HIGHLIGHTS OF NATURAL RESOURCES MANAGEMENT

1993

Natural Resources Programs
Natural Resources Report NPS/NRPO/NRR-94/13
National Park Service

Highlights of Natural Resources Management

A Report on National Park Service Natural Resources Management Activities in 1993

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Big Events in '93

The National Biological Survey Reborn

By Abigail Miller, Program Coordinator, Natural Resources

In 1990, the National Park Service requested the National Research Council's assistance in strengthening the research program of the National Park Service. The Council's 1992 review detailed the need for National Park Service research activities, as well as its qualities and shortcomings. The review found that the decentralized nature of research in the Park Service, and the integration of research with resources management, were often counterproductive. One of its most important recommendations was for an autonomous research program.

The National Biological Survey, proposed by Secretary Babbitt in early 1993 and created with an appropriations on November 11, 1993, provides an alternative means of establishing an autonomous research program for parks. While the National Park Service pursued several means to make improvements to its research program, Secretary Babbitt considered the broader picture. Looking at the needs of all Department of the Interior land managers and the nation as a whole, Babbitt ordered a reconstitution of the National Biological Survey to consolidate and thereby focus biological expertise on the pressing issues faced by Interior decision-makers and by the country.

The excising of National Park Service research activities and personnel during 1993 was a gut-wrenching process. If the inverse of the axiom "no pain, no gain" is true, the National Biological Survey should yield substantial gains. The same integration of research and resources management that the National Research Council found detrimental to the quality of our research program made its removal extremely painful and difficult. No budgets and very few personnel were dedicated exclusively to research. Project funding targeted the highest priority, whether it was the research or implementation phase of a particular problem. Likewise, given the paucity of highly-trained resources management specialists, research scientists often performed resources management functions, overseeing operational activities and advising managers.

The dis-integration of research from natural resources programs changed the question of where to draw the line between research and resources management from a philosophical inquiry to the basis for splitting budgets. It gave new motivation to efforts to define what a resources manager should be trained and able to do to meet today's land management challenges. The process has resulted in a refined definition of the problem and scope of resources management needs facing the Park Service. This can be a vital spur for us to develop ways to adequately address these needs, giving increased weight to recent professionalization initiatives, including those in the FY 1994 and FY 1995 budgets.

The National Biological Survey also presents the opportunity to focus a stronger research program on park research needs. The National Biological Survey is committed to providing at least the same level of research to the National Park Service that we sent to the new agency. Additionally, the National Biological Survey recognizes the value of parks as places for the research that they will need to conduct to meet its broader national mission. The transition will be difficult while the agency establishes new procedures and lines of communication to accomplish park research needs. However, the potential exists for more and better research to benefit parks at the end of that transition.

Rare Orchid Located at Pipestone

By Pamela K. Benjamin, Natural Resource Management Specialist, Midwest Regional Office

Pipestone National Monument may be one of a few places in the Midwest that benefitted from the 1993 floods. Areas flooded for the first time in many years may have provided appropriate conditions for the growth of the federally threatened Western prairie fringed orchid.

Located in the southwestern corner of Minnesota, Pipestone National Monument preserves the significant cultural, historical, and ethnological resources associated with past and present day quarrying of the sacred red pipestone by Native Americans. Established primarily for its cultural resource values, the National Monument has the added benefit of containing numerous significant natural resources, most prominent being the park's native prairie setting.

Last sighted in 1984, the Western prairie fringed orchid was thought to have been lost from the National Monument. However, in July 1993 a population of 33 plants was located within a wet prairie/sedge meadow community not previously documented as containing the orchid. Prior to the 1993 discoveries, only two sightings of this orchid had been re-

corded at the National Monument, with each past sighting consisting of only a single plant.

Once occurring throughout the Red River Valley and extending southeast to Iowa and Missouri and west to northeastern Oklahoma, eastern Kansas, and eastern South Dakota, the Western prairie fringed orchid is federally threatened and is on the endangered list for the State of Minnesota. A stout, showy plant with distinct bisymmetrical white flowers, including a fringed lower petal, the orchid occurs most frequently in mesic to wet prairies, prairie seeps, and sedge meadows. The orchid is a long-lived perennial that reportedly has a unique ability to remain dormant, underground, for up to 10 years. Very little is known about the biology or population dynamics of this species; however, aboveground growth and subsequent reproduction appear to be highly related to soil moisture conditions.

Historically, Pipestone Creek, which traverses a 3/4 mile path within the National Monument, occupied a single, main channel, with water flowing into several secondary channels during "normal" flooding conditions. These secondary channels spread through a wide area of the adjacent landscape providing moisture to many of the small, depressional mesic/wet prairie communities and prairie pothole wetlands that were not directly associated with the creek. Channelization of the upper portion of Pipestone Creek in 1910 resulted in drastic alterations to the natural hydrology of the area. The wide distribution of water through the secondary channels became limited to only extreme flooding conditions.

As with most of the midwestern portion of the United States, the Pipestone region received heavy precipitation during the spring and summer of 1993, including a 75-year rain event. The resulting flood conditions provided a similar distribution of water as existed prior to the creek's channelization. Numerous short duration impoundments of water and the resulting soil saturation within the wet prairie and pothole communities is suspected of providing the appropriate environmental conditions for the aboveground growth of the Western prairie fringed orchid in 1993.

In order to provide for future monitoring of this species at Pipestone National Monument, each plant location was mapped and measurements of distance and direction were made to a permanent, fixed reference point. General phenological and morphological measurements (i.e., plant height, number of flowers/buds, etc.) were also recorded for each plant.

Currently, the Western prairie fringed orchid is only known to grow in fifty-five sites in seven states and one Canadian province. The rarity of this orchid species is best explained by habitat loss, initially associated with European settlement and the conversion of vast acreages of prairie habitat within the Great Plains region for agricultural use. Today, increased use of herbicides and pesticides, continued conversion to cropland, overgrazing, and hydrological alterations of the few remaining prairie remnants continue to threaten this orchid species and its associated habitats.

From left to right: David Mihalic, Roger Kennedy, Elizabeth Johnson, and Lloyd Loope.

Director's Awards

Each year, the Director of the National Park Service awards three individuals for outstanding achievements in natural resources management and research. The recipients of the awards receive $2,500 and a plaque honoring their achievements.

Director's Superintendent of the Year Award for Natural Resources Stewardship, David A. Mihalic, Superintendent, Mammoth Cave National Park

Director's Award for Natural Resources Management, Elizabeth A. Johnson, Chief, Division of Research and Resource Planning, Delaware Water Gap National Recreation Area

Director's Award for Research, Lloyd Loope, Research Scientist, Haleakala National Park

David Mihalic has managed and addressed park resources issues from a sustainable ecosystem perspective throughout his tenure at Mammoth Cave National Park. Major threats to the park resources involve water quality issues generated primarily from lands external to the park, such as sewage and wastewater disposal, industrial pollution, and agricultural runoff.

Mihalic has addressed these problems by creating partnerships with groups outside the park and by emphasizing the importance of resources management and research information and techniques. His leadership has made possible the development of several decision-making cooperative entities, such as the Mammoth Cave Area International Biosphere Reserve and the Mammoth Cave Area Special Water Quality Project.

Mihalic considers information to be vital to making sound resources management decisions. To address the lack of adequate baseline resources data and long-term monitoring information, he established a division of natural and cultural resources management to provide the expertise needed to develop and implement information collection projects.

Elizabeth Johnson has spent the last decade fighting to keep clean the part of the Delaware River within the Delaware Water Gap National Recreation Area. As development in the area has increased, sewage and wastewater treatment has become a serious concern. Because the soils in the region are not well-suited for septic systems, local residents want to use small wastewater treatment facilities that require the discharge of treated effluent into the river, which threatens the high water quality of the Middle Delaware Scenic and Recreational River. With the help and cooperation of many people, Johnson led the effort that has resulted in the adoption of new regulations by the Delaware River Basin Commission. These regulations will help protect existing high water quality in waters deemed to have exceptionally high scenic, recreational, ecological, or water supply value.

Johnson accomplished this herculean task by gathering hard, scientific data that proved the dangers to the river, and by developing cooperative partnerships with local groups. In cooperation with the Delaware River Basin Commission, Johnson planned and negotiated the development of irrefutable documentation of existing water quality through an intensive water quality monitoring investigation spanning 120 river miles. She documented patterns of adjacent land-use by initiating a prototype GIS-based land-use study; this study was crucial in convincing local planners, land managers, and regulators of the short- and long-term implications of changing land use upon water quality. By sharing this information with local towns, townships, and counties, Johnson earned their trust, which led to increased cooperation in identifying, discussing, and attempting to resolve water resources issues of mutual concern.

Lloyd Loope conducts research that is directly applicable to the resources management of the parks. And in Haleakala, that means exotic species research. Haleakala is the home of more endangered and threatened species than any other national park. Virtually all organism extinction and reduction of biological diversity in the park can be linked to the introduction of exotic life forms. Loope has conceived and implemented an exotic species outreach program aimed at gathering information, raising public and agency awareness, and developing strategies for control of species that are established on Maui, but have not yet spread into the park.

Through research, persistence, and talented use of the media, Loope has successfully identified and reduced the threat to the park of several exotic species, including destructive domestic rabbits, pampas grass, and a highly invasive tree. Loope also developed an emergency recovery plan to rescue the Haleakala Greensword from almost certain extinction.

Loope is recognized as a leader in the field of exotic species research. What has not been so well-known--and this award should change that--is his ability to recognize a potential problem and, with creativity and empathy and scientific data, persuade managers of the need for action.

The Firestorms of 1993: NPS Response in the Santa Monica Mountains

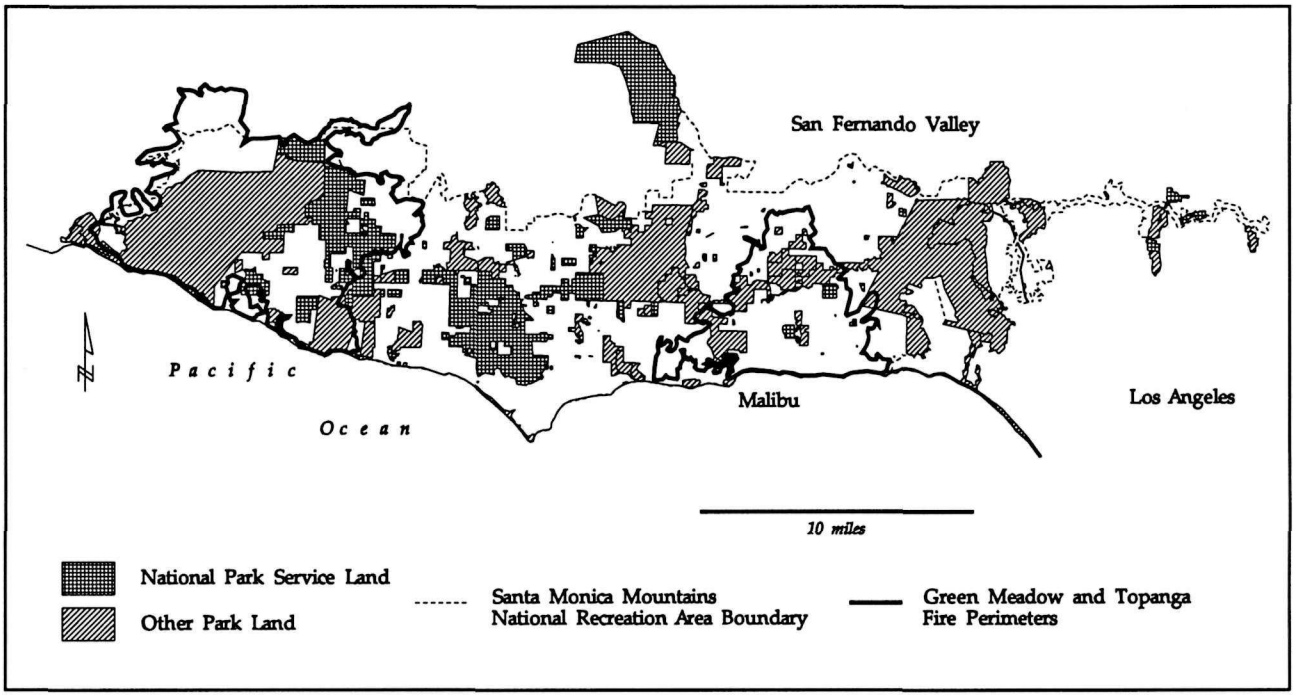
By Raymond M. Sauvajot, Ecologist, Santa Monica Mountains National Recreation Area

For thousands of years, southern California has been subjected to a variety of dramatic natural forces that have helped to shape its landscapes and affect its natural communities. The Santa Monica Mountains National Recreation Area is no exception to this pattern. Fire has occurred in the Santa Monica Mountains for thousands of years, and since 1925, when detailed record taking began, fires of greater than 25,000 acres have occurred on an average of every ten to fifteen years.

In the fall of 1993, history repeated itself with ferocity as over a dozen major wildfires burned throughout southern California. In the Santa Monica Mountains, over 55,000 acres burned in two large and destructive fires, the Greenmeadow (38,000 acres) and the Old Topanga (17,000 acres). In both cases, the human-caused fires were fanned by strong Santa Ana winds, which pushed the flames from their interior starting points to the Pacific Coast in a matter of hours.

Even before the flames were extinguished, National Park Service resources managers from the Santa Monica Mountains National Recreation Area were called upon to provide information, support, and recommendations to the multiple agencies involved in fire suppression and post-fire rehabilitation efforts. As a substantial landowner and resources management agency in the Santa Monica Mountains, National Park Service post-fire responsibilities and activities have been extensive. Several prominent issues in which the National Park Service took a leading role demonstrate how obtaining baseline resources data, linking these data to a comprehensive geographic information system (GIS), and coordinating resources management activities between agencies is critical for effectively addressing resources concerns during crisis situations such as wildfires.

Perhaps the most widely publicized rehabilitation issue following the southern California wildfires focused on the perceived need to reseed natural areas that had burned. Park staff quickly addressed this concern by compiling, reviewing, and disseminating available scientific data on reseeding, and coordinating an interagency response with local



agencies and university experts. Armed with this information, the Superintendent was able to immediately develop a credible and defensible policy statement disallowing any emergency reseeding on National Park Service lands in the Santa Monica Mountains and strongly suggesting the use of natives if reseeding was proposed for other property in the Mountains. This was based on research that demonstrated that reseeding, especially with exotic species, (1) may not significantly decrease soil erosion hazards, (2) can interfere with natural vegetation regeneration processes, and (3) may create additional erosion and fire hazards in the future. A number of local agencies and organizations concurred with the National Park Service position and, because park staff rapidly coordinated with these groups and compiled relevant scientific data, the National Park Service provided an informed and authoritative voice in post-fire resources management planning. Partly due to these efforts, only 10,000 acres were reseeded in the Santa Monica Mountains, and none on federal or state parklands. In addition, throughout southern California, post-fire reseeding efforts focused more on long-term natural resources protection, with native species often used when seeding was recommended.

As a follow-up to the reseeding "debate," the National Park Service immediately contacted local agencies and researchers about post-fire research opportunities, specifically to address rehabilitation alternatives, including reseeding. As a consequence, the park was able to take the lead in helping to coordinate and facilitate post-fire vegetation and erosion research. This work, which is ongoing, includes both fire effects monitoring initiated by the National Park Service and interagency-supported research by university investigators. The research addresses vegetation regeneration, erosion, and sedimentation in seeded and unseeded areas.

Perhaps the most visible role played by the National Park Service both during and after the Santa Monica Mountains wildfires has been to provide critically needed GIS support to the many agencies involved in fire-related activities. The park had already developed a comprehensive and sophisticated GIS for the Santa Monica Mountains National Recreation Area. Using the GIS, park staff were able to quickly generate crucial maps and data to assist in interagency fire suppression and rehabilitation efforts. This support included mapping fire spread and hotspots through the use of global positioning and remote sensing technology, providing digital fire history information, identifying and evaluating fire-damaged resources, and mapping fire-affected structures and jurisdictions throughout the Santa Monica Mountains.

The park has continued to provide this type of support and has taken a leading role in promoting the benefits and needs for an interagency GIS program focused on the Santa Monica Mountains ecosystem. Efforts by the National Park Service are currently underway to build a resources database, which will include an accurate, field-based vegetation map for the Mountains based on satellite imagery, aerial photography, ground-truthing, and other sources of data. In addition, the park is already collecting data on archeological resources, on the status and distribution of threatened and endangered species, and on wildlife distribution. Throughout all of this work, an important fact has been continually emphasized: All of the fancy GIS software and hardware available will be of little value without collecting detailed and accurate resources data linked to the GIS. The park is currently working in cooperation with state, county, local, and other federal agencies to build this critical resources database for the Santa Monica Mountains ecosystem.

Making the Most of a "Sod" Situation

By Rebecca Dahle Lacome, Park Ranger, Resources Management, Homestead National Monument

The "year of the great floods" wreaked havoc throughout many midwestern National Park Service areas. At Homestead National Monument in southeastern Nebraska, two separate flooding incidents caused serious erosion and collapse of stream banks, leading to the loss of part of the park's trail system. When faced with the need to relocate a section of trail through the 55-year-old tallgrass prairie restoration, the park transplanted 1000 cubic feet of established sod from the trail relocation to a new portion of the prairie restoration. In so doing, "new ground" was broken in the continuing history of restoration at Homestead--the prairie restoration became a sod donor to itself.

The prairie restoration at Homestead is one of the oldest ongoing efforts of its kind in the world, and the first in a national park area. In 1938, wildlife technician Adolph Murie wrote the first management plan describing two management techniques; one was seeding and the other was transplanting sod from a local prairie. He recognized the advantage of sod transplants that bring not only prairie grasses into the restoration, but also the native species of "prairie herbs." We know today that sod transplants may also bring other necessary native elements into the restoration such as soil nutrients, microbial elements, and insects and larvae which may be required for plant propagation and ecosystem viability.

Sod transplanting has become a time-honored management technique in the Homestead restoration effort. Beginning in 1939, and throughout the 1940's, sod strips from native prairie remnants in the vicinity were relocated to control erosion on the upland slopes of the restoration. Combined over the years with seeding and transplanting greenhouse-grown seedlings, these techniques created a diverse and increasingly representative tallgrass prairie facsimile. Even at its small size of 100 acres, the historic restoration serves well to introduce visitors to the natural environment pioneers encountered as they crossed and eventually settled the Great Plains. It also teaches the value of native plant communities in the perpetuation of land health in a part of the country which has been substantially altered by agricultural practices.

During the 1980's, sod transplanting from a local donor prairie was again initiated, this time with the intent of increasing the forb (flowering herb) diversity in newer areas of the restoration. Funding from the Servicewide Natural Resource Preservation Program initiative has allowed this project to continue into the 1990's. In 1992, 85 sod plugs were transplanted to increase forb diversity in a 1960's grass seeding along a relocated highway right-of-way. Each cubic foot plug targeted a specific forb species for transplanting. A 67% survival rate resulted in the first growing season and much was learned about the adaptive abilities of the different species.

The summer flooding of 1993 provided a different kind of transplanting opportunity and a chance for the prairie to restore itself. Using emergency flood funding, seasonal maintenance and resources management personnel worked through the fall to transplant sod from the trail relocation necessitated by flood erosion. Sod blocks were dug by hand, loaded onto a flatbed trailer pulled by an all-terrain vehicle, and transported 1/3 mile to an area which had just begun to undergo restoration earlier in the year. The sod blocks were then packed into trenches prepared by a backhoe. Moisture in the soil from the year's abundant precipitation and continuing rain showers through the fall eliminated the need for irrigation.

Experimentation with a variety of techniques at Homestead has resulted in a successful prairie restoration capable of providing its own sod and seed for continuing propagation and diversification. As these techniques are fine-tuned in the restoration's *next* fifty years, the waving grasses and prairie flowers which are already well established will serve as a storehouse of supply, as well as inspiration.

Forest Dynamics Research Studies Post-Hurricane Ecosystem Recovery

By Richard A. Clark, Chief, Research and Resources Management, Congaree Swamp National Monument, and Eric F. Pauley and Rebecca R. Sharitz, Research Ecologists, Savannah River Ecology Laboratory

On a human scale, hurricanes are disasters. On a time scale of a millennium, however, hurricanes are normal features of the climate. For example, five major hurricanes and many less severe storms have struck South Carolina within the last 110 years.

On September 21-22, 1989, Hurricane Hugo came ashore near Charleston, South Carolina. As Hugo traveled inland, winds in excess of 97 mph struck the old-growth floodplain forests of the Congaree Swamp National Monument near Columbia. In an effort to understand ecosystem recovery following natural disasters, the National Park Service entered into a cooperative agreement with researchers at the University of Georgia's Savannah River Ecology Laboratory in Aiken, South Carolina, to survey damage to the Congaree Swamp and to initiate long-term monitoring of natural recovery processes.

The researchers established ten 2.5-acre plots in the two major forest types in the Congaree. Six plots were in seasonally flooded bottomland hardwood forests--rich mixtures of sweetgum, oak, elm, sugarberry, and ash. Four plots were in the more frequently flooded sloughs dominated by bald cypress and tupelo.

Detailed measurements included tree diameter and type and degree of hurricane damage inflicted to each tree. The position of each tree in each plot was mapped; computer-generated scatter plots prepared from this information precisely delineate the spatial distribution of each species and the spatial pattern of damaged trees. In 1991, the researchers installed 30 smaller plots within four of the plots (two bottomland hardwood and two slough plots) to monitor natural seedling recruitment and growth.

Although this forest recovery research is expected to continue at the Monument for at least the next 20 years, the initial post-hurricane tree survey revealed some intriguing patterns. Hurricane Hugo damaged more trees (37%) in the bottomland hardwood forests than in the sloughs (10%). Although sloughs have wet, unstable soils, uprooting by high winds was more than ten times as frequent in bottomland hardwood forests. (Many bottomland hardwood species have large spreading crowns that may make them more susceptible to wind damage.) Within each forest type, Hugo hit some tree species harder than others. For example, in bottomland hardwood forests, 61% of the oaks but only 45% of the sweetgums suffered serious damage. In sloughs, only 3% of the bald cypress were injured, while about 10% of the tupelos were damaged. In both forest types, the hurricane affected larger trees more than smaller trees.

Despite site-specific differences in damage from Hurricane Hugo, sunlight intensities at ground level have increased throughout the Congaree Swamp due to widespread loss of branches. The canopy in bottomland hardwood forests is a mixture of both shade-tolerant and shade-intolerant species. The expected pattern in such forests would be a gradual succession toward increased abundance of shade-tolerant species. In bottomland hardwood forests, partial canopy opening appears to be favoring seedlings and saplings of shade-tolerant species (red maple, sugarberry, ironwood). By damaging the existing overstory and releasing shade-tolerant species, Hurricane Hugo may accelerate this

expected shift. In contrast, both canopy and seedling/sapling layers in sloughs are composed mostly of shade-intolerant species, suggesting little compositional change in response to hurricane damage.

The hypothesis of keen interest to the Congaree Swamp National Monument's research and resources management program, and the basis for which this research will continue, is that natural disturbances such as hurricanes are essential to the biological diversity within the forest system. The Congaree Swamp contains more than 45 species of trees in a relatively small area. Ecologists now recognize the importance of natural disturbances in maintaining species diversity in many ecosystems. Hurricane Hugo provided a natural experiment that will be used to test and refine ideas about the relationships between disturbance and diversity in an old-growth floodplain forest. The hurricane also provided a dramatic example to the public of the natural dynamics of such ecosystems.

Resources Management Plans: The Foundation of Park Resources Management Programs

By Jen Coffey, RMP Coordinator, Wildlife and Vegetation Division

The Resources Management Plan (RMP) provides a strategic plan for each park, serving as the foundation for the park's resources management program. The RMP provides the vehicle for a park to describe the impacts or threats to the park's resources, to analyze those impacts and rank them in importance, to propose specific actions for dealing with the most important and urgent problems, and to present a program to achieve progress in accomplishing the actions that have been proposed.

Although some parks began preparing RMPs more than 20 years ago, a 1987 General Accounting Office review of activities taken by the National Park Service to address threats to park resources found that RMPs were not consistent in format from park to park, and that many parks did not have current RMPs. As a result, guidance issued in 1989 directed that integrated natural and cultural resources management plans be prepared for all parks and updated at least every four years.

Four years after that guidance was released, in March 1993, the Service held a Resources Management Plan Workshop in Tucson to explore ways to enhance the resources management planning process and improve the quality of RMPs, as well as their utility to the parks. Representatives of both the natural and cultural resources disciplines from regions and parks across the National Park Service participated in the week-long workshop. Based on the recommendations that resulted from the workshop, the instructions to parks on how to develop a resources management plan have been enhanced.

Another recent change in the area of resources management planning arose from the *Planning for the Future: A Strategic Plan for Improving the Natural Resources Program of the National Park Service*. Issued last November, Staff Directive 93-2 ensures that parks make opportunities available for the public to participate in resources management planning. While the extent and type of external involvement will vary from park to park, other federal agencies, state and local governments, and indigenous populations in the area of the park should be involved during some phase of the planning process for those RMPs initiated after the receipt of Directive 93-2 by the park. Since the RMP can be a rather detailed and lengthy document, an executive summary of the RMP may help facilitate external participation in the planning process.

In 1990, the National Park Service began to develop a computerized database system for parks to use in managing information on their RMP projects. Each year, data from the parks is summarized into regional and national data bases and used to help document park resources management activities and needs in areas such as endangered or exotic species management or air quality management. This is the first time the National Park Service has had access to this information on a national basis.

Several additional enhancements to resources management planning currently under development should be ready for implementation next year. These include a computerized annual accomplishments report that will allow the National Park Service to measure and track progress toward long-term management goals. (Although some parks have already been preparing an annual report, the reports have never been standardized for application on a servicewide basis.) A method to archive project statements for completed projects will also be added to the RMP software, allowing parks to maintain a record of projects that the park has completed, and adding further to their ability to track their progress in resources management. New program-based codes will augment the servicewide issue codes currently used in RMPs; this will facilitate the use of RMPs by parks in a program-based approach to management of park resources, rather than a more scattered approach based on the implementation of disconnected projects. Finally, the format for a state of the park resources report is being developed for disseminating information concerning resources management activities in the parks and the current condition of the natural resources.

Professional Development Program Key to Achieving Employee Excellence

By Abigail Miller, Program Coordinator, Natural Resources

Enabling employees to achieve excellence is the cornerstone to achieving organizational excellence. And organizational excellence is needed to meet the technically and politically complex natural resources stewardship mission facing park managers today.

The valued natural resources of the National Park System--many in nearly intact ecosystems--are threatened by increasing population growth and attendant land development, predicted global change effects, pollution, increasing visitation and use, and continued incursions of exotic species. The five-year *Strategic Plan for Improving the Natural Resources Program of the National Park Service* seeks to develop a more scientifically based, professionally staffed, and adequately funded natural resources program to address these challenges. The first of the plan's four goals embraces the human, organizational, and financial aspects of the program, with an emphasis on developing an organization that allows each employee to excel.

The new Professional Development Program is the key to achieving excellence in our natural resources employees. It is aimed at attracting, maintaining, and promoting qualified individuals in the National Park Service, including those who already have long experience. Three strategic plan teams assisted in creating the Professional Development Program. The teams involved 25 people--11 from parks, 9 from regions or cooperative park study units, and 4 from Washington offices. The result includes: 1) role and function definitions; 2) model organizations; 3) identification of professional standards for natural resources positions; 4) a career management scheme; 5) an introductory training module for new natural resources personnel; 6) a continuing education curriculum and opportunities; and 7) a recruitment strategy.

Begun before the creation of the National Biological Survey, the effort focussed first on evaluating the appropriate respective roles of research scientists and natural resources managers. This responded to concerns that researchers were over-occupied with resources management tasks to the detriment of research and that some resources management staffs might not be fully qualified to carry out resources management duties. To address these issues and the qualifications necessary to carry out resources management duties, it was important to carefully define the appropriate responsibilities of natural resources managers. Once roles and functions were articulated, organizational issues, professional standards, and career ladders were evaluated and developed. One major emphasis in the resulting career paths is on classifying positions for specialized disciplines rather than exclusive reliance on generalists. A clear distinction is made between specialist functions and "integrator," or management, functions. The career management scheme also recognizes that different levels and degrees of specialization will be required for parks of different size and complexity.

An evaluation was conducted of the Natural Resource Management Trainee Program, a program providing comprehensive education in both basic resources management and Park Service policy and procedures. It concluded that the program had been successful, but that new circumstances dictated new objectives and different types of training to meet them. In particular, the emphasis on hiring into specialized disciplines obviates the need for extensive basic training. Therefore, a new introductory training module for all new natural resources personnel will replace, at least temporarily, the former trainee program. Second, the Professional Development Program outlines strategies and a curriculum for continuing education. These consist of additional courses, principally outside one's primary discipline, and the opportunity for existing personnel to obtain advanced degrees.

Managers are recognizing that fully trained and qualified individuals are vital in managing resources and representing park interests in the face of the threats to resources encountered today. Despite losing over 100 professional level employees to the National Biological Survey in 1993, the National Park Service experienced a net gain of 50 permanent employees in professional natural resources positions (as measured between February 1992 and March 1993).

An initiative that continued this trend toward the goals of the strategic plan began with the FY 1994 budget. Through budget requests, the National Park Service is seeking to increase the number of professional natural resources positions available in parks--more wildlife biologists managing native, threatened and endangered, and exotic animal populations; more botanists to restore and protect native plant communities; more hydrologists, paleontologists, foresters, geologists, etc., working together to conserve the ecosystems of the national parks. In response to the FY 1994 budget request, Congress appropriated $5.1 million, funding 85 FTEs, for natural resources professionals in parks.

Through these efforts--additional professional positions and the implementation of the Professional Development Program--the National Park Service will be able to meet its goal of excellence in resources management.

Managing Cave Resources

Caves Receive Protection from the Federal Cave Resources Protection Act

By James Simpson, Resources Management Specialist, Ozark National Scenic Riverways

In 1988, Congress recognized the importance of caves and their ecosystems with the passage of the Federal Cave Resources Protection Act, which requires inventory and management of the nation's significant federally-owned caves. After five years of interagency negotiations, the Department of the Interior published regulations for the implementation of the Act on October 1, 1993. Throughout the nation, cavers will be happy to hear that a cave need not be unique to qualify as significant under the Act. The regulations state that a cave only has to meet one of the following six criteria to establish significance. The cave has to (1) have populations of native cave fauna; (2) have historic or archeological resources; (3) have geologic, mineralogic, or paleontologic features; (4) be part of a hydrologic system; (5) provide recreational or scenic values; or (6) offer educational or scientific study opportunities.

The five-year delay in publication of the regulations resulted from a requirement in the Act that the implementation regulations of the secretaries of Interior and Agriculture be similar. With the publication of the final rules defining the criteria for significance, Department of the Interior land-managing agencies can now began the inventory and assessment of caves on federal lands. Information derived from this nationwide inventory about the sizes, locations, characteristics, and resources of federally-owned caves will be vital to the National Park Service and other federal agencies with cave management responsibilities. Identification and listing of significant caves on these lands will ensure that cave management will be integrated into agency planning and resources management actions and will provide a higher level of protection for all cave resources. Effective manage-

ment of the underground environment will require an interdisciplinary effort involving hydrologists, geologists, biologists, paleontologists, archeologists, historians, and cave explorers.

Cavers who have had concerns about confidentially of cave information will be reassured by specific provisions for agencies to protect cave location data, which are specifically exempted from the Freedom of Information Act. In the National Park Service, parks will keep information on their caves in secure storage, controlling access to location information to protect caves from misuse and vandalism.

Caves will be nominated for significant status in two stages. In the first stage of the nomination process, the nearly 60 parks known to have cave resources will, in consultation with individuals and cave organizations, inventory and evaluate their cave resources and produce an initial list of known caves. This list will then be continually updated as new caves are discovered and evaluated for significance. A National Interagency Oversight Team will coordinate the nomination process, and regional interagency teams have been formed to review and verify nominations from six regions of the country.

A close association with volunteer cavers and caving organization will be necessary for the National Park Service to locate and identify their cave resources. For years, volunteer cavers have been exploring and studying caves and their ecosystems. The Park Service is fully committed to strengthening the cooperative relationship with these volunteers, who have already contributed much to the protection and study of cave resources.

Volunteers Help Inventory Oregon Caves

By John E. Roth, Resources Management Specialist, Oregon Caves National Monument

Effective monitoring, restoration, and mitigation can be done only if good inventories exist. However, since caves are diverse, hard to get to, and alien to most people, few caves anywhere have good inventories.

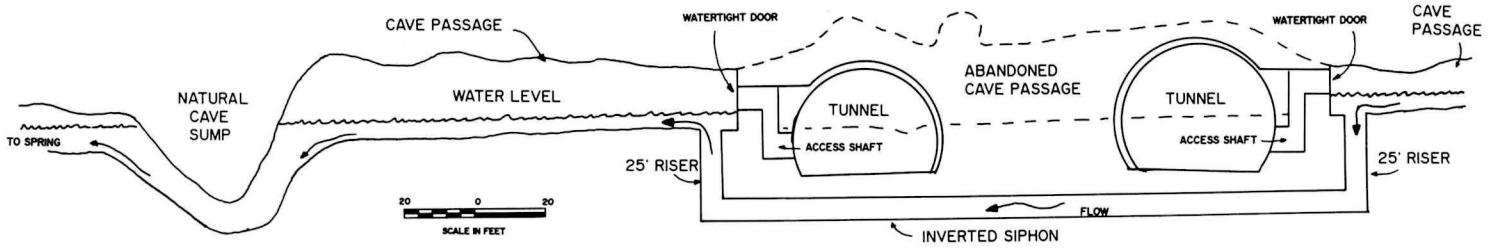
To close this data gap, volunteers from Earthwatch helped Oregon Caves National Monument complete a comprehensive bio/geo/cultural inventory with over 100,000 items. Each station yielded 100 items, the maximum deemed possible without data degradation due to fatigue of those doing the inventory. The items inventoried were chosen from a glossary produced by the parks that can be used by other parks. Choosing items from an established glossary caters to each park's needs yet allows cross-cave comparisons for those features many caves have in common. Definitions sometimes set arbitrary limits and in other cases take advantage of marked breaks between the dimensions of various cave features, such as the parallel ridges of microgours and rimstone dams. Multiple inventories of the same site by different teams helped redefine the least consistent items.

Correlations abound. The largest passages in the caves coincide with fault directions and the steepest hydraulic gradient, the direction in which water flows the fastest. This helps explain why Oregon Caves is so big compared to nearby caves. This orientation also is the same one in which molten rock beneath the cave rose along faults formed when the ocean basin of the original limestone (now marble) stretched and deepened.

Most of the complex clay "worms" occur in areas of highest airflow, where water evaporates to allow thin films of clay to grow into complex shapes. Limestone sheets of flowstone tend to form from water slowly seeping between rock layers, while stalactites form from water dripping rapidly from joints (regular cracks cutting across rock layers). Adjacent land use therefore would affect cave formations differently, causing rapid changes in stalactite growth and slower but more lasting changes in flowstone formation. Cave depth also influences how fast changes occur. The deepest parts still had many rapid drip sites, while the rest of the cave dried up by the end of the summer drought. Rills (parallel grooves in the wallrock of the cave) increase away from airflow and near pools and dome pits. While nobody knows how most cave rills form, degassing from pools and dome pits and subsequent acidic dew may etch rills on ceilings. Bevels (horizontal notches in cave walls) occur where floodwaters ponded behind passage constructions. Commonly found with rills, the etched areas extend about 2' high, the top of the floodwaters being the most acidic level.

Similar features were separated by breaks in averaged measurements and by different distributions. This suggests separate origins. For example, microgours usually range up to about 1/4". The low end of rimstone dams is about 1". Microgours at Oregon Caves are related to flowstone, while rimstone dams follow stream flow. This type of feedback helped revise the inventory standards.

With more insight on human impacts, restoration can begin. "Cave slime" are actinomycetes bacteria, small white spots on walls. Both the amount of cave slime and white formations decrease near the trail. Bacteria feeding on lint from clothing may be outcompeting native bacteria, a "paradox of enrichment" often found in human impacts on caves. Lint, skin oils, and smoke from torches darkened formations that can be cleaned now that the extent of the impact is known. All areas with trail rubble or broken formations have been located and can be cleaned up or repaired one-by-one.



Scientists and Engineers Work Together to Save Threatened Cave Stream

By Joe Meiman, Hydrologist, Division of Science and Resources Management, Mammoth Cave National Park

The traditional relationship between scientists and engineers has often been marked with a certain degree of antagonism. Sometimes these feelings are fostered by stereotypes of the eccentric, mad-scientist who will not produce a definitive answer, and the stubborn, number-crunching engineer who will not believe an answer that is not a mathematical expression. At Cumberland Gap National Historical Park (NHP), individuals of vastly different disciplines worked together to solve a difficult engineering problem by using and conserving a natural hydrologic system.

A highway tunnel is being constructed in an effort to eliminate traffic through Cumberland Gap, for reasons of both transportation safety and historic restoration. A problem arose when the tunnel intersected a cave with an active stream. The Federal Highway Administration, responsible for the completion of a safe tunnel; the National Park Service, responsible for maintaining the natural flow of water through the cave system; and a consulting engineering company, responsible for designing a mechanism to accomplish both goals, all soon realized that a karst aquifer is a dynamic force to be reckoned with.

The cave bisected by the tunnel runs roughly perpendicular to the tunnel about 15' above the tunnel floor, and contains a significant stream with a flow ranging from 20 to over 3000 gallons per minute. The engineers designed an inverted siphon beneath the tunnel to reconnect the severed cave stream. While constructing the tunnel and the inverted siphon, the water was diverted through the tunnel and periodically pumped to the downstream section of the cave stream, which flows to a natural sump (a completely and perennially flooded cave passage).

When construction of the siphon was completed, water flowed through the siphon and into the downstream section of the cave, but also shot out of the tunnel floor. To address this problem, the siphon was shut off, the tunnel floor sealed, and flow resumed. This time water came in through the tunnel wall.

The Superintendent of Cumberland Gap requested the assistance of the author, a hydrologist at Mammoth Cave National Park specializing in the behavior of karst aquifers. Fluorescent tracer-dye tests revealed that the tunnel had intersected a small, natural conduit connected to the cave sump. Plugging the conduit with concrete stopped the leaks into the tunnel. Further investigations by Mammoth Cave's hydrologist and Cumberland Gap's resources management specialist suggested that the tunnel construction activities had upset the natural hydraulic balance of the sump, which is similar to a kitchen sink "S" trap; sediment had accumulated and effectively stopped-up the drain. To re-establish the natural flow through the cave, the water level in the sump would have to be pumped down and the sediment removed. Usually a karst hydrologist does not have the material or personnel resources to accomplish such a task, but the engineers responded with the plans, pumps, pipes, and people to do the job.

After a concerted effort, the sand and water was pumped out, revealing a large, 25'-deep natural sump. Taking advantage of the situation, park staff explored and surveyed approximately 1100' feet of normally-flooded cave passage. The engineers then removed the remaining post-tunnel construction sediment.

The weather soon put to the test this unlikely marriage of man-made siphon and natural cave system; over 4" of rain fell on Cumberland Mountain in one day in early December. The system easily handled a peak flow estimated at 3000 gallons per minute.

Groups and individuals with seemingly divergent goals worked in concert to solve a difficult problem at Cumberland Gap NHP. The Federal Highway Administration secured a safe tunnel, and the National Park Service ensured the continuation of the natural flow of water through the cave system.

Holistic Cave Resources Management at Mammoth Cave Biosphere Reserve

By Rick Olson, Ecologist, Mammoth Cave National Park

An interdisciplinary approach emphasizing principle threats, rigorous inventory, and long-term monitoring provide a scientific foundation for the resources management program based at Mammoth Cave National Park. Long ago, it was realized that parks cannot be managed as islands, that expertise in all the required fields could not be incorporated within park staff, and that partnerships would therefore be part of the success formula in both research and resources management.

The subsurface drainage basins of the Mammoth Cave System extend well beyond park boundaries, and this hydrological domain was designated an international biosphere reserve by UNESCO in 1990. The importance of the biosphere reserve and symbiotic regional planning is illustrated by the Mammoth Cave Area Special Water Quality Project. The project is a cooperative effort between the park, the Barren River Area Development District (which coordinates management actions in the Reserve), 10 federal and state agencies, local communities, and individual farmers. These groups are working together to create a sustainable economy. As an example, agricultural best management practices developed by the Soil Conservation Service are implemented to reduce impacts on the karst aquifer.

Similarly, the Caveland Sanitation Authority, in which the National Park Service is also a significant partner, has resulted in construction of a regional sewage treatment facility. The effectiveness of these programs are tracked via direct evaluation of water quality in concert with biological monitoring of both cave and surface aquatic communities. These data will be correlated with detailed land-use information collected for each subsurface drainage basin, and entered into the GIS as part of a comprehensive database.

In a cooperative venture with Earthwatch, funded through the Challenge Cost-Share Program, highly precise techniques for inventory and monitoring of cave resources have been devised. The protocols were developed as part of the first quantitative assessment of the world-class archeological artifacts in Mammoth Cave, and will be virtually universal in their application to natural resources in large passages. Briefly, a Total Station Electronic Distance Measuring Instrument is used to locate each object, and both survey data and attribute information are automatically recorded in an electronic data logger. Each evening the Earthwatch volunteers download the data to a computer which allows for immediate display and analysis. To date, 2200 hours have been volunteered to the project. The "time capsule" nature of dry upper level passages has preserved *in-situ* archeological evidence of early Native American exploration and mineral mining that began almost 4000 years ago. These early explorers penetrated by torchlight farther into Mammoth than any other known cave in the world.

Mammoth Cave National Park has been selected as a future participant in the Servicewide Prototype Long-Term Ecological Monitoring Program. This project will be conducted in cooperation with the National Biological Survey, and partnerships both established and new will play a key role in this research.

Cavers and Park Service Protect Caves Together

On December 2, 1993, the NPS signed a Memorandum of Understanding (MOU) with the National Speleological Society, committing the two organizations to cooperative efforts to preserve and protect cave resources in the National Park System. Through this agreement, National Speleological Society members will assist the National Park Service in cave management activities, including exploration, surveying, mapping, inventories, and research. The MOU builds upon a productive, long-standing relationship between the National Speleological Society and the National Park Service. In the past, local Society chapters have contributed thousands of volunteer hours in National Park System caves, exploring and mapping hundreds of miles of passages, conducting numerous geological and hydrological studies, and documenting many rare and endangered species. The National Speleological Society, founded in 1941, includes more than 11,000 members with interests ranging from recreation to research.

Threats to Natural Resources

Above-board Decision Affects Underground Concession in Carlsbad Caverns

By Nancy Skinner, Natural Resource Specialist,
Division of Environmental Coordination, Southwest Regional Office

Imagine that its 1933. You're visiting Carlsbad Caverns National Park for the first time. Being adventurous, you decide to go on a seven-hour guided hike into Carlsbad Cavern. You don a hardhat equipped with headlamp, and venture into the underworld through the natural cave entrance. Inside the cavern lie myriad odd shapes and colors of speleothems (e.g., stalactites and stalagmites). Following your guide, you descend some 800', clambering over bat guano filled sacks that serve as steps up and down into various chambers of the cavern. You duck under low ceilings, squeeze through tight passages, and are careful not to slip on the wet cave floor. About halfway through the tour you arrive at the Big Room, where a box lunch awaits you. At this point food really hits the spot, considering the energy you've expended to get here. After lunch the tour group begins the long, arduous trip back up the many wooden ladders and guano sack steps, up and out of the cavern's natural entrance.

Now, picture a visit to Carlsbad Caverns in 1993. Because you are adventurous, you and your party elect to walk into the cavern through the natural entrance instead of riding the elevator down. You begin your self-guided tour with a brief message from the ranger at the entrance. The asphalt trail is easy to follow and along the way you encounter interpretive signs and exhibits explaining some of the features that you observe from the trail. You descend 830' viewing the Main Corridor, Scenic Rooms, and Big Room. After two to three hours you arrive at the large, well-lit concession area that provides a place to eat lunch, buy a souvenir, and relax with your group. After a brief respite, you and your party ride the elevator, one minute and 750' to the surface.

In the sixty plus years since lunches were first provided to underground visitors, much has changed at Carlsbad Caverns National Park. Facilities have expanded in the underground as well as on the surface to serve over half a million visitors each year. In recent years, several events served as catalysts for the National Park Service to evaluate the need for, and appropriateness of, concession facilities underground at Carlsbad Caverns: the concessions contract at Carlsbad Caverns expires in 1994, new concessions management policies in 1988 strengthened the agency's approach to enforcing the Concessions Policy Act, and the Vail Symposium specifically recommended minimizing development within parks. The combination of these three events encouraged the Park Service to examine concessions management alternatives underground at the caverns.

Why were we interested in making changes to the underground concession facilities at Carlsbad Caverns National Park? Ever since the elevators were constructed to provide direct access to the caverns, the need for an underground concession in the heart of the resource has been questioned. We wanted to take a fresh look at options that would protect natural resources, provide visitors with an experience con-

Tourists will no longer be able to buy underground T-shirts once the new concessions policy in Carlsbad takes effect.

sistent with the agency's mission, and respond to new guidance in concessions management.

Today, we have new understandings about the delicate workings of the cave environment. We know that an inadvertent food source lures surface animals such as ringtail cats into the cavern. We know that introduced food and waste in the cavern affects native arthropod numbers and distributions. We know that accumulations of lint on speleothems encourages algal growth, causing discoloration and disrupting natural speleothem development. We know that the "popcorn" (speleothems) found throughout the Left Hand Tunnel results from a delicate interaction between cool, dry air and warm, moist air causing condensation corrosion; this delicate balance is a function of airflow, humidity, temperature, and carbon dioxide, which are influenced by large congregations of people. Finally, we suspect that what we know of the cavern environment is inadequate to anticipate all the impacts of a developed underground concession facility designed to serve up to 700 people.

The existing operation consists of food and retail sales counters, walk-in refrigerators, microwave ovens, beverage dispensers, a dry goods storage area, trash compactor, cleaning equipment, and seating to accommodate 700 visitors, all occupying approximately 35,000 ft^2 within the cavern.

In order to make an informed decision regarding the concession contract, an interdisciplinary team compared three alternatives in an environmental assessment: (1) the "no action" alternative would leave things as they are, (2) a reduced concession service would provide beverages and snacks, and (3) the proposed action would completely remove the concessions operation from within the cave.

Knowing that change, of any kind, would be highly controversial, an important part of the environmental assessment involved requesting public comment. The public responded vigorously. Most of the people who commented were from the local community and preferred to leave the underground lunchroom as it was. All of the comments we received were from people who felt strongly about the future of Carlsbad Caverns.

In the end, after all public comments were considered, the Regional Director made a tough decision. In the face of controversy, the Park Service decided to remove all concession facilities and services from the underground of Carlsbad Caverns. The Park Service will provide some mitigation measures addressing the concerns raised by the public, as long as they do not adversely affect the cave resources. The decision reflects the agency's commitment to conserve and protect cavern natural resources while providing for visitor enjoyment of Carlsbad Caverns National Park.

Lechuguilla Cave Survives a Major Threat

By Joe Sovick, Chief of the Division of Environmental Coordination, Southwest Regional Office

In 1986, cave explorers broke through the floor of Lechuguilla Cave, a "small" cave in Carlsbad Caverns National Park. They discovered the eighth largest cave in the world and the deepest in the United States. Exploration continues today in Lechuguilla, and is still measured in miles.

In addition to its impressive size and its incredible beauty, Lechuguilla possesses great scientific value. Undisturbed by human activity, the cave offers the opportunity to study a truly pristine cave environment. From the beginning, strict management controls restricted activity in the cave to preserve the resources, and use has been limited to exploration and scientific study.

However, the National Park Service can only control activities within park boundaries. The first real threat to Lechuguilla came from outside the park.

In 1985, one year after the explorers broke through the floor and before the cave's importance was known, the Bureau of Land Management issued oil and gas leases adjacent to Carlsbad Caverns National Park. As the significance of Lechuguilla increased, so did the concern about the nearby oil and gas leases. Drilling in a limestone area characterized by numerous caves and sinkholes (karst) could result in hydrocarbon leaks into Lechuguilla Cave. Leaks in the oil and gas pipe casings could also occur in the highly corrosive environment.

In 1991, the oil and gas lessee applied to the Bureau for a permit to drill. Because the proposed drilling site was in a karst area approximately one mile from Lechuguilla Cave, the National Park Service expressed serious concerns to the Bureau. The Bureau responded by forming a task force of oil and gas experts from federal and state agencies, including the National Park Service, and private industry. The task force developed drilling stipulations that would mitigate potential adverse impacts on cave resources. The Bureau then released an environmental assessment which proposed to allow drilling with the mitigating measures recommended by the task force.

The National Park Service, along with many others, did not feel that the mitigating measures would adequately protect the cave, and therefore recommended the preparation of an environmental impact statement. The Bureau prepared and released a draft environmental impact statement for public review in 1992. About 95% of the 500 public comments objected to drilling because of risks to Lechuguilla

Cave. The National Park Service submitted 19 pages of detailed comments discussing the potential risks to Lechuguilla. Finally, the Environmental Protection Agency rated the draft EIS as inadequate.

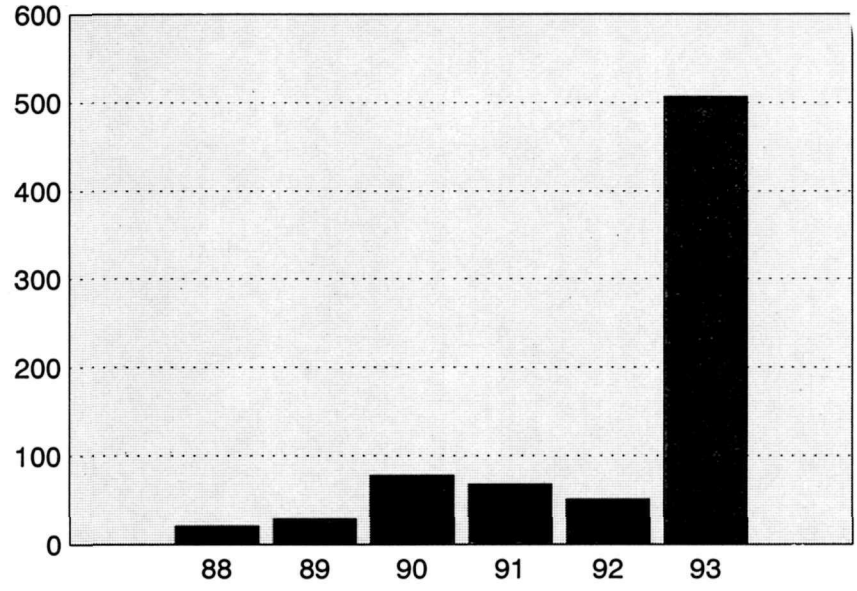
Economic considerations soon became an issue. The situation concerned Congressman Bruce Vento, who drafted a bill that would protect Lechuguilla, as well as give the Secretary of the Interior the authority to buy back the lease if necessary. Meanwhile, the Bureau, anticipating a possible buy-out, arranged for an appraisal of the oil and gas lease. The Bureau and the lessee agreed to an appraisal of $18,700,000. Now, the preservation of a world class resource as well as millions of dollars depended on whether or not drilling was allowed.

In meetings with the Bureau, it became apparent to the National Park Service that the Bureau believed the potential threat to Lechuguilla Cave was overstated and that mitigation measures could adequately reduce risks. To try to convince the Bureau of the dangers to the cave, the National Park Service convened a panel of scientists with extensive expertise in the geology of the area. This panel acknowledged the potential threat to the cave. After analyzing the geology of the area and the risks to Lechuguilla, the panel outlined geological and hydrological criteria for the establishment of a cave protection zone in which no new drilling would be allowed. The National Park Service embraced the panel's recommendations.

The National Park Service provided the panel's report to the Bureau, along with the mapped cave protection zone. The cave protection zone eliminated any access to 1/4 of the lease. However, the remaining 3/4 of the lease could be developed through specified vertical and directional drilling methods. After the National Park Service met with the Bureau a few times to further explain the panel's findings, the Bureau agreed with the scientific rationale of the panel and accepted their report and the use of the cave protection zone. In December 1993, the Bureau released the final environmental impact statement and Congress passed the Lechuguilla Cave Protection Act. The Bureau has proposed no drilling in the cave protection zone in order to protect Lechuguilla Cave.

Through a consistent and strong position expressed by National Park Service throughout the environmental evaluation process; the use of an effective and prestigious scientific panel; and support by the public along with national publicity, Lechuguilla Cave appears to have survived its first threat. The National Park Service learned a great deal about mitigating oil and gas impacts to caves through its participation in the cave and karst task force. Other caves will benefit from changes effected by the Bureau of Land Management in administering oil and gas leases and in application of the mitigation measures developed by the task force in karst areas. For Lechuguilla Cave, a new threat was eliminated and the experience has established a major precedent for future managers to apply the highest standards of protection to preserve this "jewel of the underground."

Black Bear Observations 1988-1993



Black Bears Back in Big Bend

By Raymond Skiles, Wildlife Resources Management Specialist, Big Bend National Park

Ever wish you could go back and do it over again now that you've made most of the mistakes--and learned from them? Many of us wish that today's techniques of bear management had been available yesterday to those managers running the parks when bears and people first came into conflict.

Big Bend National Park has just such an opportunity: to manage a new population of black bears with today's techniques and knowledge. The Chisos Mountains, a range of only 20 square miles surrounded by the Chihuahuan desert, provided suitable habitat for a small population of black bears. Hunters and cattlemen wiped them out prior to the park's 1944 establishment. Bear populations persisted, however, in isolated Mexican mountain ranges south of the Rio Grande, and migrating individuals visited the park on occasion over the years. Finally, in 1988, a small population was found living in the park.

The Big Bend bears are definitely back. Sightings remained infrequent until last year; in 1993 over 500 sightings of more than a dozen bears were reported--a ten-fold increase over the previous year. (See graph.)

Park managers diverted funds from other programs to lay the foundation of modern bear management--preventing bear/human contact. The park installed bearproof dumpsters and recycling containers in the Chisos Basin development, and placed metal food storage boxes in backcountry campsites of the Chisos mountains. Education and information campaigns were brought to full tilt, regulations were promulgated, and an interim plan was developed to meet the challenge of managing the Big Bend bears.

And none too soon. Most of Big Bend's bears do not retreat to winter dens. As the busy Christmas and New Year holidays brought camping and hiking to capacity in the Chisos Mountains, park managers received a clarion call. Thirty bear incidents occurred over a three-night period. At least three groups of bears went camp-to-camp; they couldn't get to the securely stored food, but they damaged or destroyed numerous tents, backpacks, and other inedible objects in their quest. One bear reduced an alto recorder to the ursine equivalent of toothpicks.

Options are limited. Some of the traditional solutions to bear problems cannot be used. Relocation of even one individual, for example, could result in serious consequences to the genetic viability of the small, isolated population. Bear habitat is extremely restricted at Big Bend, and bears, hikers, and campers all prefer a small portion of the park. Managers are busy becoming experts at managing people and bears.

Much more is left to be done. The park is consulting authorities inside and outside the National Park Service, and diverting staff time to planning and implementing programs such as aversive conditioning, modifying trash collection schedules, and designing new brochures.

The National Park Service had a checkered start with bear management. Is it possible for one park to learn from all the others and do it right the first time? The bears of Big Bend depend upon it.

White-tailed Deer Overpopulation Research and Management

By Hal Greenlee, Natural Resources Management Specialist, and Karen L. Finley, Park Ranger, Natural Resources Management, Gettysburg NMP/Eisenhower NHS

Over the past 30 years, the white-tailed deer population has increased dramatically within Gettysburg National Military Park (NMP) and Eisenhower National Historic Site (NHS). This increase has hampered the ability of the park to fulfill its management objectives of maintaining the historic rural and agricultural character of the land.

To achieve management objectives for crop fields in the national parks at Gettysburg, fields should contain crops with the general appearance of those raised in the historic period. They should also reflect historic field patterns and 75% of the plants should reach maturity. For almost 100 years, the park has issued permits to local farmers to cultivate the 1,835 acres of cropfields cultivated at Gettysburg NMP/Eisenhower NHS. In the past, this program has been a cost-effective and efficient method of managing an agricultural landscape to achieve the parks' goals and objectives.

As early as 1980, however, agricultural permittees in the park began to notice a loss of crop yield and evidence of feeding by deer, particularly in fields of corn. From 1986 to 1989, corn planted in the southern part of the battlefield and on the Eisenhower Farm was damaged by 80-100%, and damage to other crops became more noticeable. This damage has progressed to the point where the current agricultural leasing program may no longer be economically viable to the farmers; in 1993, Gettysburg NMP/Eisenhower NHS waived agricultural permittee fees on 929 acres of cropland because of losses attributed to deer damage.

Woodlands are also suffering from deer overpopulation. There are a total of 1,600 acres of woodlands in the parks. In the 1980's, park staff began to notice heavy browsing of saplings, a lack of seedling regeneration, and a distinct browse line in the park's woodlands.

The increasing deer populations have also created concerns for public safety. Deer and motor vehicle collisions rose from 50 in 1985 to 150 in 1992. The potential for increased incidence of Lyme disease caused by deer ticks also cause concern.

Park Service and CPSU researchers have studied the population status, movements, habitat use, and impact of deer at Gettysburg NMP/Eisenhower NHS since 1985. The total deer population rose from 721 in April 1987 to 1,190 in April 1993. The population currently averages 108 deer per square mile; the Pennsylvania Game Commission recommends no more than 20 deer per square mile of woodland and no deer in cropland to prevent damage to habitat and crops. Monitoring of the white-tailed deer population and its effects on the parks will continue indefinitely. New techniques to determine relative abundance and total deer populations have recently been proposed. Fecal-pellet surveys, and the use of thermal infra-red sensing may be utilized at Gettysburg in the near future to supplement current monitoring procedures and to add to our knowledge of deer populations and research techniques.

To begin to address deer management, the park developed an interim deer management plan in 1991. The plan allows for the waiver of agricultural permittee fees and the continuation of research until a final deer management plan is developed. Based on the extensive research, long-term

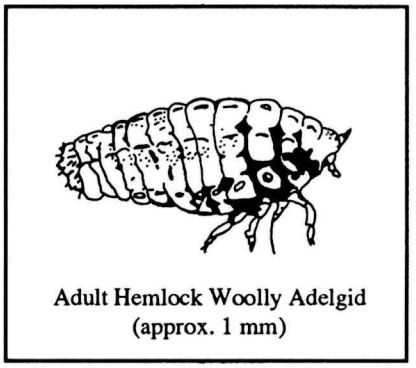
monitoring, and intense and growing interest by the public in the deer overpopulation issue, the Park Service decided that an environmental impact statement should be developed prior to making a management decision. In the winter of 1993, two public meetings on deer management were held. Management alternatives suggested by the public included trapping and transfer, controlling fertility, fencing, using repellents, planting crops less attractive to deer, and reducing the herd by deputized marksmen, rangers, and/or by public hunt. The public's primary concern in managing the deer was public safety.

The park is currently working on the draft environmental impact statement. Once the draft passes internal review, public comment will again be solicited. The recommendations of the final environmental impact statement will have implications for all eastern National Park System units with similar deer overpopulation problems in determining their respective courses of action.

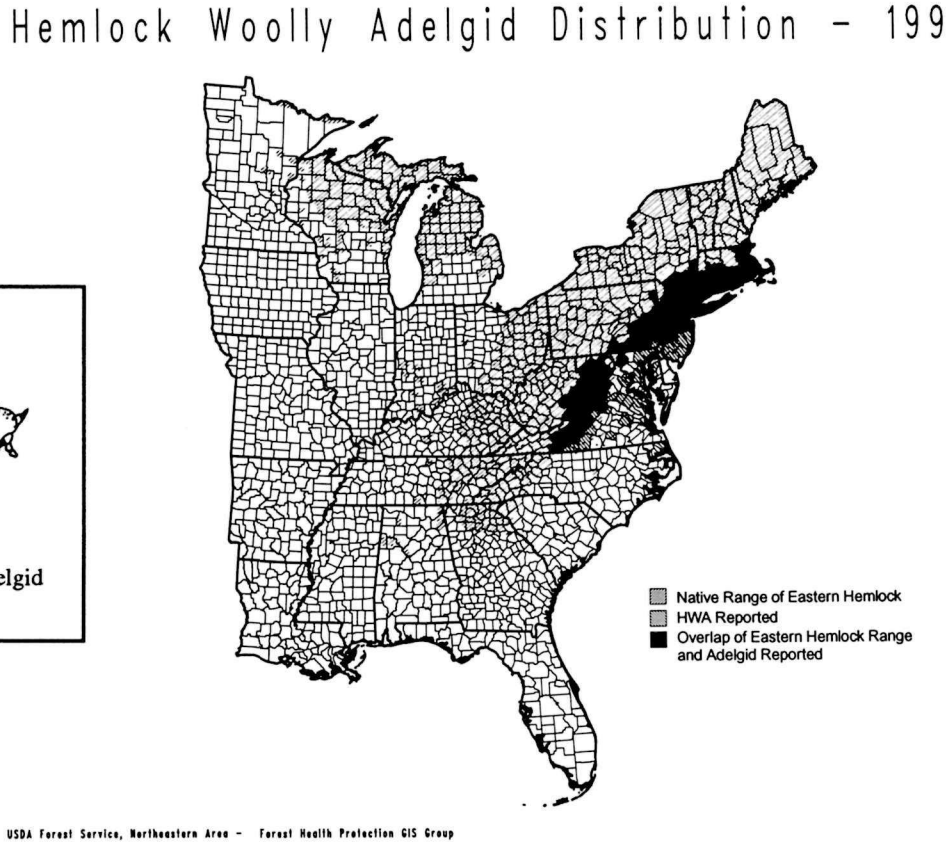
Exotic Insect Threatens Native Hemlocks

By Richard A. Evans, Hemlock Woolly Adelgid Program Coordinator,
Delaware Water Gap National Recreation Area

A tiny, exotic insect called the hemlock woolly adelgid threatens the health and survival of hemlock stands in the eastern United States. This aphid-like insect, native to Japan, can kill eastern hemlock trees within four years of initial infestation. Since its discovery in Virginia during the 1950's, the hemlock woolly adelgid has spread into West Virginia, Maryland, Pennsylvania, New Jersey, New York, Connecticut, Rhode Island, and Massachusetts. Massive mortality or declines in the health of eastern hemlock trees are suspected to have resulted from hemlock woolly adelgid infestations in many locations. However, the exact cause of these hemlock declines has been open to question because the hemlock woolly adelgid populations have not been documented and monitored. Furthermore, information about the ecological effects of hemlock decline and mortality is not currently available.



Adult Hemlock Woolly Adelgid
(approx. 1 mm)



Numerous National Park System units, such as Delaware Water Gap National Recreation Area (NRA) and Shenandoah National Park, have already been affected by hemlock woolly adelgid infestations. In 1989, resources management staff learned that hemlock stands at Delaware Water Gap NRA were infested with hemlock woolly adelgid. They also learned that massive hemlock mortality was associated with an infested hemlock stand not far from the park.

Many areas of Delaware Water Gap NRA are valued because of the distinctive aesthetic, recreational, and ecological qualities of hemlock ravines. Formally recognized as outstanding natural features, these ravines typically have nearly pure stands of eastern hemlock on steep slopes surrounding swiftly flowing trout streams with cascading waterfalls. Many of the streams in these ravines depend on the shade of the hemlocks to remain cool enough to support native brook trout. Other species of special concern at Delaware Water Gap NRA, such as the solitary vireo and the long-tailed salamander, also occur primarily in these hemlock ecosystems.

Eastern hemlocks infested with hemlock woody adelgid lose needles, depriving the tree of food and energy. The loss of needles also allows sunlight to penetrate the forest canopy, thus warming and drying the understory environment.

Because of the importance of hemlock ravines at Delaware Water Gap NRA, and the need for management information, the resources management staff applied for funding from the Natural Resource Preservation Program. With these funds, Delaware Water Gap NRA initiated a Hemlock Woolly Adelgid Program in 1992. The primary objectives of this program are to assess: (1) the distribution and abundance of hemlock woolly adelgid, (2) the health and condition of hemlock stands, and (3) the biota and microclimates associated with hemlock ecosystems at Delaware Water Gap NRA. Although no practical methods currently exist to suppress hemlock woolly adelgid infestations in hemlock forests, it is important to collect this data to document affected resources and to develop management options.

In 1993, Delaware Water Gap NRA involved a number of cooperators and initiated field studies to fulfill the three hemlock woolly adelgid program objectives. With detection surveys, park staff found infestations in over half of the hemlock stands in the park. We measured very high population levels on infested trees in several locations. We permanently marked 540 hemlock trees and rated their health and condition using standard methods established by the USDA Forest Service. Through a cooperative agreement with the New Jersey Division of Fish, Game, and Wildlife, we completed the first year of a two-year inventory of small mammal, amphibian, and ground invertebrate populations in two hemlock ravines. Researchers now with the National Biological Survey also cooperated and sampled fish populations from the streams in these two ravines. Cornell University was contracted to complete quantitative understory vegetation surveys and establish permanent understory vegetation plots in the same two hemlock ravines.

We have also identified a potential new, quick field method of estimating hemlock woolly adelgid populations. Traditional methods of actually counting individual insects requires removing branch samples to examine under a microscope. Most resources managers do not have the time or equipment to complete this kind of sampling. The new method involves counting the number of twigs that have hemlock woolly adelgid present and the number of twigs that do not. During much of the year, hemlock woolly adelgid presence on twigs is evidenced by the white "woolly" balls (like cotton swabs) they produce. Park staff with limited training should be able to determine hemlock woolly adelgid populations in the field, without removing branches and thus damaging hemlock trees, in about a tenth of the time required by "direct count" methods. Adoption of this new method should enable more resources managers and researchers to document hemlock woolly adelgid infestation levels in more hemlock stands than was previously feasible.

Restoring Natural Resources and Historic Landscapes

Agencies Cooperate to Restore Arid Land Mines in Joshua Tree National Monument

By Mark Holden, Supervisory Resources Management Specialist, Joshua Tree National Monument

When Joshua Tree became a park over 50 years ago, it inherited a number of restoration problems from past gold and silver mining and milling activities. Over the years, miners filed more than 2000 claims in the area now within the boundaries of the monument, some small prospects, others large-scale operations. While some of these workings are preserved and interpreted for their historic significance, many others remain as scars on the landscape.

As a result of restoration requirements throughout the country, successful methods have been developed for many types of mining in the east. However, special restoration problems exist in the desert southwest, including the paucity of precipitation, extremes in temperature, and fragile ecosystems. The U.S. Bureau of Mines approached Joshua Tree with an interest in mine land restoration in the desert southwest. The Bureau wished to investigate Joshua Tree's successful planting methods in the Mojave and Colorado deserts for applicability to mine restoration; Joshua Tree hoped the Bureau could offer suggestions and assistance for restoring Joshua Tree's abandoned mine lands. In 1993, Joshua Tree entered into a cooperative agreement with the Bureau, with the Bureau agreeing to provide supplemental funding and extra technical support for projects conducted by Joshua Tree staff.

Arid Lands Restoration Bibliography The agreement had three parts. The Joshua Tree nursery's information branch, the Center for Arid Lands Restoration, had been slowly compiling an arid lands restoration bibliography. The Bureau was interested in the bibliography, but sought more entries pertaining to mining, specifically in the southwest. This information would be helpful to those beginning the task or needing assistance with abandoned mine restoration. With this emphasis in mind, the nursery staff updated and expanded the bibliography, and created annotations using software called Papyrus. The *Bibliography for Revegetation of Mined Areas in Desert Environments* by Danielle Tilford, published by the Bureau of Mines (USBM Open File Report 95-93), currently stands at 515 entries.

Vegetation Survey Under the second part of the agreement, Joshua Tree staff examined the extent of natural recovery of vegetation on mining disturbances, and identified those species which seemed to rapidly colonize these sites for potential use in restoration projects. We surveyed disturbed plots on mine sites for vegetation density, cover, species richness, and physical site characteristics (elevation, aspect, slope, and soil substrate). At each plot, we then performed the same survey on an adjacent undisturbed plot for comparison. We sampled 105 disturbed plots on different kinds of disturbances, across a gradient of elevations and vegetation types.

Vegetation Survey Data Analysis

Analysis of the vegetation survey data, not surprisingly, showed statistically significant differences between disturbed and undisturbed areas for vegetative cover, density, and species richness. However, we also found differences in mining effects among the vegetation types. Most species (61% of the 82 sampled species) either did not return to disturbed sites or returned extremely infrequently (i.e., one plot). Certain species, brittlebush, four o'clock, sweetbush, desert trumpet, needlegrass, and California buckwheat, showed a tendency to return to disturbed plots more frequently than other species, and may have potential restoration use.

Between disturbance types, piles of waste rock and tailings showed the least recovery. In these cases, the rock overlaid the original soil strata, with a complete loss of soil structure and topsoil. On the other hand, old roads showed the most recovery, perhaps due to immediately adjacent seed sources and the soil strata, which, though compacted, was still relatively intact.

Significantly, evidence of disturbance was still extremely visible at every site even after 50 to 75 years. Returned vegetation composition rarely matched that of the surrounding undisturbed area. Also, waste rock brought up from below ground rarely matched the surface substrate, making mine sites that much more visible. These visual components must be addressed in overall mine site restoration.

In cooperation with the Bureau of Land Management, the Silver Bell Mine site is being revegetated with plant materials grown in the Joshua Tree nursery. Helicopters hauled supplies and water to the site; here, the helicopter fills a portable water tank used to irrigate during planting. Finished plantings are visible on the right side of the photo.

After we had gathered the data, we had difficulty finding an agency to analyze our data. Here, a third federal agency, also interested in mine land restoration, gave assistance. In the past, Joshua Tree had grown plants for the San Bernardino National Forest for use in a mine restoration experiment. We discovered that forest resources management personnel had the needed software and personnel to analyze and interpret our data, and that they were also interested in the results of our mine vegetation survey.

Forest Service personnel analyzed the data in three steps. They classified the undisturbed samples into vegetation types. They then examined relationships among the recognized vegetation types, and among vegetation types and environmental characteristics. Finally, they compared characteristics of the recognized vegetation types, characteristics of mining disturbance plots to undisturbed plots, and characteristics of different kinds of disturbance across vegetation types. (See sidebar for analysis description.)

Restoration Experiment The third task in the cooperative agreement with the Bureau of Mines is on-going. We chose a mine site to perform revegetation using plant materials grown in the nursery. However, we have decided to experiment with pots shorter than Joshua Tree's 30" PVC "tall pots." The shorter pots will be less expensive to prepare and easier to transport to remote locations. We will monitor planting survival to compare with the performance of the taller pots. We are currently growing 25 species of plants, some of these not yet tried in the nursery. Planting will be performed in February 1994 on the Silver Bell Mine, a site with a variety of disturbances and planting substrates.

Our collaboration with the U.S. Bureau of Mines has allowed us to perform experimental propagation with new container sizes and heretofore untried plant species, expand the Center for Arid Lands Restoration bibliography, begin to look objectively at Joshua Tree's abandoned mine lands, and start abandoned mine restoration work. The information and experience gained from the project will also be available to other agencies and organizations facing similar challenges and problems in the desert southwest.

Employees from Dames and Moore, an environmental services contractor, sample a 55-gallon drum for hazardous chemicals at one of the eight cleanup sites in Denali National Park and Preserve.

16 Tons and What Do You Get? Mineral Land Restoration in Alaska!

By Kevin Meyer, Dennis Schramm, and Dr. Page Spencer,
Environmental Specialists, Alaska Regional Office

"16 tons and what do you get? Another day older and deeper in debt!" In 1993, the Minerals Management Division of the Alaska Regional Office rewrote that verse to read "55 tons and what do you get? Eight sites cleaner and reduced environmental threat!" Granted, this updated verse of Tennessee Ernie Ford's classic may not make it to the Top 40, but it certainly has been a happy tune for those cleaning up abandoned and acquired mining properties in Alaska National Park System units during the summer of 1993.

With the passage of the Alaska National Interest Lands Conservation Act in 1980, over 4,800 mining claims and scores of abandoned mining properties with their associated environmental impacts were incorporated into Alaska park units. In 1990, the National Park Service completed environmental impact statements on the cumulative impacts of mining on three park units—Denali, Wrangell-St. Elias, and Yukon-Charley Rivers. The National Park Service decision to acquire and reclaim all mining properties in Alaska National Park System units sent National Park Service staff in the Alaska Regional Office and affected parks scurrying to develop and implement a resources stewardship program to counter environmental degradation on both abandoned and active mineral properties. The staffs estimate that cleanup actions and reclamation will be required on over 3,000 acres of disturbed land, 190 miles of access roads, and 70 miles of disturbed floodplains.

Responding to this daunting reclamation work load is a small, energetic, and eclectic staff in the Resource Assessment Branch of the Alaska Regional Office's Minerals Management Division. Operating from a broad base of arctic ecology and practical Alaskan field experience, the Resource Assessment Branch staff, working with researchers from Denali National Park and Preserve, have been busy refining and applying elements of the rapidly evolving mine land restoration field to the rough and tumble Alaskan environment. The result is an innovative program designed to reinstate basic environmental processes on degraded landscapes—not necessarily to restore sites to pristine conditions. The program's objectives are to provide affected sites with the basic elements for natural recovery: clean land and water, functioning floodplains, fertile soils, pioneer vegetation, and water tables within reach of plant roots. With these elements as a foundation, recovering sites can proceed naturally through succession and evolve as productive ecosystems. With the exigencies of the Alaskan environment in mind, it's no surprise that the application of this ecosystem approach couples "high science" with Alaskan "bush ingenuity" to meet its objectives!

Twelve action steps provide the framework for the Alaskan National Park Service Mineral Lands Restoration Program: site inventory and survey, restoration plan development, environmental and cultural compliance, explosives removal, hazardous material removal, personal property relocation, abandoned equipment and debris removal, mine adit and shaft safing, recontouring, floodplain reconstruction, revegetation, and monitoring of restoration success. Each of the

twelve steps requires support from all levels of the National Park Service organization, and assistance from a wide range of Park Service professionals.

With initial inventory and planning efforts completed for a few properties during the 1991 and 1992 seasons, the Resource Assessment Branch targeted major cleanup actions in two parks during 1993. The first effort, in Denali National Park and Preserve, focused the attention of park, regional office, and volunteer staff on seven former mining sites in the Kantishna Hills, a remote area just north of Denali's massif. On those seven sites hundreds of drums and lead acid batteries, which were leaking and deteriorating in the harsh Alaskan environment, were intermixed with modern debris and historic remnants of early Alaskan exploration and gold mining.

A Bell 206B helicopter, an International 540 loader, and a six-wheel-drive army surplus dump truck provided access and transportation through the deep ridge and valley landscape. Over 2,200 hours of heavy labor were required to haul 300 55-gallon drums, 55 lead-acid batteries, 2,000 gallons of waste fuel and oil contaminants, 7 tons of garbage, 3 wrecked and abandoned pickup trucks, and 3 large mining washplants from the park. Additionally, 19 tons of scrap steel were shipped out of the park for recycling. The Resource Assessment Branch staff worked closely with historians and archaeologists from the Cultural Resources Division to ensure that significant historic features were unaffected by the cleanup process.

The project coordinators for the 1993 Kantishna cleanup effort were ecstatic with the results of their two-year push to initiate cleanup in the area. It was gratifying for everyone involved, from procurement clerk to back-country ranger, to see the tons of abandoned mining equipment and hazardous material littering the park's back-country transported to recycling centers, licensed landfills, and hazardous waste remediation facilities.

In September of 1993, the Resource Assessment Branch coordinated the first phase of a two-year cleanup project on an abandoned mining property in Glacier Bay National Park and Preserve. From there, Resource Assessment Branch and park staff removed over 7 tons of steel and 3 tons of abandoned mining debris from a former lode mine at Ptarmigan Creek, 50 miles upbay from park headquarters. A landing craft, four days use of a Bell 206B helicopter, and over 400 hours of labor were required for this project.

Design of the next phase of restoration for the properties is underway. Utilizing information gleaned from research on Denali's Glen Creek watershed over the past four years, the planners hope to reestablish basic ecological processes within degraded watersheds by recontouring tailings, stabilizing soils, reconstructing stream floodplains, and planting pioneer species.

Wilson's Creek Restores Its Battlefield

By Russel Runge, Biological Technician, Wilson's Creek National Battlefield

Over 130 years ago, a bloody battle was fought in rural Missouri that proved to be pivotal during the Civil War. Despite a Confederate victory, the conflict guaranteed that the state would stay in the Union. Today, the National Park Service protects the site of the battle at Wilson's Creek National Battlefield.

After more than a century of change, the task of management at Wilson Creek is great, but the long-term benefit has proven to be worth the effort. The battlefield is only one of three in the National Park Service considered to be "pristine." Taking advantage of that distinction, restoration efforts are underway that will provide visitors with a unique perspective on this important part of history.

Since August 10, 1861, when the Battle of Wilson's Creek was fought, the land of the battlefield has undergone many changes. After the Civil War and prior to the establishment of the park in 1960, the land was privately owned and subjected to intense agricultural use. During this period, the native oak savanna that once characterized much of this rolling Ozark hill country was eliminated. Extensive research has produced a composite picture of the battlefield's lost landscape.

In 1991, the park completed and initiated a historic landscape restoration action plan that set a long-term goal of restoring 1,000 of the park's 1,750 acres to the 1861 scene. Restoration goals include reconstructing savanna communities in current fescue and successional fields, increasing species diversity in old prairie plantings, and reducing woody and exotic plant dominance on limestone glades. The action plan prioritized restoration goals and established a multiyear timetable for the first phase of restoration. Through a series of management actions, including exotic plant control, woody plant removal, seeding of native grasses and wildflowers, and prescribed fire, the park has begun to recreate the historic scene. Extensive vegetative monitoring efforts are an integral part of the restoration and will provide an evaluation of restoration progress.

During the three years of the initial restoration effort, some 5,200 exotic trees, primarily Osage orange, were removed from the battlefield and approximately 169 acres were planted with warm season grasses and forbs. Most of the effort focused on the Bloody Hill area, the site of heaviest fighting during the Civil War battle. Funded primarily with park base and Natural Resources Preservation Program

monies, this complex project represents thousands of hours of planning, implementation, and documentation.

Prescribed fire is an important tool for the restoration project and has been used extensively to help prepare open areas for planting and to maintain previously planted fields. Since the project started in 1991, some 800 acres have been burned. In years to come, prescribed fire will be the primary method of maintaining all restoration units within the park.

Restoring the battlefield is an intricate task requiring cooperation and coordination with other agencies. In 1986, the Missouri Department of Conservation completed a two-year study to determine the historical vegetation that was present in 1861, to map current vegetation, and to recommend methods to restore the appearance. This study was used as a basis for the action plan written by park staff. The Department has continued with cooperative efforts by providing a seed drill and operator for planting approximately 90 acres with warm season grasses. The Missouri Highway and Transportation Department has also assisted by cooperatively planting 100 trees along the highway leading to the park. Park staff worked with the Department's highway landscape supervisor to select species consistent with the park's revegetation efforts. Tree locations were also decided upon to provide optimum screening value.

Replacing the historic landcover is only part of the overall restoration project. The landscape is considered to be the primary resource of the battlefield and anything affecting the landscape affects the perception of the park. Resources management tasks would be less intense if all issues were internal; however, the battlefield is located in close proximity to one of the fastest growing areas of the country. This makes external issues a real concern, since urbanization of the rural area is changing the landscape outside the park to a considerable degree. These changes are painfully evident from historically significant interpretive viewpoints within the battlefield. The utilization of such management tools as a geographic information system (GIS) have allowed park management to make more informed decisions affecting these historical viewsheds. Already work has been planned or completed based on GIS output that will reduce viewsheds and make exterior intrusions less visible, such as planting trees for screening.

Wilson's Creek itself is a principal component of the battlefield's landscape. While restoring the creek to its original condition may not be possible, it is reasonable to hope for adequate water quality conditions. Wilson's Creek and its upper tributaries originate in and flow from the heart of Springfield, Missouri, then converge southwest of the city near the Southwest Sewage Treatment Plant servicing Springfield. The water coliform count, clarity, odor, dissolved oxygen content, and pH levels in Wilson's Creek are frequently unacceptable. The karst topography of the region also causes water resources to be extremely susceptible to contamination from farm fields and old sludge lagoons. A continued fluctuation of tested water quality parameters has proven that the problems with Wilson's Creek are ongoing. The Southwest Sewage Treatment Plant recently brought a significant addition to their facility on line with hopes of curing problems associated with the plant. It is still too early to determine the extent of improvement, but the clarity and smell are better now. The treatment plant is not the only contributor to the demise of the creek and continued monitoring will identify others.

Clearly, restoring the landscape of Wilson's Creek National Battlefield is a large multi-faceted project that goes beyond replanting prairie fields. Park management has recognized the growing need for additional resources management staff to work on the numerous issues effecting the park's primary resources and has recently created a new Resource Management Division. With three years of revegetation progress complete, additional tasks underway to screen outside intrusions, and cooperative efforts continuing with local and state entities, the landscape is beginning to transform. Now, with a dedicated resources management staff, additional headway is insured. Slowly but surely the battlefield will once again begin to look like the authentic historic scene.

Examining the Wetland Restoration Prospects of Indiana Dunes' Great Marsh

By Eddie L. Childers, GIS Specialist, and Paul M. Stewart,
Research Ecologist, Indiana Dunes National Lakeshore

An exceptional relict of the extensive wetlands that once existed in the Calumet Region of northern Indiana can be found at Indiana Dunes National Lakeshore--the Great Marsh. Originally stretching over 25 miles, this vast wetland has changed considerably over the decades. During the late 1800's the Great Marsh was drained by extensive ditching to Lake Michigan, filled, dredged, and then dissected by railways, highways, and industrial and municipal development. Although it once spanned over 3,300 hectares of northwest Indiana, this wetland ecosystem, now only 1,500 hectares, remains an outstanding natural area.

Three major waterways drain the Great Marsh into Lake Michigan: the natural Dunes Creek and two constructed ditches that cut through sand dunes, Derby Ditch and Kintzele Ditch. Dunes Creek, though a natural outlet into Lake Michigan, suffers from significant ditching in sections of its drainage. Present data indicate high fecal coliform levels in all three drainages. Bacterial counts in these drainages have exceeded state health department standards, causing intermittent closures of several very popular swimming beaches in the park. Last year, one lake sampling point off Dunes Creek had a fecal coliform count nearly 70 times the legal limit, resulting in prolonged beach closure.

After identifying the high fecal coliform level problem in the Great Marsh watershed, national lakeshore staff began searching for an appropriate management strategy. Previous research indicated that the high bacteria levels originated from animal waste in the Great Marsh. Restoration of the Great Marsh to pre-settlement water level conditions would theoretically solve the problem by increasing retention time of bacteria-laden water in the Great Marsh, allowing for decomposition of the bacteria before it reached the open waters and swimming beaches of Lake Michigan. Restoration would have the added advantage of restoring the native sedges and bluejoint grasses that have been replaced by cattails and trees taking advantage of lower water tables.

A study was initiated for a portion of the Great Marsh in the East Unit of the national lakeshore to determine its potential for restoration. Long-term objectives of the restoration study included estimating the past and present size of the Great Marsh; determining Great Marsh restoration impacts on roads, structures, and water quality; providing data on the land-use patterns, water levels, water and biological

Dunes Creek outfall

quality of the Great Marsh drainage; addressing bacterial contamination of beaches; comparing the ecology of Great Marsh watersheds draining similar areas; and determining possible actions necessary for restoration.

Implementing restoration of the Great Marsh creates the problem of determining the impacts of increased water levels on roads and structures. These impacts were estimated by using the national lakeshore's geographic information system's (GIS) digital elevation model and topography themes. Preliminary GIS analysis indicated that the impact of increasing the water level by 1' above the present Great Marsh water level would have minimal detrimental consequences on roads, houses, and national lakeshore property.

Predicting the full range of wetland restoration impacts is difficult. Resource Management Division and National Biological Survey staff continue to work together on this project, with plans to monitor the watershed before, during, and after restoration. Following restoration of the Great Marsh, we hope that Indiana Dunes National Lakeshore will be able to support safer swimming opportunities for the public while simultaneously increasing the size, quality, and biological diversity of a significant feature of the national lakeshore.

Developing Steelhead Broodstock for the Elwha River Restoration

By John Meyer, Fisheries Biologist, Olympic National Park

Two hydroelectric dams block access to over 70 miles of excellent spawning and rearing habitat in the upper Elwha River. Over ten years ago, the National Park Service, along with several cooperating agencies and the Elwha S'Klallam Tribe, began efforts to restore anadromous fish into the upper river. These efforts culminated in the Elwha River Ecosystem and Fisheries Restoration Act, passed by the Congress in 1992. The Act directed the Department of the Interior to review options for restoration of the ecosystem and the river's historic fisheries, recommend a restoration strategy, estimate its costs, and submit a report to Congress by January 1994. This report has been completed and concludes that removal of the dams is the only means of fully restoring the river's ecosystem and fisheries.

In anticipation of this restoration effort, Olympic National Park began to explore options for acquiring the most suitable brood stocks for fisheries restoration. In some cases, such as chinook salmon, a remnant stock exists in the lower river and would logically be used for restoration. However, for other species there are few, if any, remnants left, and other alternatives are being explored. For example, a steelhead run exists at the tribe's hatchery, but genetic identification techniques indicate it has mixed with exotic fish which were planted into the river for many years. (Steelhead are rainbow trout that migrate to the ocean.) Wild runs exist in neighboring rivers, but their ability to adapt to the Elwha's environment is unknown. Another alternative, preferred by Olympic National Park, is to utilize the rainbow trout population above the dams. These trout are believed to be descendants of the river's original steelhead that were trapped in the river when the dams were constructed.

Olympic National Park undertook a steelhead broodstock capture effort in 1993 in cooperation with the Elwha Tribe. The goal of this project was to capture 60 rainbow trout from the upper river using electrofishing techniques, and transport them via helicopter to the tribal hatchery. There they would be spawned and the resulting juveniles released into marine waters. Fish that return to the river and exhibit an anadromous life history pattern (one or more years of rearing in the ocean) will be used in restoration of the upper Elwha River.

The initial trip into the watershed in April was intended to move equipment and supplies into the project area, which is very remote and only accessible by hiking 12-20 miles from the trail head. Electrofishing confirmed that no spawning had begun in early April. After the initial reconnaissance trip, subsequent efforts produced only a few fish each week. These fish were held in live pens for up to four weeks. By mid-May, warm weather triggered the spring runoff and spawning activity commenced. Over the next week, 81 trout were captured; five died in the live pen from unknown causes. The remaining 76 fish were transported to the tribal hatchery in good condition. The mature fish were spawned using a 2x2 mating design; each female was mated with two males, and each male mated with two females. Unfortunately, a high percentage of the fish captured were males and only 4,300 eggs were collected.

Individual families are being incubated and reared separately until they are distinctively marked with tags. This will allow an analysis of the contribution of individual families to the adult return, an important factor in maintaining genetic diversity. Half the fish will be fed a diet supplemented with salt prior to release to determine if this promotes smoltification and anadromy. Smolt indicators will be monitored to determine the optimum time of release. Adult steelhead should began to return from these plants in 1996 and will be available to begin restoration of this pristine river system.

Historic Scene Restored at San Juan Island

By Shirley Hoh, Resource Management Specialist, San Juan Island NHP

Vegetation management at San Juan Island National Historical Park primarily highlights and preserves the cultural landscapes of the park. The landscapes should be similar in composition, structure, and function to those seen during the historic period, 1853-1872. At issue during that time was the ownership of the San Juan Islands, whose possession had been clouded by the 1846 Oregon Treaty that set the 49th parallel as the boundary between the United States and Canada. Tensions between the two countries peaked in 1859 when an American shot a pig belonging to the Hudson's Bay Company. For the next dozen years, both American and British soldiers occupied the island to protect their respective citizens. A neutral arbitrator eventually settled the boundary dispute peacefully. After the military occupation ended, many agricultural modifications were made to the landscape. In some areas, the existing landscape does not even remotely resemble that seen during the historic period.

To assist the park in restoring and preserving its cultural landscapes, the University of Washington's Cooperative Park Studies Unit developed a park vegetation management plan. Completed in 1993, this document outlines vegetation management proposals for the restoration or reestablishment of selected park cultural landscapes and describes the current and historical conditions for each. A management objective has been identified for each landscape, accompanied by a set of ecologically feasible, cost effective, and politically sustainable management alternatives. The vegetation management prescription specified for each alternative is consistent with the mandate to maintain the park's historic landscapes. Park staff selected proposed objectives in consultation with the Pacific Northwest Regional Office and the plan's authors. These objectives are not static and are subject to modification as future research and monitoring studies expand the park's knowledge base.

The park didn't waste any time implementing sections of the vegetation management plan. As a first step, a cooperative arrangement with Olympic National Park enabled a seasonal fire crew from that park detailed to San Juan Island in August to begin a hazardous fuels removal program at the British Camp unit. Dense, nearly impenetrable stands of Douglas fir and grand fir have become established in abandoned agricultural fields in that area. These crowded conditions--up to 12,000 stems per acre in some instances--limit tree growth and high rates of mortality can be expected. The 30-year-old trees are susceptible to blowdown, insect damage, disease, or simply collapsing under their own weight. In an admirable initial effort, the work crew thinned out several acres of forest, chipping or stacking the downed trees. The public removed a substantial portion of the cut wood from the site through a firewood and wood chip giveaway program. A carefully-designed program of multiple thinnings over a period of years will be needed to achieve the desired stand density of 300 stems per acre and allow the forest to recover to the mature Douglas fir-grand fir successional stage that was its condition during the historic period.

British Camp was also the site of another vegetation management activity. When the occupying force of British Royal Marines landed at Garrison Bay in March 1860, they set up their camp along the shore. A steep hillside south of the main camp was subsequently cleared and three terraces constructed as sites for officers' quarters. In the years following the occupation, the coniferous forest reestablished itself on the hill. Park maintenance staff recently cleared the understory of shrubs and young trees. The forest overstory, which includes a few remnant witness trees, has been retained to maintain the historic scene.

While primarily focusing on the restoration of the park's historic landscapes and their attendant values, some park vegetation management objectives addressed the perpetuation of natural ecological processes. Areas more distant from the park's military structures are largely free from human modification. Management of these outlying areas for their natural values can significantly benefit the ecological integrity of the island as a whole. An example is the park's tansy ragwort eradication program. Tansy ragwort is an exotic plant that grows in the perennial grassland at American Camp where it successfully competes with native species for nutrients and water. One of a number of plants identified as "noxious weeds," the plant's removal is required by Washington state law. Opting not to use a chemical herbicide, the park scheduled several days during which individuals from all divisions pitched in to manually remove the plants from the park. Pulling tansy is a big job; in 1993 our collection of ragwort totaled 125 fifty-pound bags. That's a little over three tons of plants!

Using the vegetation management plan to restore park landscapes to their historic appearance will provide several benefits. Visitor appreciation of San Juan Island National Historical Park will be enhanced by gaining a better understanding of historic conditions. Restoration activities will improve habitat for native wildlife and discourage the spread or establishment of exotic species. Additionally, the long-term sustainability of these landscapes means that only minimal management action will be needed to maintain them.

Innovative Partnerships Get the Job Done

IPM Manual Keeps Managers Informed

By Susan Alberts, Invertebrate Specialist, North Atlantic Regional Office

The North Atlantic Region has many small acreage parks with natural and/or historic landscapes that contain a wide variety of plant species. To maintain the diversity of plants, a high level of expertise is necessary in horticulture and pest management, with additional specialized training in the care of historic plants.

The availability of this level of expertise in the parks varies greatly. Few employees have all this information at their fingertips. In addition, expertise developed through on-the-job training frequently is lost due to personnel transfers. Without written records on landscape maintenance, new employees have to re-learn their duties from the ground up.

To alleviate this problem, the North Atlantic Region decided to develop integrated pest management (IPM) manuals to assist the parks. With funding from the Natural Resource Preservation Program for Small Parks, the Region signed an agreement with the University of Massachusetts Cooperative Extension Service, Amherst, to complete IPM manuals for the small parks. These manuals will contain IPM plans for the parks' natural resources to provide a one-source, user-friendly reference for landscape maintenance and pest control.

In the first phase of the program, two parks, Minute Man National Historic Park and Adams National Historic Site, received prototype IPM manuals. Selection of plant species addressed in the plans was based on frequency of occurrence and the priority level of the resources in the Region. Modeled after the *Landscape Preservation Maintenance Program for Adams National Historic Site*, a field notebook developed by the Olmsted Center for Landscape Preservation, the manuals contain comprehensive site information, including landscape maps, calendars for horticultural maintenance (such as pruning and fertilizing), and field notes.

In addition to information from the Olmsted Center, each IPM manual will include a listing of insect and disease pests, organized by plant injury; key pest fact sheets, with lifecycles and color photographs; and monthly and yearly monitoring calendars. To provide an easy reference for monitoring, the calendars will be correlated with growth stages of plants located at the parks. (This information comes from research at the Massachusetts Cooperative Extension Service.)

Standardized computer formats for all report forms were developed in WordPerfect to be compatible with the parks' own computer systems. This enables the parks to up-date field information to the plan, and to add additional resources. The IPM plans are also being reviewed for compatibility with the Inventory and Condition Assessment Program (ICAP), the WASO software program provided to the parks for assistance in maintenance management, which would further enhance the plans' utility.

In the second phase of this program, the manuals will be expanded to include IPM plans for additional species of vegetation at Minute Man National Historic Park and Adams National Historic Site, and more small parks in the Region.

KEY PEST FACT SHEET

Elm Leaf Beetle (*Pyrrhalta luteola, Xanthogaleruca luteola*)

HOSTS: All species of American elm; zelkova.

DESCRIPTION OF PEST

Injurious stages: Adult, larva.

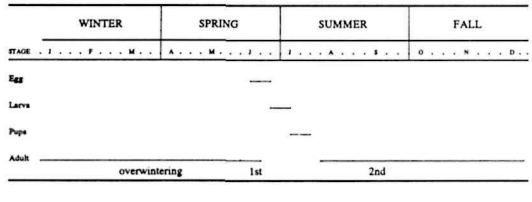
Treatment stage: Larva.

INJURY/DAMAGE

The adults skeletonize the leaves.

LIFE CYCLE

The adult insects overwinter in houses, sheds, and in protected places outdoors (under loose bark of trees or house shingles, etc.). In the spring, they fly back to elms and eat the expanding foliage. Eggs are laid in clusters on the leaves. Larvae feed on the foliage for a while. At the end of the feeding period, they migrate to the lower parts of the elm tree and pupate openingly on the ground at the base of the tree, or in cracks, crevices, or crotches on the trunk or larger limbs. In about two weeks they transform to the adult stage. The new adults return to the foliage of the same or adjacent elms and lay eggs. In late summer and fall, the adult beetles leave the host tree and seek an overwintering site. There are two generations per year.



MONITORING

Stage to Monitor/Timing/Techgniques:

Adult, late May through early June, 363-912 GDD (NY), ruby horsechestnut and black locust in bloom.

- Visually inspect expanding foliage for evidence of adult elm leaf beetle feeding which appears as roughly circular holes in the leaves.

Larvae, mid June through late June, 363-912 GDD (NY), Kousa dogwood, cranberry bush, beauty bush in full bloom.

- Visually inspect the undersides of leaves for skeletonization caused by feeding of larvae.

Threshold/Action Level:

MANAGEMENT (NON-CHEMICAL)

Cultural:

Biological:

Eulophid wasp parasites, *Tetrastichus brevistigma* and *T. gallerucae*, are pupa and egg parasites, respectively, of the elm leaf beetle. However, they are not abundant enough to provide controls.

Mechanical/Physical:

COMMENTS

Elm species differ in their suitability as food for elm leaf beetles.

References: 3, 21, 42.

The Great Ice Plant Pull

By Howard Overton, Chief, Resources Management and Visitor Protection, Cabrillo National Monument

As Southern California developers bulldoze what remains of coastal sage scrub, small parks like Cabrillo National Monument become increasingly important islands of protected habitat. Located within the city limits of San Diego, the 145-acre National Monument provides habitat for numerous species, 97 of which are considered rare, threatened, or endangered by the criteria of various federal, state, or local agencies and institutions. Resources managers at Cabrillo place a high priority on protection of this ecosystem for these and other species. The park's vegetation management plan identifies exotic plants that needed to be removed, and the park is in the process of implementing the plan.

One of these exotics is the ice plant. In 1934, after acquiring Cabrillo National Monument from the War Department, the National Park Service made improvements to a lighthouse originally constructed in 1855. When the project was completed, no funds remained for landscaping, so interested citizens and agencies donated plants to the park, including the ice plant. The ice plant escaped cultivation and spread rapidly throughout the park, out-competing the native plant species.

While some removal of the ice-plant had been accomplished by park staff, getting rid of the huge numbers of remaining plants seemed overwhelming until one of our seasonal rangers offered to coordinate a volunteer project. Seventy volunteers from a number of groups interested in natural resources participated in the Great Ice Plant Pull. Cub Scouts, church groups, individuals, school groups, Boy Scouts, members of the Sierra Club, park employees, and many others came and worked from 9 a.m. to 4 p.m. Two 40-yard dumpsters were quickly filled, and refilled four more times before all of the targeted ice plants were removed from the park.

Through this volunteer program, the park staff learned that seemingly overwhelming obstacles can be overcome. We gained new friends through the VIP program, and the native vegetation of the park now has more room to grow. What started out as a simple idea grew into a positive reality.

Sample screen from white-tailed deer management computer program.

How many acres of your forest are:
(Total forest size limited to 100,000 acres.)

Mature hardwood forest: _____

Open, grassy fields: _____

Marshes or wetlands: _____

Brush or scrub: _____

Ponds, lakes, rivers, or creeks: _____

Total forest size: _____ acres

How many deer live in your forest?:

_____

Destroying Bambi's Image

By John Howard, Resources Management Specialist, National Capital Region, and Sally Griffin, Interpretive Specialist, Catoctin Mountain National Park

Despite years of research and monitoring, the recent dramatic population increase of white-tailed deer in the eastern United States has placed many natural resources agencies, including the National Park Service, in a precarious situation as far as management actions go. One of the major problems has been the common public perception of the white-tailed deer as a brown, fuzzy creature that can do no harm. Unless their landscaping has been devoured, or they have gotten up-close-and-personal with one of these fuzzy creatures at 50 mph, the public's conception of a white-tailed deer is the one they got from Walt Disney--a sweet, little fawn in a forest glen pathetically calling "mother, mother."

In an attempt to relate the complex factors involved in reaching decisions on white-tailed deer management, the National Capital Region used Challenge Cost-Share Program funding to develop an interactive white-tailed deer management computer program for use on personal computers. An interpretive specialist and a volunteer at Catoctin Mountain Park developed the program using input obtained from a variety of research sources.

The program can be used either in visitor centers or as a part of a school curriculum for sixth-grade students. It allows the participant the opportunity to select factors on habitat, predators, and human influence to determine the kind of park they manage. They are then presented with a variety of options to manage the resources of the park, thereby displaying in simple, straight-forward terms the complex factors involved in reaching a decision, such as legislative requirements that often limit a park managers options, and the impact that public opinion and involvement has on this issue.

This innovative use of computer technology and coordination between natural resources and interpretation will provide the opportunity for natural resources issues to be presented to park visitors and the general public in a easily understood manner using available technology.

Cooperative Surveying Reduces Backlog

By John Howard, Natural Resources Specialist, and Mike Barnhart, Resources Protection Specialist, National Capital Region

Trespass or encroachment on National Park Service land is a common event in areas threatened by urban sprawl. Such situations exist on a weekly basis for parks such as Prince William Forest Park and Manassas National Battlefield, where land use patterns are changing from agricultural and forests to single family homes and light industry. Correcting established encroachments though litigation takes a great deal of time and money. Often natural, cultural or, recreational resources are permanently damaged as a result of the trespass, a loss that often cannot be recovered.

Clearly delineated park boundaries would solve most of these encroachment problems. Unfortunately, identification and management of park boundaries within the National Capital Region has been a long-standing problem, with limited funding and the high cost of surveying creating a critical Catch-22 situation. In 1990, the National Capital Region experienced a backlog of over 100 survey requests considered to be critical to the protection of natural or cultural resources.

In an attempt to alleviate this backlog, the National Capital Region entered into a reimbursable work agreement with the Bureau of Land Management's Eastern States Office to perform cadastral boundary surveys within the National Capital Region. The project has grown into a five-year Memorandum of Understanding (MOU). After three years, the Region has completed a total of 19 projects and saved the government in excess of $250,000 in survey costs.

This cooperative arrangement has provided the National Capital Region with a high quality survey product when completed. All survey work is preformed with a survey grade GPS unit. When the Bureau of Land Management completes each survey, they provide the region with not only the traditional paper plat and deed descriptions, but also a database file which can be converted to any geographic information system. Because of the flexibility of the MOU, the National Capital Region can respond to an immediate threat by sending a Bureau survey crew to the threatened area to provide needed boundary identification and protection, often within 24 hours. And we receive all these services at an average cost of 1/2 that of a private survey contract, and with none of the headaches which can be associated with the procurement process.

The use of this cooperative relationship with the Bureau of Land Management has provided the National Capital Region with another tool for use in protection of the Region's varied natural and cultural resources.

Center Coordinates Olympic Peninsula Research

By Cat Hoffman, Chief, Natural Resources Management, Olympic National Park

In 1988, 32 citizens representing the timber industry, conservation and wildlife groups, Native American tribes, schools and other trust beneficiaries, local Olympic Peninsula community leaders, legislators, and financial, legal, and forestry experts joined together to form the Commission on Old Growth Alternatives for Washington's Forest Trust Lands. The Commission's purpose was to advise the Washington Department of Natural Resources regarding future management of old growth forests on state trust lands on the western Olympic Peninsula.

The Commission recommended eight actions to improve management of the state's forest lands, one of which was the creation of an Olympic Natural Resources Center "to develop research and educational programs in support of the management of the natural resources of the Olympic Peninsula for both the production of commodities and maintenance of ecological values. There is no other forestry resources center with a similar mission."

In 1994, construction will begin on the Olympic Natural Resources Center near Forks, Washington. The University of Washington, Seattle, will direct and manage the Center under the supervision of a nine-member governing board that includes the Superintendent of Olympic National Park and other Peninsula land managers and agency representatives.

The Center's program will integrate research efforts already in place or proposed for the Olympic Peninsula, including silvicultural and wildlife research by the Pacific Northwest Research Station (USDA Forest Service), ecological research and monitoring by the National Biological Survey and the Park Service, and stream research by the University of Washington's Center for Streamside Studies. The Center's primary objective is to develop concepts to manage forests and related resources at all levels--stand, watershed, landscape--to retain ecologic values while also generating commodities.

...a tangible first step towards practicing ecosystem management on the Olympic Peninsula.

Specific objectives of the center include: (1) providing a facility available to all scientists, educators, and economists working on the Olympic Peninsula; (2) developing research and education programs on natural resources (terrestrial and aquatic) and their social and economic implications; (3) providing a structure for long-term cooperation between the various land managing agencies and owners and resources interest groups on the Peninsula; and (4) providing assistance to resolve conflicts over research and data related to old growth forests and associated species.

The Center may also explore the biosphere reserve concept as a method of integrating the concerns of various landowners and user groups on the Olympic Peninsula. Olympic National Park managers are excited about establishment of the Olympic Natural Resources Center as a tangible first step towards practicing ecosystem management on the Olympic Peninsula.

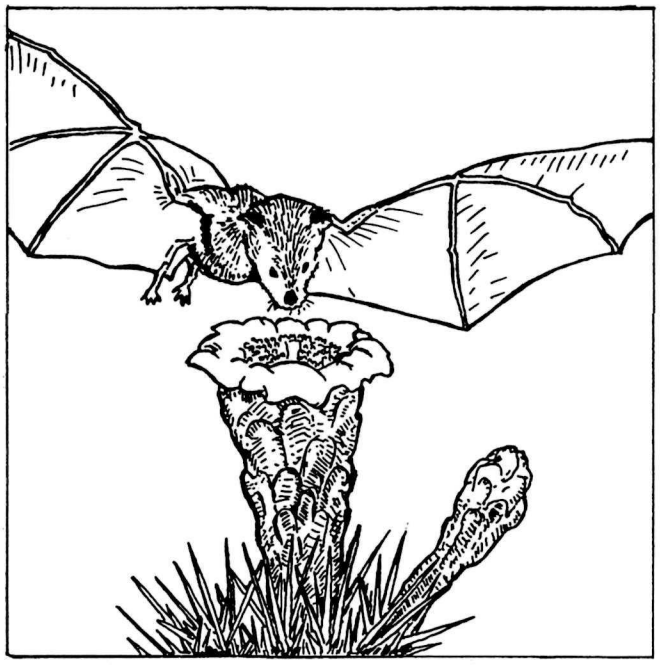
Inventory and Monitoring

Monitoring Bat Populations at Organ Pipe Cactus National Monument

By Jim Barnett, Chief of Resources Management and Research,
Organ Pipe Cactus National Monument

Thirteen known species of bats occur in Organ Pipe Cactus National Monument, including the largest maternity colony in the United States of the federally listed endangered species, the lesser long-nosed bat. The California leafnose bat and Underwood's mastiff bat, both Category 2 species, are also found in the monument.

In 1979 and 1980, a study provided information on bat species presence, life histories, and habitat requirements. Since the completion of this study, cattle grazing has been eliminated in the monument, allowing for the recovery of natural systems. Unfortunately, this decision may have also negatively affected bat populations, due to the elimination of man-made water sources. In addition, the closure of



abandoned mines since the early 1980's may have resulted in a net loss of bat roosting habitat. Urbanization and agricultural development adjacent to the monument, primarily along the southern boundary with Mexico near known foraging sources such as Quitobaquito springs, has increased dramatically and also threatens bat habitat.

Resources management staff and supporting scientists developed a study to provide a status of bat populations at Organ Pipe Cactus National Monument. This information will be compared with data collected in the early 1980's. Objectives included censusing bat populations throughout the monument, evaluating the status of the endangered lesser long-nosed bat maternity colony through census counts and guano analysis, and developing a monitoring protocol for future assessments.

The first component of this study was to evaluate and assess the status of the lesser long-nosed maternity colony in the monument. Objectives included: 1) conducting flight counts of the maternity colony to determine total number of bats utilizing the roost; 2) assessing all past environmental and flight count data and developing alternatives for long-term monitoring of the colony; 3) analyzing guano collected over the past two years to obtain quantitative data on plants utilized in foraging; and 4) outlining long-term research and monitoring objectives and priorities.

Two videotaped censuses of the maternity colony were conducted in July and August 1993, using night vision devices with supplementary infrared illumination. Counts commenced at dusk and concluded when the number of bats emerging dropped significantly and/or when the number of bats returning to the mine roughly equaled the number emerging. In July, the videotapes showed 18,000 bats emerging, and 15,000 in August.

During the season, guano samples were collected regularly, both during and after the primary food sources were in bloom or bearing fruit. Guano splatter sheets were placed in the mine tunnel and replaced every other week. Samples to be analyzed were taken from these sheets and frozen.

The second component of the populations study was to census bats monument-wide. Objectives included: 1) conducting a systematic survey of known and suspected watering sites to determine the presence of bat species; 2) developing a protocol to routinely monitor bat populations, for integration into the monument's long-term ecological monitoring and assessment program, and; 3) training resources management staff in bat censusing techniques.

Ten nights of mist netting at various locations throughout the monument were completed. Three sites were surveyed for two consecutive evenings to evaluate species present and number of recaptures. One site, Wild Horse Tank, was netted once in August and again in September to evaluate differences before and after monsoon rains. Other sites were only sampled for one evening. Ten different species were observed throughout the survey, including the first confirmed record of the Mexican freetail bat. An unexpected observation was the significant use of water sites by the lesser long-nosed bat.

Removing bats from mist nets proved challenging. While some individuals remained calm and resigned to minor manipulation necessary for removal, others insisted on resisting all efforts of assistance. One particular species, the big brown bat, was unaffectionately called the "bad attitude bat" for good reason. Without fail, individuals of this species would give the greatest resistance to any handling and provided an excellent reminder on the need for good leather gloves when removing bats. Overall, most bats were removed quickly and unharmed from the nets, and those that took a little more time did not suffer any physical injury.

Final project deliverables are scheduled for completion by January 31, 1994. Products include: 1) a data set and analysis of census data for bats throughout the monument; 2) a tested monitoring protocol for monument staff to continue to assess the status of bat populations over time--this protocol will have the potential for extrapolation to other NPS areas; 3) a data set for FY 1993 on the lesser long-nosed bat maternity colony, including roost environmental data, population numbers and status and foraging assessment based on guano analysis; 4) a final report providing an evaluation of data collected on the lesser long-nosed bat maternity colony to date as well as a monitoring protocol and recommendations for future monitoring and research; 5) a video documenting all project activities and providing step-by-step instructions for monitoring protocol implementation.

In 1994, on-going evaluations of the lesser long-nosed bat maternity colony will continue via roost monitoring and censuses. Proposals for expanded research, including foraging ecology studies, will be evaluated. Bat population assessments will be integrated into the monument's ecological monitoring program and implemented in the 1994 field season. Finally, a Southwest Parks and Monuments Association funded research project will examine the use of Quitobaquito pond by two sensitive bat species, Underwoods mastiff and the western mastiff.

Small Parks Monitor Aquatic Resources

By Brendhan Zubricki, Water Resources Coordinator, Southeast Region

The National Park System contains many small units that were originally created for reasons other than outstanding aquatic resources. Accordingly, these units have received only minimum funding levels for water resources management activities. However, since many of these units have prohibited development and significant internal land use changes for decades, they often contain stable aquatic ecosystems and impressive natural assemblages that differ drastically from developed areas just outside of the unit boundaries.

In recognition of the important aquatic resources in our smaller parks, and in an effort to provide small parks with a cost-effective, self-sustaining mechanism to acquire and interpret sound aquatic resources data, the Southeast Regional Office supports a region-based, water resources monitoring program designed by the Water Resources Coordinator. The program aids in developing baseline aquatic biological and water quality information and in addressing threats to these resources. The program strives to be consistent with broader Servicewide efforts to develop monitoring protocols and park-based water quality data sets.

The monitoring program at Kennesaw Mountain National Battlefield Park in Georgia, the prototype unit for this program, serves as a template for other parks. Thus far, King's Mountain National Military Park in South Carolina and Shiloh National Military Park in Tennessee have instituted similar programs. More parks will follow as funding becomes available.

The details of each study plan differ from park to park, but in general park rangers conduct monthly water quality sampling using state-of-the-art field instruments and in-kind analytical services from local laboratories (where possible). High school students recruited under the VIP program conduct biological monitoring every two months using the Izaak Walton League's Stream Quality Survey technique. Park staff and the Southeast Region Water Resources Coordinator work together to analyze the water quality and biological data on a semi-annual basis using a holistic approach that considers how water quality actually affects the functional integrity of the aquatic ecosystem.

The reports generated suggest possible pollution problems and discuss what "normal" conditions and seasonal variations at a particular park appear to be. Park managers may then use this information to better preserve, protect, enhance, and interpret these aquatic resources by working with parties who appear to be degrading resources in our trust and by gaining insight on typical conditions.

Eventually, we intend for staff at each park to become proficient with the necessary protocols and data interpretation skills. At that time, each park will accept full responsibility for the program in an effort to professionalize resources management capabilities within the National Park Service. The time necessary to achieve this turnover of responsibilities will vary depending on the resources available at each park. However, regardless of the "learning curve" involved, small parks have begun to more effectively manage aquatic resources for a relatively low cost, while park staff become more adept at protecting aquatic resources. In addition, American youth have become allies with the National Park Service and are gaining direct access to educational guidance from Park Service scientific staff and programs.

Volunteers Help Inventory and Monitor Big Bend

By Keith Yarborough, Natural Resources Specialist, Big Bend National Park

The first part of the Long-term Environmental Monitoring Program has begun in Big Bend National Park. As part of the 1993 Expedition into America, 25 Earthwatch volunteers, including high school, university students and teachers, and professional scientists, spent two weeks in the park assisting on inventory and monitoring projects.

The project established 22 1-hectare quadrat plots along a linear transect, extending from the Chisos Mountains in the center of the park down through the upper Chihuahuan Desert grasslands and ending in the lower desert shrublands. The plant and animal populations at each quadrat were carefully inventoried and recorded, and will be re-read each season. This work begins an effort to establish a network of transects radiating from the mountains down to desert, to inventory and monitor plant and animal species, populations, and communities.

This project is part of an overall assessment of the park's natural and cultural resources. Researchers will re-read all the formerly established transects in the park, establish the additional transect network, and begin periodic evaluation of these sites. The goal of the project is to develop baseline data by which to measure environmental and ecological change.

The National Park Service Challenge Cost-Share Program provided partial support for this work, with Earthwatch supplying in-kind services of the volunteers.

The volunteers maintained their enthusiasm and good humor through the long, hot days of the summertime field work. One undergraduate student from the first team stayed to help direct the other two; many said that they would like to participate in future projects at the park; and all of them felt the work was successful and the experience beneficial.

The First Ten Years of a Cooperative Long-term Raptor Study at Golden Gate

By Buzz Hull, Golden Gate Raptor Observatory Coordinator, Golden Gate National Recreation Area, Allen Fish, Golden Gate Raptor Observatory Director, Golden Gate National Park Association, and Daphne Hatch, Wildlife and Fisheries Specialist, Golden Gate National Recreation Area

Each fall, against the dramatic backdrop of the Golden Gate Bridge and the San Francisco skyline, some 20,000 raptors of 19 species pass over the Marin Headlands in the largest known concentration of birds of prey on the Pacific Coast. "Discovered" by a California Academy of Science ornithologist in 1972 and first described in the literature in 1979, this flight attracts thousands of birders and outdoor enthusiasts alike to "Hawk Hill" in the Golden Gate National Recreation Area (NRA).

Since 1985, the Golden Gate Raptor Observatory, a cooperative project of the Golden Gate NRA and the Golden Gate National Park Association, has monitored this spectacular migration. Using volunteer energy and leadership through the Volunteers in the Parks program, this project has grown from a National Park Service raptor banding program in 1983 to a cooperative long-term raptor monitoring and education organization by 1993. During 1993, under the supervision of park and observatory staff, over 250 volunteers performed more than 35,000 hours of work and carried out the four programs of the Raptor Observatory: Hawkwatch, Banding, Radiotelemetry, and Outreach.

The Hawkwatch Program serves to record the general numbers or activity of hawks in the Headlands each fall. In 1988, we developed an innovative new technique called the Quadrant System, that uses six to ten volunteer observer teams to tally hawk sightings, with the aim of establishing baselines based on multiple year averages. Although raptor migration lookouts have developed at numerous sites in the United States (e.g., Cape May Point, New Jersey), the Golden Gate NRA approach is unique insofar as we are using consistent methods that are described and repeatable over the long-term. Hawkwatch numbers are compiled nationally by the Hawk Migration Association and the National Audubon Society.

Volunteer teams of the Banding Program use spring-powered bownets and mistnets to trap and band raptors, operating one to four trapping stations in the Headlands. Through band recovery data provided by the U.S. Fish and Wildlife Service's Bird Banding Lab, we learn about the breeding and wintering areas for the species involved, as well as the movement corridors. Moreover, since this is the

first comprehensive study of migrating hawks on the Pacific Coast, each hawk is studied and measured while in hand.

To date, Observatory banders have banded more than 6,000 raptors of ten species, for which we have some 150 recoveries (2.5%). With nearly 100 recoveries for red-tailed hawks, we have an overall view of the movement patterns for that species: Golden Gate red-tails have travelled from Washington state to Idaho, from northern Mexico to Arizona. In the next decade we will focus more attention to the small accipiters--Cooper's and sharp-shinned hawks--which are poorly known in the west. Their preference for undisturbed woodland habitat and songbird prey make them critical species to monitor.

Since 1990, the Radiotelemetry Program has tagged and tracked eleven immature red-tailed hawks for periods ranging from two days to two months after the hawk passed into the Headlands. Tracking is accomplished by two to three teams in cars, and when necessary, in a small private airplane. Teams might drive thousands of miles to follow a hawk a few hundred miles. Telemetry volunteers are working on the day-to-day patterns of movement, behavior, and habitat use; this information is too detailed to be learned from band recoveries. For example, during the course of a day, when does a hawk migrate? When does a hawk sleep? What habitat does it choose for roosting? For hunting? How does it move through an urban area?

So far, in general, we are uncovering patterns of movement that do not resemble classic migration where a hawk travels south in the fall and north in the spring, but rather resemble some form of dispersal. Dispersal is a nondirectional movement, guided more by ecological factors, like food or competition, than by genetic instruction. For a moderate climate like that of coastal California in the wintertime, the question for a bird of prey may not be whether to go farther south so much as how to find a winter food source.

The fourth part of the project is the interpretive Outreach Program. Begun in 1992, this program utilizes experienced volunteers from the Observatory to present docent talks and banding demonstrations to thousands of visitors who are attracted to Hawk Hill during the fall raptor migration. The docent brings the talks to life by their own experiences as hawkwatchers, banders, or telemetrists, and seek to impress upon the visitor that they too may be involved with meaningful wildlife work through the National Park Service and other agencies.

These Golden Gate Raptor Observatory programs serve to monitor Pacific Coast raptors over the long-term and to alert the research community and general public when dramatic shifts take place. Our education program facilitates the public understanding that the best time to monitor a species is when it's common, and that the national parks provide key refuges in the migration corridors that are essential for many vertebrate species. With a community involvement effort, we hope to cultivate among our volunteers the highest standards of awareness and personal responsibility for preserving local wildlife and wildlands.

The Golden Gate Raptor Observatory project underlines how a national park can be a focal point for monitoring a natural phenomenon that extends far beyond its boundaries. Information learned in the Golden Gate National Recreation Area is contributing to a picture of raptor population dynamics and movements across a broad landscape.

Inventory and Monitoring in Small Parks

By Trish Patterson, Inventory & Monitoring Coordinator, Southeast Region

The Southeast Regional Office was presented with a special opportunity when more than $250,000 in Service-wide and regional project funds was made available to address the natural resources needs of small parks--typically cultural and historic units. The opportunity, however, presented challenging conditions--more than thirty parks in the Southeast Region met the criteria for funding, centralized information about their natural resources was generally very limited, and time was short for making funding decisions.

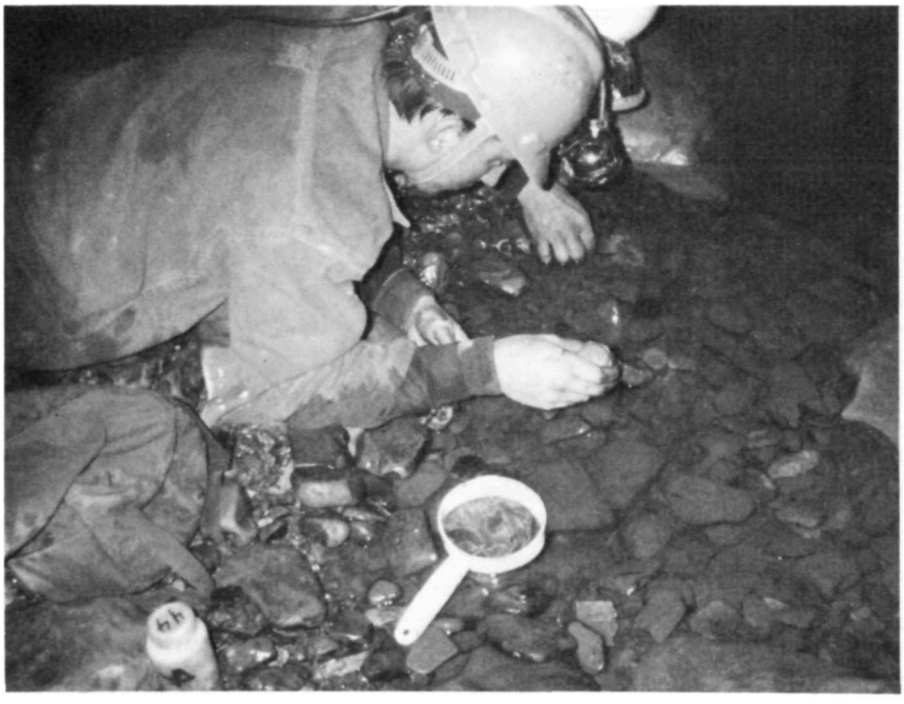
To tackle this challenge, the regional inventory and monitoring coordinator assembled an advisory group and presented some fundamental choices: Should we fund a single "theme" or type of project in many parks (e.g., rare plant surveys)? Should we develop comprehensive programs for one or two pilot parks? Or should we allocate funds on a project-by-project basis, and, if so, how would priorities be established given the large number of parks and potential needs?

The members of the advisory group faced some sobering truths after reviewing park resources management plans. Virtually every park lacked systematic baseline inventories--or, in some cases, even adequate descriptions--of natural resources; most lacked natural resources expertise on staff; and prospects were dim for base funding to provide long-term resources protection. Thus, while we recognized the importance of addressing specific park needs and threats, we also sought solutions that would secure long-term advocacy for significant natural resources in small parks. The steps we followed to establish and implement program goals are described here.

1. We devised a "quick and dirty" method to select a half-dozen parks likely to harbor the most significant natural resources. In addition to consulting park resources management plans, we gleaned information from computerized literature searches and queried the region's newly established Biological Conservation Database, which contains information on occurrences of rare species and natural communities.

2. We conducted site visits to assess park needs and establish priorities. A multi-disciplinary team of natural resources managers visited the selected parks and prepared preliminary assessments describing significant natural resources, threats, and inventory, monitoring, and mitigation needs.

3. We allocated available funds to fulfill program goals. With a better understanding of park resources and needs, and mindful of our overall goal of developing a long-term solution, we selected the following program components for funding. (1) Two years of salary and support for a regional data manager for small parks, who would seek out and assemble existing natural resources information as well as manage data from new field work. (2) Preparation of long-term inventory and monitoring plans for five parks, dynamic documents in a loose-leaf format that describe the



Under a cooperative agreement with Wittenberg University (Ohio), eight caves at Russell Cave in Alabama and thirteen within the Lookout Mountain unit of Chickamauga-Chattanooga National Battlefield were sampled for physical, chemical, and biological features. Preliminary identifications of cave fauna reveal at least 87 distinct species of cavernicoles from these caves. Shown here, a research assistant examines stream substrata for aquatic invertebrates in Russell Cave with the aid of a bulb baster and tea strainer. (Photo by Horton Hobbs, Wittenberg University.)

Evaluation team members discovered a surprisingly high degree of species richness in five relatively small (310 to 8100 acres) parks they visited. Rock outcrops at Kennesaw Mountain National Battlefield in Georgia and Lookout Mountain in Tennessee, as well as limestone glades at Chickamauga Battlefield in Georgia (shown here), provide habitat for a number of federally listed endangered plants. In fact, there seems to be a correlation between battlefield sites and rare plant communities. Keith Langdon, supervisory biologist at Great Smoky Mountains National Park and evaluation team leader, conjectures "Sometimes this may be due to chance, or less manipulation than occurs on surrounding lands; often, however, I believe it is because military commanders selected unusual terrains due to their defensibility." (Photo by Rob Sutter, The Nature Conservancy.)

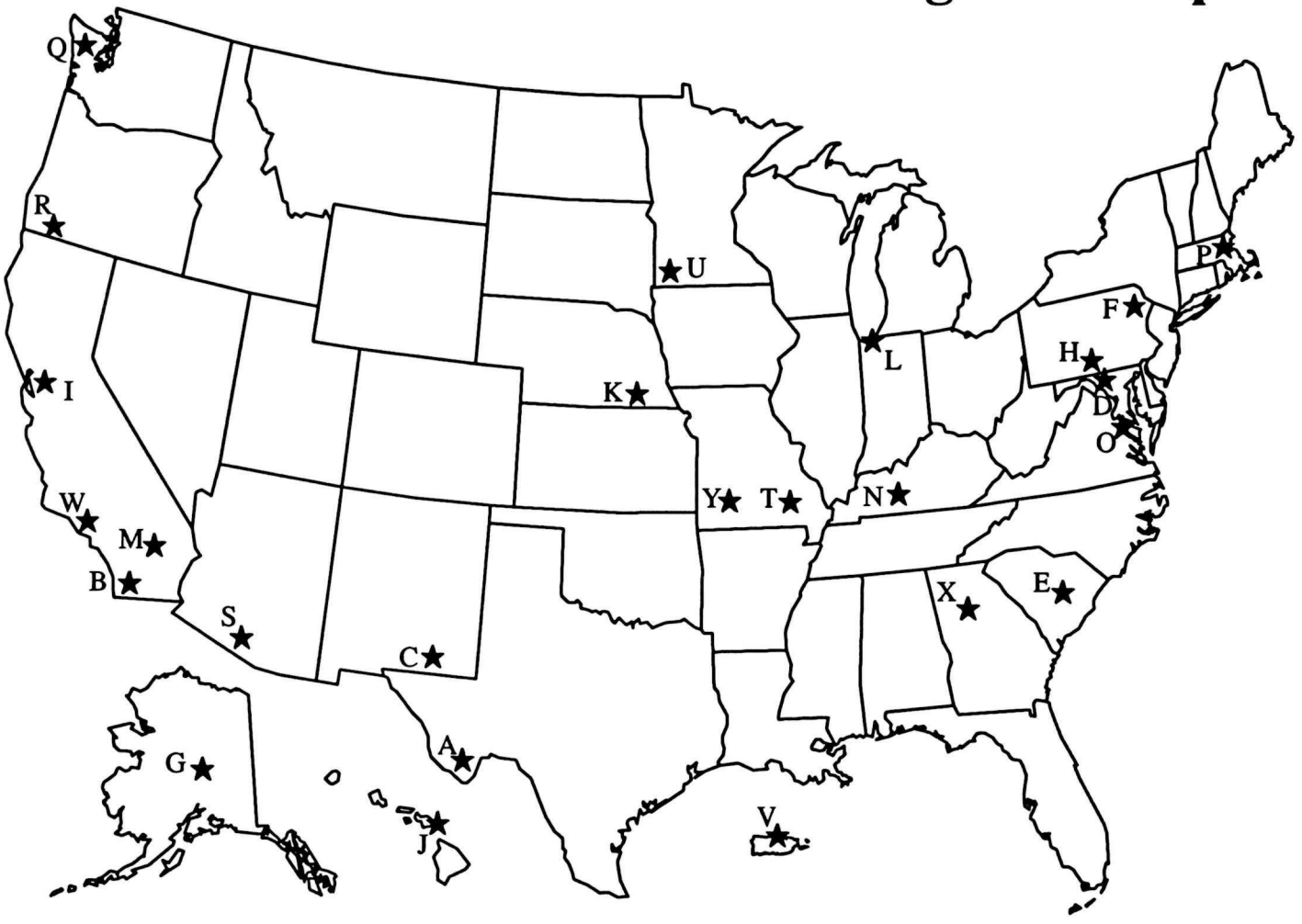
significant resources, document past and current studies, establish program priorities, and document data collection protocols. (3) Development of agreements with seven cooperators having a demonstrated commitment to resources protection, who were interested in forming long-term relationships with the parks, and with whom park staff could consult on an on-going basis. We envisioned the cooperators--including several universities and The Nature Conservancy--as advocates for the parks' significant natural resources.

Projects to be carried out under the terms of the agreements included inventory and monitoring of rare plant populations, vascular plant checklists with voucher collections, lichen surveys, long-term vegetation plots, and surveys of more than a dozen caves. In addition, the regional water resources coordinator was to establish water quality monitoring programs in several parks (see "Small Parks Monitor Aquatic Resources," page 43). We knew we could count on the Park Service's Servicewide Inventory and Monitoring Program to provide basic information for our parks, such as bibliographies and digital cartographic data; therefore, we focused our efforts on specialized inventories and monitoring.

4. We arranged for on-going program implementation and oversight. The regional Inventory and Monitoring coordinator obligated all funds and now handles project administration, while park staff work closely with principal investigators on site.

We recognize that limited funds and personnel must be directed toward the primary resources for which each park was created. Natural resources in small historic and cultural park units will not, at least in the foreseeable future, receive the same level of support found in larger parks established for their natural resources values. However, we are learning that our historic and cultural parks can be nuggets of significant natural resources. The program we have initiated will help ensure that they receive the attention they deserve.

National Park System Units Represented in 1993 Highlights of Natural Resources Management Report



A. Big Bend NP
B. Cabrillo NM
C. Carlsbad Caverns NP
D. Catoctin Mountain NP
E. Congaree Swamp NP
F. Delaware Water Gap NRA
G. Denali NP&P
H. Gettysburg NMP/ Eisenhower NHS
I. Golden Gate NRA
J. Haleakala NP
K. Homestead NM
L. Indiana Dunes NL
M. Joshua Tree NM
N. Mammoth Cave NP
O. National Capital Region
P. North Atlantic Region
Q. Olympic NP
R. Oregon Caves NM
S. Organ Pipe NM
T. Ozark National SR
U. Pipestone NM
V. San Juan Island NHP
W. Santa Monica Mountains NRA
X. Southeast Region
Y. Wilson's Creek NB

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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