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See back cover for new *Park Science* phone, FAX & address.

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Cover: An electron micrograph shows a dry sandstone crust interlaced with cyanobacteria, enlarged 90 times. (Story pages 3,4).

Guest Editorial

By Eugene Hester, Associate Director, Natural Resources

These are exciting times in Natural Resources in NPS. We have nearly completed the groundwork for future improvements, including completion of the Natural Resources Assessment and Action program, development of new guidelines for planning and implementing resource management activities, and training nearly 100 graduates of the Natural Resource Management Trainee program.

Among several exciting initiatives getting underway is our advocacy of parks as appropriate places for global change studies and our expectation that our role in this program will begin in FY 91. (See page 10.)

Understanding our natural resources and what is happening to them over time (Inventory and Monitoring) is one of our most basic needs. Last year I convened a task force to expedite implementing I&M strategies outlined by the "Evison Committee." Based on the task force results, I allocated FY 90 funds to start implementing the program and developed proposals for FY 92 and a 10-year plan. We have great potential to improve our research and resource management programs, but need a clearer understanding of our needs and a plan to meet those needs. I am recruiting a deputy associate director to give the kind of day-to-day oversight I believe these initiatives need. Also, I have recommended a number of other FY 92 resource management funding proposals.

Congress asked us to do a study of our research program and make recommendations for its future. The National Academy of Sciences has that study underway with an excellent panel that includes members with experience in NPS and government research administration. It should be able to provide genuinely helpful recommendations. Finally, we have a director who is a real advocate for developing and using scientific data bases.

Other activities that attest to our bright future are the recent Regional Chief Scientists' meeting and a meeting of Natural Resource Specialists at a training workshop in Denver in May. While the RCSSs have been meeting regularly, this was the first meeting of NRM personnel. It was organized by regional personnel (special kudos to Kathy Joep). based on their perceptions of the need to have a stronger natural resource management focus throughout the organization. Among the themes that emerged was that research often developed excellent management recommendations, but there often is no funding or personnel to implement them.

Funding is not the only deficit; we still have need for more well-trained specialists, as well as generalist rangers with good education in natural resources. Another theme was the need for more strategic planning and objective setting. Finally, improved communication and cooperation emerged as a prescription for improved natural resource management.

I expect to move forward, making more effective use of our existing resources and proving, with the expected FY 91 increases, that we can make wise use of additional resources. Less case-by-case crisis management and a more programmatic approach is needed, as well as consideration of the larger ecosystems and biogeographical areas in which our resources are embedded.

To effect these improvements, we must provide increasingly effective national and regional leadership and strategic planning, and we must move forward with park-based information and with adequate resources directed at the park level.

Regional Chief Scientists

Anderson, William H.
NATIONAL CAPITAL REGION
1100 Ohio Drive, S.W.
Washington, D.C. 20242
8 (202) 342-1443

Dottavio, Dominic
SOUTHEAST REGION
75 Spring St. S.W.
Atlanta, GA 30303
8-841-4916 (404) 331-4916

Larson, James W.
PACIFIC NORTHWEST REGION
83 S. King St., Suite 212
Seattle, WA 98104
8-399-4176 (206) 442-4176

Lovaas, Allan L.
ALASKA REGION
2525 Gambell St., Room 107
Anchorage, AK 99503-2892
8 (907) 257-2568

Hiebert, Ron
MIDWEST REGION
1709 Jackson St.
Omaha, NE 68102
8-864-3438 (402) 221-3438

Huff, Dan
ROCKY MOUNTAIN REGION
P.O. Box 25827
Denver, CO 80225
8-327-2650 (303) 969-2650

Karish, John F.
MID ATLANTIC REGION
Ferguson Bldg., Room 209-B
Pennsylvania State University
University Park, PA 16802
8 (814) 865-7974

Mike Ruggiero, Chief
WASO WILDLIFE AND
VEGETATION DIVISION
National Park Service—PO Box 37127
Washington, DC 20013-7127
8-343-8100, (202) 343-8100

Mary Foley, Acting
NORTH ATLANTIC REGION
15 State Street
Boston, MA 02109
8-223-5129 (617) 223-5129

Fletcher, Milford
SOUTHWEST REGION
P.O. Box 728
Santa Fe, NM 87501
8-476-1870
(505) 968-1870

Kilgore, Bruce
WESTERN REGION
450 Golden Gate Ave.
P.O. Box 36063
San Francisco, CA 94102
8-556-4968 (415) 556-4968

Please address requests for information to appropriate Regional Chief Scientist.

Microbiotic Crusts: Their Role In Past and Present Ecosystems

By Jayne Belnap

Microbiotic crusts are found throughout the world, from the hottest deserts to polar regions. Most of these crusts are dominated by cyanobacteria, and also include lichens, mosses, green algae, microfungi, and bacteria. The crusts are critical components of these ecosystems, significantly modifying the surfaces on which they occur. In the cold deserts of the Colorado Plateau region (parts of Utah, Arizona, Colorado, and New Mexico), these crusts are extraordinarily well-developed, and may represent 70-80 percent of the living ground cover.

Cyanobacteria, previously called blue-green algae, are the oldest form of life known. The earliest fossils found, called stromatolites and dating back more than 3.5 billion years, are extremely thick mats of these prokaryotic organisms. It has been suggested that it was these marine organisms that converted the earth's original carbon dioxide-rich atmosphere into the oxygen-rich atmosphere necessary for the evolution of life as we know it today. Stromatolites are still being formed along the coasts of Baja California, Africa, and Australia, where meters-thick mats of cyanobacteria such as *Microcoleus chthonoplastes* and *Lyngbya* can be found in various stages of fossilization.

Cyanobacteria occur as single cells or as filaments. The most common form found in desert soils is the filamentous type. The cells, or filaments, are surrounded by a sticky mucilaginous sheath that is made of polysaccharides and other compounds that can be extremely persistent in these soils.

Their Soil Binding Role

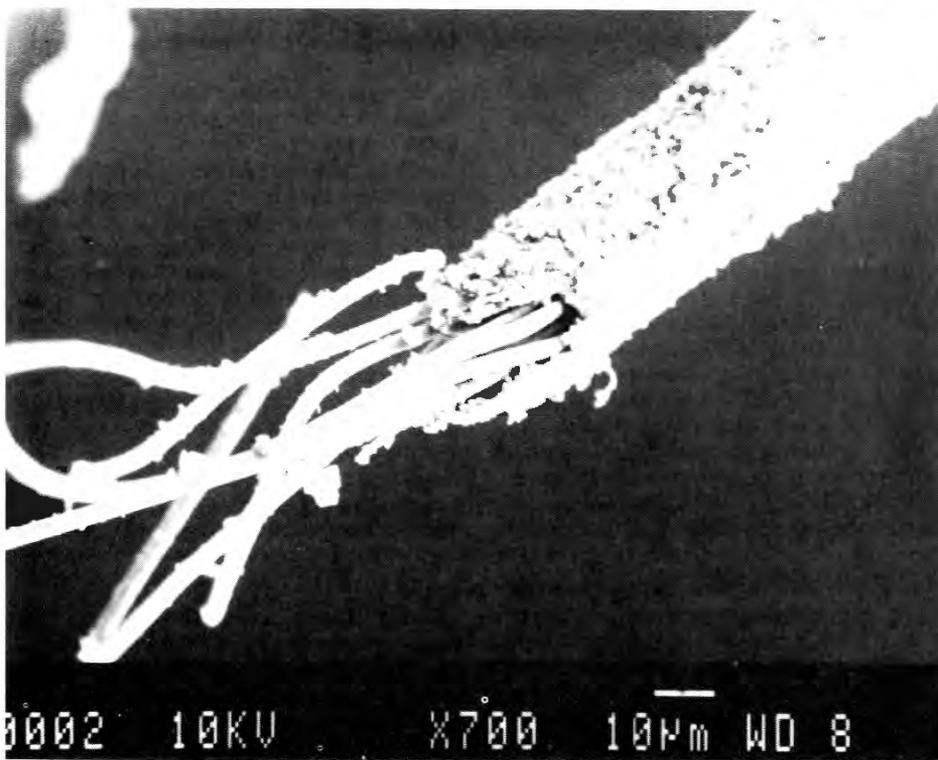
One ubiquitous species, *Microcoleus vaginatus*, not only has sheaths around each filament, but has filaments occurring in bundles that are surrounded by a common sheath. When moistened, these cyanobacteria become active, moving through the soil and leaving a trail of sticky mucilage behind. The sheath material sticks to surfaces such as rock or soil particles with which it comes into contact. Since many of these cyanobacteria occur in long filaments, the result is an intricate webbing of fibers throughout the soil, joining soil particle to soil particle, like beads on a string.

As with fiberglass, this webbing gives the soil great stability and tensile strength, and enhances resistance to erosional forces such as wind and water. Of considerable significance is the fact that this binding action is not dependent on the presence of living filaments: layers of abandoned sheaths, built up over long periods of time, can still be found clinging tenaciously to soil particles at depths greater than 15 cm in sandy soils. These sheaths provide cohesion and stability, even at depth, to otherwise highly erodible soils.

The sheaths have other functions as well. They are extremely hydrophilic, swelling up to as much as 10 times their dry size when moistened. Consequently, the sheaths become a way of intercepting and storing water, especially important in arid areas where rainfall is sporadic and intense. This enables the cyanobacteria, which are active only when wet, to remain active longer.

Their Nutrient Holding Role

Recent research also shows that vascular plants grown in crusted areas have much higher levels of essential nutrients than plants grown in areas without



Microcoleus vaginatus is a major constituent of soil crusts on the Colorado plateau. This 700 times enlargement shows the filaments clustered in their common sheath, like a bundle of optical fibers. When moistened, they move through soil and weave it together with their sticky, mucilaginous trails.

crusts. Electron micrographs of *Microcoleus* suggest a mechanism for this nutrient enriching property. Pictures show the outer sheath of cyanobacteria covered with fine clay particles. Both the sheaths themselves and the adhering clay particles are negatively charged; therefore, they attract and bind important positively-charged nutrients, keeping them from being leached out of the upper soil horizons or becoming bound in a form unavailable to plants.

This circumstance benefits the crustal organisms, since attached nutrients are thus readily available, and also the surrounding vascular plants. As with soil stability, this soil-enriching function is not dependent on the presence of living filaments, but only on the presence of sheath material.

Sheaths also offer protection to the organism from both abrasion and desiccation – especially important in dry, unstable soils. Perhaps equally important, the sheaths and the organisms they surround contribute a great deal of organic matter to soils in which they occur.

Their Nitrogen Fixing Role

Nitrogen fixation is another significant capability of many cyanobacteria. Vascular plants are unable to utilize nitrogen as it occurs in the atmosphere and are dependent on microbial organisms to reduce atmospheric nitrogen to a form they can use. This is especially important in desert ecosystems, where nitrogen levels are low and often limiting to the system's productivity. Cyanobacteria play an even more critical role in cold desert ecosystems, where symbiotic and heterotrophic bacterial fixers – often important contributors of fixed nitrogen – do not perform well.

Cyanobacteria, then, are basically nutritionally independent organisms, needing only light, atmospheric nitrogen, a few minerals, and water to survive. This, along with sheaths that give them the ability to stick to surfaces, stabilize soil particles, capture nutrients, and hold water, enables them to colonize areas of bare rock and soil, such as newly-formed land masses.

Their Role As Colonizers

This capacity of cyanobacteria can be seen today in areas such as Iceland and Hawaii, where they are the first to colonize lava flows and cinder cones. For all the above reasons, it is thought that these organisms probably were the first colonizers of earth's early land masses and were integral in the formation and stabilization of earth's earliest soils.

Production of weak acids by the cyanobacteria, as well as the trapping and holding of water next to the rock, would have accelerated the weathering of the parent material and the production of soil particles. The binding of newly-formed particles by the cyanobacteria's sticky sheaths, greatly increasing resistance to water and wind erosion, would have aided the formation of small soil pockets. These small pockets of soil would further accelerate the weathering process, as more water would be trapped and more substrate would be available for colonization by more cyanobacteria.

Unfortunately, human activities are generally incompatible with the presence and well-being of cyanobacterial crusts, whether the disruption comes directly through construction and recreational activities, or

Continued on page 4

The Biosphere Reserve Coordinating Committee (BRCC) held its first meeting March 26-27. The BRCC was established by the US/MAB National Committee in January to coordinate planning and development of the US Biosphere Reserve (BR) program. Seven federal agencies, the five MAB directorates, the Southern Appalachian MAB program, and The Nature Conservancy are represented on the committee. It agreed to convene a workshop later this year to bring together Committee members, BR managers, and outside scientists to develop a strategic plan for the US/BR program. It deferred consideration of a national workshop of BR managers, pending completion of the strategic plan.

The first and, so far, only institutionalized MAB regional program in the US, the *Southern Appalachian Man and the Biosphere Cooperative* (SAMAB) continues to stretch its wings. Although the IRS has not yet formally approved the SAMAB Foundation's nonprofit status, the Foundation has a bank account and is accepting contributions. The goal is eventually to fund most SAMAB projects through this Foundation.

The Cooperative has numerous projects underway or on the drawing board. A commission with local citizen input is studying ways that Pittman Center, a small community on the northwest border of Great Smoky

Mountains NP, can develop economic alternatives to the strip development that has afflicted other tourist centers in the area. Land ownership, soils data, and other information are being entered into a geographic information system (GIS). North Carolina State University has agreed to do a computer analysis of viewsheds from various strategic points under various development scenarios, and the local planning commission has recommended prohibiting any new billboards and phasing out old ones.

A workshop, held at Asheville, NC, reviewed the state of knowledge about native economic plants of the region and discussed protection measures. Establishment of a local industry to grow these plants commercially is one possible way to conserve wild populations, but workshop participants felt that much more information on the present situation is needed before alternatives can be explored.

Late this summer a meeting will be held to educate public officials and others about the rapid spread of dogwood anthracnose, a fungal disease causing high mortality for which no effective control has been found. Flowering dogwood grows throughout most of the East and provides a spectacular spring show of white blossoms in the southern Appalachians. It is the basis

of numerous "dogwood festivals."

Our Backyard Biosphere Reserve, a teacher's manual, is being used to develop an environmental education curriculum in public schools in Sevier County, TN. With assistance from SAMAB and the Alliance for Environmental Education, schools in the county are joining Econet, a satellite computer network that will allow exchange of information on EE programs with schools in California, Michigan, and elsewhere in the US. Links with European countries may become possible through the OECD (Organization of Economic Cooperation and Development).

Big Bend BR sees great potential for applying MAB/BR concepts both in association with the other two Chihuahuan Desert BRs and in the immediate Big Bend region. Managers from Big Bend, the Jornada Experimental Range in New Mexico, and Mapimi BR in Mexico met at Mapimi in February to discuss mutual interests and possible projects. After a meeting at Jornada next November they expect to produce concrete proposals.

Already, however, evaluation of proposed restoration of the endangered Bolson tortoise to Big Bend is underway. This large (up to 45 pounds) tortoise ranged much more widely during the Pleistocene but now is restricted to the Mapimi region of Mexico. It is speculated that aboriginal man hastened its demise over much of the original range, and capture for food has continued to decimate the population in Mexico. Suitable habitat in Big Bend has been identified and enough captive animals apparently exist in Arizona and Mexico to provide stock without depleting the wild population. The main issues remaining are to alleviate Big Bend area ranchers' concerns about burrowing and grass-eating by the tortoises, and approval by various Mexican and US agencies.

Phil Koepf, chief ranger at Big Bend, says he is excited by the possibilities of working with park neighbors to develop a BR approach to many other environmental issues. Nearby are a Texas wildlife management area of 100,000 acres and a state natural area that will reach 300,000 acres, besides some ranchers who are "ardent conservationists." Across the Rio Grande, Mexico contemplates creating a large national park or biosphere reserve. The land base and human attitudes seem favorable for cooperation.

At MAB/UNESCO in Paris, Jan. 23-26, 12 scientists from the USSR, China, Czechoslovakia, UK, USA, France, West Germany, and Canada discussed ways of setting up an *international network of sites* in BRs to study global change. They recommended selecting 20 to 40 BRs and initiating pilot projects to test the abilities of the network to conduct scientific research. Ray Herrmann, NPS; Caroline Bledsoe, National Science Foundation; Guillermo Mann, Conservation International; and Paul Rissler, University of New Mexico, represented the US.

The *international biosphere reserve brochure* has been reprinted with an updated list of reserves. Copies may be had from the GPO Bookstore, 941 N. Capitol St., NE, Washington, DC 20401; (202) 783-3238. Stock No. 044-000-07277-0, \$3 each. No bulk rate is available, but the MAB Secretariat hopes this can be arranged if orders show enough demand.

Dated March 20, 1990, a *status report on biosphere reserve programs* in each of the 24 biogeographical provinces and 12 coastal regions represented in the US is available from David Figlio, NPS Wildlife and Vegetation Division, PO Box 37127, Washington, DC 20013-7127; (202) 343-8135 or FTS 343-8135.

Napier Shelton, Washington Office. NPS

Microbiotic Crusts: (Continued from page 3)

indirectly through domesticated grazing animals or pollutants. The cyanobacterial fibers that confer such tensile strength to these crusts are no match for the compressional stress placed on them by footprints (cows or people) or by machinery, especially when the fibers are dry, and therefore brittle. Air pollutants, both from urban areas and from coal-fired power plants, significantly affect the physiological functioning of these crusts.

Human Needs Pose Threat

The arid West, where the crusts play such a critical role, is facing expanding human presence. With that comes ever-increasing pressure to provide energy resources (such as coal, and oil shale), to provide locations for energy production (such as coal- and oil-fired power plants), and to provide locations for waste disposal (whether incinerators or landfills). These activities can be devastating to the microbiotic crusts, which are, in essence, the topsoil of most of the West. No research has been done on recovery rates of crusts after physiological disturbances by pollutants and so this remains unknown.

There is information on recovery from mechanical disturbances, of which there are two types: trampling, like that from hoof or foot traffic, that breaks up the crust but leaves pieces in place that may re-establish themselves; and total removal, as in road construction.

Recovery from trampling depends on the extent of trampling and the time of year it occurs. When they are dry, crusts are very brittle and easily broken up: the problem is not that anything is killed, but that the impacted area is destabilized. Fiber connections are broken, both in sheaths containing living filaments and in those that are abandoned. For living filaments, repair and re-stabilization is possible only when moisture is present, so that if impacts occur just before or during dry times (of which there are plenty in the desert), re-establishment can be difficult.

Large Disturbances Hurt Most

All this is exacerbated when large areas are destabilized, as with grazing or wildfires, or when destabilization occurs as a continuous strip, such as

vehicular or bicycle tracks. These situations leave areas highly susceptible to wind and water erosion. Wind not only blows pieces of the pulverized crust away, thereby preventing reattachment of pieces, but it also blows around the underlying loose soil, covering nearby crusts. Overland water flows carry loose material as well. Since crustal organisms need to photosynthesize, burial can mean death.

When large sandy areas are impacted in dry periods, previously stable areas can become a series of moving sand dunes in a matter of only a few years. Continuous strips, e.g. those left by bicycles and motor vehicles, are highly susceptible to water erosion and channels form quickly, especially on slopes. These areas may never recover fully.

In situations where crusts have been removed, re-establishment is very slow and depends on the size of the disturbance. In sandy areas, under the best of circumstances and where the disturbance areas are small, a thin veneer - 2-4 mm thick - consisting of one or two species of cyanobacteria, may return in five to seven years. This compares to an undisturbed crust 50-100 mm or more thick, that may consist of 14-15 species of cyanobacteria, along with lichens, green algae, and other organisms. It is not known how resistant this thin layer is to erosion, especially those tremendous overland water flows that can occur in the desert. Damage to abandoned sheath material beneath the surface cannot be repaired but must be rebuilt slowly through years of cyanobacterial growth.

Artificial inoculation can significantly increase recovery rates, and should be an integral part of recovery plans for these areas.

Impacts on crusts occur in all arid land parks. Crusts in some parks are affected directly by livestock grazing allowed in those parks. All parks are affected by people, foot traffic, and various types of construction. Most parks, if not currently threatened by air pollution problems, could be in the near future. It poses a real challenge for managers of these parks to find ways to protect these crusts, given the host of factors that affect them and the important contributions they make.

Belpap is a Biologist with Canyonlands NP.

Renewable Gravel Sources for Road Maintenance in Denali NP&P

By Kenneth F. Karle

A 90 mile gravel road forms the main transportation corridor into Denali National Park and Preserve (DNA). Decisions by previous park managers not to pave this road were based on a desire to maintain a 'wilderness' quality to the road system. Also, it was felt that asphalt pavement might act as a hindrance to migrating wildlife within the park. As such, the gravel roadbed requires long-term material sources for annual maintenance and resurfacing. NPS requirements for in-park material sites impose special constraints upon managers considering source development. Perhaps the most important of these is that the site and method of excavation operations should lend themselves to as close a return to a natural condition as possible.

In response to the constraints of these criteria, the NPS has determined that alluvial floodplain sites will help meet the needs of replenishable gravel production in Denali NP&P. Because of its size, central location, and acceptable material quality, the Toklat River floodplain has been chosen by park engineers as a primary alluvial gravel removal site. However, numerous questions remain as to the quantities of gravel that may be mined without causing floodplain degradation, as well as to which removal methods will best promote a natural floodplain rehabilitation.

A research program was initiated in 1988 to provide a detailed and comprehensive analysis of the fluvial processes that occur near and in an alluvial floodplain gravel removal site. The determination of a safe yield for gravel removal and the proper placement of removal sites on the Toklat River floodplain required a two-fold approach.

Computer modeling was employed to note the effect of annual floods on various excavation configurations. A predictive computer sediment transport code was used for the modeling effort. With such a code, floodplain gravel removal sites may be modeled by altering river bed geometry, and noting replenishment in the form of surface elevation changes after the passage of a flood. In this manner, scrapes or pits for gravel removal may be designed for optimum size and location in order to assure a maximum replenishment rate.

The second approach method used in the study was analysis of experimental gravel pits excavated on the Toklat floodplain during the 1988 and 1989 summers. Three gravel removal sites, each significantly different in design, were analyzed for both qualitative and quantitative information regarding replenishment and site rehabilitation. The first two scrapes involved excavations placed longitudinally and laterally (respectively) to the direction of flow on the floodplain. Both scrapes eventually incurred natural replenishment and rehabilitation over a two year period. However, the third design tested offered much quicker rehabilitation results, and merits further investigation by park managers. A brief explanation of this scrape design follows.

Floodplain Gravel Excavations

The Toklat River is a 100 mi² watershed located on the northern side of the Alaska Range. The basin is extremely mountainous, with several peaks over 7000 feet high. In addition to snowmelt and rainfall, the Toklat is fed by glaciers, which cover two percent of the basin

area. The river is extremely braided in nature, and is usually milky in color, due to the large amount of glacial silt in the water.

The third Toklat River test scrape, designed with the assistance of William Jackson, NPS Water Resources Division, was excavated on June 6 and 7, 1989. The idea behind this design was to try to mimic the braiding processes that occur on the gravel bed drainage course. To accomplish this, a main channel with substantial water flow was identified and surveyed. The excavated scrape was placed so that it mirrored a significant meander in the main channel. The scrape, in the form of a channel, matched in length, width, depth, and slope the channel it mirrored. Approximate dimensions of the excavated channel included an average width of 25 feet, depths of 2-3 feet, and a length of 430 feet, which resulted from the excavation of 1000 cubic yards of gravel. This excavated channel was connected both downstream and upstream to the existing channel, which allowed immediate inundation to occur. The design was implemented to provide an equal flow split between the existing and excavated channels. Upon completion, the designed channel pattern was essentially indistinguishable from natural channel patterns. To monitor this scrape, six cross-sections were located along the test area, and level surveys were used to keep track of elevation changes in the original and excavated channels. These cross-sections were surveyed June 5 and 6 (time of excavation), July 15, and Sept. 12, 1989.

Aesthetic healing of the excavated scrape was observed to begin almost immediately following streamflow inundation. Even at relatively low flow conditions, scour and deposition of streambed materials was significant enough to erase most signs of heavy

equipment operations in and near the excavated channel within a two-week period. By the end of the first four weeks, casual observers unfamiliar with the project could not identify the test channel as a human-engineered excavation.

Though significant aesthetic healing processes occurred soon after excavation, substantial gravel deposition and replenishment did not occur until much later in the summer. This may be attributed to significantly larger streamflows on the west side of the Toklat drainage course, which took place from the beginning of August through the middle of September.

By Sept. 12, topography changes in the drainage course were so substantial that the excavated channel was completely obliterated. From the surveys, it is roughly estimated that at least 77 percent of the removed gravel in the excavation was replenished.

Conclusions

Based on the study results, it would appear that extraction design based on mimicking natural channels on a braided drainage course will encourage rapid healing and gravel replenishment. It should be noted that terms such as 'healing' and even 'replenishment' are difficult to quantify, and that estimates of replenished gravel (such as 77%) should be used with caution, and perhaps only in terms of general trends.

Additional hydrologic studies of the Toklat basin are continuing. A complete analysis, based on both empirical observations and mathematical modeling, should allow NPS planners to formulate a practical, yet conservative, gravel extraction management plan to meet park needs while vigorously protecting park resources and promoting rapid site rehabilitation.

Karle is a Physical Science Technician at Denali NP.



The Toklat River study site, looking upstream (South).

Spotted Owls in National Parks:

By Douglas B. Houston

The northern spotted owl (*Strix occidentalis caurina*) occupies forests from southern British Columbia to Marin Co. California. Management of this handsome, demure appearing, creature has been a contentious issue in the Pacific Northwest. The bird inhabits coniferous forests that exhibit a particular structure, notably: multilayered, multispecies canopies dominated by large overstory trees showing moderate to high canopy closure; a high incidence of large trees with cavities, broken tops and other signs of "decadence"; numerous large snags, and heavy accumulations of logs. These conditions are most commonly, but not exclusively, associated with "old-growth" forests – and therein lies the rub.

Old forests are being harvested very rapidly, thereby eliminating large areas of suitable owl habitat and leaving much of the remainder as fragmented, isolated stands. Spectacular legal battles have been waged recently among environmental groups, federal land management agencies, and timber interests over how much owl habitat should be maintained on public lands. These owl wars led to the establishment, in 1989, of an Interagency Scientific Committee¹ to address the conservation of the bird. The Committee, headed by USFS Biologist Jack W. Thomas, was charged with developing "... a scientifically credible conservation strategy" for the owl.

I represented the National Park Service at the deliberations of the committee² from October 1989 until April 1990, when the strategy was made public³. These activities represented the most intensive, group scientific effort I have ever been involved with. The team of 17 biologists worked for 6 months to muster all relevant information on the biology of the owl, and then applied this knowledge to produce an on-the-ground, map-based, conservation plan.

The purpose of this note is to outline the process used by the team in deriving the conservation strategy (because it may serve as a blueprint elsewhere), to discuss the impact of the plan on park management, and to offer some observations on the relative quality of NPS baseline data.

Sideboards and Processes

The committee adopted certain operating sideboards, four of which are relevant here⁴:

1. A successful strategy will be rooted in the philosophy embodied in the National Forest Management Act which requires Forests to maintain viable populations of native species that are well distributed.
2. All land ownerships will be considered in the conservation strategy.
3. "Hands on" management of habitats and animals will be considered, i.e., transplanting owls, modifying silvicultural prescriptions, etc.
4. Although the spotted owl issue is, to some degree, a surrogate for the old-growth forest issue, i.e., how much old-growth shall be preserved, where, and in what form – we will focus strictly on questions of spotted owl population viability across its occupied range.

The process by which the team obtained, examined, and interpreted information was completely open. Anyone with information was welcome to address the group, to participate in discussions, etc. The open-door policy lasted until the team began to prepare the final report, the last month of the 6 month process. Moreover, much of the report consists of appendices that should allow anyone to track the logic and steps which led the team to their conclusions. Finally, a draft was

submitted for peer review by scientists selected by the presidents of five professional societies⁵.

The procedures followed in designing the strategy are noteworthy. All relevant literature on the owl was acquired, reviewed, and synthesized. Virtually everyone conducting research or monitoring the status of owls made presentations and supplied data. Owl habitats across 3 states were examined during field trips. The committee also sponsored three workshops: 1) Field biologists experienced with owl biology appraised several proposed conservation strategies based upon their knowledge of landscapes and owls; 2) Silviculturalists and forest ecologists explored silvicultural alternatives to enhance owl habitat in managed forests; 3) Conservation biologists and landscape ecologists critiqued the evolving strategy for owls in light of their experience and knowledge of applicable theory. The team also evaluated the current quality and consistency of management by interviewing field personnel on National Forests and BLM Districts.

Synthesis of the information led the team to conclude that a conservation strategy was indeed warranted: the bird was imperiled over significant portions of its range⁶. The committee proposed a two-part strategy. In the first stage, steps were taken to ensure that adequate amounts of habitat were protected and well distributed to provide for the owl's long term survival. Large blocks of suitable habitat, *Habitat Conservation Areas* (HCAs), were proposed throughout the bird's range. The second stage calls for research and monitoring to test the adequacy of the strategy and to seek ways to produce and sustain suitable owl habitat in the managed forests (i.e., outside the HCAs). Knowledge gained in the second stage will be used to alter or replace habitat conservation plans prescribed in the first stage, but only if the modified strategy provides adequately for the owl.

The rationale for the size and spacing of HCAs drew heavily from demographic studies, modeling of owl extinction probabilities in differently arranged landscapes, and inferences from extinction rates of small populations of other birds throughout the world. HCAs capable of providing for 20 or more interacting pairs of owls spaced no more than 12 miles apart (based on studies of dispersal distances of juvenile owls) formed the basis for the strategy. Where geography, land ownership patterns, or past logging precluded large HCAs, smaller ones were to be established closer together. Dedicated corridors for owl dispersal among the HCAs were deemed unnecessary, provided forests in the intervening landscape matrix met certain structural criteria. All logging in HCAs was to cease.

Once this rule set was established, maps were drawn for Washington, Oregon, and northern California, and checked for consistency with the guidelines. Not surprisingly, "real world" landscapes often forced modification of the idealized design. At least 10 iterations of each map were necessary before tests produced the size and spatial arrangements deemed satisfactory. The committee estimated that the system of HCAs proposed for federal lands now contains about 1465 pairs of owls. As young, previously covey, forests in HCAs mature, these areas might support 1750 pairs. This brief introduction to the complex, map-based strategy is necessarily oversimplified – the report must be read to gain full understanding.

Owls in Parks

The spotted owl is known to occur in 8 NPS areas from North Cascades to Muir Woods (table 1). The bird



The Northern Spotted Owl (*Strix occidentalis caurina*)

may also occupy the Whiskeytown NRA because it is known to occur in that region of California. NPS areas may altogether contain about 570,000 acres of suitable owl habitat, but these estimates should be regarded as crude first approximations, particularly for the larger parks. The configuration and quality of habitat differ markedly among the areas. Habitat in the large, mountain parks of Washington and Oregon occurs in blocks at low elevations around the perimeters of the parks, separated by unsuitable high elevation areas in the interior. Overall, NPS areas contain roughly 7-8 percent of the existing owl habitat and may support 100 or more pairs of owls (in contrast, about 74 percent of the owl habitat occurs on National Forests). The largest single park population may occur in Olympic NP; estimated conservatively by the park staff at 40 pairs. The committee, using additional information from Landsat, estimated the Olympic population at 60-80 pairs. Other parks have populations ranging from perhaps 1 to 20 pairs.

Several things are apparent from the information in table 1. First, the NPS is a relatively minor player in the overall business of conserving the northern spotted owl. More importantly, conservation biology suggests that the numbers of owls in National Parks are too small for the species to persist over time if isolated from birds in surrounding areas because of habitat fragmentation. Considerations of physiography and size of parks in Washington and Oregon, for example, suggest that survival of the birds in these areas is closely tied to the welfare of owls on surrounding lands. Each park contains owls at the upper elevational limit of their distribution, and North Cascades and Olympic also approach the species' northern geographic-range limits. Spotted owls that exist under such biogeographic constraints may be particularly susceptible to wide fluctuations in abundance over time, with correspondingly increasing probabilities of extinction. Spotted owl populations on the Olympic Peninsula, including Olympic NP, already appear to be isolated from other populations and are thought to be especially vulnerable.

Report of the Interagency Committee

The Committee and the Parks

The committee viewed the management objectives for National Parks as generally compatible with conserving owls. They recognized the importance of maintaining ecological processes (as opposed to preserving particular biological states), and accepted single species management as generally inappropriate.

The committee showed particular concern for the welfare of NPS owls: parts of six Park Service units are within proposed HCAs (table 1). Additionally, an HCA abuts the southwest corner of Crater Lake.

What does inclusion in an HCA mean to park management, given the committee's apparent acceptance of broad NPS objectives? Overall, in my view, HCA designation will have relatively little effect on park operations. Certain activities, however, are prohibited in the management prescriptions for HCAs: 1) timber harvest, including firewood cutting and salvage of downed trees; 2) road construction, except when no feasible alternatives exist.

A fire plan is also to be prepared for each HCA, and the NPS was asked by the committee to review existing fire plans for compatibility with owl management objectives. Prescribed fire was recognized by the committee as being important in maintaining the structural diversity of some forest communities occupied by owls. Intense stand-replacement fires obviously can do bad things to owl habitat in the short term. Over the long term, in my view, maintaining mosaics of different-aged forest communities (which differ in fuel loading and susceptibility to burning) may be important in reducing probability of large, catastrophic fires⁷.

I judge that the NPS will receive considerable pressure to survey owls in parks. Monitoring the status of owls annually will be required in some HCAs as part of the adaptive management strategy. Inventory and monitoring efforts will be closely coordinated among agencies; this will require NPS to develop Geographic Information System capabilities that are compatible with those of other agencies. Parks may also receive more attention as owl research sites: Redwood NP, for example, has a unique opportunity to document the stand structure and age at which owls first recolonize second-growth redwood forests.

NPS Baseline Data

Overall, the quality of information that the NPS could bring to bear on the owl issue was relatively poor, compared to that of other federal and state agencies. This included not only data on owls, but reliable, accessible information on forest distribution and structure. (There were bright exceptions: Mount Rainier, for example, has wonderful information on forests.) The committee noted that the "...inadequacies of information on the status of the owl and its habitat in the National Parks, particularly the Olympic NP, have presented problems to us in developing the conservation strategy." In response, it might be argued that since park management is generally compatible with owls, and all parks certainly have management issues that are seemingly more pressing, there was little need heretofore to acquire such information. This granted, the counterargument still lacks bite, and underscores fundamental shortcomings. I believe, in our inventory and monitoring programs.

Implementation?

Whether or not the plan, or any part thereof, is implemented remains to be determined. Two things are certain: 1) Watching this issue play out to resolution will be

Table 1. Areas (1000s of acres), distribution, and results of spotted owl surveys on NPS lands

STATE Locality	Estimated area of owl habitat ^a	Habitat ^b distribution	Owl pairs ^c		Owl inventories ^d	HCAs ^e
			Known	Estimated		
WASHINGTON						
North Cascades	126	1	0	20	P	Y
Mt. Rainier	31	1	8	?	P	Y
Olympic	323	1	12	40	P	Y
OREGON						
Crater Lake	50	1	4	14	P	N
Oregon Caves	0.5	3	1	1	C	N
CALIFORNIA						
Redwood	20	2	0	5	U	Y
Pt. Reyes	16	2	2	4	P	Y
Muir Woods	0.5	3	1	1	C	Y
Whiskeytown	4?	?	0	?	U	N

^a Generally gross estimates subject to revision, small areas excepted.

^b 1 = Habitat around low elevation perimeter and separated into blocks by mountains or lakes in the core of the park; 2 = blocks of contiguous low elevation habitat; 3 = essentially all suitable habitat.

^c Known pairs are those located from 1985 to 1989. Estimates are habitat capability extrapolations, usually from FS or FWS Status Review Supplements.

^d P = Partial surveys with large backcountry areas still unsurveyed; C = complete surveys; and U = unsurveyed lands.

^e Y = Part of the area within one or more designated HCAs.

extremely interesting; 2) We on the team found the effort challenging and educational.

The postscript to the report offers an appropriate perspective: "We were asked to do a scientifically credible job of producing a conservation strategy for the northern spotted owl. We have done our best and are satisfied with our efforts. We have proposed. It is for others - agency administrators and elected officials and the people whom they serve - to dispose. That is the system prescribed in law. It seems to us a good one. We can live with that."

Houston is a Research Biologist with the NPS Pacific Northwest Region, based at Olympic NP.

Notes and References

1. Agencies involved were: U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, and National Park Service.
2. The six member core committee consisted of: J.W. Thomas, E.D. Forsman, B.R. Noon, and J. Verner of USFS; J.B. Lint of BLM; and E.C. Meslow of JSFWS. The overall team included: (1) a represen-

tative from each of the 3 states; (2) advisors/participants representing timber interests, environmental groups, and academia; and (3) technical staff advisors from the federal agencies. On the team were 17 biologists (12 of whom were experienced in dealing with the biology and management of the owl). All team members participated fully in all aspects of the effort, with the core committee responsible for signing the final report.

3. Thomas, J.W. et al. 1990. A conservation strategy for the northern spotted owl. Interagency committee to address the conservation of the northern spotted owl. Portland, Oregon, April, 1990. 458 pp.
4. Some of what follows is taken nearly verbatim from the committee's report, with permission from J.W. Thomas.
5. Reviewers were drawn from: American Ornithologists Union, Ecological Society of America, Society for Conservation Biology, Society of American Foresters, The Wildlife Society.
6. The decision whether or not to list the owl under provisions of the Endangered Species Act is currently being considered by a committee of USFWS biologists; this was not the responsibility of the Thomas team.
7. See for example, Romme, W.H. and D.G. Jespar. 1989. Historical perspective on the Yellowstone fires of 1988. *Bioscience* 39:695-698.

I thank Bruce Moorhead and Janis Burger for reviews of this manuscript.

Howell's Final Quote Seems So Apt Here!

An article by Judd Howell, Wildlife Ecologist with the Golden Gate NRA in San Francisco, appearing in the current issue of the George Wright Society's FORUM, deals with the natural resource values of the broader community and the roles of key individuals in opposing NPS proposals to remove the Australian Blue Gum (an alien species) from 16 locations in the Recreation Area. The paper explores the formation and mobilization of Marin County citizens into a group named POET (for Protect Our Eucalyptus Trees) and discusses a widespread public perception of federal and state agencies as "elites, with exclusive access to specific natural resource knowledge." (See Bader article, this issue).

"Knowledge shared in joint planning," Howell suggests, "can result in cooperation and in maintaining the trust in information developed by agency planning groups." One segment of Howell's final paragraph reads in part:

"... people seemed to believe that scientific knowledge sprang out of the democratic process of open debate, rather than through the exactitude of the scientific process. Too often in the public arena, scientific information was misrepresented for purposes of persuasion. (Granted that management must sometimes make decisions without all the facts,) still the facts must withstand the rigors of science. At some point in this process we must say: 'Persuade me not; before you lies the truth, bloodied but unaltered by the battle.'"

Resource Managers and the Courts: A Decision-making Process Designed to Achieve Public Confidence

By Harry R. Bader

To the overworked natural resource manager on public lands it may often seem as though courts take a special delight in crafting anxieties that would render even Dante speechless. However, courts do not actively seek to entangle their own limited resources in the highly technical and specialized field of resource management.

The judiciary usually becomes involved because an error within the decision-making process has been detected by an aggrieved interest group. With standing in hand, the group may then seize this transgression in the hope of eventually forcing a substantive result through the procedural door.

The purpose of this comment is to acquaint the natural resource manager, whether s/he be associated with NPS, USFS, BLM, or the USFWS, with some of the fundamental principles guiding judicial review of agency decisions. Armed with this knowledge, our nation's natural resource stewards can create better decision-making processes, which reduce exposure to unwanted judicial intervention.

Bureaucratic agencies, it is no revelation, are beheld with a certain degree of suspicion. Their broad grants of authority, coupled with their insulation from the traditional avenues of democratic process, create an operational milieu where discretion may be motivated by the vicissitudes of bias or favoritism toward particular special interests.

Juxtaposed with this suspicion however, is the recognition that administrative agencies have institutional strengths that demand deference. Agencies are uniquely suited to handle complex problems because of their specialized personnel and the expertise that accrues from repeated exposure to certain types of issues.

There are many kinds of agency conduct which demand various levels of judicial scrutiny to insure fairness and accuracy. The Administrative Procedure Act and the judiciary distinguish between formal and informal activities, and between decisions premised upon findings of law or fact. (5 U.S.C. pp 551-706). The majority of natural resource decisions by agency field managers consist of informal discretionary actions based upon a finding of fact taken in the regular course of their normal duties.

These are the decisions that lead to a particular forest tract being harvested or a specific access road being constructed; these are the decisions that generate alternatives in plans and impact statements, or decree whether certain conduct may harm an endangered species. Sometimes the decisions may be as simple as deciding where to place a new public access cabin or trail. Such decisions confront resource managers every week, and these same decisions serve as the basis for innumerable lawsuits, which lead to costly delays, stifled initiative, and personnel demoralization. This comment addresses these informal discretionary decisions and the proper process for generating them.

Because the Administrative Procedure Act provides only a dim beacon for guidance, the courts have crafted innovative techniques for reviewing agency conduct. The techniques are diverse and go by many names, but are often referred to collectively as "the hard look doctrine." (Sunstein, "Deregulation and the Hard Look Doctrine," 1983 S.Ct. Review 177).

In reviewing agency conduct, the goal of the judi-

ary is to establish a decision-making process that assures a reasoned decision which can stand up to public and scientific scrutiny. (Ethyl Corp. v. EPA 541 F.2d 1. 66, 1976). Therefore, a judge will overturn an agency decision only if it is arbitrary, capricious, or an abuse of discretion. (Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council 435 U.S. 519, 545-546 and 548, 1978, and Citizens to Preserve Overton Park v. Volpe 28 L.Ed 136, 153, 1971).

Because the focus is procedural, it is possible for a decision to be invalidated, no matter how scientifically correct under the circumstances. On the other hand, if a resource manager follows the demands of Hard Look doctrine, the decision will be accepted, even if the court disagrees with the substantive outcome. The only role for a court is to ensure that the agency has taken a hard look at the salient facts; it cannot interject itself within the area of discretion as to which action should be taken. (Kleppe v. Sierra Club 427 U.S. 390 at 410, 1976). For example, alternative selection from a properly prepared environmental impact statement cannot be dictated by a judge. That substantive decision resides within the scope of the agency's discretion. The judicial role rests solely upon determining whether the EIS is a full disclosure document, generated in good faith after a detailed inquiry. This type of review is purely procedural.

Judicial review is intended to build confidence in the legitimacy of government authority by insuring an honest and earnest process. Review "underlines the court's rigorous insistence on the need for articulated rationale and reflective findings rather than whim, misplaced zeal, or improper influence. (Greater Boston Television Corp. v. FCC 44 F.2d 841, 851-852, 1970).

In order to realize legitimacy, judicial review makes four principal demands. (Sunstein, "Deregulation and the Hard Look Doctrine," 1983 S.Ct. Review 177, 181-182). Agencies must (1) offer detailed explanations for their decisions, (2) justify any departures from past decisions under similar circumstances, (3) consider a set of alternatives before making decisions, and (4) involve the public whose interests are affected wherever appropriate.

The following checklist, addressing concerns in the first three components, is derived from various requirements articulated from 23 federal cases, most involving natural resource issues.* The 12 elements contained here should be considered as essential steps for a legitimate decision building process and adhered to in every decision regarding resource management, whether or not one expects controversy. All 12 elements focus upon the concept of full disclosure and reasoned inquiry as a means to facilitate public understanding and acceptance of agency logic and considerations.

Checklist for Decision-Makers

1. The goals and objectives to be achieved by the decision must first be identified.
2. The agency's general policy mandates, prior decisions, and predispositions, as they relate to the matter at hand, must be explained.
3. The facts that are considered in resolving the problem, and why they are relevant to the problem, must be expressed.
4. The criteria used for decision-making and their relative weights must be articulated and justified.
5. Analysis techniques and methods must be explained.

6. All pertinent assumptions and areas of uncertainty (or where information is incomplete) must be disclosed.

7. The agency must articulate a rational connection between the facts found and the choice made.

8. The decision-maker must demonstrate that the choice selected will achieve the goals and objectives previously stipulated (Efficacy).

9. The decision-maker must show that the choice selected is the best possible solution available from a set of viable options (Supremacy).

10. The agency must demonstrate, when competing user groups are involved, that it has made a good faith effort to distribute equitably the benefits and burdens accruing from its decision.

11. The solution must encompass an internal system of self evaluation and review so that the decision can be modified as circumstances dictate.

12. If the decision marks a change from prior agency conduct in similar situations, a reasoned analysis indicating what factors brought about the change, and why, must be provided.

The 12 elements that comprise this checklist facilitate legitimacy concerns because the elements tend to (1) eliminate ambiguity and vagueness, inconsistency, and the cursory statements that can mask favoritism and bias, and (2) reinforce a good faith effort to ascertain truth, achieve accuracy, and find the most effective answer to a problem. Legitimacy concerns are extremely important because decisions that affect resource allocations such as timber, water, wildlife, minerals, open space, and recreation management go straight to the heart of "personhood values."

"Personhood" Values

Human beings are cognizing and goal-directed organisms. Attempts at needs satisfaction involve the ordering of one's own personal environment in an effort to maximize creative options and freedom of choice. These options and choices create the opportunities for self-development (personhood). To achieve this goal, an individual needs some control over personal activities-- the assurance that environmental conditions are stable enough to allow a person to make plans, investments, and commitments. In short, people must be able to rely on the assumption that society and government will respect these expectations.

A chosen lifestyle can provide a unique sense of personal fulfillment. Offer a farmer, a miner, a fisherman or a lumberjack work on an assembly line for a higher wage and many would reject the offer. Opportunities for recreation, such as hiking, camping, and wildlife viewing, also are essential to the human soul and contribute to the creation of individual identity.

Thus, expectations based upon personhood values give rise to a moral claim stronger than other expectations. A resource management decision that tends to trample upon personhood expectations must be especially carefully arrived at. Any perception that such decisions are cavalierly made, carelessly reasoned, or subject to favoritism and bias, calls into question the legitimacy of government authority. When an agency frustrates personhood values, the process that developed the course of action in question must be beyond reproach--open, broad-searching, rational, and consistent. Nothing less must be tolerated; the social stakes are too great.

Continued on page 9

Global Issues, Natural Areas

A global issues symposium, "Natural Areas and Yosemite: Prospects for the Future," is scheduled for Oct. 13-19, 1990 at Yosemite NP (Oct. 13-14) and at the Sheraton Conference Center in Concord, CA (Oct. 15-19) as a highlight of the Yosemite Centennial Celebration.

Sponsored by Yosemite NP and the Natural Areas Association in cooperation with the Yosemite Fund, the gathering will look backwards to the establishment of Yosemite NP in 1890 and ahead to the future of parks and natural areas in the year 2090. Resource managers, scientists, agency administrators, students, conservationists, all will find opportunities to learn and to contribute at the gathering.

Six plenary sessions will feature speakers from government, academia, national and international conservation organizations. The final keynote address, by Gilbert Grosvenor, president of the National Geographic Society, will be broadcast on National Public Radio. Field trips will take participants to San Francisco Bay Area natural areas such as Muir Woods, UC Botanic Gardens, Angel Island, Ring Mountain, Point Reyes, Grizzly Island, and other such areas.

Contact Coordinator, NA: Yosemite Centennial Symposium, Golden Gate NRA, Fort Mason Bldg. 201, San Francisco, CA 94123.

Biodiversity Training Course

"Managing for Biological Diversity" is the title of an NPS training course to be held in San Francisco Sept. 10-14, 1990. Course designer and coordinator Dick Cunningham, of the NPS Western Regional office, is targeting the course at park managers, scientists, resource managers, and interpreters.

Managers and Courts

(Continued from page 8)

Because of the high social costs involved in frustrated public expectations, courts review agency decisions to insure that agencies conduct themselves professionally, fairly, and with impeccable integrity. The checklist contained in this comment may lead to better decisions, which pre-empt the opportunity for judicial review. It is designed to win acceptance and respect from those whom resource decisions impact.

"When administrators provide a framework for principled decision-making, the result will be to diminish the importance of judicial review by enhancing the integrity of the process..."

Ethyl Corp. v. EPA
541 F. 2d 1. 67 (1976).

Bader is a Professor of Environmental Law at U/AK, Fairbanks, and a member of the Sea Grant legal team.

*National Audubon Soc. v. Hester 801 F.2d 405 and 627 F.Supp. 1419 (1986); Sierra Club v. Clark 755 F.2d 608 (1985); Friends of Endangered Species v. Jantzen 760 F.2d 976 (1985); Village of False Pass v. Clark 733 F.2d 605 (1984); Sierra Club v. Clark 577 F. Supp. 783 (1984); Baltimore Gas & Electric v. NRDC 462 U.S. 87 (1983); Motor Vehicle Mfr. Assoc. v. State Farm Mutual 103 S. Ct. 2856 (1983); Humane Society v. Watt 551 F. Supp. 710 (1982); Cabinet Mts. Wilderness v. Peterson 685 F. 2d 678 (1982); Cayman Turtle Farm v. Andrus 478 F. Supp. 125 (1979); Vermont Yankee Nuclear Power Corp. v. NRDC 435 U.S. 519 (1978); Connor v. Andrus 453 F. Supp. 1037 (1978); Palila v. Hawaii Dept. of Land and Natural Resources 471 F. Supp. 985 (1979); Environmental Defense Fund v. B um 458 F. Supp. 650 (1978); Local 777 of the Democratic Union v. NLRB 603 F.2d 862 (1978); Defenders of Wildlife v. Andrus 428 F.Supp. 167 (1977); Ethyl Corp. v. EPA 541 F. 2d 1 (1976); U.S. v. A. Iegheny-Ludlun Steel 406 U.S. 742 (1972); Environmental Defense Fund v. Ruckelshaus 439 F. 2d 584 (1971); Citizens to Preserve Overton Park v. Volpe 28 L Ed. 2d 136 (1971); Greater Boston Television Corp. v. FCC 444 F. 2d 841 (1970).

meetings of interest

1990

Sept. 10-14, MANAGING FOR BIOLOGICAL DIVERSITY, a training course for NPS research scientists, resource managers and interpreters, in San Francisco. Contact: Dick Cunningham, NPS Western Reg. Office. (415) 556-3184.

Sept. 13-15, FORT UNION FUR TRADE SYMPOSIUM, a day of historic review and presentations of the Fort's reconstruction, with a historic tour of the confluence area; sponsored by Friends of Fort Union Trading Post. Contact: Fort Union Trading Post National Historic Site, Buford Route, Williston, ND 58801. (701) 572-9083.

Oct. 3-5, ECOLOGY AND PLANNING: THE LANDSCAPE DIMENSION, at the Red Lion Inn, Sacramento, CA (second of a series - see p. ??). Sponsored by U/Cal/Davis Extension, featuring fundamentals and techniques of landscape ecology and case study applications to specific land use problems. Contact: Dana Abell, Univ. Extension, U/Cal Davis, 95616.

Oct. 13-19, NATURAL AREAS/YOSEMITE CENTENNIAL SYMPOSIUM, at Yosemite NP and the San Francisco Bay area; jointly sponsored by the Park and the Natural Areas Assn., "Natural Areas and Yosemite: Prospects for the Future;" contact: Coordinator, Natural Areas/Yosemite Symposium, GGNRA, Fort Mason Bldg., #201, San Francisco, CA 94123; (415) 556-1009; FAX (415) 556-1399.

Nov. 12-17, SIXTH CONFERENCE ON RESEARCH IN THE NATIONAL PARKS AND EQUIVALENT RESERVES, at the Westin Paso del Norte Hotel, El Paso, TX; Contact: Conference Committee at (415) 556-1866.

Nov. 27-29, NEW PERSPECTIVES FOR WATERSHED MANAGEMENT; Balancing Long-Term Sustainability With Cumulative Environmental Change, sponsored by U/WA Center for Streamside Studies and OR/St/U Col. of Forestry, at U/WA, Seattle. Contact: Continuing Education, Coll. of Forest Resources, AR-10, U/WA, Seattle, WA 98195 (206) 543-0867.

1991

May 19-23, THIRD ANNUAL SOCIETY FOR ECOLOGICAL RESTORATION CONFERENCE, in Orlando, FL. Contact SER, 1207 Seminole Highway, Madison, WI 53711; (608) 262-9547.

Nov. 4-8, THIRD GLOBAL CONGRESS OF HERITAGE INTERPRETATION INTERNATIONAL, in Honolulu, to explore how effective interpretation can help protect natural and cultural heritage while providing meaningful and memorable experiences for residents and visitors. Contact: Gabriel Cherem, EMU Geography & Biology, Ypsilanti, MI 48197; (313) 487-0218, or Ray Tabata, UH Sea Grant, (808) 948-3191.

Tourism Is Conference Theme

"Joining Hands for Quality Tourism: Interpretation, Preservation, and the Travel Industry" is the theme for the Third Global Congress of Heritage Interpretation International, to be held Nov. 4-8, 1991, in Honolulu, HI. Proposed topics should fall into one of the six Congress subthemes of: preserving environments and cultures; guided travel experiences; interpreting across cultures; interpreting communities; applying appropriate techniques; and building partnerships.

More information and program announcements are available from Dr.Gabe Cherem or Ray Tabata, Conference Chair, UH Sea Grant, 1000 Pope Rd., MSB 226, Honolulu, HI 96822 USA, (808) 948-8191; FAX (808) 955-6950.

Landscape Ecology and Planning

"Ecology and Planning: The Landscape Dimension" is the second conference in the series Ecology and Planning offered by U/Cal Davis's University Extension Service. It will be held Oct. 3-5, 1990 at the Red Lion Inn in Sacramento.

The conference will cover fundamentals and techniques of landscape ecology, especially as they apply to forest management, regional planning, resource management, and land restoration. It should be especially helpful to those who seek to bring ecology into the decision-making process on the use of land and resources. Contact is Susan Berman at (916) 757-8777.

Watershed Management Perspectives

The University of Washington's Center for Streamside Studies, together with Oregon State University's College of Forestry, will co-sponsor a symposium, "New Perspectives for Watershed Management: Balancing Long-Term Sustainability with Cumulative Environmental Change," on the U/WA campus in Seattle November 27-29, 1990. The underlying theme is the linking of environmental integrity to watershed management and human needs. Symposium objectives are to:

- present the current status of watershed research and regional models;
- identify indicators of environmental changes at different scales;
- investigate new technical tools and system models; and

- explore how to relate the tools to management and human needs.

Posters are solicited for topics related to research and management activities of watershed management, including range utilization, urbanization, old growth harvest, maintenance of biodiversity, and long-term productivity of agricultural and forested lands. Submit two copies of a 200-word abstract by Sept. 1, 1990, to George Ice, Technical Poster Coordinator, NCASI, PO Box 458, Corvallis, OR 97339.

Contact, Continuing Education, College of Forest Resources, AR-10, U/WA, Seattle, WA 98195 (206) 543-0867.

Does Global Change Evidence Signal Biological Catastrophe?

Editor's Note: A battery of world class scientists addressed a two day conference at UCA/Davis recently, evoking the following report from Tom Stohlgren, Ecologist with the NPS/CPSU at UCA/Davis.

On April 30 and May 1, I heard world renowned experts address two major questions: (1) What is the evidence for global change?, and (2) How is life on earth responding to global change? Because their comments are pertinent to the proposed NPS Global Change Program, I have summarized them briefly.

Dr. Paul J. Crutzen, atmospheric chemist and Executive Director of the Max Planck Institute for Chemistry, West Germany, displayed convincing evidence of recent changes in the planet's atmosphere. He estimates a doubling of tropospheric ozone in the Northern Hemisphere in the past century. Debate, he said, should no longer focus on whether global temperatures will rapidly change, but on what combination of interactions (e.g. increased penetration of ultraviolet radiation, with increased CO₂, with changes in precipitation, etc.) will impact the earth's inhabitants. He stressed that CFCs (chlorofluorocarbons) released into the atmosphere today may not reach an equilibrium state for more than a century. Although we may internationally reduce CFC production by 50 percent, a reduction of at least 80 percent may be necessary to reduce the rate of further atmosphere degradation to the current rate of degradation.

Dr. Michael I. Budyko of the State Hydrological Institute, Leningrad, USSR, spoke for international cooperation to detect and predict climate change impacts. He showed that empirical data from many areas must be

synthesized to detect trends. He also suggested that the strengths (i.e. computer modeling by US scientists, empirical data gathering by USSR scientists) could be maximized by sharing technique developments and data.

Dr. Paul E. Waggoner from the Connecticut Agricultural Experiment Station in New Haven, emphasized the potential impacts of global climate change to California. Californians consume one quarter of the annual fresh water produced in the continental US. He claimed over 90 percent goes to agriculture. Even slight reductions in precipitation amount could reduce groundwater storage, decrease water use efficiency by plants, and increase salinization of cropland soils. His talk helped me focus on the role many national parks play as primary watersheds for agricultural districts downstream.

Dr. Vernon H. Heywood of the IUCN - the World Conservation Union - United Kingdom, suggested we focus more effort on protecting species diversity, particularly plant species. He showed how alien plant species invasions are drastically changing local habitats and microclimates. Together, these invasions are profoundly affecting our efforts to preserve the biological diversity present only two centuries ago. Dr. Heywood suggested increasing our efforts to protect genetic diversity as well - focusing on small, isolated plant populations all over the globe.

Dr. Daniel Simberloff of Florida State University, drew upon the fable of the elephant (in this case, habitat fragmentation) and the flea (climate change). He asked whether, if the elephant kills a person, does it really matter if the flea also bites said person? He cited forest destruc-

tion in the past 200 years. Over 40 percent of wet tropical rain forests are gone, the rest is being cut at a rate of 1 percent a year. Old growth forests in the Pacific Northwest once covered 19 million acres; now they occupy only 2.5 to 3.8 million acres, primarily on USFS lands in Oregon, and are being cut at 2.5 percent per year - a faster rate than tropical forests.

In another US example, southeastern long leaf pine, which covered 70 million acres 300 years ago, has been systematically reduced to only 1,500 acres; thus, it was cut at about 5 percent per year. Along with forest destruction and habitat fragmentation comes the loss of biological diversity and landscapes that may never recover due to invasion of alien species, urban development, etc. Dr. Simberloff stressed the need to inventory resources and assess the possible impacts to all remaining fragments (small parks and large?) in light of continued habitat fragmentation compounded by climate change stresses.

Dr. William C. Clark from Harvard's John F. Kennedy School of Government spoke on "Managing Global Climate Change." He noted that in the past 100 years, the human population increased 300 percent and that agricultural productivity and energy production were up 500 and 2,500 percent respectively for that same period. Forest cover, however, decreased 15 percent, atmospheric CO₂ and CH₄ increased 100 percent each, and the flux of zinc and lead increased 300 and 1,800 percent respectively. Dr. Clark added that more than 70,000 new synthetic chemicals in use today were virtually unknown 100 years ago.

Continued on page 11

Global Change Sites Selected

On Feb. 27, 1990, the Director announced the National Park Service's Global Change program. This announcement included a call for park-based bioregional areas to submit statements of capabilities and research interest for inclusion as core areas in the program. To evaluate the Capabilities and Interest Statements of the 27 potential core research areas that submitted proposals, the NPS convened a workshop in New Orleans, the week of May 14. At the workshop, representatives for the candidate areas presented their areas' capabilities and research interests to the NPS Global Change Program Committee (GCPC), established by the Associate Director for Natural Resources in April, and to a group of outside reviewers representing major fields of global change science.

The NPS GCPC and the outside experts evaluated the written proposals and oral presentations with respect to the following criteria:

1) Potential resource sensitivity to global change; 2) Availability of relevant basic data; 3) Scope of the existing science program; 4) Support capability; 5) Existence of scientific, management, and educational linkages; and 6) Relevance of proposed scope of work to both Committee on Earth Sciences (CES) priorities and objectives and NPS mission.

For each core research area, one FTE and base funding of \$60,000 for operational support of a long-term global change research program will be provided shortly following the enactment of FY 1991 Congressional appropriations. Each core area will be eligible to

compete on a Servicewide basis for additional global change program funds for research projects.

The GCPC recommended that NPS consolidate its focused FY 1991 Global Change Research Program in six subject areas:

- Monitoring of Potentially Sensitive Species and Ecological Communities
- Research on Potentially Sensitive Species and Ecological Communities
- Ecological Research in Small Watersheds
- Resource Ethnography
- Interdisciplinary Studies of Historical and Prehistorical Ecosystem Change
- Dynamics of Coastal Systems

The first five areas comprise a single program, "Integrated Studies of National Park Ecosystems." The program will encourage research of species, community, and landscape levels to develop a predictive understanding of the effects of global change on the ecosystems represented in NPS units and their surrounding ecological regions. The sixth area of study focuses on potential changes in the dynamics of coastal processes in response to sea level rise and the frequency and intensity of coastal storms. This thematic program builds upon the long history of NPS research on coastal barriers and other coastal areas to improve our capability to predict the effects of global change.

Each of 11 core research areas will prepare, by Sept. 1, 1990, a Global Change Operations and Conceptual Research Plan, identifying staffing, funding, logistic, and other operational requirements for the core area's

long-term global change research program. This plan also will describe proposed research concepts in greater detail. The GCPC will review these plans at its next meeting in mid-October, and will recommend proposed research concepts to be developed as full proposals. The allocation of program funds is expected to be complete by May 1, 1991.

In addition to the core area programs, NPS will develop global change research initiatives based on several cross-cutting "themes." An initiative to study the dynamics of coastal barrier systems will be developed, and a symposium held. Other themes to be studied include assessing opportunities for NPS participation in research on glaciers, and the potential impacts of global change on urban national parks, with a focus on understanding the climate change effects on horticultural plants.

As a result of the New Orleans workshop, the GCPC recommended 11 research areas to the Associate Director (AD) for Natural Resources as core sites for FY 1991. Based on this review and recommendation, the AD has identified these 11 core research areas, in no priority order, for inclusion in the FY 1991 Global Change Research program: Colorado Rockies, Florida Keys, Glacier NP Area, Great Basin, Northwest Alaska, Olympic Peninsula, Ozark Highlands, Sonoran Desert, Southern Blue Ridge, Southern and Central Sierra Nevada, and Western Lake Forest.

The Fall issue of *Park Science* will include a tear-out supplement concerning the global change program.

GIS Thesis Provides Insights

Editor's Note: As part of the requirements for his Master's Degree in Landscape Architecture from the University of Washington, Dirk Wascher studied the role and function of GIS technology in NPS natural resource management. Harvey Fleet of the NPS Geographic Information Systems Division reviewed the thesis and culled the following highlights:

The study's objectives were to discover technical and institutional issues regarding implementation of GIS in the NPS and to learn about NPS expectations of GIS use and Park Service philosophy, thinking, and attitude toward use of the technology. To obtain data on these topics, 21 NPS units were interviewed by telephone in April of 1989. The findings were:

(1) The start of a system frequently is accompanied by management frustrations with its complexity. User-friendlier software, particularly for vector operations, needs to be implemented. Despite this shortcoming, overall acceptance of the hardware and software is high. (2) The largest handicap for successful GIS implementation appears to be the common lack of time to dedicate to GIS activities. Adequate staff training and funding also are frequently lacking. Suggested institutional improvements include cooperation with other agencies and the GIS Division in Denver, and improvements in communication among all NPS GIS

users. (3) GIS technology has vastly improved the capability of most parks to conduct, maintain, and manipulate resource inventories. The technology will very likely help parks move toward their short- and long-term resource management goals. (4) Half of all GIS users reported that they had discovered new management concepts and strategies while working with the technology.

The findings led to formulation of 17 recommendations that delineate vital aspects of technical devices, suggestions for proper choice of software applications, suggestions for training and cooperation, alternatives for internal organization, ways of extending communication, the significance of financial support, optimal definitions for management projects, and the future role of GIS for the research disciplines in the parks. The overall conclusion emerges that GIS technology provides significant enhancement of parks' capabilities to conduct, manage, and manipulate data inventories, which, in turn, can lead to more effective resource management. These advantages clearly outweigh any drawbacks that stem from the various technical and institutional deficiencies.

In addition to the direct technical enhancement of day-to-day traditional resource management tasks, GIS technology can induce more sophisticated and interdisciplinary resource management strategies: lead to a redefinition of the role of research and sci-

ence in the parks; and result in new approaches toward the enhancement of interagency cooperation. The NPS eventually could serve as an intriguing model for other land management agencies. The far-sighted use of the technology can be an important contribution toward overcoming the limitations of territorial jurisdictions in the management of natural resources.

If Mr. Wascher's findings have not been prophetic, they have been insightful. In the year or so since his study, the NPS is moving forward in many of the areas he identified. The technology is being accepted ever more widely as proof of its effectiveness grows. Staffing, funding, and other institutional issues, such as cooperative mechanisms and support arrangements, continue to be problematic, but proposals for dealing with them have emerged for discussion, particularly in relation to the 1992 budget. In time, I believe we will see the realization or resolution of virtually all of Mr. Wascher's findings.

The full text of Wascher's thesis, *The Role and Function of the Geographic Information System for the Management of Natural Resources in the National Park Service*, (178 pp) may be obtained from me, NPS GIS Division, PO Box 25287, Denver, CO 80225; (303) 969-2593.

Wascher received his MA in Landscape Architecture from U:WA in June 1989, and currently is working in a nature preservation agency in West Germany.

Global Change

(Continued from page 10)

The concept of sustainable development was explored as a means of managing our global environment. Simply stated, sustainable development is management of resources to meet a society's current needs (at some reasonable level of life quality) without compromising the resources of future people. Some short term environmental degradation may occur while a given society reaches that minimum standard of living before we (citizens of the richest country on earth) can expect full international cooperation in planning global environmental management strategies. In the short term, however, we can set a better example in the US, show leadership in helping other countries achieve sustainable development, and share research and technology with developing countries.

Dr. Thomas E. Lovejoy, Assistant Secretary for External Affairs of the Smithsonian Institute, chairman of the US MAB Program, and a member of both the President's Executive Committee of the International Council of Scientific Unions and the Scientific Committee on Problems of the Environment, spoke last. He summarized current international efforts to detect and predict impacts of global change on biological diversity and then discussed why such efforts seemed only a token gesture on the part of past Administrations, the scientific community, and society. Why aren't we fully controlling CFC production? Why do we purchase products packaged in excessive, non-biodegradable containers? Why is the scientific community so fearful of taking a pro-active stance on environmental issues?

Dr. Lovejoy's presentation was delivered in a humble, almost depression-laden tone. He touched upon several of the preceding speakers' topics, concluding that "we don't know very much, we're doing very little with what we do know, and it's time to get angry."

The two-day symposium ended. The crowd left the auditorium. The speakers left Davis, presumably to speak at other symposia or to go home and carry on their important work. I left feeling more informed, more inspired to champion the cause. Perhaps it was because I was starting to get angry.

SER Conference Inspires Letter

"If not us, who? And if not now, when?"

Tony Gross, Park Ranger at Sequoia and Kings Canyon NPs, included this implicit apology for his unsolicited report on the Second Annual Conference of the Society for Ecological Restoration, held April 29-May 3 in Chicago. No apology needed. Excerpts from his excellent report follow:

An Aldo Leopoldian tone was set for the conference with an informal bratwurst and beer reception at the Fermilab. There, the impact that one person can have toward restoration is embodied in the work of Dr. Robert Betz. Betz, a physicist and a restoration visionary, led a group of volunteers in restoring farmlands and construction sites. Their work continues and they hope to reintroduce the native animal component to this magnificent restored prairie.

A synergistic effect was felt as the conference took on a life of its own – a spirit of excitement and a sense of the urgency of the mission of restoration ecologists. Jacob Sigg of the California Native Plant Society urged restorationists' involvement when he addressed the President's plan to plant 100 million trees in the next 10 years. (Without such involvement, we might have eucalyptus planted in Dr. Betz's prairie, creating a biological wasteland.)

Five symposia were presented: Recovery and Restoration of Endangered Species; Prairie Restoration; The State of the Art; Restoration, Mitigation and the Sistine Ceiling Debate; Setting Standards for Monitoring in Tallgrass Prairie Restoration; Global Climate Change – the Implications for Restoration Ecology. The theories and philosophies expounded were supported with documentation and case studies. The conference participants were not only visionaries and thinkers, they were the dirt-under-the-fingernails workers of an undeclared Leopoldian Society.

A surprising group of "doers" emerged – the US

Army! Dr. Ray Hinchman of the Argonne National Lab put together an extensive program depicting the US Army's role in restoring training sites throughout the world to native vegetation.

Dr. Tom Bonnicksen's "Hi Tech" computer graphics presentation was a show stealer: a backward look in time (1987 to 1857) into a Sequoia grove at Sequoia NP. For restorationists a potentially valuable tool to describing "pristine" or any other "target-time" has emerged.

With almost evangelical fervor, soft-spoken Dr. Vine Deloria, a native American, spoke of how an effective restoration ecologist must "read the land," must "sense the spirit" of the land. Romantic notions of American Indians must give way to a close look at how they treated the land and worked with nature. Compared to European man's 500 years here, the Indian managed the land successfully for over 2,000 years. Pause to wonder!

The capstone presentation of what one individual can do was given by Dr. David Wingate of Bermuda. During his life's work of over 50 years, he and his family not only snatched the Bermuda petrel back from extinction, but restored to a "natural" state Nonesuch Island, his family's home.

SER members from all over the world participated in Chicago and will continue to encourage the grass (and trees and shrubs) to grow under their feet as they return to their own habitats with the seeds of inspiration and new techniques gleaned from this conference. Convinced that one man can indeed make a difference and that together we can leave a legacy of biodiversified natural wonders, the Restoration Ecologists reaffirmed their Partnership with Nature.

The 1991 SER Conference will be May 19-23 in Orlando, FL. Contact, SER, 1207 Seminole Highway, Madison, WI 53711; (608) 262-9547.

What is Science?

By Stephen D. Veirs, Jr.

Sometimes, we think scientists do science and other folks, including resource managers, do not. Most of us do science in informal ways all the time. The gap, if any, between resource managers and researchers shouldn't exist. Some of us have more skills than others. Some of us do more actual research than others. Some of us do research but we call it management study.

What is science? Science is an informal and formal system of discovery based upon communication, logic, rules of experimentation and so on. Scientific discoveries, new theories, and experimental results are meant to be communicated, exposed to the light of critical examination, repeated, refuted, massaged and fed back into the system. By exposing methods and results, the system builds an improved understanding of the natural world. There is no sleight of hand, no magic. There may be competition and other human vices among scientists, but also there is and has to be review and professional criticism, because science requires independent verification, not just authoritative pronouncements. The recent topic of "fusion in a test tube"² is an excellent example of how verification and criticism work in science.

The scientific method is similar to the way most of us, more or less well, comprehend our world. We observe regular events in the world around us. We test them by experience. If they hold up we come to rely upon them as facts of life. Day follows night. Summer follows winter. Water flows downhill, becomes a solid when cooled, and so on.

As we become more sophisticated or curious, we may wonder how these wonderful things happen. What rules guide the events we observe? Can we predict future events based on our knowledge? Here I want to tell you what science is, and is not. I want to give you some examples to show you what bad science or non science might be. I want you to be sure that even though you might not be a research scientist, there are things that you can do and should do in your work to make it better. I also want to tell you what science can't do for you.

First, it is essential that you know clearly what you want to understand about your resources. You must ask very specific questions of your surroundings if you want answers that will permit you to manage them. To predict future events or effects you must have a clear understanding of the relationships of facts and the laws or theories which describe the way the facts of observations are strung together.

Much of the science done in the parks from long ago to the present has been descriptive – gathering facts, making geologic maps, mapping vegetation, taking photographs. Gathering facts, making observations, is the essential first step in understanding our park resources. Assembling the observations in some sort of order is the beginning of understanding their relationships. Based upon our perception of this information we may begin to draw inferences about how the organisms, the physical setting and natural processes work to produce the landscape we see before us. Thus we begin to construct our own theories describing these relationships whether in our work or in formal scientific study.

The observations we make in everyday life as well as the more systematic observations of science reveal certain repetitions or regularities in the world. The laws

of science are nothing more than statements expressing these regularities as precisely as possible. Facts are particular events, and are distinguished from laws, which are universal statements. **Science begins with direct observations of single facts. When many observations are compared with one another, regularities may be discovered.³ These regularities are expressed by statements of theory.** Scientific theories are regularly proposed to explain observed phenomena. Before they can become accepted explanations, part of scientific knowledge, they must prove their worth. Until then they are merely hypotheses and as the history of science shows, even highly plausible hypotheses all too frequently turn out to be false. What is the method by which they are tested and found acceptable or unacceptable?

Scientific theories are tested by deducing from them consequences regarding observable states of affairs and comparing these consequences with the results of observation and experiment. Hypotheses are tested by appropriate tests that have a high probability of a positive outcome if the hypothesis is true and a high probability of a negative outcome if the hypothesis is false. A hypothesis is either accepted because it has passed an appropriate test or rejected because it has not. Statistical methods are widely employed today as a part of the procedures by which we accept or reject hypotheses. The science of statistics has developed over the last hundred years and is increasingly used in formal scientific studies.

Unhappily, it is not possible to arrive at a complete verification or confirmation of a law or theory even after much testing of hypotheses. There is, however, a simple way laws or theories can be falsified or found untrue. We need only to find a counter instance. It is, of course, important that we be sure the counter instance is certain in itself, that we have not made an error. It is easy to refute a law, but it is exceedingly hard to find strong confirmation. The theories of evolution have been tested many times over with confirming results. Is evolution proven? No, but it is the best theory we have explaining observed changes in populations of living organisms. The recent assault by creationists on the teaching of evolution in science classes was facilitated in part by the rules of science. Evolution is an accepted scientific theory, not a provable fact, but well supported by the great preponderance of biological evidence. Other theories of why things are as they are have been set forth, but these are only weakly supported by facts and their contradictions have excluded them from serious scientific consideration. Scientists accept this ambiguity as they look to refine the "theory", but creationists use scientific skepticism as an opportunity to establish their views as a co-equal "scientific theory".

In the physical sciences, the greater ease of experimental testing tends to make confirmation of theories easier, yielding "laws" as we come to know them in the classroom – the gas laws, the law of gravitational attraction, and the periodic table are examples. Those of you dealing with biological systems must realize by now that it's much harder to come by a good biological law. The term "theory" will more often be used to describe regularities of nature as pertains to living organisms and ecosystems. By now you know that a research scientist can prove a theory wrong, but can never prove it right. As a manager you should be careful about asking them to do the impossible.

Teleology is any explanation of a phenomenon that attributes purpose to a biological behavior or function

and refers to motive rather than cause. If it is said that a butterfly mimics a more aggressive organism for the purpose of protecting itself from predators, we must clarify the issue. If it is said that this mimicry is for some purpose inherent in the design of the universe, then clearly we are unable to test the explanation empirically. If we can translate the idea into a non-teleological or non-purposeful statement that deals with the evolution of a trait in relation to differential survival of the individual butterfly and the perpetuation of the species, then we may be able to sort out some tests of the explanation. Green plants will grow toward a strong source of light. Not because they "need" the light (they do) but because of biological mechanisms that we have come to understand from experiment. Cell elongation depends on chemicals produced in the stem tip. Light degrades those chemicals. The side of the stem exposed to strong light grows more slowly than the shaded side and soon the plant is growing toward the light source as all sides of the stem are evenly illuminated. You should avoid seeking "purpose" as an explanation of a natural process.

I can tell the Superintendent at Redwood something about the frequency and effects of fires in his forests. I can tell him "why" in the sense of how and when fires are ignited and spread, but not "why," in some cosmic sense, that the fires occur. Natural fires do not have a purpose. They are neither good nor bad. Their effects are just the "natural" consequences of the fire, the weather, the biological setting and so forth. Any individual may assign a value judgment to the results of a fire, depending upon his frame of reference. A forester seeking to maximize yield of sawtimber views a fire as bad. In the strict sense of managing the natural resources of a park, a naturally ignited fire in a natural ecosystem is neither good nor bad. It is just a part of the natural system.

Many of you have done or will do research, or management studies. If you do a study upon which you base some management action and it is a badly designed study, you may find your management decision reversed in court or in the courtroom of public opinion because of faulty methods, faulty interpretation of the results, poor logic, etc. You may be embarrassed. You may have wasted money. We all need to be sure what question we are asking. If we begin making predictions based on formal or informal hypotheses or theories, we may wish to test our theory by some form of test or experiment. Here are some steps to follow:

1. Carefully define the question;
2. Review what is known about the matter;
3. Consider how you will perform your experiment;
4. Write up the experimental procedure;
5. Have it reviewed by a reliable critic;
6. Revise as appropriate, and determine that you are still asking the right question;
7. Perform the experiment, accept or reject your hypothesis;
8. Assess the implications of the result for your management.

Remember that even if your hypothesis is accepted this time, it does not prove that the hypothesis is true. Your theory may fail in its next test. Or your interpretation of the results may be inappropriate. Just because there is good correlation between some observations does not mean that there is a causal relationship. Fish are always found in water. Just because we find a body of water doesn't mean we will find fish.

Is science real? Scientific realism is the position that scientific theory construction aims to give us a literally

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Rocky Mountain

Canyonlands and Arches NPs have been experiencing drought for the last two years. Data gathered through the parks' ongoing I&M program document declines in vascular plant cover and frequency (total cover, shrub cover, grass cover, and forb cover) last year, as well as a decline in small mammal populations. This year a further dramatic decline in both vegetative cover (all categories) and small mammal populations has been accompanied by a severe drop in raptor nesting success. Numbers of individuals and species of migratory birds have dropped as well.

Science in Glacier National Park, 1989 is a handsome 52-page publication, edited by Kathy Dimont of Glacier's science staff, that summarizes research projects conducted in the park. The booklet is produced by the Glacier Natural History Assn., printed by *Hungry Horse News* of Columbia Falls, MT, and is a \$4 sales item at all park visitor centers. Introductory material from Supt. Gil Lusk, Chief Scientist Cliff Martinka, Ecosystem Coordinator Brace Hayden, Chief Naturalist Cynthia Nielsen, and Bob Andrews, Chief Ranger, deals with the role of science in park management, ecosystem management, and the symbiotic relationship between science and interpretation. Martinka's contribution ("Science and the Park Management Model.") opens with this quote from Lewis Thomas:

"You either have science or you don't, and if you have it you are obliged to accept the surprising and disturbing pieces of information, even the overwhelming and upheaving ones, along with the neat and promptly useful ones. It is like that."

What Is Science?

(Continued from page 12)

true story of what the world is like. The acceptance of a theory involves the belief that it is true, even though scientific progress is attained by proving theories false and then moving on to construct another. Bas van Fraassen² makes the point that science is a biological phenomenon, an activity by one kind of organism (we humans) which facilitates its interaction with the environment. He continues, "The Darwinist says: do not ask why the mouse runs from its enemy. Species which do not cope with their natural enemies no longer exist. That is why there are only ones who do." van Fraassen³ claims that "the success of current scientific theories is no miracle. For any scientific theory is born into a life of fierce competition, a jungle red in tooth and claw. Only the successful theories survive – the ones which have *in fact* latched onto actual regularities in nature."

Veirs is Leader of the NPS Coop. Park Studies Unit at U/Cal Davis. This paper was presented at a Western Region Resource Management Workshop in 1989.

¹ Throughout this presentation I have liberally used ideas and words from a collection of papers on the *Philosophy of Science*, in the book *Scientific Knowledge – Basic Issues in the Philosophy of Science* by Janet A. Kourany, Wadsworth Publishing Company, Belmont, CA 1987.

² Pool, Robert, 1989. *Research News*, Science 243:1661-1662

³ Carnap, R. 1987. *The confirmation of laws and theories*, pp. 122-138. In Kourany, J. (see 1).

⁴ *Ibid* p. 343.

⁵ *Ibid* p. 358.

NPS and the USFWS have just released *Wolves for Yellowstone? - A Report to the U.S. Congress*. The 586-page report was produced in response to questions asked by Congress related to proposals to reintroduce wolves to Yellowstone. The report may be bought for \$16.30, postage paid, from the Yellowstone Assn., PO Box 117, Yellowstone NP, WY 82190. Executive summaries (Vol. 1, 44 pp) are available for \$4.20 from the same source. An 11-page digest, *Yellowstone Wolf Questions*, is available on request from Yellowstone NP Superintendent, PO Box 168, Yellowstone NP, WY 82190 or from USFWS, Federal Bldg., US Courthouse, 301 S. Park, PO Box 10023, Helena, MT 59626.



You mean it's a book about us? (Photo by Monty Sloan, Wolf Park)

At Devils Tower National Monument, researchers Fred Lindzey and Evelyn Merrill from U/WY will be conducting a three year study on deer movement and habitat ecology, beginning June 1990. Twenty deer will be radio collared and extensive habitat analysis of the area undertaken in response to the game-proof fence construction on private land along the west, north, and east boundaries of the park.

Increasing threats to the quality and flow characteristics of the Gunnison River are being examined by the NPS Water Resources Branch, assisted by Monument personnel. Field studies aim at data collection and quantification, with expectation that results will be considered by the court in adjudicating the Monument's decreed water rights. The outcome of these studies may have far-reaching implications for other NPS units.

NPS has been cooperating with the Colorado Division of Wildlife (CDOW) in the removal of exotic sheep and goats from Black Canyon. Mouflon, Ibex, and feral goats have been seen there in association with reintroduced Rocky Mountain Bighorn Sheep. Mouflon sheep are known to interbreed with Bighorn, and all the exotics can carry disease. To protect the health and habitat of the Bighorn herd, CDOW is conducting helicopter overflights to eliminate the exotics. Since fall 1989, 11 feral goats have been eradicated by CDOW.

CDOW is continuing Peregrine studies in the region including Black Canyon. In addition, a seasonal biological aid has been hired jointly between Curecanti NRA and Black Canyon of the Gunnison NM to provide more extensive study on Peregrine habitat within the two areas. To date, 3 Peregrines within Black Canyon have been observed. One pair has been seen defending its territory against a lone, immature female Peregrine, possibly hatched here last season. We will be looking for additional eyries this summer.

Great Smoky Mountains NP in the Southeast region has become the latest area to participate in red wolf recovery efforts. Studies have been initiated to determine habitat suitability and effects of competition with coyotes. At the same time, Superintendent Randy Pope and his staff are meeting with state agencies and local interest groups to provide information on the proposed reestablishment and allay public misgivings about once again having wolves as neighbors. If all goes well, a few wolves could be experimentally released in the Great Smokies in the spring of 1991.

Steve Cheney, Science and Resource Management Chief at Mammoth Cave NP in Kentucky, has been named Chief, Resource Management Branch, Rocky Mountain Regional Office's Division of Science and Natural Resources, beginning July 15. Prior to Mammoth Cave, he was resource management specialist at Buffalo National River in Arkansas.

Black Canyon of the Gunnison National Monument is currently addressing four areas of resource management concern: (1) water quality and water rights, (2) exotic sheep and goat impacts on Bighorn Sheep, (3) Peregrine falcon nesting activities, and (4) grazing activities and impacts.

Pacific Northwest

From John Dalle-Molle at North Cascades NP comes a two-page compendium of information about bear resistant methods of protecting food and garbage. The subjects covered are garbage containers, incinerators, food storage, and methods for warning, deterring, and aversive conditioning of bears. For more information contact Dalle-Molle at North Cascades NP, Marblemount, WA 98267; (206) 873-4590.

Dalle-Molle also put in a good word for the North American Bear Society, notice of whose new publication is contained in Information Crossfile (this issue). "They have raised considerable money to help agencies with projects such as bearproof garbage cans and providing bear information to the public," writes Dalle-Molle, who says he learned of the organization from Al LeCount, a bear biologist with AZ Fish and Game and currently president of the International Assoc. of Bear Research and Management.

"Influences of Adjacent Forest Management Activities on Migratory Elk of Mount Rainier NP" is the title of a new publication from the NPS/CPSU at OR/St/U. Authors Ed Starkey and Kurt Jenkins investigated the reasons for increased elk population in the northeastern portion of Mount Rainier NP as they related to past and future influences of forest management activities. They concluded that, although rapid liquidation of old-growth forests improved forage conditions for elk temporarily, secondary forest succession resulting from harvest has now diminished forage supplies widely and forage values are expected to decline further until regenerating second-growth Douglas-fir stands again reach harvestable age in the early 21st century. Also, they noted, elimination of mature forests used by elk during severe winters may result in elk mortality that would limit population numbers to below carrying capacity.

For copies of the 70-page report, contact the CPSU, Oregon State Univ., Peavy Hall, Corvallis, OR 97331.

Pacific Northwest (Continued)

A new center for research and educational activities associated with natural resource management systems that integrate production of commodities with protection of ecological values... this is the ambitious concept for the Olympic Natural Resources Center (ONRC), proposed by the University of Washington for the western Olympic Peninsula, with logistical support facilities that will cost about \$4 million.

In addition to assisting resource managers in designing and scientifically evaluating new management practices and providing academic and continuing education programs, the center will seek to facilitate discussions among all interest groups regarding policy trade-offs involved in particular natural resource management problems. The National Park Service will be a cooperator in this project. Cat Hawkins, Natural Resource Management Specialist at Olympic NP is serving as liaison.

North Atlantic

A three-year study to determine the population levels, distribution, and movement of white-tailed deer in and around Gettysburg National Military Park has been completed by research scientists from the School of Forest Resources and the Cooperative Fish and Wildlife Research Unit at PA/St/U. This study was undertaken because of the park's concern with damage to historic woodlands from excessive browsing, the increasing losses to area farm crops, and the high incidence of deer-vehicle collisions on local roads. Copies of the 500-page report are available only from the National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22161. A 15-page executive summary is available from Acting Supt. Deckert, Gettysburg NMP, Gettysburg, PA 17325.

Dr. Gerald Wright of the NPS/CPSU at U/ID is also developing a draft Environmental Impact Assessment for the park that will describe and evaluate alternative actions for controlling the deer population. These include live-trapping and transplanting, use of fertility-control drugs, repellents, fencing, alternating agricultural crops, and no action.

The USFWS presented its regional conservation award to Cape Cod National Seashore and Gateway NRA for their work on recovery of the piping plover (*Charadrius melodus*), a federally-listed threatened species. USFWS Regional Director Ronald Lambertson presented the awards in ceremonies at Cape Cod on Apr. 18 and at Gateway on Apr. 24, 1990.

Dr. Mary Foley has been named Regional Chief Scientist for the North Atlantic Region. Foley has worked as a forest ecologist in the Region since 1979.

The report on the white-tailed deer workshop held last year in Atlanta has been completed. Edited by Michael Soukup, Nora Mitchell, and Alan O'Connell, "White-tailed Deer in Eastern National Parks - A Management Perspective" will be published in the NPS Technical and Natural Resource Report Series and will be available in September from Donna O'Leary, Natural Resources Division, PO Box 25287, Denver, CO 80225.

Western Region

Three recent reports, obtainable from CPSU leader Denny Fenn at U/AZ, Tucson, are:

1) Rice, Carol. 1989. Live Fuel Moisture Sampling Methods for Chiricahua Ntl Mntm. CPSU Tech. Report #27. 28pp.

2) Tamarisk Control in Southwestern United States: Proceedings of Tamarisk Conf. U/AZ, Sept. 2 and 3, 1987. Tech. Coordinators: Kunzmann, Michael R., R. Roy Johnson, and Peter S. Bennett. 1989.

3) Felger, Richard. 1990. Non-Native Plants of Organ Pipe Cactus Ntl Mntm., AZ. CPSU Tech. Report #31. 93 pp.

Charles van Riper III (Northern UA/U) recently co-authored two peer-reviewed articles for journal publication:

1) Kern, Michael D., Mark K. Sogge, and Charles van Riper III. 1989. Water Vapor Pressure in Newsts of the San Miguel Island Song Sparrow. Submitted to Condor. 17 p.

2) Sogge, Mark K., Charles van Riper III, and Charles Drost. 1989. Design Considerations for Monitoring Land Birds in Channel Islands NP. 1989 Transactions of the Western Section of the Wildlife Society. 7 p.

A May workshop at Sequoia/Kings Canyon (SEKI) included NPS cave management expert Ron Kirbo of Carlsbad Cavern, to evaluate options for managing a major, newly discovered cave in the drainage of the Kaweah River in Sequoia NP.

David Parsons, together with Norm Christensen of Duke University, has organized a special symposium titled "Climate, Fire and Forests: Understanding Vegetation Dynamics of Western Conifer Forests," to be presented at the July 30-Aug. 2 Ecological Society of America meetings in Snowbird, UT. Talks will be presented by leading scientists in the fields of climate reconstruction, paleoecology, and forest dynamics.

Vegetation and Floristics of Pinnacles National Monument is the title of a 113-page publication, Tech. Report No. 34 from the CPSU at U/Cal Davis. Authors William Halverson and Ronilee Clark surveyed 87 sites for physical features of habitat and the composition and structure of vegetation, describe 13 plant communities, and analyze the amount of ground disturbance caused by pig rooting. (The California buckeye woodland (67%) and blue oak woodland (39%) were the most disturbed.)

The Hawaii Environmental Education Assn. (HEEA), to foster increased effectiveness of EE in Hawaii, has elected officers, is incorporating and applying for non-profit status. Chief Interpreter Kim Sikoryak (HALE) and Research Scientist Chuck Stone (HAVO) are Directors; Stone is President. A catalog of EE programs in the State has been prepared, and breakfast meetings to encourage networking were held on four islands in October.

Roy Johnson, Senior Research Ecologist with the CPSU at U/AZ in Tucson, was selected to participate in the Arizona Rivers Assessment and is serving on the project's Riparian Vegetation committee. Johnson met recently with 20 participants from eight state and federal agencies to discuss riparian vegetation, geology, and hydrology. The working groups began standardizing a system for inventory and monitoring of riparian ecosystems, part of a statewide effort to inventory and evaluate the significant river, stream, and riparian resources of Arizona.

This cooperative project is being undertaken by state and federal agencies in conjunction with the Governor's Task Force on Streams and Riparian Resources.

Dave Parsons, Research Scientist at Sequoia and Kings Canyon NPs, presented an invited talk titled "Horses, Helicopters, and Hi-Tech: Managing Science in Wilderness" at the Society of American Foresters conference, "Preparing to Manage Wilderness in the 21st Century," in Athens GA, April 4-6. The paper will be published in the Conference Proceedings.

The 1990 March/April issue of *American Forests* contained articles by Nathan Stephenson, David Parsons, and Top Nichols (SEKI) and by Supt. Bob Barbee (Yellowstone NP), under the heading "Replies from the Fire Gods." The articles countered many of the criticisms of NPS fire management and research leveled by Thomas Bonnicksen in an earlier article, "Fire Gods and Federal Policy," appearing in the July/August 1989 issue of *American Forests*.

Southeast Region

More than 150 researchers, resource managers, and fire management personnel attended a Fire and Environment Symposium March 20-24 at the Knoxville Hilton, chaired by Ed Buckner, U/TN Professor of Forestry. Stephen Nodvin, leader of the NPS/CPSU at U/TN, chaired the conference committee, which began its work a year and a half in advance and involved U/TN, Clemson U, the TN Div. of Forestry, USFS Tall Timbers Research Station, and NPS. Presentations covered fire ecology, fire policy, and cultural aspects of fire. Presenters and attendees were from the US, Canada, Brazil, Australia, Thailand, Portugal, Kenya, and Greece.

A *Conference Proceedings*, to be published jointly by USFS and NPS and edited by Nodvin and Thomas Waldrop, will include poster and paper presentations and the keynote address by Dr. Norman Christensen. Christensen contrasted the fire status of ecosystems across the country with special examples from Sequoia, Yellowstone, and Shenandoah NPs and the southeastern piedmont forests, and summarized by tying observations on fire ecology to present and past fire policies for the NPS, the USFS, and The Nature Conservancy.

The Southeast Region is funding a coastal mapping project, with a significant portion of the GIS work taking place at U/VA. The Dept. of Environmental Sciences there has developed extensive GIS capability, to which SERO has contributed additional equipment and resources for the coastal work.

Southeast Region (Continued)

The following publications in the SE Region's Research/Resource Management Series now are available through Jim Wood, NPS SE Regional Office, 75 Spring St. SW, Atlanta, GA 30303:

SER 89/04, "Exotic Plant Species Management Strategies and List of Exotic Species in Prioritized Categories for Everglades NP," by Louis D. Whiteaker and Robert F. Doren.

SER 90/01, "Evaluation of Electrofishing as a Management Technique for Restoring Brook Trout in Great Smoky Mountains NP," by Jerry L. West, Stephen E. Moore, and M. Randall Turner.

"Abstracts of the 15th Annual Scientific Research Meeting, May 25-26 1989, Great Smoky Mountains NP," compiled by Jim Wood.

With the approval of the Florida Panther Interagency Committee (FPIC), the USFWS announced in the Feb. 15, 1990 *Federal Register* their intent to prepare an environmental assessment on the proposed capture of Florida panthers for captive breeding purposes. This was the culmination of a series of technical meetings and workshops held in 1989 and 1990 to address recovery efforts for the panther. Recommendations for a captive breeding program were formalized in the Species Survival Plan prepared for the FPIC by the Captive Breeding Specialist Group of the IUCN.

The *Federal Register* notice stimulated an unanticipated level of negative responses from the public, especially from certain animal rights and environmental groups. This prompted the USFWS to schedule a series of public meetings in Florida in July to present additional information on panther status and the captive breeding program in an effort to increase public understanding and acceptance of recovery efforts. Southeast Regional Chief Scientist Dominic Dottavio will represent NPS at the meetings.

An article by Dennis Jordan, Florida Panther Coordinator, Florida Cooperative Fish and Wildlife Research Unit, will appear in the Fall issue of *Park Science*.

Midwest Region

Butterfly Biodiversity is the title of an Isle Royale brochure designed to acquaint visitors with the ecological importance of insects and to familiarize them with Isle Royale's butterfly populations. It describes how butterflies serve as "environmental barometers," and includes sketches of several species plus an observer's checklist. Bruce Weber, Isle Royale's Interpretive Specialist, calls the brochure "our attempt to help visitors focus on the diversity of wildlife other than the wolves and moose for which we're famous."

Weber will be happy to send copies to other parks that request it. Meanwhile, he is developing a new one-pager on "the little green plants commonly overlooked - mosses, liverworts, etc."

The 1988 Annual Science Report for the Region, now available, lists the research and monitoring projects for natural and social sciences conducted in the Region in 1988. It also lists issues that face the Region in the next five years. Reference copies are kept at the Regional office Omaha.

A 2 1/2 year study to develop management recommendations for the federally endangered plant, *Lesquerella filiformis*, has been completed by staff at Missouri Southern State College. The report discusses strategies that will be useful in achieving long-term management goals. Reference copies are kept at the Wilson's Creek National Battlefield and the Midwest Regional office.

Apostle Islands National Lakeshore is attempting to parlay \$15,000 of NPS science funds into a study of anthropogenic toxics in Lake Superior eagles. The lakeshore has proposed a challenge grant through its contacts in the Western Lake Superior Region Resource Management Cooperative. Formed through a memorandum of understanding initiated by NPS, the Cooperative is composed of seven Federal agencies, Michigan and Wisconsin Departments of Natural Resources, and five academic institutions from Minnesota, Wisconsin, and Michigan.

Contract negotiations have been completed with Ecological Services, Urbana, IL, to carry out a feasibility study for establishing an Ozark Highlands MAB program. The study is supported by a grant from the US MAB Committee and contributions from the USFS, NPS, three State natural resource agencies in Arkansas and Missouri, and The Nature Conservancy. Study planning and coordination is being done through a steering committee made up of representatives from the above agencies and chaired by Dave Foster, Research Biologist at Ozark National Scenic Riverways. The Ozark Highlands MAB concept is based on surface and groundwater watersheds of the Buffalo River in Arkansas, the Current River in Missouri, and potential adjacent areas, representing this ecoregion.

The Midwest Region and Lincoln University, a historically black university in Jefferson City, MO, signed a cooperative research agreement on March 15. As a land grant institution, the university has an active extension and cooperative research program, an established natural resources department, and excellent plant and soil science research facilities. Under the agreement, the university will conduct a 2-year evaluation of the open-field management program at Ozark NSR. The university also will provide assistance in large prairie restorations at Wilson's Creek NB and several prairie parks, beginning next October.

Water Resources

The Water Resources Division was represented at the April 14 meeting of the American Society of Civil Engineers National Parks and Recreation Planning Committee. Marshall Flug was elected to the Control Group of the committee and assumes the position of Secretary beginning Oct. 1, 1990. The committee was formed to write a comprehensive Park and Recreation Planning Guidebook and to organize conference sessions, a mini symposium, and a specialty conference. NPS employees are invited to contribute to this effort.

Seven NP programs were represented at the annual NPS Watershed Research and Monitoring meeting hosted in Fort Collins April 3-5. Discussions revolved around the status of each area's watershed activities and plans and how the field watershed sites will be participating within and as part of other program initiatives such as the Global Change and the Inventory and Monitoring programs. The watershed program is aimed at implementing hydrologically, geologically, and ecologically sound monitoring and research to establish baseline data on the state-of-the-art long-term ecosystem health.

The WRD participated in the Yellowstone NP Northern Range meeting April 4-6 and assisted the Northern Range Riparian Review Committee in developing a proposal for an integrated riparian area research project at Yellowstone. The Division also took part in an interdisciplinary team to review stream channel and riparian conditions along the Merced River in Yosemite NP and to develop recommendations for the Superintendent for a comprehensive restoration and management program.

The NP System Natural Resources Law and Policy Course held at Clemson during the week of April 9 afforded the WRD an opportunity to meet all 22 of the Natural Resource Management Trainees in Class V. They found the group "filled with enthusiasm" and they look forward to seeing them in Fort Collins for a full week on water issues. The Clemson-based course was an introduction to natural resource law and was coordinated for the NPS by the World Wildlife Fund/Conservation Foundation.

The heaviest element known to science was recently discovered at the Lawrence Livermore National Laboratory. The element, tentatively named ADMINISTRATIUM, (Ad), has no protons or electrons, thus it has atomic number 0.

It does, however, have one neutron, 75 associate neutrons, 125 deputy neutrons, and 111 assistant deputy neutrons. This gives it an atomic mass of 312.

The 312 particles are held together in the nucleus by a force that involves the continuous exchange of meson-like particles called memos.

Because it has no electrons, ADMINISTRATIUM is inert. Nevertheless, it can be detected chemically, because it seems to impede every reaction in which it takes part.

According to Dr. M. Languor, one of the discoverers of the element, a very small amount of ADMINISTRATIUM made one reaction, that normally takes less than a second, take more than four days to go to completion.

ADMINISTRATIUM has a half-life of approximately three years. At the end of this time it does not actually decay. Instead, it undergoes an internal reorganization in which the associates to the neutron, deputy associates to the neutron, and assistant deputy neutrons, all exchange places.

Some studies indicate that the atomic mass actually increases after each reorganization.

Ethics of Environment and Development, edited by J. Ronald Engel and Joan Gibb Engel, is a collection of 23 essays by ethicists from 15 nations, providing a multicultural perspective on the ecological and human values at stake in the creation of an ethic of sustainable development.

How can we make ethical decisions about our environment in the face of increasingly conflicting needs and opinions? What is the precise meaning of the much discussed term "an ethic of sustainable development"?

The essayists address these questions from the differing perspectives of environmental ethics, development ethics, ecofeminism, religion, and humanistic philosophy. The result is food for constructive thought on new development paths that can satisfy human needs, while at the same time demonstrating respect for Earth's environment and its myriad life forms.

The 264-page volume (ISBN 0-8165-1183-7) is available from the University of Arizona Press, 1230 N. Park Ave., Tucson AZ 85719.

In the April issue of *Harper's*, the Forum section is titled "Only Man's Presence Can Save Nature: Toward an Understanding of the Environment." In it, Frederick Turner (Founders Professor of Arts and Humanities, UTX, Dallas) argues:

"... the fundamental tendency of evolution from the big bang to the higher animals ... is a tendency toward greater reflexivity, greater open-endedness, greater complexity, and greater 'encephalization' - that is, a larger proportion of nervous tissue. Evolution in pre-living chemical systems occurs slowly and has no way of changing itself. Sexually reproducing life can record itself and then reshuffle and recombine the recordings. It can improve itself; that is evolution. Then you have organisms that thrive in societies, which is just another, perhaps more sophisticated, way of passing on information to another generation. Nature has had this tendency toward increasingly more complex ways of passing on information from the big bang all the way up. Humankind is what nature has been trying, all these millennia, 'to be'."

In the same April *Harper's* Forum, Daniel B. Botkin (professor of biology and environmental studies at UCal Santa Barbara and author of *Discordant Harmonies: A New Ecology for the Twenty-first Century*) observed:

"As long as we thought nature was 'one state,' we didn't need to monitor it. Now that we know that nature is always changing, we must track its conditions. We need global-research institutes - one research center per continent - to study the atmosphere and the dynamics of Earth. I would revise the national park system so that the parks were connected in such a way that natural migrations might occur. As a symbolic action, I would honor the treaty with the Sioux, return the Black Hills to them to run buffalo and manage the ecology."

The concept of a sustainable society, so prominent in Earth Week celebrations all over the world in April, was a major theme of Fritjof Capra in an address covered by *The Oregonian* in a March 8 report. "What sustainability means is keeping the long-term future in

mind," Capra said. In describing such problems as poverty, development, and environmental degradation, "the only solutions acceptable," he said, "are sustainable solutions that will not create new problems of equal magnitude." Capra, who teaches at U/Cal Berkeley and researches theoretical high-energy physics at the Lawrence Berkeley Lab, calls himself a "systems theorist." "It involves," he said, "an interdisciplinary study of the relationships of all kinds of living systems...individual organisms, social systems, and ecosystems."

The National Academy of Science panel, which will review scientific research in the National Park Service, consists of the following members:

Paul Risser, Chairman; VP Research, U/NM; Durward Allen, Forestry and Natural Resources, Purdue; Ann Bartuska, SE Forest Experiment Station, USFS; John Bright, retired DSC landscape architect/regional planner; Roger Contor, retired, former NPS superintendent/regional director; Jerry Franklin, College of Forest Resources, U/WA; Thomas Heberlein, Dept. of Rural Sociology, U/WI; John Hendee, Forestry, Wildlife, and Range Sciences, U/ID; Ian McHarg, Landscape Architect and Regional Planner, U/PA; Duncan Patten, Center for Environmental Studies, AZ/StU; Roland Wauer, retired NPS researcher and natural resources administrator; Norman Wengert, retired, public administration, CO/SU; and Peter White, Dept. of Botany, U/NC.

The American Museum of Natural History in New York City has joined forces with two conservation and research organizations in an effort to save the world's endangered turtles, with Michael Klemens of the Museum's Department of Herpetology and Ichthyology as program director. The Museum will work with the World Conservation Union (IUCN) and Durrell Institute of Conservation and Ecology in Canterbury, England, to implement conservation projects for more than 100 species of fresh-water turtles and tortoises on 6 continents. Of the 350 species of fresh-water turtles and land tortoises, a third are in need of conservation attention. The Museum, as a research center, will bring to the project the baseline scientific data that makes both a study of dynamic ecosystems and conservation projects of this kind effective, according to Michael Novack, dean of science at the Museum. The *New York Times* Environment section carried in its March 13, 1990 edition, an extensive story of the "plight of turtles" and the Museum's efforts to reverse the decline.

Donella H. Meadows, adjunct professor of environmental and policy studies at Dartmouth College, in an article for the *Los Angeles Times* and reprinted May 15, 1990 in *The Oregonian*, described biodiversity as "the world's most valuable library: the genes of all living organisms." Biodiversity, she wrote, "contains the accumulated wisdom of nature and the key to its future." The DNA within living cells is "nature's knowledge" and as yet we have no clear idea how much of the free service performed by the earth's ecosystems will be canceled out as we crowd more and more species off the face of the planet.

Biodiversity performs services beyond price. "How would you like," Professor Meadows asks, "the job of pollinating all trillion or so apple blossoms in New York state some sunny afternoon in late May? It's conceivable, maybe, that you could invent a machine to do it, but inconceivable that the machine could work as elegantly and cheaply as the honey bee, much less make honey on the side.

"And suppose," she continues, "you were assigned to turn every bit of dead organic matter, from fallen leaves to urban garbage to road kills, into nutrients that feed new life. Even if you knew how, what would it cost? A host of bacteria, molds, mites and worms do it for free."

A USFS employee, (unnamed), is reported in *Restoration & Management Notes* (Vol. 2 No. 2, p. 57) to have "brought down the house" at the San Francisco Society for Ecological Restoration Conference in 1989 when he referred to mitigationists as "biostitutes." He was warning restorationists not to allow themselves to be used, "or you'll become apologists for development."

Russell Stafford, horticultural program coordinator for The Center for Plant Conservation (125 Arborway, Jamaica Plain, MA 02130-3520), describes in the Spring 1990 issue of *Plant Conservation* the 10-year plan to bring into the National Collection the 530 threatened plant species not yet represented. A two-year matching grant from the Andrew W. Mellon Foundation will double the donation money available for this conservation work. The spring issue features Kearney's Blue-Star - its botanic history and its reintroduction in a sycamore-lined canyon in the Baboquivari Mountains of south-central Arizona.

Don Falk, executive director of The Center, notes that the Mellon matching grant offer is "like the rare flora of the United States and this blue-green planet we live on - good for a limited time only."

A report by Mercer Cross of *National Geographic*, written for AP Newsfeatures, describes the winter haze that dims the views at Grand Canyon NP and the U.S.EPA's conclusion that the haze originates mostly from the giant Navajo Generating Station - a coal-powered, 2,250-megawatt plant at Page, AZ, a dozen miles from the northern rim of the park. EPA's conclusions were based on a 1987 study by the NPS showing that 40 to 70 percent of the layered winter-time haze in the canyon is attributable to sulfate particles coming from Navajo's 775-foot smokestacks. EPA's preliminary proposal is that \$300 million to \$450 million worth of pollution control equipment be installed at the Navajo plant - devices that can remove 90 percent of the pollutants. In the case of Navajo, which burns as much as 24,000 tons of low-sulfur coal each day, this amounts to an estimated 200 to 265 tons of sulfur dioxide emitted daily. A federal court has extended for one year the Feb. 1, 1990 deadline for EPA to decide what cleanup measures Navajo should take.

"The issue," says Bob Yuhnke, attorney for the Environmental Defense Fund, "is whether or not we can develop a stable environmental future with a growing population. We can handle it. It's just a question of putting policies in place but making sure we don't trash the environment while we're accommodating growth."

An Eastern Perspective on Fuels Management and Historic Structures

By Susan Bratton

In 1981, a lightning ignited fire burned through 690 hectares of scrub and marsh vegetation on Cumberland Island National Seashore. The fire destroyed an abandoned sawmill and swept towards the historic district at High Point, which contains several turns of the century structures. The size and the intensity of the 1981 South Cut fire made southeastern resource managers aware that fires of natural origin could potentially threaten historic resources and jump the boundaries between natural and historic zones within a park.

Historically, fire in southeastern parks was generally less of a threat to structures than it is today. When the land was still under cultivation, property owners living in or near plant communities subject to frequent or high intensity wildfires, either situated buildings in locations resistant to burning, or cleared fuels from around developments. In many cases, lawns, gardens, fields and pastures adjoining cabins and barns would have provided substantial fuel breaks.

Conscious and unconscious strategies of fire prevention included placement of homes in less flammable live oak and mixed hardwood forests, sweeping lawns clear of leaf litter, and frequent burning of forest understories to remove brush and "vermin". On coastal barriers, such as the Outer Banks of North Carolina, free range grazing formerly reduced fuels around buildings. Sites such as High Point on Cumberland Island had large lawns, that protected them from high intensity fires in the nearby scrub.

Since acquisition by the NPS, the land management around many historic structures has changed. Agriculture, grazing, and anthropogenic burning have ceased, and shrub or forest succession has occurred, causing fuel loadings to increase. In some cases, the site maintained as "historic landscape" around structures on the National Register incorporates much less acreage than the area historically clear of flammable vegetation and shrub succession may occur almost up to the eaves of the buildings. These problems also concern

concessions, retained rights properties, and residential inholdings.

In the southeastern U.S., many of the more flammable fuel types burn naturally on relatively short rotations. Fire history studies have documented a rotation of 20 to 25 years for scrub communities on Cumberland Island, for example. Anthropogenic burning of forest understories and litter was traditionally conducted on a one to five year basis, and settlers would reburn pine stands almost as soon as enough fuels had accumulated to carry a fire. Although major conflagrations do occur on longer rotations in the southeast, historically southern farmers and fishermen had seen numerous fires burn across the woods and marshes, and managed to reduce the risk of a natural disturbance they had observed and recognized. In some western vegetation types, where fire rotations may be 100 to 300 years, settlers and developers may have been less cognizant of the long term dangers.

In general, NPS fire protection strategies have not been coordinated with historic landscape planning, nor are they included in retained rights agreements. Fuel breaks have been constructed on the "suppression model," of narrow zones of cleared vegetation, often forming abrupt boundaries with adjoining shrub or forest communities. To improve aesthetics, to conform to historic landscape practices, and to reduce fire suppression costs in case of a wildfire, fuel breaks should be redesigned. Fuel breaks may be maintained by expanding the lawn area around buildings or by returning to historic types of lawns. This type of strategy should be effective for historic structures on Cumberland Island National Seashore, for example, where plantation lawns had a live oak canopy and an open understory with a grass sward and evergreen plantings along lanes.

Reclamation of fields or gardens, or extension of these features to their historic boundaries can produce visually appropriate fuel breaks. In cases where reestablishing historic crops, such as cotton, is not

feasible, another type of vegetation, such as an open grass sward, may be encouraged as a substitute vegetation type (with appropriate interpretation to the public). Fuel breaks can be situated along historic fence lines and actually used to define the boundaries of an historic site. Where fuel breaks around retained right structures (including those on the National Register) become part of lawn or field management schemes, the holders of the retained rights may be willing to continue to mow or otherwise clear the area themselves, thus saving the NPS person time and funds. Some fuel breaks can be better cared for by park staff responsible for cultural landscape maintenance than by fire suppression crews. Extension of lawns and fields may, in some cases, require realignment of the boundaries between natural areas and historic districts, and expansion of cleared areas in "historic zones". In all circumstances, a carefully documented historic landscape study is a necessary prerequisite to fire planning.

In the east, historic cultivars or plantings rarely present a hazard. The preference for broadleaved shrubs and trees around buildings and for evergreen hedges generally does not increase fire risk. Some species, such as bamboo, may, however, grow into thickets. When trimmed back to their historic height or boundaries, such species usually do not form continuous fuels ladders. Fire managers need to recognize that fuels reduction efforts may accidentally remove or damage historical plantings of cultural significance or of importance in conserving genetic diversity. Before any vegetation removal is attempted, the positions of plantings, borders, fences and all other historic landscape features should be determined and a fuel reduction strategy chosen which protects key historic landscape elements.

In cases where original historic vegetation types or management practices cannot be easily maintained, vegetation conversion to more easily managed semi-natural types may be considered. Around historic structures, such as life saving stations, in the inter-dune of the Outer Banks of North Carolina, for example, scrubland might be converted to grassland, and maintained either by prescribed burning or by herbicides. This would reduce fuel loadings, and allow access for fire management personnel and equipment. In many historic settings, the abrupt boundaries caused by standard fuel breaks could be "softened" by expanding the width of fuel breaks and integrating them into surrounding vegetation along waving or broken lines providing natural looking scrub-grassland or grassland-forest borders. The impacts of establishing more easily managed semi-natural vegetation as a buffer between natural and historic districts need further investigation.

Incorporating fire prevention and suppression strategies into historic landscape management plans will provide better and more visually pleasing fuel breaks for historic structures. Further communication between fire ecologists, natural resources managers and cultural resources managers can optimize fire prevention strategies and lessen the chances of loss of irreplaceable historic resources.

Bratton is Coordinator of the U-GA's NPS/CPUSU, Athens, GA 30602.

information crossfile

A proposal currently in the process of fulfillment would result in the world's largest nature reserve - the Chang Tang Reserve in Tibet - eventually encompassing 150,000 square miles of cold, wind-swept plain populated with scores of birds, plants and animals found nowhere else on Earth. According to George Schaller, an American biologist who has explored the region and helped negotiate preliminary agreements signed in January, this almost unexplored place "survives intact" much as it was a century ago. Schaller, a leading wildlife biologist, has done pioneering studies on gorillas, pandas, snow leopards, and other endangered animals. When he returned in late January from Chang Tang (the Tibetan words for "northern plain"), Schaller brought with him an agreement with the Tibetan Environmental Protection Agency that sets aside an original area of 100,000 square miles - about the size of the state of Colorado - and outlines steps toward establishing the reserve and proposed additions in adjoining provinces that would increase it by half again. Research will be

conducted with the Tibet Institute of Plateau Biology. (Corvallis, OR Gazette-Times, March 8, 1990)

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A new quarterly journal, *URSUS*, is being launched by the North American Bear Society, PO Box 9281, Scottsdale, AZ 85252-9846. The full color publication will feature articles by leading biologists, naturalists, and outfitters, and deal with questions such as "What effect did the Yellowstone fires have on the bear population?"

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In laboratory experiments performed on gravel retrieved from Alaska's Prince William Sound after the Exxon Valdez spill, a biodegradable surfactant containing a soap-like material secreted by *Pseudomonas aeruginosa* bacteria removed three times the amount of oil washed away by plain warm water - the method commonly used by cleanup crews there. Steven Harvey of the U.S. Army Chemical Research, Development and Engineering Center in Aberdeen, MD and his co-workers report the findings in the March 1990 *Bio Technology*.

Wildfire at Park Boundaries: The Wildland/Urban Interface

By Ted Morlock

As the trend towards rural development continues across the U.S. into the 1990s, parks that share their boundaries with privately owned lands need to look more closely at their wildland/urban interface. The idea of having a National Park "in your backyard" is so popular that realtors and other developers often use it as a primary selling point. With each new home constructed along a park's boundary two management problems escalate. The first is the potential for a structural or powerline fire igniting nearby vegetation within the park. The second is the potential for a wildfire exiting the park and destroying a structure. These seem like opposite scenarios but in fact they share one factor – the park boundary. Thus they require a multi-faceted solution, which may involve many individuals and agencies. During the winter of 1989-90, Cape Hatteras National Seashore undertook an experimental program of boundary fuels management and public education to reduce hazard situations at the wildland/urban interface in the Buxton Woods area of Hatteras Island.

Prior to initiation of the management program, fuel and vegetation maps were prepared for Buxton Woods, the largest remaining maritime forest in North Carolina. A fire history study by Kent Turner indicated ignitions at Cape Hatteras were primarily anthropogenic. Field survey data

Effects of Severe Fire in Coastal Scrub

Although National Seashores are not usually considered to be "fire prone" parks, several east coast barrier islands have areas of high fuels. During 1987 and 1988, the University of Georgia Cooperative Studies Unit investigated the historic impact of severe fire in coastal scrub (or pocosin) and fresh water marsh communities on adjoining live oak (*Quercus virginiana*) forest on Cumberland Island National Seashore. Seven series of aerial photographs, taken between 1953 and 1988, were analyzed to determine the location of boundaries between plant community types before and after fires. A sampling team established permanent transects between scrub and forest communities, and evaluated the basal area of woody vegetation along gradients between scrub and better developed oak forest. A green house bioassay of soil fertility also was conducted.

The project found, that despite the highly flammable nature of the scrub and the history of repeated fires in the dense thickets, disturbance was not correlated to the areal extent of scrub or marsh communities. The scrub and marsh boundaries expanded, rather, in response to periods of high precipitation; thus boundary changes were related to the coastal drought cycle.

Scrub forest boundaries were relatively dynamic compared to marsh/forest boundaries. In recent years, extensive browsing by white-tailed deer has limited survival of live oak sprouts after fires. If scrub communities expand into oak forest, it will ultimately be a result of herbivore impacts, and not of high intensity fires. The data suggest wildfire plays a minor role in boundary dynamics among these communities, and that fire suppression should not be necessary to prevent loss of oak forest along the scrub boundary. Further reduction of the deer herd would, however, be very desirable.

Guy McPherson/Susan Bratton
NPS/CPSU, U/GA, Athens

taken by Katherine Davidson and Susan Bratton indicated that Buxton Woods had burned several times within this century and that successional loblolly pine (*Pinus taeda*) stands had greater loadings of fine fuels and were more likely to burn than laurel oak (*Quercus laurifolia*) and mixed hardwood stands. In some cases, new homes had been constructed in pine stands adjoining the extensive, and moderately flammable, pine and wetland areas within the park. The simplest, and often only strategy, in such a situation is to provide a fuel break along the boundary. This may be accomplished either through mechanical manipulation and removal of fuels using chain saws and other tools, or through the use of prescribed fire.

In Buxton Woods, the volume of pine litter and the proximity of homes to the park boundary discouraged the use of fire. Further, historic vegetation analysis indicated the Woods had been dominated by live oak (*Quercus virginiana*) prior to the colonial era. Prescribed burning might inhibit desirable hardwood succession and might actually maintain more flammable pine forest types. The use of prescribed burning also was limited by authorization difficulties, public aversion to burning near their properties, and shortages of fire protection personnel (both in the planning and execution phases) and equipment. Although more time consuming and less effective than prescribed burning, mechanical manipulation was thus effected along the six-mile park boundary through the Woods.

The actual treatment consisted of removal of all underbrush (laddering fuels), trees less than 3" dbh and any dead and down fuel concentrations for a 10' width along the relatively level terrain of the boundary. Resulting slash was scattered in the park or hauled to a safe burning location, to prevent hazardous fuel buildups along the treated area. This initial treatment required 10 person days (1 pay period) and 50 hours chain saw useage per mile (using an experienced sawyer). Long-term management will require 4 person-days and 20 hours motorized brush cutter useage per mile if done annually. The resulting fuel break provides minimal protection against anything more intense than slow-moving ground fire, but greatly increases access

along the boundary for firefighting personnel and equipment. Providing high boundary discernment is a benefit with some disadvantages. It may increase use by poachers and ATVs. It may inhibit movement of some small animals. If not done carefully and with forethought it may be aesthetically repulsive and cause homeowners and park visitors to object.

In conjunction with fuels management, a complex, though potentially more effective program, was undertaken to educate and involve the neighboring community, including homeowners, local fire departments, and developers. In the eastern U.S., many homeowners are unaware of the dangers of fuels build-up and do not perceive wildfire as a threat to a second home "at the beach". Further, those that do recognize the danger do not consider it their responsibility to take preventive measures. They assume the fire departments and government agencies will suppress fires and conduct any necessary fuels reduction. The education program therefore attempted to make the public recognize that the responsibility of fire protection is not the Park Service's exclusively, and that in the event of a major wildfire, available fire protection personnel and equipment might be insufficient to save their homes. Through meetings with officials (fire chiefs, county planning board members, county fire marshalls, etc.), discussions with school authorities (to develop programs for students), and instructional handouts for homeowners, the concept of fuels management as a community responsibility began to spread in the Buxton Woods area. A fire technician personally met with homeowners to explain how they could help protect their residences, and presented training videos to the local fire department.

The fuel management program for Buxton Woods encountered a perception of forestry that clashed with contemporary fire management concepts, especially at the county planning level. Since maritime forest is a threatened habitat in North Carolina, the trend has been to push for open space areas, with limited vegetation removal. Although this type of land use planning

Continued on page 19



Burning slash after fuels removal along the boundary between Cape Hatteras National Seashore and nearby developments.

Do Parks Make Good Neighbors?

By Robert E. Manning

Many of America's national parks have become islands of nature in a sea of civilization. Development of land around and adjacent to parks has raised a variety of management issues, including air and water pollution which flow into the parks, limited range for wild animals, increasing demand for recreation opportunities, and incompatible development along park boundaries. These and related park management issues – collectively termed “external threats” – reached crisis proportions in the decade of the 1980s.

However, another side of this issue is beginning to emerge as well. Just as parks and park management can be affected by surrounding lands, so too can surrounding lands and their owners be affected by parks. Parks, wilderness and related public lands often draw thousands or even millions of visitors annually, and public ownership of land can have important implications for property taxes and other community affairs. This study was designed to explore how the presence of a national park was perceived to affect private land-owners and their communities.

The study focused on Acadia NP, which is located on Mt. Desert Island, Maine. The park occupies approximately one-half of the island, the other half comprised of private lands organized into a number of small communities. The park boundary is highly irregular, resulting in a complex landownership pattern highlighted by substantial intermixture of public and private land. The park is heavily visited.

The principal objective of the study was to determine the effects of the park on surrounding areas as perceived by residents of Mt. Desert Island. A standard questionnaire was administered by mail to a 10 percent

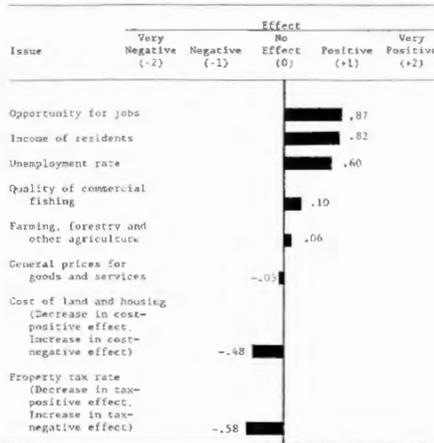


Figure 1. Resident perceptions of the effects of Acadia NP – economic issues.

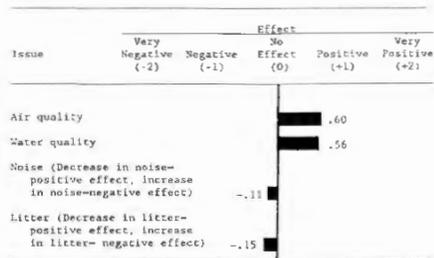


Figure 2. Resident perceptions of the effects of Acadia NP – environmental issues.

Wildland/Urban Interface (Continued from page 18)

is derived from an interest in protecting the uniqueness of the maritime forest, it is self defeating from a fire prevention standpoint. The resources it strives to protect will be destroyed in the event of a wildfire. At Cape Hatteras a 170 unit subdivision, which is located immediately adjacent to the park boundary, is being developed under a county ordinance which prohibits removal of any vegetation beyond 30 percent of the lot area (roughly the amount necessary to build the structure, no more). The justification for this code is protection of the freshwater aquifer from excessive runoff. This same subdivision is being built under building codes which require “low visual impact”, highly flammable, natural building materials. Hazard fuels were not considered when the ordinances were developed, so the design of the subdivisions considers only the impact of the new housing on the natural ecosystems and does not consider potential impact of adjoining wildlands on the housing. Future plans should consider both elements, thereby avoiding conflicts between human communities and park resource management programs.

Evaluation of the wildland/urban interface at Buxton Woods suggests that further research and managerial experimentation on maintaining fuel breaks is desirable. Use of fire resistant vegetation or vegetation conversion to low fuel plant communities, for example, are options which have rarely been employed in national parks. This approach can encourage natural succession of native fire resistant vegetation, such as live oak, or their use in landscaping applications. This may be a very valuable option around residences and park historic structures where removal of vegetation using

either mechanical means or prescribed burning may be undesirable. This treatment may also be viewed, by county planning boards and other officials, as a suitable compromise in situations where runoff and watershed protection are primary considerations. Vegetation conversion or establishment of fuel breaks of adequate width to protect structures and developments exterior to the parks may, however, effect wildlife movements or habitat use. More information is needed on optimal strategies for boundary management.

Parks interested in obtaining information or training materials on the wildland/urban interface should contact: NPFA (National Fire Protection Association), Battery March Park, Quincy, MA 02269.

Available publications are: *Protecting Your Home From Wildfire*, a handout booklet for distribution to homeowners; *Wildland Fire Management Briefings*; *Wildfire Strikes Home*, Newsletter; *Wildfire Strikes Home*, Annual Report; and *People and Fire at the wildland/urban interface* (a sourcebook).

Contact: Bill Baden (wildland/urban interface specialist) 617-770-3000, ext. 7484.

Available videos are: *Wildland Fire Strikes Home*, discusses the 1985 fire season, the worst in history for the wildland/urban interface; *Wildland Fires Satellite Broadcast*, looks at the 1987 wildfire season, details ways to protect your home and methods for building interagency cooperation.

Contact: Manuscriptions, 28 South Main St., Suite 256, Randolph, MA 02368 – also available through BIFC by spring, 1990.

Morlock is a Research Technician, Institute of Ecology, University of Georgia, CPSU, Athens, GA.

systematic random sample of residential property owners on the Island. Sampling was conducted using the property tax records of all communities on the Island. Respondents were asked to rate the degree to which the park positively or negatively affected 33 items related to personal and community life. A response rate of 83 percent was attained, yielding 542 completed questionnaires.

Study findings are summarized in Figures 1-5 which report mean responses. From the findings several conclusions may be drawn. First, respondents feel that the park does affect them in a multitude of ways. For only two of the 33 items included in the questionnaire did a majority of respondents feel the park had “no effect.”

Second, it is clear that the park is perceived by residents as having both positive and negative effects. Using the mean responses shown in Figures 1-5, it can be concluded that respondents felt the park had a slightly-to-moderately negative effect for 12 of the 33 items explored. The most clearly negative items were property tax rate, cost of land and housing, and traffic congestion. Most residents apparently believe that property tax rates are abnormally high due to the presence of the park. This situation may be due to the fact that land in public ownership generates little or no property tax revenue for local governments, placing what is perceived to be an undue burden on private property owners.

Another contributing factor may be an abnormally high rate of appreciation of private land values as there is a reduced supply of private land and their market price may be bid up quite steeply. (Demand for commercial tourist development and vacation homes is spawned by the presence of the park.) Most residents also believe that the park has a negative effect on the cost of land and housing; that is, the presence of the

Continued on page 20

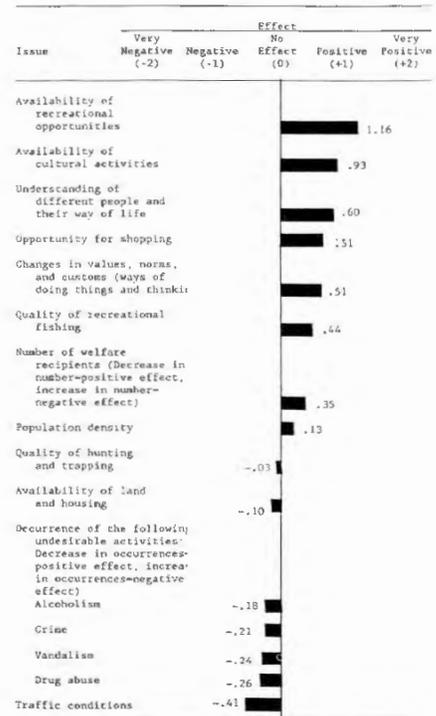


Figure 3. Resident perceptions of the effects of Acadia NP – social and cultural issues.

Do Parks Make Good Neighbors? (Continued from page 19)

park has caused land and housing costs to rise abnormally high. Finally, respondents clearly believe that the high level of visitation to the park causes traffic congestion with which local residents must contend.

The majority of items explored were perceived to be slightly-to-strongly positively affected by the park. The most clearly positive were availability of recreational and cultural opportunities, opportunities for jobs, income of residents, and fire protection. Respondents apparently recognize that the large number of visitors attracted to the park makes possible the provision of opportunities for recreation, shopping and culture which could not otherwise be supported on the island. They also appreciate the economic benefits brought about by a large infusion of park visitors and under-

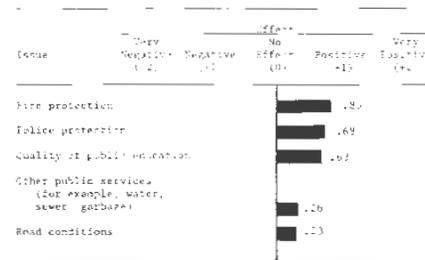


Figure 4. Resident perceptions of the effects of Acadia NP – public service issues.

stand that these expenditures create jobs and income in local communities. There is also an apparent belief that the presence of a major unit of the National Park System can enhance traditionally local government services such as fire and police protection.

Finally, a summary item, "general quality of life," was included in the questionnaire. The vast majority of respondents felt the park had an overall positive effect on their lives and on their communities.

Findings from this study indicate that, for the most part, parks can indeed be good neighbors. However, two notes of caution are in order. First, it should be emphasized that these findings relate to perceived effects of the park. These perceptions may or may not be related to real effects, at least for some items. Nevertheless, perceptions of local residents are important unless they can be proven wrong empirically. Second, although most items explored in the questionnaire were perceived as positively affected by the park, the



Figure 5. Resident perceptions of the effects of Acadia NP – overall quality of life.

attention of the park managers should be drawn to the issues perceived as negatively affected. Negative perceptions should be corrected where they are believed to be in error; action should be taken to ameliorate negative effects where possible.

Over the past decade it has become clear that parks are inextricably tied to lands outside their boundaries. This issue has been framed primarily in terms of the effects of these surrounding lands on park management. This study illustrates that there is another side of this issue as well. Parks are clearly perceived to affect surrounding lands. As the interconnectedness of public and private lands is more widely recognized, it will be necessary for park managers to reach out beyond the borders of their areas to deal successfully with "external threats". They are likely to be more effective in this process if they are aware and sensitive to effects they in turn have on surrounding communities.

Manning is a Professor and Chairman of the School of Natural Resources Recreation Management Program at UVT, Burlington.

In the Next Issue

"Investigations of the Malaspina Glacier, Wrangell-St. Elias NP&P, Alaska," by Bruce Molnia and John Jones; "Peregrine Falcon Research in the Yukon-Charley Rivers National Preserve, Alaska," by Skip Ambrose and Steve Ulvi; "The Cumberland Island Cotton Mouse," by James Boone, Joshua Laerm and Michael Smith; "Great Basin National Park: A Crisis in Vegetation Management?" by Raymond Jandl, Lee Edelman, William Brock and Boyd Eyelich; "Native Brook Trout Restoration in Great Smoky Mountains NP," by Stephen Moore and Gary Larson; "Natural Resource Management at Colonial NHP," by Chuck Raffkind; "A Sea Urchin's Response to Mass Mortalities," by Don Levitan; and "Visitor Services Project," by Dana Dolsen.

In addition, the Fall issue will include a separate section on the NPS Global Change Project plans.

Black Canyon Grazing Plan

Black Canyon's grazing management plan was implemented in 1989. Grazing was authorized in 1984 as part of the Monument's legislative expansion and land acquisition. Under the plan, the Monument administers allotments that include private, BLM, and NPS lands. Cooperative agreements were obtained so that a single plan, overseen by Monument staff, would assure a cohesive grazing operation. Current drought conditions may test the durability of the current plan and identify necessary changes.

A Superintendent Says YES!

In the early years of the National Park Service Stephen Mather dealt directly with park neighbors. Frustrated with Great Northern's procrastination at removing a "temporary" sawmill in Glacier NP, Mather assigned a trail crew to blow it up. Today, however, the world is more complicated; such "quick fix" solutions are sure to generate more problems than they solve.

Although methods may have changed, the need for interaction between parks and their neighbors has grown. All of today's park managers and employees need to expand their vision, knowledge and expertise over the boundary fence and become directly involved in the issues of nearby communities. We can better preserve our national treasures by taking a leadership role in protecting ecosystems, landscapes and waterways whether or not we own them. When we protect the region from the adverse impacts of acid rain, we protect our parks. When we help manage visitor impacts on neighboring communities, we in fact manage visitor impacts within our parks. When we recognize that parks are an integral part of the national and international tourist industry, we can better articulate why our parks are important in local and regional economies. When we emphasize that parks are educational resources, increase their use for scholarly pursuits, illuminate their historical and scientific value, then we establish the parks as unique and vital entities in the

communities in which they are located.

Acadia NP is intimately linked with the communities of Mt. Desert Island. Dr. Manning's study has documented and illuminated many of these relationships. We are reassured that Acadia is perceived as a good neighbor in many ways. However, there is room for improvement. Since completion of this study we have worked in several ways to further improve our relationships with surrounding communities. A few samples include:

- Our general management plan leader has moved to the park making a long term commitment to learn and understand park issues and their implications on the region's economy and quality of life.
- The park's advisory commission (which has representation from 10 towns as well as state and federal appointees) has been directly involved in the general management plan process.
- The park participates actively in the Mount Desert Island League of Towns (comprised of the managers of the four communities on Mount Desert Island and the Superintendent of Acadia). The League has identified five problems of islandwide significance and is acting cooperatively to seek solutions. These problems include solid waste management, affordable housing, property tax relief, regional planning, and water resources.

- The park actively serves on the University of Maine Forest Resources Research Advisory Commission, which sets the agenda for the University's resource management and wildlife research programs.
- The park serves on the Eastern Maine Development Commission Tourism Advisory Council which develops recommendations on tourism management issues for eastern Maine.
- The park helped in establishment of monthly informal breakfasts with the Superintendent, President of the College of the Atlantic, Director of Jackson Laboratories, Superintendent of public schools, Coast Guard Base Commander, Director of Mount Desert Island hospital, and the four town managers.
- A number of park staff serve on selected municipal conservation and planning committees.

Based on our experiences I can report both promises and pitfalls as a result of increased interaction with surrounding communities. The effort may tax one's nervous system, strain financial and staff resources, and encourage accusations of "federal interference." However it can also add vitality and excitement to an organization's blood that some feel has grown thin. Ultimately, it is the only way to ensure preservation of Acadia NP and Mt. Desert Island as well.

Jack Hauptman, Superintendent
Acadia National Park

Purple Loosestrife Control In Voyageurs National Park

By Jim Benedict

Voyageurs National Park was established in 1975 to preserve the outstanding scenery, geological conditions, and waterway system which constituted part of the historic route of the voyageurs who contributed significantly to the opening of the Northwestern United States. Located in northeastern Minnesota along the international boundary with Ontario, Canada, the park is distinct from the adjacent Boundary Waters Canoe Area Wilderness (BWCAN) in that motorized recreation, (e.g. motorboating and snowmobiling) are permitted in Voyageurs but not in the BWCAN.

Resource management and research at Voyageurs NP are designed to maintain, protect and restore the integrity of the park's natural ecosystem and ecological processes. The principles and techniques of restoration ecology are being used to restore the integrity of park resources to the extent practical and feasible. Implementation of these programs would be impossible without the cooperation and support of numerous federal, state, provincial and local agencies, organized groups, and private citizens.

A survey for purple loosestrife (*Lythrum salicaria*) in the park in August 1987 and June and August 1988 revealed scattered pockets of this exotic weed along the west shoreline of Kabetogama Lake. About 60 acres of wetlands are currently affected. Most affected sites are accessible only by boat and contain populations densities from 100 to greater than 100,000 plants per acre. If we fail to control these scattered, isolated weed populations in the next few growing seasons, they could foreseeably become widespread in the park and impossible to control or limit.

Purple loosestrife is an erect, herbaceous perennial of Eurasian origin. Introduced to North America in the early 1800s, it now poses a serious threat to native emergent vegetation and associated wildlife in shallow-water marshes throughout the northeastern and northcentral states. In Minnesota, this phenomenally prolific exotic has spread to more than 800 sites. Over 20,000 acres of wetlands now are covered with loosestrife. Because of its exotic origin, it has left behind all of its natural enemies and predators and multiplies with no checks and balances in North America. Loosestrife crowds out undisturbed native wetland vegetation, such as cattails, bulrushes, reeds and sedges, that are required by fish and wildlife for food, shelter and breeding, while having little forage value itself for fish and wildlife.

A coalition of Minnesota government agencies and conservation organizations (The Purple Loosestrife Coalition, Minnesota Trappers Association, Minnesota Waterfowl Association, and Pheasants Forever) has initiated a loosestrife control program in Minnesota. In 1987, purple loosestrife was designated a noxious weed in Minnesota by the commissioner of agriculture. In 1988, the commissioner designated wand lythrum (*Lythrum virgatum*) and winged loosestrife (*Lythrum alatum*) and any combinations thereof to be noxious weeds. This action was taken because identification of *Lythrum* hybrids and cultivars is very difficult if not impossible. The noxious weed law and 1988 order prohibit the sale and transport of all these plants in Minnesota.

The Minnesota Departments of Natural Resources (MDNR) and Agriculture (MNDA) are the two lead



Purple loosestrife control in Voyageurs NP, MN.

agencies responsible for coordinating loosestrife control efforts throughout the state. Voyageurs NP has been working with these and other state and county agencies, groups, and private citizens to control park loosestrife populations and to make areawide control actions more effective. Control work and permitting for loosestrife control are being coordinated among landowners in the Kabetogama Lake area.

NPS Management Policy on Exotic Plants and Action Threshold

The NPS defines exotic species as those that occur in a given place, area, or region as the result of direct or indirect, deliberate or accidental introduction of the species by humans. Exotic species, such as purple loosestrife, in Voyageurs NP are of special management concern because: (1) when they invade and displace native plant and animal species they could alter park successional processes, community productivity, diversity and stability; (2) they represent deviations from natural ecosystem conditions present during the era of the voyageurs; and (3) their presence provides the visitor with a skewed impression of the park's natural vegetation and wildlife.

Management of populations of exotic plants, up to and including eradication, will be undertaken wherever such species threaten park resources or public health and when control is prudent and feasible. The presence of one individual plant growing anywhere in the park is an unacceptable risk to Voyageurs' natural resources. The threshold for control action in Voyageurs' is, therefore, the presence of one individual plant in the park.

Implementing the Control Program

Methods for eradicating large, dense populations of loosestrife are not currently available. The most effective and efficient control strategy at this time is to quarantine loosestrife to sites already severely infested by: (1) monitoring wetlands that do not currently have loosestrife to ensure that any invasion is detected early and removing any discovered seed sources; (2) eradicating small populations in wetlands that are not severely infested; and (3) removing plants around the edges of severe infestations to prevent

further spread of the patch. A number of control or eradication methods have been tested: doing nothing, pulling and digging, cutting, burning, flooding, and broadcast and spot spraying with various herbicides.

Since August of 1988, we have been controlling purple loosestrife in Voyageurs by annually spot spraying individual plants of high density populations (from 10 to greater than 1000 plants per acre) twice between late June and early August with SEE-2,4-D, an aquatic herbicide which is not lethal to all wetland plants. Great care is taken to treat only the loosestrife and avoid spraying associated wetland plants, such as cattails, bulrushes, sedges, willows and alders.

To prevent regeneration, any flower stalks remaining after early August are cut and bagged, removed from the wetland, and burned. Treatment areas are posted as closed to swimming and fishing for three days after spraying. In low density populations, with young plants (less than 10 plants per acre) and localized areas where herbicide use may be restricted for public health reasons, we annually control loosestrife using non-chemical control methods, primarily pulling and digging of individual plants. Wetlands that do not currently have loosestrife are monitored to ensure that any invasion is detected early. The control program effectiveness is monitored annually.

To date, the most effective and least costly method for controlling loosestrife where the plants cannot be pulled, is with spot applications of herbicide. The aquatic herbicide SEE-2,4-D effectively kills purple loosestrife while not posing a threat to public health. SEE-2,4-D is biodegradable and very short-lived, quickly inactivated when it contacts moist soil. SEE-2,4-D is approved by the U.S. Environmental Protection Agency and the Minnesota Department of Natural Resources for use over open water, such as wetlands. Spot application allows effective use of the herbicide with little or no damage to desirable perennial plants. SEE-2,4-D is taken up through leaves or young stems and will kill any herbaceous, broadleaved plant that it contacts on these tissues. This makes it important to treat only the loosestrife and avoid damaging the desirable perennials. If this can be accomplished, most of the loosestrife will be removed and the relatively small "holes" in the vegetation will quickly fill with other perennials.

Follow-up treatment with SEE-2,4-D for at least three or four more seasons will be necessary to take care of missed plants, new seedlings that will germinate, the roots of many older plants that will survive and resprout, and seed transported to the park by wind, water and wildlife from infested areas inside and outside of the park. Some level of control action using herbicides will be required on an annual basis thereafter for the foreseeable future. If we can prevent the park's loosestrife plants from setting and dispersing any more seed, we will gradually use up all the seed stored in the soil. Over time, therefore, we should see a dramatic reduction in the areal extent of the infestation.

As the park's purple loosestrife populations develop resistance to SEE-2,4-D, another selected broadleaf herbicide approved for use in aquatic environments will be used to control loosestrife for several years. At that time, we may switch back to using SEE-2,4-D or another approved herbicide. We can hope that a biological control agent for loosestrife will be found by the

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Vegetation Restoration Planning at Lincoln Boyhood National Memorial

By Noel B. Pavlovic

Many NPS units were created in the 1960s and '70s from a mosaic of natural communities and man-produced landscapes. The 200-acre Lincoln Boyhood National Memorial (LIBO), Spencer County, Ind., for example, was amalgamated in 1962 from a mosaic of reforested land, old fields and abandoned homesites. In 1984, I was asked by Mike Ruggiero, then Midwest Region Chief Scientist, to conduct a study of what the vegetation was like when the Thomas Lincoln family arrived there in 1816.

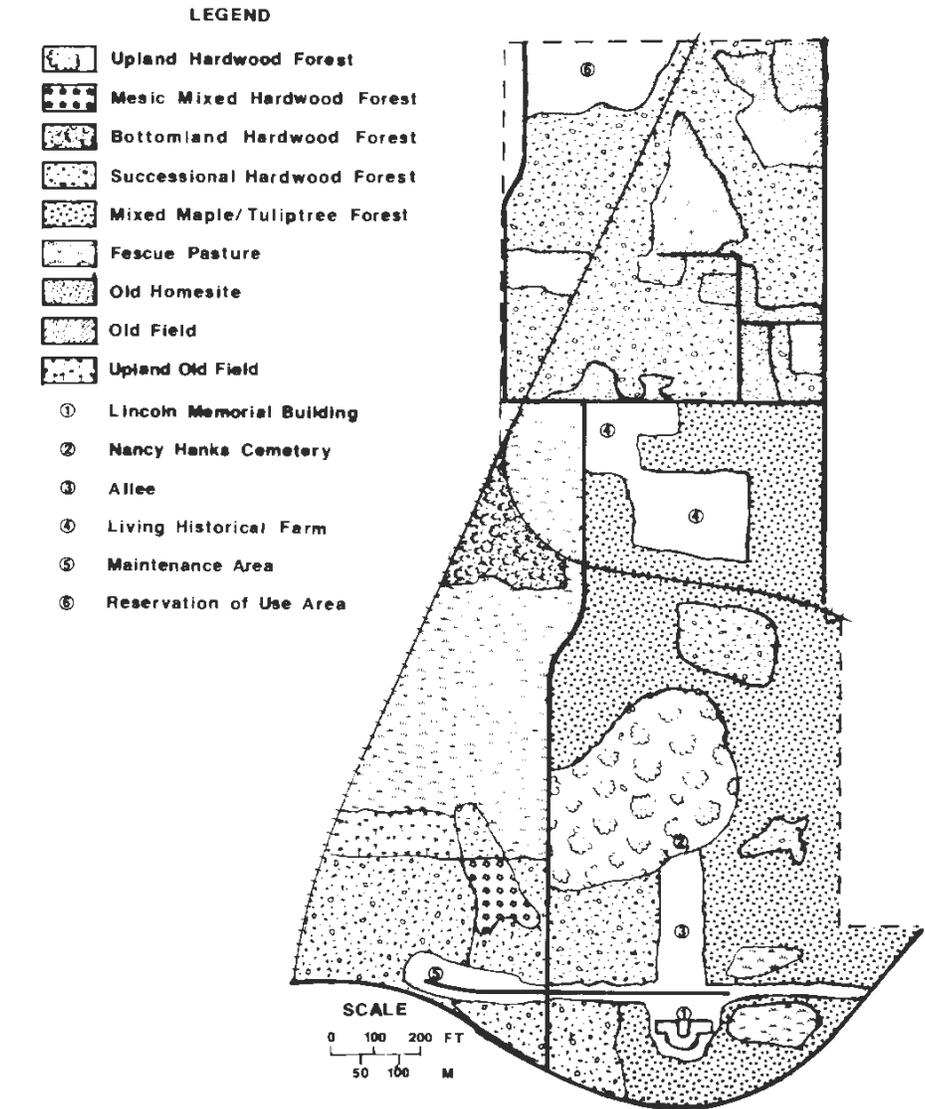
The project was motivated by the park's management goal of re-establishing the historic scene. Here Abraham Lincoln spent most of his childhood and suffered the loss of his mother, Nancy Hanks, from "milk sickness." We were to compare and contrast the 1816 vegetation with existing vegetation and recommend how the park could recreate similar community types. A ranking system was developed to assist in the prioritization of management activities. Unlike historical and cultural parks in the east, there were no records that would allow the recreation of a historically accurate landscape scene.

We used the 1805 General Land Survey Notes to examine the presettlement forest cover surrounding the land that was to become LIBO. We sampled the existing vegetation, using 52 stratified random 1:10th hectare plots throughout the park. All trees were identified and measured for diameter at breast height and shrub species were counted in a nested 1:20th hectare plot. Herbaceous frequency was quantified based on a systematic sample from 10 quadrats within each plot.

Classification Problems

Indirect gradient analysis and cluster analysis indicated a diverse type of communities bearing little relationship to topographic moisture gradient position. Consequently, the stands were classified relative to composition and past history and included bottomland and upland old fields, successional forest, upland old growth forest, mixed maple/tulip-tree forest (planted in the early 1900s) and abandoned homesites. Additional management research examined the possibility of tree planting in abandoned land and methods for eliminating Japanese honeysuckle.

Witness tree composition was examined across a topographic gradient and revealed the landscape was dominated by variants of oak-hickory forest. Based on these findings, along with soil and ecological information, Lincoln Boyhood was judged to have three types of oak-hickory forest: 1. bottomland forest, 2. mesic mixed forest, and 3. upland forest. The bottomlands



Map of existing vegetation at Lincoln Boyhood National Memorial.

and flatwoods had a mixture of pin oak, bitternut hickory, red maple, sweet gum, red elm and sycamore and river birch along stream courses. North facing drainages had a high diversity of mesic species, including white and black oak, black walnut, bitternut

and shagbark hickory and white ash, with an understory of dogwood, pawpaw, and spicebush. Such diversity was probably maintained by protection from fire and moderation of droughts. Uplands were dominated with white and black oak, shagbark and pignut hickory and an occasional white ash. More exposed sites had more black oak and some individuals of post oak. The typical understory contained dogwood, redbud, and black haw.

Two Remnants Survive

Sampling of the existing (1985) vegetation revealed two remnants of the presettlement vegetation. Surrounding the highest point in the park and the Nancy Hanks Lincoln cemetery is a remnant oak-hickory forest. This old growth forest retained its canopy composition and structure; however past grazing (hogs) had nearly eliminated the characteristic spring ephemeral geophytic herbs. The latter conclusion was based on the abundance of jack-in-the-pulpit and

Continued on page 23

Purple Loosestrife (Continued from page 21)

time resistance becomes a concern.

Our monitoring the effectiveness of herbicide control on loosestrife and associated native wetland vegetation within the park involves permanent plots that are rephotographed each year. Photographs were taken in August 1988 prior to and after treatment and each August thereafter at Kecs Kove and Rantas Bay.

Since August of 1988, we have sprayed all loosestrife stands in the park and vicinity three times. Although the areal extent of the infestation is unchanged, we have reduced the density of plants by 95 percent in the park's wetlands. The age structure of these stands also has been altered dramatically.

Instead of flowering plants that are three to six years old, the vast majority of flowering plants during the third spraying were one year old. By spraying twice a summer, until the seed source is used up, we will be able to prevent loosestrife from setting and disseminating any seed in these infested areas. As loosestrife's seed-bank becomes exhausted, we should see a dramatic reduction in the areal extent of the infestation, as well.

For more detailed information about our program, a copy of the park's Purple Loosestrife Control Plan may be had by calling (218) 283-9821 or FTS 780-5466.

Benedict is a Resource Management Specialist at Voyageurs NP.

Island Horses' Genetic Diversity Evaluated

By Susan Bratton, Robin Goodloe
and Robert Warren

Unlike most species of feral animals in NPS areas, free ranging horses have been considered a potential historic resource. For the barrier islands along the Atlantic coast, tales of Spanish mounts washed ashore from shipwrecks dominate the popular literature on the origins of the isolated herds. The management of island equids has long been controversial. The horses themselves are very popular with park visitors. Feral equids can, however, become campground pests or endanger people who expect them to behave like pets. The larger populations, such as that on Cumberland Island, GA, heavily utilize native marsh and inter-dune vegetation, which can encourage local soil erosion via grazing and trampling. Maintenance of "historic" horses may thus conflict with other natural resources management objectives.

In 1986 and 1987, a research team from UGA, Athens, collected blood samples from feral horses on Cumberland Island National Seashore, and Cape Lookout National Seashore (Shackleford Banks), NC, by immobilizing adult animals with etorphine hydrochloride and xylazine hydrochloride. (Initial attempts at immobilization resulted in two deaths due to capture

myopathy. This problem was corrected by administering sodium bicarbonate – physiological solution intravenously to animals while they were immobilized.) The team also collected blood from ponies on Cape Hatteras National Seashore (Ocracoke Island) and from Chincoteague National Wildlife Refuge on the southern end of Assateague Island when the animals were corralled for annual veterinary care. Samples were sent to the laboratory of Dr. E. Gus Cothran in the Department of Veterinary Science, University of Kentucky, where standard starch gel and polyacrylamide gel electrophoresis were used to assess genetic variability at 10 enzyme or protein loci. In addition, red cell alloantigens at six blood group loci were detected using standard immunological procedures. These types of analyses had already been performed for many breeds of domestic horses, so genetic resemblance between populations could be easily determined.

The study looked first at measures of genetic diversity including heterozygosity and the number of alleles per locus. All 16 loci analyzed were polymorphic in at least one of the populations, and 10 were polymorphic for all of them. The samples from Assateague Island had the greatest degree of polymorphism. The four island horse populations tended to share the same

predominant or fixed allele at each locus and these, in general, corresponded to the predominant allele in domestic horses. All alleles identified had already been reported for domestic horses, implying the barrier island herds did not possess any unique genetic material found only in feral populations.

The results also provided little evidence of inbreeding. No significant deficiency in mean multilocus heterozygosity was apparent, although the mean number of alleles per locus in some feral herds was slightly lower than the mainland breeds. This, however, may have been the result of small sample sizes. The Assateague Island sample produced 74 of the 95 alleles known to occur at the loci analyzed, which suggests the Assateague Island herd is quite genetically diverse and harbors a high proportion of all domestic horse alleles.

The greatest genetic similarity among the island populations was between the Assateague Island and Cumberland Island populations, although there is no historic evidence to suggest they arose from common stock. When compared to domestic breeds, Cumberland Island horses were similar to Tennessee Walkers, while Assateague Island ponies were similar to Belgian workhorses and Shetland ponies. Since individuals of the latter breed were introduced into the Assateague Island population in the early 1900s, the similarity is not surprising. Comparison to other breeds suggests the island horses do not represent a unique gene pool from a common ancestral strain, nor are they more similar to one another than they are to various domestic horse breeds.

From a managerial perspective, the data indicate there is little reason to treat the barrier island horses as a unique or valuable genetic resource and little evidence that any of the herds represent a specific historic Spanish bloodline. This conclusion is supported by park records and oral history.

Efforts to outbreed and improve the coloration in the Assateague Island herd resulted in the introduction of Shetland ponies in the early 1900s. More recently, two Spanish barb stallions and 40 western mustangs were released on the island. On Hatteras Island there have been similar infusions of Thoroughbred, Arabian, Quarter Horse and Spanish mustang blood. The original Cumberland Island stock included saddle horses, circus horses, and western mustangs released in the 1920s as well as more recent arrivals, such as an Appaloosa stallion, whose progeny may still be seen in the wilderness area. The horses on Shackleford Banks probably derive primarily from stock brought to the island after the 1899 hurricane, and may be a mix of Hatteras Island animals, Quarter Horses, Tennessee Walkers and other breeds.

Although free range horses and ponies have been present on some of these islands since the colonial period, the present genetic composition of the herds does not appear to derive solely from relict early Spanish or English releases, but rather is the product of breeding activities conducted over the years by island residents. The Cape Hatteras horses, in fact, have a close genetic resemblance to Standardbred horses, a breed that developed in the United States in the late 17th and early 18th century. It would, in fact, be difficult to select the herd that is the most historic. All have recent genetic additions, and at least two (Shackleford Banks and Cumberland Island) may derive primarily from post-1900 introductions.

If feral equids remain on the coastal barrier islands
Continued on back cover

Lincoln Boyhood Vegetation (Continued from page 22)

green dragon, both species having toxic calcium oxalate (a deterrent to hogs), and poison ivy and the fact that the Lincolns had hogs. The forest showed no evidence for selective cutting of the overstory. Unlike the surrounding communities that were pastured in the 19th century, this stand lacked rank growth of Japanese honeysuckle. The other remnant was a small pin oak and bitternut hickory flatwoods at the western edge of the park. This remnant forest and xeric west-facing successional forests were similar in composition to presumed presettlement stands.

By the turn of the century, all the land surrounding the old growth forest was used for pasture. During the late 1920s or early 1930s a large portion of LIBO was reforested by the Civilian Conservation Corps. Plans indicated the intent of planting a wide variety of species; however the existing stand composition has low species diversity and fails to represent a natural community for this region. The overstory is a mixture of tulip tree and red or sugar maple. Sugar maple and tulip tree were introduced to the area at this time. The majority of the other forest types failed to compare with natural communities due to the predominance of shade tolerant and fire intolerant mesic species (such as red and sugar maple), the absence of oaks and hickories, the lack of herbaceous cover, and the ubiquity of Japanese honeysuckle.

Critical Management Issues

Critical management issues identified included the abundance of Japanese honeysuckle, vegetation inertia in abandoned homesites caused by exotic perennial lawn grasses, absence of oaks and hickories in the majority of the planted forests, the invasion of sugar maple and to a lesser extent tulip-tree into the old growth forest and the low abundance or absence of spring ephemeral herbs. Prescribed burning in some sections of the park may eliminate the invasion of shade tolerant and of fire sensitive tree species.

Management experiments to eliminate Japanese honeysuckle demonstrated that efforts may be most successful under a forested canopy where prolific growth is

absent. Use of glyphosate may also eliminate the few herbs present in these anthropogenic communities, unless it is applied in the fall after herb die back. Trial plantings of spring ephemeral herbs indicated that ground cover restoration is possible. Glyphosate was shown to reduce the cover of exotic perennial grasses in old lawns and allow invasion of successional herbs. Although the herbicide fails to kill all of the grasses, a somewhat natural successional process has been initiated.

Oak trees (black, white and pin) that were planted in the old field showed deer browse, which may be why old field succession has been so slow. During the final sampling, seedlings of shingle oak were found and the presence of these was taken as a positive sign for natural establishment of large-seeded tree species.

Restoration priorities were based on a quasi quantitative numerical ranking system divided into the following categories: ecological significance, historical significance, relative restoration cost, urgency for and practicality of restoration. Although all categories were given equal weights, they could be weighted to give certain categories greater importance. Stands given high priority include the upland old growth forest and the bot-tomland forest.

Forest restoration to approximate the presettlement vegetation at Lincoln Boyhood will require a long-term concerted effort of management. Restoration will require innovation, creativity, and monitoring. Failures may be expected. Those attempting to achieve the vision of an approximate oak-hickory forest should not be discouraged by failures and setbacks. All such efforts will contribute to our knowledge of community restoration.

Copies of the 106-page report may be obtained from the Superintendent, Lincoln Boyhood National Memorial, Lincoln City, IN 47552.

Pavlovic, is Biostatistician for the Research Division at Indiana Dunes National Lakeshore, IN. His expertise is in experimental design, statistical analysis, and plant population ecology.

New Park Science Address and Phone Number

4150-A S.W. Fairhaven Dr. • Corvallis, OR 97333
(503) 754-0263 or (503) 758-8503
FAX (503) 737-2668 • Forest Resources

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JAMES M. RIDENOUR, Director
National Park Service
U.S. Department of the Interior

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Horses' Genetics (Continued from page 23)

(the decision presently is made on a park-by-park basis), it would be desirable to maintain the populations at as small a size as possible to prevent vegetation damage. If the population is too small, however, and is isolated from other potential sources of new genetic material, in-breeding will result, which in turn reduces population viability. Estimates based on present sex ratios and harem composition for Cumberland Island predict that to maintain an effective population size of 50 animals, the total pre-foaling population must number about 80 animals. A study of feral impacts on salt marsh, conducted by the University of Georgia CPSU, suggested a vegetation carrying capacity of 45 to 75 animals. Adjusting for differences in harem size, a similar projection for Assateague Island National Seashore suggests a herd of about 100 animals is sufficient.

Regulated breeding and continued reintroduction of stock have maintained genetic diversity in the pony population at Cape Hatteras National Seashore, which stands currently at fewer than 30 animals. Further introductions probably will be necessary, and probably should be conducted with other island ponies. The same type of strategy would be appropriate for Assateague Island. Animals should, if possible, be from other island habitats and from populations with differing gene frequencies. Since the horses of Cumberland Island and Shackleford Banks are of relatively

recent and very diverse origin, the use of mainland stock for outbreeding would be appropriate, and was a management technique utilized by island residents prior to park designation.

Genetic evaluation should be conducted prior to determining management strategies for feral animal species (or cultivated plants) assumed to be of historic significance. Genetic data may be used to determine the probable history of a population, its relationship to other populations, and the degree of in-breeding it may already have experienced. Genetic evaluation also adds scientific objectivity to potentially emotional issues such as the management of feral equids. Many techniques, such as electrophoresis, previously used only by a few progressive researchers now are widely employed and comparative data bases may already exist for domestic breeds or cultivars. These methods also are applicable to projects concerning endangered species with very limited or isolated populations and may be valuable in the course of population recovery or reintroduction projects.

The final report from this project has been submitted to the *Journal of Wildlife Management* for review. Further information is available from Robin Goodloe at the University of Georgia, Athens.

Bratton is Coordinator of the U/IGA's NPS/CPSU; Goodloe and Warren are with U/IGA's School of Forestry.