all four PUF applications tested, please contact the National Park Service Mining and Minerals Branch at (303) 969-2092.

John Burghardt is a Geologist with the NPS Mining and Minerals Branch in Lakewood, Colorado. His phone number is (303) 969-2099.

Article Indexes for Volume 14—1994

Listed by keyword

Aerial photography
"How to prepare vegetation overlays as accomplished at Harpers Ferry." 1994, 14(2):8-9.

Africanized honeybees
"Battling bees here." 1994, 14(1):13.

Agee, James K.
Book:"Fire ecology of Pacific Northwest forests," by James K. Agee. 1994, 14(3):26.

Aldo Leopold Wilderness Institute
"Parsons named director of Wilderness Institute." 1994, 14(3):25.

Alien species
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"Notes from abroad. 1994, 14(2):10-11.

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"Reconstructing climate data in parallel watersheds provides useful data on Muir Woods." 1994, 14(3):22-23.

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"CPSU hosts 2nd Biennial Conference on Colorado Plateau Research." 1994, 14(2):30.

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"Dinosaur blood: warm or cold?." 1994, 14(3):31.

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"Olympic revegetation efforts continue to evolve." 1994, 14(2):7.

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"User study contributes to Rio Grande management." 1994, 14(2):1,3.

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Sociology
"Gap analysis and national parks: adding the socioeconomic dimension." 1994, 14(1):6-10.

Telemetry
"Captive cougars may aid Florida panther project." 1994, 14(4):26.

Trails
"Trail conditions and management practice in the National Park Service." 1994, 14(2):16-17.

Turtles
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Velvet ash
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Visitor management
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"Preventing visitor-caused damage to national park resources: what do we know? what should be done?." 1994, 14(3):8-10.
"Keeping visitors on the right track: sign and barrier research at Mount Rainier." 1994, 14(4):17-19.

Visitor surveys
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Visitors
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Volcanic activity
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Water quality
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"Water quality litigation: an update from the Everglades." 1994, 14(1):29.

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"Public education pays off at Great Smokies in smooth sailing for red wolf releases." 1994, 14(3):18-19.

Listed by Park Code

APIS--Apostle Islands National Lakeshore, Wisconsin
"Long-term monitoring on a shoestring at Apostle Islands." 1994, 14(3):17.

ARCH--Arches National Park, Utah
"Getting a handle on visitor carrying capacity—a pilot project at Arches National Park." 1994, 14(1):11-13.

ASIS--Assateague Island National Seashore, Maryland
"Assateague Island mares 'shot' with contraceptives." 1994, 14(3):15.

BIBE--Big Bend National Park, Texas
"User study contributes to Rio Grande management." 1994, 14(2):1,3.

BICY--Big Cypress National Preserve, Florida
"Captive cougars may aid Florida panther project." 1994, 14(4):26.

CACO--Cape Cod National Seashore, Massachusetts
"Piping Plover protections wins Cape Cod NS worldwide recognition." 1994, 14(1):25.

CODA--Coulee Dam National Recreation Area, Washington
"Cooperative efforts improve forest health at Coulee Dam." 1994, 14(2):31.

CRLA--Crater Lake National Park, Oregon
"10-year study of Crater Lake underscores need for long-term monitoring program." 1994, 14(1):1,28-29.

DENA--Denali National Park and Preserve, Alaska
"Bill Brown-Denali NP make a prize package." 1994, 14(3):19.

ELMA--El Malpais National Monument, New Mexico
"Latest research at El Malpais reveals dating errors." 1994, 14(2):29-30.

EVER--Everglades National Park, Florida
"Water quality litigation: an update from the Everglades." 1994, 14(1):29.

FLFO--Florissant Fossil Beds National Monument, Colorado
"Creepy-crawlys of Florissant's Eocene time." 1994, 14(1):14.

FOLS--Fort Larned National Historic Site, Kansas
"Prairie dog control at Fort Larned, Kansas." 1994, 14(4):24.

GLAC--Glacier National Park, Montana
"Glacier National Park undertakes revegetation monitoring." 1994, 14(2):6-7.

GRSM--Great Smoky Mountains National Park, Tennessee and North Carolina
"Public education pays off at Great Smokies in smooth sailing for red wolf releases." 1994, 14(3):18-19.
"Delineation of old-growth oak and eastern hemlock in Great Smoky Mountains National Park." 1994, 14(4):14-16.

GRTE--Grant Teton National Park, Wyoming
"Abandoned road restoration methods tested at Grand Tetons National Park." 1994, 14(2):4-5.
"Winter mass balance measurements on Teton Glacier begin to build basis for predicting seasonal melt and runoff." 1994, 14(3):11-13.

HAFE--Harpers Ferry National Historical Park, West Virginia, Virginia, and Maryland
"How to prepare vegetation overlays as accomplished at Harpers Ferry." 1994, 14(2):8-9.

HAFO--Hagerman Fossil Beds National Monument, Idaho
"High tech meets old bones: accurate location of fossil resources at Hagerman Fossil Beds." 1994, 14(1):31.

INDU--Indiana Dunes National Lakeshore, Indiana
"Potential beaver recolonization at Indiana Dunes being evaluated by means of GIS analysis." 1994, 14(2):15.

ISRO--Isle Royale National Park, Michigan
"Isle Royale wolf/moose update." 1994, 14(2):11.

MORA--Mount Rainier National Park, Washington
"Keeping visitors on the right track: sign and barrier research at Mount Rainier." 1994, 14(4):17-19.

MUWO--Muir Woods National Monument, California
"Reconstructing climate data in parallel watersheds provides useful data on Muir Woods." 1994, 14(3):22-23.

OLYM--Olympic National Park, Washington
"Olympic revegetation efforts continue to evolve." 1994, 14(2):7.

Study documents mountain goat impacts at Olympic National Park." 1994, 14(2):23-25.

SEKI--Sequoia-Kings Canyon National Parks, California
"Prescribed fire: current status and future directions." 1994, 14(2):26.
"Sequoia National Park hosts 'Pulse II' and the beat goes on." 1994, 14(4):1,3-6.
"Project diversification a positive sign for Pulse future." 1994, 14(4):7.
"Dave Parsons' farewell." 1994, 14(4):8.

YELL--Yellowstone National Park, Wyoming
"Yellowstone fires of 1988 told in new book: A bibliography and directory of the "Yellowstone fires of 1988." 1994, 14(3):7.

ZION--Zion National Park, Utah
"Ash yellows and defoliating insects related to decline of velvet ash in Zion National Park." 1994, 14(2):20-22.
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scapes through ecosystem management principles, acceptance of scientific evidence of environmental issues, and pressures for government reinvention and interagency cooperation. The informally constituted commission will be asked to review the progress of past U.S. MAB efforts, assess the capabilities of the present organization to contribute in the future, suggest what to keep and what to change, and propose new program areas that should be pursued.

The U.S. delegation to the Euro-MAB managers meeting provided a good cross section of the U.S. biosphere reserve program. The delegation participated in discussions on the challenges and opportunities marine areas provide to the MAB program and developed recommendations for making EuroMAB biosphere reserves more effective partners.

These notes obviously touch on only some of the highlights of the MAB program. I will be glad to help as I can with specific questions or collaborations, and I encourage all of you who participate in biosphere reserves or other MAB activities to share information about your activities as much as possible, and to look ahead to participating in biosphere reserve managers meetings as they are convened.

Department contributor John Dennis is presently serving as the Acting Deputy Associate Director, Natural Resources. You can reach him at (202) 208-5193, (202) 208-4620 fax, or cc:Mail--WASO DAD/ Natural Resources.

Meetings of Interest

March 15-17

The national conference on Environmental Regulation and Prescribed Fire: Legal and Social Challenges will be held in Tampa, Florida. The gathering will provide a forum for prescribed fire practitioners and environmental regulators to discuss their respective roles in maintaining ecosystem health, preserving endangered species, reducing hazardous fuels, and protecting air and water quality. Contact Diane Ots, Environmental Regulation and Prescribed Fire Conference, Center for Professional Development and Public Service, Florida State University, Tallahassee, FL 32306-2027, (904) 644-7543 or fax (904) 644-2589, for details.

March 24-29

The North American Wildlife and Natural Resources Conference will be held in Minneapolis, Minnesota. For more information contact Lonnie L. Williamson, Wildlife Management Institute, 1101 14th Street N.W., Suite 801, Washington, D.C. 20005, (202) 371-1808.

April 3-7

The U.S. Army Corps of Engineers is sponsoring the National Interagency Workshop on Wetlands: Technology Advances for Wetlands Science in New Orleans, Louisiana. For more information contact the U.S. Army Engineer, Waterways Experiment Station, Wetland Research and Technology Center, Attention: CEWES-EP-W, 3900 Halls Ferry Road, Vicksburg, MS 39180-6199, (601) 634-2569.

April 11

Get in touch with Richard L. Knight, Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO 80523, (303) 491-6714 to learn more about the symposium, Paradigms in Transition: Natural Resource Management in the New Century, to be held in Fort Collins, Colorado.

April 17-21 (Earth Week)

Sponsored by the George Wright Society, the Eighth Conference on Research and Resource Management in Parks and on Public Lands will be held this spring in Portland, Oregon. This premier interdisciplinary conference on protected lands will focus on the theme, Sustainable Society and Protected Areas, Challenges and Issues for the Perpetuation of Cultural and Natural Resources. Presentations will include integration of natural and cultural resources in landscape management, the role of inventory and monitoring in resource management planning, the status of ecosystem management, and theory and practice in landscape restoration, among others. To register, contact The George Wright Society at P.O. Box 65, Hancock, MI 49930-0065, fax (906) 487-9405.

April 24-27

The Western Society of Weed Science will hold its Noxious Weed Management Short Course in Bozeman, Montana, for the cost of $350. Register by February 15 by contacting Celestine Duncan, (406) 443-1469. The course will cover weed identification, biological control methods, herbicides, computer use in weed science, noxious weed management on range and pasture, weed inventories and planning, safe handling of pesticides, and use of application equipment.

August 12-16

The Second International *Martes* Symposium will be held at the University of Alberta, Edmonton, this summer to explore integrating this genus, which includes weasels and skunks, into forest management. The deadline for abstracts is January 31, 1995. Call Dr. Paul Woodward at (403) 492-4413 or Dr. Gilbert Proulx at (403) 464-5228 for further information.

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