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Window to the Past: Providing a Framework for theFuture

By Carol McNulty-Huffman

Historians are fond of saying that those who forget the past are doomed to repeat it. Such thinking can be valuable for park natural resource managers as well. Taking the time to look at where you have been and what has happened in your park in the past can provide a valuable framework for determining future direction. Often, however, with daily activities demanding your attention, it is difficult to find the time for reflection and research.

In choosing a topic for my master's thesis, I looked for something the park staff would find useful but probably would not have time to do on their own. Dave Haskell, Chief of Natural Resources and Science at Shenandoah NP (SNP), expressed a desire for a comprehensive record on the evolution of resource monitoring activities in the park. I jumped at the opportunity to dig through park files, old research reports, journal articles, and anything else I could find that might prove useful. With the help of John Karish, Mid-Atlantic Regional Chief Scientist, the park staff and I developed this project.

My thesis objective was to document monitoring activity between 1978 and 1988 in 5 areas of the natural resource management program at SNP--air quality, fisheries, integrated pest management, vegetation, and wildlife. I spent 2 years reviewing and synthesizing information, and completed a thesis that the park staff has found useful.

A separate thesis chapter addresses each of the 5 subject areas by (1) presenting a synopsis of research efforts, (2) identifying management objectives, (3) reviewing monitoring programs and presenting a chart of the results or the parameters monitored, and (4) discussing the relationship between monitoring data and management concerns. Following are the highlights of my research.

Big Meadow, an ecologically diverse open area at Shenandoah NP, is both a cultural and a natural resource. *(Photo by Dan McNulty-Huffman)*

Using a flame thrower to selectively kill black locust trees was one of the techniques used for meadow management at Shenandoah HP in August 1983. *(Photo by Dan McNulty-Huffman)*

Research Highlight

SNP, a crown of forested peaks and hollows, lies along the crest of the Blue Ridge Mountains in Virginia. The blue haze for which these mountains were named occurs naturally; it is a combination of dust particles, water vapor, and organic compounds given off by the vegetation, and it is deepening as air pollution increases in the eastern United States.

Air pollution is recognized as one of the most serious threats to the natural resources of SNP. The park is designated a Class I airshed, with special attention to protecting visibility values; thus it has maximum protection under the Clean Air Act from future air quality degradation.

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PARK SCIENCE

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A report to park managers of recent and on-going research in parks with emphasis on its implications for planning and management.

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Editorial

By F. Eugene Hester
Associate Director, Natural Resources

Recently Secretary Babbitt has identified the need for a national focal point for biological information -- a National Biological Survey -- perhaps similar to the U.S. Geological Survey for physical resources and the National Oceanographic and Atmospheric Administration for weather information.

The concept involves the collection, analysis, and dissemination of biological information by a research organization without management responsibilities to maintain objective, credible information not driven by an individual bureau's management decisions.

Biological inventories and research are located in nearly every bureau in government. By consolidating resources to provide a more coordinated and systematic approach to understanding the status and trends of the nation's biological resources, we should be able to anticipate such things as threatened ecosystems. Increasingly there is a recognition that ecological problems cannot be resolved on a single issue or a single species basis, but must be addressed on an ecosystem basis. Early recognition of ecosystem problems should enable agencies to identify more options for resolution than when the problems are identified by such things as petitions to list endangered species at the eleventh hour.

Implementation of this concept within the Interior Department requires many important decisions as to which present financial and manpower resources could be consolidated into this new National Biological Survey organization. This requires an analysis of which resources are essential to bureau missions and local day-to-day management decisions, and which could appropriately be devoted to the new organization to address the broader ecosystem and national needs. Developing standardized approaches to data collection and data management is an essential part of this new concept.

Options for developing this new concept have been formulated. The National Park Service has much to offer and much to gain from this initiative.

With this issue, *Park Science* is going to a slightly larger typeface and a few additional pages. Complaints about the eye-watering print size were well founded, but the amount of "good stuff" coming in from the field simply could not be accommodated in larger type so long as we were bound by a 24-page format.

The compromise of 32 pages of "10-point on 11" type, gives the bulletin the equivalent of about 4 1/2 more pages of the former "9-point on 10" copy. The additional information contained in each issue will take slightly longer to read in its entirety, but the larger type will make reading go faster. One reader recently complained, "The headlines intrigue me, but I can't squint enough to read the articles." The current issue is our attempt to bring the entire contents into easy focus, cover a variety of information from across the Park System, and still keep "reading time" to a minimum.

We continue to urge authors to stay within the outer limits of available space–which is 6 double spaced pages. And we still require that all manuscripts be run by the Regional Chief Scientist and any Superintendent whose park is the subject of the article.

Also, we welcome photographs. Since *Park Science* is a black and white, offset publication, what we need are photos (**not negatives**) that contain enough contrast to "pick up" in black and white. A good way to ascertain whether your color photos will be acceptable is to run them through a photo copier. If they come out looking good in black and white, they'll do. – *Editor*

Air quality research in the park has been extensive; scientific projects have ranged from acid rain research to studies about pollution effects on vegetation. Ozone damage has been found on several plant species, with widespread damage on milkweed. High levels of sulfur were found in lichens.

In 1983 the park staff began a program to monitor ozone and sulfur dioxide levels. Air quality monitoring has indicated that levels of ozone and sulfur dioxide in the park between 1983 and 1988 were just barely acceptable according to standards established by the EPA. For 2 days in 1988 ozone levels exceeded the standards that were established to protect public health.

Visibility Cut in Half

Acid deposition monitoring has showed that precipitation in the park is more than 10 times as acidic as natural precipitation. Visibility monitoring has determined that SNP visibility is among the worst reported at any of the NPS visibility monitoring sites. Comparison with historical records indicates that visibility in the area has decreased more than 50 percent since 1948.

As early as 1936, work focused on the study and management of native brook trout populations so that these fish could be harvested by recreational anglers without negative population impacts. Much of the early fisheries work was accomplished by USFWS and the state of Virginia. The NPS expanded its involvement in fisheries management in 1981and began a comprehensive monitoring program. In addition to providing opportunities for the public to fish, the fisheries management plan adopted in 1987 aims at preserving native brook trout as an essential element of the aquatic ecosystem.

The essence of this philosophy of management is demonstrated by the new fishing regulations developed for the park. Under the old regulations, all waters in the park were open to trout fishing unless specifically closed. Under the new regulations, all streams in the park are closed to fishing except those specifically designated as open. Unless the brook trout population in a stream is consistently adequate to sustain harvest, the stream will be closed to fishing. These regulations are based on the concept that brook trout have value in the ecosystem beyond their contribution to angler harvest.

Gypsy Moth Management History

The third monitoring program I reviewed in my thesis was integrated pest management which, at SNP is predominantly gypsy moth management. The earliest record I could find of gypsy moths in the park described the capture of a male moth in 1969. It was not until 1984 that gypsy moth infestations became a regular occurrence and the park staff began a comprehensive monitoring and management program. The heaviest defoliation documented in my research was in 1988 and encompassed 16,000 acres (8% of the park). By 1990 defoliation had reached 40,000 acres. Repeated use of insecticides for gypsy moth control is considered only in developed areas that represent about 4 percent of the park land.

Vegetation management has been extensive and includes I&M and management of meadows, vistas, backcountry, and fire. Botanical work at SNP began in the early 1900s, before creation of the park. Much of this early work involved collecting plants and documenting the park's flora.

Big Meadow, an ecologically diverse open area in the center of the park, has attracted the interest of scientists and park staff alike. A fascinating evolution of thought about the meadow, as well as the evolution of management actions taken to protect the meadow, can be traced. Early park management practices to keep the meadow open and similar to the way it appeared in historic times involved mowing the area every fall. Between 1935 and 1969, the meadow went through successional changes that turned the area from a meadow where grasses, sedges, and a few forbs were dominant, to an area that contained about 12 different plant communities, including extensive black locust thickets.

Meadow Mosaic Achieved

Because mowing seemed to encourage the sprouting of black locust trees, park staff investigated other management techniques such as repeat mowing, fire, cutting of individual trees, and treatment of stumps with an herbicide. By 1988, a combination of these methods produced a meadow that appeared to be stabilizing into a mosaic of grass, herbaceous, and shrub communities. Currently, annual maintenance of the meadow involves cutting black locust stems by hand and treating the stumps with an herbicide.

Wildlife management at SNP has focused on bears and deer. Extensive research has been conducted on both of these species. Park staff is working to develop a comprehensive monitoring and management program for deer.

An annual black bear population survey was begun in 1983 and indicates that bear population levels through 1988 were relatively stable. The evolution of bear management in the park, from the time of numerous bear/human conflicts to a time when it is uncommon to see a bear in the park, reflects an emphasis on controlling visitor activities rather than taking action against offending bears.

To Sum It Up...

Taking time to review the monitoring program at SNP was a valuable learning experience for me, and provided the park staff with a useful document. For parks that have not yet taken the time to synthesize and document past resource management activities, Dave Haskell, John Karish, and I highly recommend it. The process provides insights for new directions, reminds you not to repeat past mistakes, and helps reinforce the things you're doing right.

Maybe you can even find a naive grad student like me to do most of the work for you.

McNulty-Huffman is a Natural Resource Specialist at the NPS Denver Service Center. Copies of her thesis, A Review of Natural Resource Monitoring at Shenandoah NP between 1978 and 1988, *may be had from the author at NPS, DSC-TEA, PO Box 25287, Denver, CO 80225-0287; 303-969-2462.*

In the next issue...

- **"Insularity Problems in Rocky Mountain Bighorns"** by Francis J. Singer
- **"Wildland Fire Management at Carlsbad Caverns NP"** by Tim Stubbs
- **"USGS Provides Baselines for Two Alaska Parks"** by J.G. Crock, R.C. Severson, and L.P. Gough
- **"Interpreting Resource Management on a Self-guiding Trail"** by Dave Clark, Craters of the Moon National Monument
- **"Effects of Fire on Cultural Resources in Mesa Verde NP"** by William H. Romme, Lisa Floyd-Hanna, and Melissa Connor
- **"Leadership and Management Course: A Multi-disciplinary Approach to Training at Albright"** by Mark Maciah
- **"Ice Age Floods in Eastern Washington"** by Dan Brown
- **"Evaluation of a Particular Groundwater Basin in Mammoth Caves NP"** by Joe Meiman
- **"High Altitude Mountaineering: Visitor Types and Management Preferences at Denali NP"** by Elan Ewert.

NPS Team Documents Hurricane

Before Hurricane Andrew struck everglades NP, this was a tropical hardwood hammock in Long Pond key near Royal Palm.

By Gary Davis

How did Hurricane Andrew affect the resources of NPS units in South Florida? Immediately after the storm a team of 25 scientists conducted a rapid appraisal of hurricane effects in Biscayne Bay NP, Everglades NP, and Big Cypress National Preserve. They made field observations for one week and gathered information from colleagues who were also active in the field before and after the storm.

Teams were formed for Marine Resources (James Tilmant, team leader), Freshwater Resources (Charles Roman, team leader), Upland Resources (Lloyd Loope, team leader), Archaeology (George Smith, team leader), Air Quality (Brian Mitchell, team leader), and GIS (Donald Myrick, team leader).

Chronic anthropogenic stresses, such as habitat fragmentation, non-native species, altered water resources, and air pollution have affected ecosystem stability in south Florida. Can such stressed ecosystems recover to pre-storm conditions before the next major disturbance? Do storm clean-up activities threaten resources and human health and safety in the parks? These questions needed to be addressed immediately to protect park resources and to develop long-term strategies that assured their perpetuation.

Impacts

Hurricane Andrew was a small, intense hurricane. When it made landfall in southern Florida at 5 a.m. on Aug. 24, 1992, it was a category 4 hurricane, one of the most intense storms ever recorded in Florida. The National Weather Service estimated the maximum sustained wind speed at 150 mph.

The storm hit near the time of high tide. It produced a large but localized storm surge in the coastal portion of southeastern Dade County, 15 miles south of Miami. Storm surge overtopped coastal water control structures and levees. The USGS estimated Hurricane Andrew's maximum storm surge at 16.2 feet. A 105-foot boat was blown from its deep water anchorage and transported inland.

Coastal flooding was minor, but high winds caused extensive damage throughout the 25-mile wide storm path across the state. Rainfall from the storm was low, presumably in response to the storm's rapid forward movement. Rainfall and water levels were above normal throughout most of southern Florida before Hurricane Andrew arrived. Inland flooding was a problem primarily in southeastern Dade County, where saltwater inundated a large portion of farming areas.

The assessment team documented resource conditions immediately after the storm and identified actions needed to avert additional resource damage and recover irreplaceable information. While storm effects on natural resources were dramatic, initial ecosystem responses appeared normal.

Trees sustained severe damage, especially mangroves and tropical hardwoods. Many defoliated trees resprouted within weeks of the storm, and rare plants in hammock and forest understories were relatively unaffected. Coastal wading bird rookeries, eagle nests, and red-cockaded woodpecker cavity trees were damaged, but no major mass mortality of wildlife occurred.

Hurricane winds and water spread non-native plants. Exotic animals escaped from storm damaged facilities and entered the parks. Some freshwater fish populations declined dramatically after the storm. Storm damage to the South Dade water delivery system interrupted normal freshwater flow into Florida Bay. The storm scoured shallow marine communities and altered marine water quality. An artificial reef broke up and moved into Biscayne NP. Sea turtle nesting beaches may have been enhanced by storm overwash, and seagrass beds survived remarkably intact. Windthrown trees and storm-scour exposed previously unknown archeological artifacts on ship wrecks and upland sites. Disposal of urban debris from the hurricane threatens air and water quality in the parks.

Short-term Recommendations

The storm destroyed most of the NPS hydrologic, meteorologic, and air quality monitoring networks in the parks. They need to be replaced and activated to measure the potential effects of post-hurricane cleanup on air and water quality and to evaluate short-term ecological responses.

Historic shipwrecks exposed by the storm need to be surveyed, stabilized, and monitored to enhance site protection. Backcountry patrols need to be increased over normal levels to detect and remove non-native animals before they become established in the parks. Removal techniques for exotic animals may need to be developed and tested in conjunction with other agencies. Short-term ecological storm effects need to be determined, and boat warning signs protecting manatees should be replaced.

Studies to determine the short-term ecological effects of Andrew need to be initiated

Damage at Everglades National Park

After Andrew, the hammered hammock looked like this. *(Photos by James R. Snyder)*

while the first, most dramatic changes are taking place. Historical data need to be compiled and analyzed to provide a basis for designing studies and establishing monitoring plots stratified by hurricane influence. Opportunities to determine spatial variability of storm effects, examine the roles of storm-altered detritus distribution and nutrient cycling, and to evaluate storm effects on fishery recruitment, subtidal sediments, and heavy metals in hardwood hammocks soon will be lost.

Surveys of seedling non-native plants need to be conducted to assess the extent and magnitude of storm-caused spread, and to determine if new control methods should be developed. The status of mangrove forests and rare plant populations will not be apparent until a year after the storm. The environmental monitoring networks need to be hardened to survive future storms in addition to restoring their pre-storm capability. Additional monitoring sites are needed to evaluate storm effects on park resources and link upland effects to estuarine and marine systems. Detection of storm impacts on fish and wildlife will require intensified surveys during reproductive seasons to document reproductive efforts, success, and recruitment.

Significant park staff time will be required to coordinate debris disposal regulated by other agencies to assure protection of park interests. The NPS needs to characterize emissions from debris burning, model air quality and visibility, and monitor air quality, visibility and meteorology to establish actual impacts on park resources.

Removal of artificial reef KEVORKIAN debris from natural reefs needs to be initiated before the debris is incorporated into the sediment and overgrown. Its damage to the natural reef needs to be documented to help develop guidelines for future artificial reef placement. Storm breached plugs on Cape Sable permit accelerated saltwater intrusion into coastal marshes and will continue to widen with tidal flushing if not repaired soon. More permanent solutions to restoring the integrity of these marshes need to be found, such as filling in longer sections near the coast, to prevent this kind of damage and repair costs with each hurricane.

Fire management practices need to be verified following storm-altered fuel loads. Impacts of storm cleanup activities on rare plants and opportunities for interpreting hurricane influences on native communities need to be evaluated. The effects of storm-altered shelter for manatee and crocodile populations on protection activities must be considered before public facilities and access are fully restored.

Long-term Monitoring

Long-term monitoring also is needed, to differentiate natural dynamics driven by hurricanes, fires, and freezes from changes caused by chronic environmental stresses. The monitoring program would be designed to (1) determine current and future health of ecosystems, (2) establish empirical limits of variability, (3) diagnose abnormal conditions early enough to implement effective remedial actions, and (4) identify potential agents of ecological change.

Research Agenda

Finally, experimental research is needed to assess the potential of Hurricane Andrew to alter flows of energy and nutrients in South Florida ecosystems. Potential nutrient releases from storm-related detritus and the effect of changes in landscape heterogeneity on large animals need to be measured over time. A variety of approaches will be necessary to address these questions. Past research and restoration efforts have focused on individual species or habitats, usually within limited spatial or temporal scales.

An integrated understanding of the system's response to anthropogenic and natural perturbations such as Hurricane Andrew would greatly refine ongoing restoration and management activities. Several critical hypotheses concerning the ecosystem's productivity and resilience must be resolved to produce a scientific basis for restoration and management.

In the weeks following completion of the resource assessment, a prioritized list of projects was completed, based on recommendations of the assessment team. That list was presented to Southeast Regional Director Jim Coleman for development of funding priorities by the superintendents at Everglades, Biscayne, and Big Cypress. A multipark meeting took place on Jan. 29, 1993, to establish priorities for the funding available for resource recovery activities. Consensus was reached to proceed immediately on several projects for osprey, cape sable sparrow, hydro station repair/upgrade, and documentation of the Fowey site. Other priorities will be set after the various scopes of services are received.

Davis acted as the NPS team leader in this study; he is a Marine Research Scientist at Channel Islands NP.

Great Basin NP and USGS Cooperate On a Geologic Mapping Program

By Janet L. Brown and Vidal Davila, Jr.

The U.S. Geological Survey (USGS) Geologic Division, through an Interagency Agreement with NPS, is funded to provide basic geologic mapping and geologic thematic data sets to the geographic information System (GIS) newly established at Great Basin NP (GRBA) in Nevada. The GIS is a computer hardware and software system designed to collect, manage, analyze, and display spatially referenced data. The new geologic thematic data sets or themes can then be merged with digital data sets such as hydrography, topography, and transportation, or other themes such as soils or vegetation, to be analyzed for park management purposes. The GIS data sets will be shared between USGS and NPS, as well as local, state, and national data users.

Janet L. Brown (USGS), Vidal Davila, Jr. (NPS-GRBA), and Albert J. Hendricks (NPS-GRBA) developed the research proposal and Interagency Agreement (IA), to provide current large-scale geologic mapping of six quadrangles at 1:24,000 scale. This meets the baseline inventory required by Great Basin NP (Fig. 1).

Interagency Management Plan

The GRBA draft General Management Plan proposes development in several locations in Kious Spring and Lehman Caves 1:24,000 topographic quadrangles, and these proposed developments need geologic evaluation before construction. Brown will act as project manager to coordinate the IA with time frames, budget constraints, and the timely preparation of required maps, reports, and GIS data sets. In addition to having been an interpretive Ranger-Naturalist in two National Parks, Brown has published USGS interpretive geologic maps and USGS bulletins. Her research includes sedimentologic, stratigraphic, and structural analyses of Laramide intermontane basins in the Western Interior.

Academic collaboration for the project is provided by Dr. Elizabeth L. Miller, Associate Professor of Geology at Stanford University, and Dr. Phillip B. Gans, Assistant Professor of Geology, U/CA Santa Barbara. Both Drs. Miller and Gans have done extensive geologic mapping in the Great Basin over many years, have published extensively on geometry and kinematics of normal fault systems in the Basin and Range province, and have made metamorphic and geochronologic studies in the North and South Snake Range. Davila is responsible for managing research in the park; Hendricks, Park Superintendent, integrates research programs with park policy and management needs. Kurt S. Pfaff, Physical Science Technician, acts as archivist to build the park geologic library and provide field assistance.

The project will provide current large-scale geologic mapping of six quadrangles at 1:24,000 scale in two forms:

(1) as published maps, and

(2) as a digitized product compatible with the needs of the GRBA GIS.

These data provide information on suitability and limitations of bedrock and surficial geology for NPS resource uses and activities. The geologic maps will provide data in support of the NPS Global Climate Change Research Plan for GRBA. The USGS Water

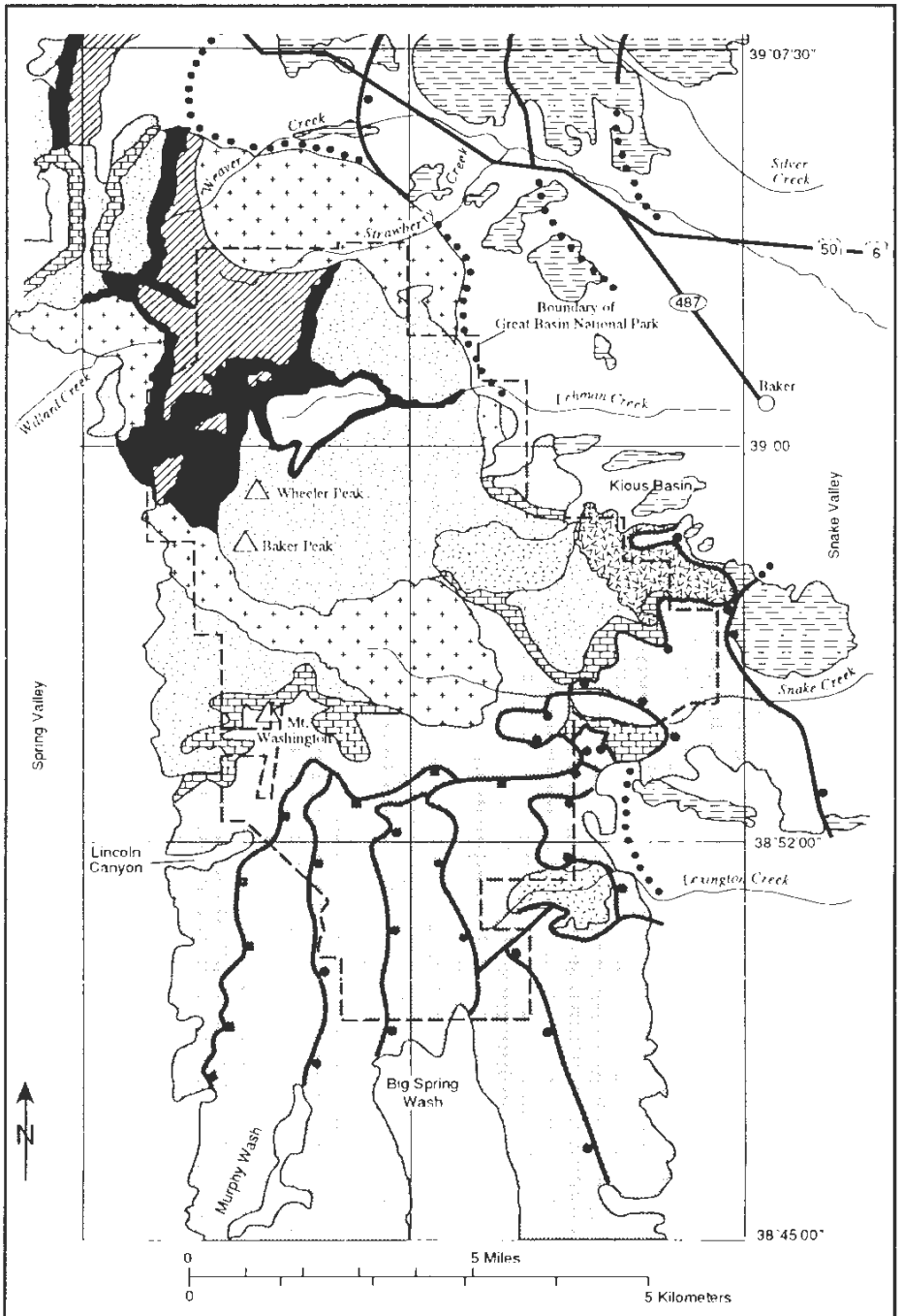
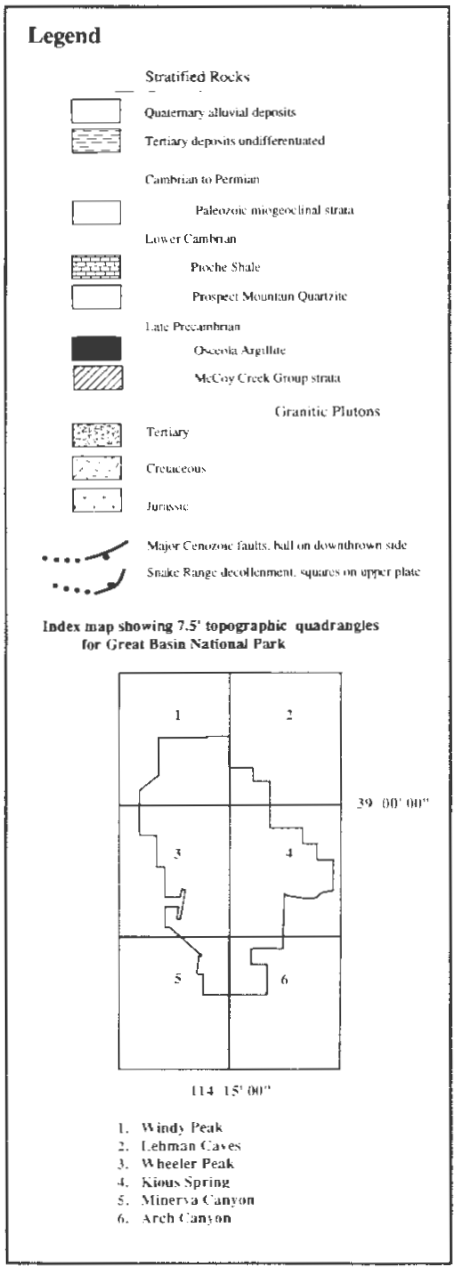


Figure 1

Resources Division and NPS currently are collaborating on research on the water and energy budget for Baker Creek east of the South Snake Range. The geologic mapping and GIS data base support two current USGS Geologic Division Programs: the Evolution of Sedimentary Basins Program in the Eastern Great Basin, NV; and the Basin and Range to Colorado Plateau Transition (BARCO) Program. The maps also will be archived with the national GIS geologic data base in the USGS National Mapping Division Program as well as with the GIS geologic data base being developed for the Nevada Bureau of Mines and Geology in Reno.

Objectives, Methods, and Products

Great Basin NP, a region of great structural complexity, provides important insights into the Cenozoic history of this part of the Basin and Range province. The South Snake Range represents the transition between the unextended Confusion Range structural block to the east and the more highly extended region encompassing the Snake, Schell Creek, and Egan Ranges to the west (Gans and Miller, 1983). It exposes the southern extent of an important low-angle fault system, the Snake Range decollement (Misch and Hazzard, 1962), interpreted by Misch and Hazzard (1962) and by Whitebread (1969) as a thrust fault. The South Snake Range project will provide up-to-date large-scale geologic mapping and data on the movement history of faults in the range, the deformational and intrusive history of metamorphic and igneous rocks, and information on the young uplift history of this impressive mountain (based on studies of Cenozoic conglomerates and apatite fission-track geochronolgy).



The South Snake Range project includes six 1:24,000 topographic quadrangles (Fig. 1), from north to south: Windy Peak, Lehman Caves, Wheeler Peak, Kious Spring, Minerva Canyon, and Arch Canyon. To date, there is no published geologic mapping at 1:24,000 scale of the South Snake Range (see Suggested References).

Field procedures for GRBA will include standard geologic field mapping methods, field checking, and compilation. The field compilation will be assisted by aerial photo interpretation of the geology using the Kern computerized photogrammetric mapping (PG-2). As the geology is mapped and compiled, it will be drafted onto registered stable base greenlines and published as paper copy in USGS Open-File Map and Report format. USGS Open-File Reports serve to make the maps quickly available to the NPS and the geologic community. Additionally, the digitized geologic quadrangles will be available in digitized form as either computer discs or possibly as CD-ROM. A USGS Bulletin on the interpretive geology of the park, prepared in cooperation with NPS, will be written by Brown.

Field work commenced in the summer of 1992. Three geologic quadrangles (Lehman Caves, Windy Peak, and Kious Spring) have been submitted already as USGS Open-File Reports. In the following two years of the project, the remaining three quadrangles (Wheeler Peak, Minerva Canyon, and Arch Canyon) will be mapped and then published as paper copy in USGS Open-File Report format and in digital form. The digitized versions of the six large-scale geologic maps can be combined into a smaller scale version that includes the whole park and is appropriate for other management uses.

As our work unfolds, we anticipate presenting our collaborative results at professional meetings, such as the Geological Society of America Section Meeting in Reno, NV in May 1993. The USGS Bulletin on interpretive geology of the park will be a color publication that will include a geologic map of the park and have contributions from NPS staff as well as academia. The project is slated for completion by Dec. 31, 1994.

Brown is a Research Geologist with the USGS; Davila is Resource Management Specialist at Great Basin NP.

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Pollen Analysis in Historical Landscape Studies: Fort Necessity, Pennsylvania

By G.K. Kelso, J.F. Karish and C. Smith

During his 1754 road building expedition to the forks of the Ohio, Lt. Col. George Washington ordered construction of an earthwork and stockade fortification in an opening in the forest called "Great Meadows." The fort was surrendered to the French and destroyed in July 1754 after a brief siege that now is considered to have been the opening battle of the French and Indian War. The forest surrounding Great Meadows was a critical element in the battle because it provided cover within musket shot of the fort for the attacking French-led Indian force (Washington 1754).

The forest was cleared and converted to pasture between 1856 and 1880 (Torres-Reyes 1970:10). A reconstruction of the 1754 fort (Fig. 1), based largely on Harrington's (1957) archeological data, now occupies the original site, and the Fort Necessity General Management Plan calls for restoration of the forest to its 18th century boundaries by the 300th anniversary of the battle (A.D. 2054).

Figure 1. National Park Service Reconstruction of Fort Necessity based on archeology and documentary sources *(Photo courtesy of Charles Smith, Chief Ranger, Fort Necessity National Battlefield).*

A pollen study of the vegetation history of Great Meadows now is underway, and this paper reports progress in defining the 18th century vegetation communities.

Six soil cores were taken in a transect down the hillside on the western side of the meadow and across the meadow to the edge of the reconstructed fort lawn. Agricultural development at the site is clearly recorded in the pollen spectra of all six cores. Oak pollen frequencies (primordial forest) are highest at the bottom, and grass pollen (the developed pasture) counts are highest at the top of all six Great Meadows cores. Weed pollen, of one kind or another (the clearance period), is most prominent in the center of the cores. This tree-weed-grass pollen domination sequence clearly records forest clearance and pasture development. In cores 1 and 2 (hillside) it registers the removal of local trees, but the oak pollen in cores 3-6 does not reflect trees at the sampling sites. This pollen blew onto the open meadow from oaks on adjacent hillsides (Janssen 1973:40). In cores 3, 4, (dry flats) and 5 (moist flats), agricultural development is most clearly recorded in the decline of local herbs and small trees and shrubs, such as meadow rue, goldenrod, ironweed, holly, and alder. The installation of drains and the re-routing of the creek bed are registered in the decrease of sedges in cores 5 and 6 (wet flats). Because these 19th century agriculture-related changes in the flora are recognizable in the cores, they can easily be factored out of the analysis in order to focus on the 18th century vegetation recorded in the deeper portions of the cores.

A distinct series of vegetation changes correlated with local topography is evident among the pre-agricultural period spectra in the Great Meadows core transect. To make it easier to visualize the primordial vegetation, the pre-clearance/pre-drainage pollen spectra in each core are combined as single samples, and presented in order down the hillside and across the meadow in Figure 2.

Oak pollen is the most common type in all cores. It is most prominent in cores 1 and 2, and these counts reflect oak-dominated forest covering the western hillside above the meadow. The lower, relatively uniform oak percentages of cores 3-6 record the background oak pollen contribution that was homogenized while being wind-transported onto the treeless meadow (Janssen 1973:40). The relatively high hickory (*Carya*) and red maple (*Acer rubrum*-type) counts of cores 1 and 2 indicate that these trees were present among the oaks on the western slopes. The slightly higher beech (*Fagus*) and birch (*Betula*) percentages of cores 1-4 suggest a local, rather than an extra-local or regional, pollen source. They probably reflect the presence of a few trees of this kind on the western side of the meadow near--just outside perhaps--the treeline of the oak-dominated forest.

Alder (*Alnus*) pollen percentages rise and fall in a bell-shaped curve from core 1 to core 6. They peak where the oak contribution falls off in core 3, suggesting that most of this pollen came from an alder population situated between the tall forest and the grass-dominated portion of the meadow. The largest percentages of black locust-type and holly pollen also were found in this segment of the core transect (cores 3-5), and a few of these trees must have been scattered about the meadow between the forest proper and the marshy area near the fort.

The pollen contributions of pine (*Pinus*), hazel (*Corylus*), hemlock (*Tsuga*), spruce (*Picea*), walnut (*Juglans*), blue beech/hornbeam (*Ostrya/Carpinus*), sugar maple, (*Acer saccharum*), ash (*Fraxinus*), willow, (*Salix*), and poplar/cottonwood (*Populus*), all increase in cores 5 and 6, nearest the fort. Mesic taxa, such as cottonwood or willow, may have been growing at the lowest part of the meadow, but it is unlikely that many of the other trees were rooted here. The fort was closer to the eastern side of the meadow than to the western side, and it is probable that this pollen was blown from trees growing on the eastern slope above the fort. This suggests that the composition of the forest on the eastern side of the meadow was more diverse than that of the western side. Such an interpretation also is consistent with an 1822 report stating that stands of pines, considered unusual for the

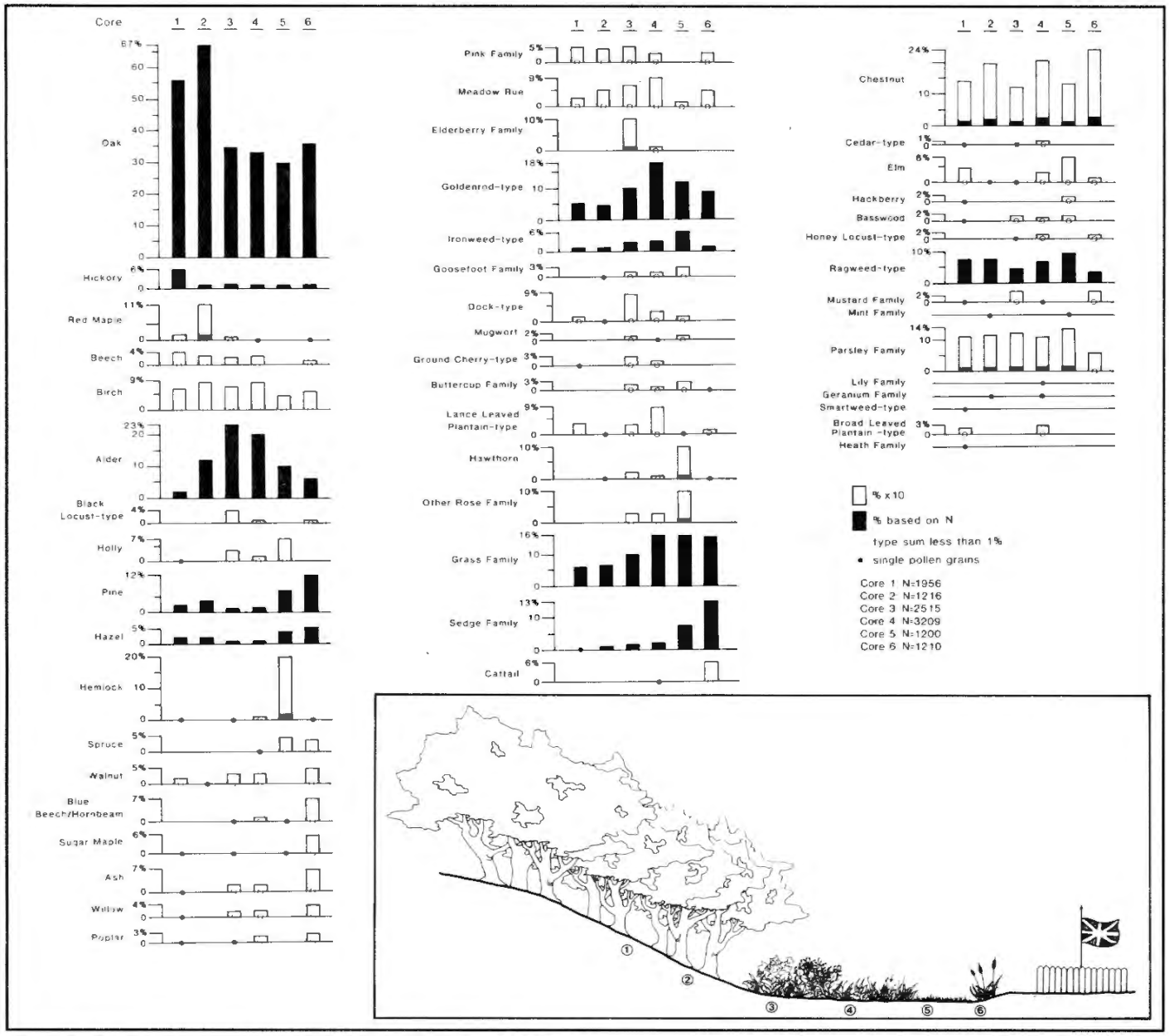

Figure 2. Pollen percentages of pre-clearance pollen samples of the Great Meadows cores presented in topographic order down the hill and onto the meadow.

Figure 3 (Inset). Stylized artist's conception of the Great Meadows in 1754

area, occupied the slopes of Laurel Hill to the east of the meadow (Torres-Reyes 1970:10).

Among the non-arboreal pollen types, only that of the pink family (*Caryophyllaceae*) was more common among the oaks (cores 1 and 2) on the western slope than on the meadow. The presence of more grass (*Gramineae*) among the alders at the forest edge is indicated by the increase in this pollen type in core 3, and the extent of the meadow proper is recorded by the high, uniform grass pollen percentages of cores 4, 5, and 6. The remaining non-arboreal pollen types, sedges excepted, were clustered in cores 3, 4, and 5. Some of these--elderberry family (*Caprifoliaceae*), hawthorn (*Cratageus*), and other members of the rose family (*Rosaceae*)-are from woody shrubs, and probably record the sort of "bushes" that Washington ordered removed to deny cover to potential attackers (Fitzpatrick 1931/1944:I:54). Some non-arboreal types--meadow rue (*Thalictrum*), goldenrod-type (*Solidago*-type), ironweed-type (*Chicoreae*), goosefoot family (*Chenopodiaceae*), and dock-type (*Rumex mexicanus*-type)--record the presence of relatively tall non-woody herbs. Others--mugwort (*Artemisia*), ground cherry-type (*Physalis*-type), buttercup family (*Ranunculaceae*), and lance-leaved plantain (*Plantago lanceolata*-type)--reflect lower growth. A similar plant assemblage has taken over the meadow since the Park Service stopped mowing. The grasses, although dominating the near-surface pollen spectra, since they now constitute an understory beneath the tall herbs on the dry portion of the meadow proper, may not have been highly visible in 1754.

Rising frequencies of sedge (*Cyperaceae*) pollen--a poorly disperse type (Handel 1976:422)--in cores 5 and 6 and the presence of a few cattail (*Typha*) pollen grains in core 6 indicate that the ground became progressively wetter nearer the fort. The pollen contributions of most herbs, including those uniformly distributed across the rest of the transect (Fig. 2, right column) were depressed in these cores, and the ground must have been too marshy for anything but sedges and grass.

Continued on page 10

Subalpine Meadows: A Promising Indicator of Global Climate Change

By Andrea Woodward and June Rugh

As one of a number of projects funded by the NPS Global Change Program, the University of Washington Cooperative Parks Study Unit (UW CPSU) has chosen to study tree establishment in subalpine meadows. Studies underway at Olympic and Mount Rainier National Parks include two that examine the relationship between climate and tree establishment; others focus on establishment after fire, seedling establishment in relation to substrate, and soil development as a result of tree establishment. It is hoped that these projects will give park managers tools to understand and interpret for the public the dynamics and consequences of change in subalpine areas, as well as the vital role these areas play in detecting global climate change.

Background

Climatic variation is integral to the Earth's history, with changes generally occurring on the scale of centuries or millennia. However, atmospheric changes following the Industrial Revolution--specifically, the atmospheric concentrations of CO_2 and other greenhouse gases--may produce rates of global climate change unprecedented since the last Ice Age. One aspect of this change involves the earth's mean surface air temperature, which already has increased approximately 0.6 C. since 1880 (Hansen and Lebendeff 1988) and is predicted to rise 1 to 5 C. during the next century (Schneider 1989). Although seemingly small, this increase would have far-reaching consequences; significantly, it is of the same magnitude as the 3 to 5 C. change in average temperature that occurred between the height of the last Ice Age and the present (Schneider 1989). Precipitation patterns are expected to change as well; however, the complexity of the hydrologic cycle makes prediction in this area more difficult.

It is intuitively clear that this changing climate will affect the biosphere, including the distribution of vegetation. One way to conceive of the effect of global change on vegetation distribution is to think of plant communities as grouped into vegetation zones appearing as distinct bands along elevational and latitudinal gradients (a useful idealized scheme; Peters 1990) and then imagine these zones shifting to new locations. There is, in fact, evidence that distribution of tree species has altered in response to changing climate in the present century (Franklin et al. 1971), as well as over the period following the last Ice Age (Brubaker 1988). However, such vegetation changes are much more complex than the migration of intact plant communities, or the shifting of vegetation zones to higher elevations and latitude in response to warmer climates; crucial factors include disturbance history, substrate availability, seed source, current conditions and the adaptations of individual species. In some places, trees may eventually be replaced by meadows, if conditions change to favor meadows.

Moreover, the accurate *detection* of vegetation change presents a tough challenge. First, to discern significant changes within the high variability of biological systems requires large sample sizes over time and space. Second, the processes of biological change operate on diverse time scales. For example, while tree establishment in subalpine meadows may happen on a scale of years, their presence might not be noticeable for decades due to the slow growth typical of higher altitudes. In contrast, redistribution of species in the adjacent montane zone depends on disturbance frequency, which generally is measured in centuries. Finally, it can be hard to find a distinct division between one vegetation zone and another because where zones meet, the vegetation types characteristic of each zone can overlap.

Such problems associated with detecting vegetation change can be avoided by studying the subalpine, an area uniquely suited to the study of global climate change. Here, where meadows are punctuated with clumps of trees, there is a distinct line between vegetation types. Also, the process of tree establishment in subalpine meadows is sensitive to climate, particularly to the winter snowpack of the Pacific Northwest. Finally, the subalpine allows researchers to examine the effect of climate patterns on vegetation on a yearly basis (by correlating annual weather patterns with tree age), rather than having to rely solely on the larger patterns of climatic trends.

In order to seize the unique opportunity to study vegetation in relation to climate provided by the subalpine zone, the UW CPSU is cooperating on several research projects.

Pollen Analysis in Historical Landscape Studies continued from page 3

The current Fort Necessity core series indicates that the western hillside above the meadow was covered by an oak-dominated hardwood forest (cores 1 and 2), that the ground near the fort (cores 5 and 6) was a marsh dominated by sedges and grass, and that a mixture of shrubs and herbs, with a grass understory, occupied the portion of the meadow between the oak forest and the marsh (cores 3, 4, and 5). There were more alders at the fringe of the forest while grass, meadow rue, goldenrod, and ironweed were thickest on the dry ground closer to the fort. The forest on the eastern side of the meadow also differed in composition from the forest on the west.

A stylized artist's conception of the battle-era vegetation is presented in Figure 3. The pre-clearance pollen spectra indicate that it will be possible to reconstruct the battle-era vegetation on Great Meadows with an acceptable degree of accuracy.

The next step in the investigation will be to fill in the gaps in this core series and to take core transects to the south, east, and north of the fort. The pollen signatures of agricultural development at different elevations on and around Great Meadows have been established in this core series. In future investigations only the deeper, pre-agricultural sediments need be investigated.

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In both Mount Rainier and Olympic National Parks we have established transects from forests into meadows and aged trees along these transects. At Olympic NP, study sites are arrayed along a precipitation gradient from the wettest to driest regions. From these studies we hope to learn how regional and local climate patterns affect the distribution of trees and meadows in the subalpine.

Management Implications

Vegetation change in the subalpine areas of national parks has important consequences for management. Typically, subalpine meadows are popular with park visitors because of their wildflowers and vistas, and many park facilities have been created to accommodate this demand. If these meadows start to shrink, park managers will need to decide how to handle greater concentrations of people in these already fragile areas. If subalpine meadows disappear altogether, the adjacent facilities will need to be redesigned or relocated.

To envision and interpret such transformations in the face of predicted global climate change is a major challenge within NPS. Biological changes that appear to proceed slowly, in human terms, will be difficult to accept if they accelerate in the future. A primary aim of the current global change research in subalpine areas is to assist park staff in making informed management decisions as parks are impacted by these changes, and in gaining public support for those decisions.

Woodward is a Research Biologist and Rugh is a Technical Writer with the NPS/ CPSU at the University of Washington.

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At least 70 years separates these two views of Mount Angeles in Olympic NP. The top photo was taken between 1915 and 1920. The lower view, taken in 1986, shows tree establishment in areas that formerly were meadow.

Southwestern Willow Flycatcher Declines In Grand Canyon National Park

By Matthew J. Johnson, Laura E. Ellison, and Mark K. Sogge

The southwestern willow flycatcher (*Empidonax traillii extimus*) is a riparian obligate species whose population has severely declined in recent decades. Factors in the decline include loss and fragmentation of riparian habitat, loss of wintering habitat, increased invasion of riparian corridors by the exotic tamarisk (*Tamarix spp.*), brood parasitism by brown-headed cowbirds (*Molothrus ater*), and predation (Whitfield 1990, Harris 1991, Rosenberg et al. 1991).

Field researcher records the song of a willow flycatcher.

The states of Arizona, New Mexico, and California comprise most of the southwestern willow flycatcher's historic and current range. Each of these states list the subspecies as endangered (Arizona Game and Fish Department 1988, New Mexico Department of Game and Fish 1988, California Department of Fish and Game 1991). In addition, the bird is listed by the USFWS as a candidate category 1 species (56 FR 58804). The USFWS was petitioned in January 1992 to list the subspecies as endangered.

Although once distributed along most major river systems in Arizona (Phillips 1948, Unitt 1987), only three areas are known to have been occupied by nesting southwestern willow flycatchers in the past 10 years. These are the lower San Pedro River, the Verde River, and the Colorado River in Grand Canyon NP (Hunter et al. 1987, Unitt 1987, Brown 1988, and USFWS unpublished data). Of these areas, Grand Canyon NP hosted the greatest number in the 1980s, with a maximum estimate of 11 males in 1986 (Brown 1988). However, this small number had declined in recent years to only two singing males (pairs) in 1991 (Brown 1991).

The southwestern willow flycatcher is a neotropical migrant that arrives in the Grand Canyon around May of every year. The breeding season continues through July and has been known to last through the first week of August. Nesting sites in the Grand Canyon are mainly confined to an introduced shrub, tamarisk (*Tamarix ramosissima*). Of 12 nests studied from 1986 to 1988, all were located in tamarisk (Brown 1988). In addition, marsh plants such as cattails (*Typha spp.*) are often part of their territories and foraging habitats (Unitt 1987).

Clutch size of southwestern willow flycatchers along the Colorado River is typically smaller than in other races of the bird: Of 28 unparasitized nests, 18 percent had two eggs, 82 percent had three eggs, and none had four (Brown 1988).

The willow flycatcher song, a "fitz-bew," distinguishes it from several other hard to identify *Empidonax* species. This flycatcher also produces a "whit" call in conjunction with the "fitz-bew," which it will use during defense of its nest or territory. Singing begins in the spring as soon as the birds arrive and establish their breeding territories, and usually ceases in July, well before their fall departure.

Breeding habitat in the Grand Canyon, preferred by the southwestern willow flycatcher.

Southwestern willow flycatcher surveys were conducted along the Colorado River within Grand Canyon National Park from mid-May through July, 1992 to determine presence and abundance of this declining subspecies. These surveys were coordinated by the NPS/CPSU at Northern U/AZ, and were a cooperative effort among the NPS, USFWS, Bureau of Reclamation, and the AZ Game and Fish Dept. Hualapai Tribe. Willow flycatcher presence was determined by sightings and song detections made from approximately 5:30 to 11 a.m. daily, when male song-rates are typically greatest (Unitt 1987). In some cases, surveys were also conducted at dusk, a period during which willow flycatchers may display a secondary peak of singing (Weydemeyer 1973). In order to maximize the likelihood of detecting willow flycatchers, surveyors used tape-broadcast songs of willow flycatchers--a proven method for eliciting a vocal response from nearby resident flycatchers (Seutin 1987, Craig et. al 1992).

Once flycatchers were detected, they were observed very closely in order to determine breeding activity. Male singing rates (songs/minute) were recorded during this observation period to provide information on daily and seasonal variation in song-rates. Nesting status was verified by inspection of the nests and then by re-inspection on subsequent survey trips. Clutch size, number and age of young, and presence of cowbird eggs or young were also noted.

During 1992, agency personnel and experienced volunteers conducted over 256 hours of surveys in 132 habitat patches along the Colorado River corridor. Only seven southwestern willow flycatchers were detected. Two pairs were found at Cardenas Marsh (River Mile 71.1). One of these pairs produced a complete clutch of three eggs with no evidence of brood parasitism by brown-headed cowbirds. Three healthy nestlings from this clutch were observed in late June, and a juvenile and an adult were detected foraging during a third visit in late July. Unfortunately, the second pair showed no sign of successful breeding. Three unpaired willow flycatchers also were observed at different sites along the river corridor. Since the Grand Canyon is part of a migratory route for other races of willow flycatchers, these three unpaired birds could possibly be migrant visitors. However, these birds were observed in the same habitat patch on consecutive days, and the sightings occurred when migrants were no longer expected within the park.

Vocalization and habitat use information were collected on the willow flycatchers found at Cardenas Marsh. Data were gathered on male song rate to determine differences in daily and seasonal song frequency. A parabolic recorder was utilized to tape vocalizations by the male and female flycatchers responding to the tape broadcast. The recorded vocalizations will be sent to the Borror Lab of Bioacoustics at Ohio State University, where specialists will determine if the southwestern willow flycatcher vocalizations differ from those of the other subspecies.

Several factors could explain the decline of the southwestern willow flycatcher along the Colorado River in the last two decades. These factors include cowbird parasitism and a variety of human-related disturbances. Although we found no evidence of brown-headed cowbird eggs or nestlings inhabiting willow flycatcher nests during this study, approximately half of the nests examined during the 1980s in the same study area were parasitized by cowbirds (Brown 1988). The cowbird population in the canyon is large, and poses a threat to many birds. Cowbird control is just one option that may be beneficial to the willow flycatcher, and to many other highly parasitized birds of the Grand Canyon.

Fluctuations in flow release from Glen Canyon Dam also may affect the numbers of southwestern willow flycatchers along the Colorado. Long-term indirect habitat changes brought about by controlled flows (e.g. habitat expansion or fragmentation, changes in plant species composition, and changes in patch size or configuration) could affect willow flycatcher breeding ecology by increasing or decreasing suitable habitat.

Human-related activities along the river corridor also could affect this sensitive bird. Recreational use of the canyon can impact flycatchers by direct degradation of riparian habitat, or disturbance from noise and activity associated with nearby campers. Although the willow flycatcher is one of seven species negatively associated with campgrounds in riparian areas in northern Utah (Blakesley and Reese 1988), the birds have been found near campsites along the Colorado River corridor. The fact that these birds are found near campers may suggest they are tolerant of nearby human activity. However, repeated human presence within a territory or close to an occupied nest could cause the birds to abandon a territory or nest.

Grazing has been shown to reduce the quality of riparian flycatcher habitat (Taylor 1986, Sanders and Fleet 1989). Although grazing is not a direct threat to riparian corridors within Grand Canyon NP, grazing does occur directly adjacent to the park on some lands near the park, and could be affecting the regional flycatcher population by reducing potential habitat.

The possibility of listing the southwestern willow flycatcher as an endangered species, coupled with its small population size and apparent widespread decline, demonstrates the need for continued monitoring along the Colorado River corridor. Future willow flycatcher surveys will provide valuable information needed to continue monitoring population trends, and will further define habitat use along with potential threats.

Johnson is an ecologist and Ellison and Sogge are biological technicians with the NPS/CPSU at Northern U/AZ.

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Notes from Abroad

***Editor's Note:** Carol L. McIntyre, Wildlife Biologist with the NPS Alaska Region, in May 1992 attended the Fourth World Conference for Birds of Prey and Owls. The meeting, held in Berlin, Germany, was organized by the World Working Group for Birds of Prey and Owls, an international working group dedicated to the conservation of birds of prey throughout the world. Here is her report.*

Surprisingly, I was the only representative from Alaska and one of only 5 women who presented papers to the conference of more than 400 participants. The major emphasis of the conference focused on declining raptor populations worldwide, and conservation and research efforts on behalf of raptors in eastern Europe. The sessions covered the following topics:

Population studies; aspects of long-term changes in numbers and distribution of raptors and owls; biology and conservation of the large falcons in the subgenus *Hierofalco*; trapping, marking, and radio-tagging techniques; environmental contaminants and raptors; declining raptor populations: their biology and conservation; reintroduction of eagles, vultures, and other raptors; population ecology of owls; the systematics and taxonomy of raptors; tropical rain forests and raptors; and the biology of extirpated, rare, or lesser-known owls.

The two papers I presented were "Reproductive performance of golden eagles in Denali National Park and Preserve, Alaska" and "Distribution, status, and aspects of the breeding biology of gyrfalcons in Alaska," co-authored with Ted Swem, USFWS; Bob Ritchie, Alaska Biological Research; Peter Bente, USFWS; and Dave Roseneau, Biosystems Consulting. The first paper was one of several presented on long-term ecological studies of golden eagles, however it was the only paper presented on golden eagles in North America and one of the few papers on a non-declining population of golden eagles. The second paper included results of gyrfalcon surveys and population monitoring at Denali. It was presented in a series of papers focusing on status and distribution of gyrfalcons throughout North America, and included presentations by K. Poole on the Northwest Territories, D. Mossop on the Yukon Territory, and M. Fuller on western Greenland.

Both of my papers were well received and stimulated good discussions. Of particular interest were the field techniques and data collection methods used for the Denali project. Biologists were excited and pleased to learn that the NPS is taking a lead role in raptor research in Alaska, and encouraged me to continue my studies on reproductive success of golden eagles and migratory movements of golden eagles in Alaska.

I participated in two field excursions. One was a visit to a newly created UNESCO biosphere reserve, Oberspreewald, in eastern Germany. This BR contains one of the largest wetlands in eastern Europe and provides breeding habitat for many bird species, including the rare Black Stork. A large number of raptors also nest in the Spreewald. One of the most interesting components of the reserve is the initiative taken to preserve the area's cultural resources, which include numerous small farming communities where farming is still small scale and conducted mainly by hand and animal power. I spent 2 days visiting conservation areas in the new federal province of Mecklenburg in northeastern Germany. Of particular interest was a visit to a small fish farm in Muritz, where we observed one of the largest concentrations of white-tailed sea eagles. We also visited a breeding area of the endangered lesser spotted eagle.

During the Mecklenburg excursion we attended a reception by the Minister of the Environment in Mecklenburg, who expressed her appreciation for our visit and described current conservation efforts in the province.

These field trips enabled me to observe wildlife and natural areas in the former East Germany, and to visit areas where westerners are only beginning to travel. It was instructive to see the extent of recent westernization in a former Soviet Bloc country and surprising to see large areas of undeveloped land, where wildlife seems to be abundant. However, a challenge awaits conservation groups in eastern Germany, where the influx of modern agricultural and industrial practices will change the landscape and where the desire for a high standard of living will prevail.

The conference and field excursions made it possible for me to meet with biologists from Scotland, Spain, Germany, Portugal, Yugoslavia, Netherlands, France, Bulgaria, Norway, Sweden, Finland, Siberia, Byelorussia, the Kola Peninsula, Kamchatka, Australia, South Africa, Canada, Israel, Japan, Cuba, and Taiwan. These contacts will be useful for the advancement of raptor research projects in Alaska, particularly through peer review of study designs and research proposals and by continued exchange of technical information.

Letters

I am a reader of *Park Science* and a tree farmer, intensely interested in the evolving land management scene. I recently attended a conference in Portland, OR, that I think would be of interest to your readers. It was sponsored by the Western Forestry and Conservation Association and titled "Science and Politics in the Practice of Forestry." The keynote address, by Washington State Commissioner of Public Lands Brian Boyle, stressed the current clash of **values**, not of **facts** in the field of natural resource management. He suggested that regulations tie our hands, whereas cooperation has a freeing effect.

Tom Nygren, USFS Regional office in Portland, suggested that science only looks at pieces, whereas managers must use more holistic thinking to do their jobs. George Frampton, president of the Wilderness Society, focused on the need for developing consensus.

Technical sessions on land use, stand management, wildlife, reforestation, fire, forest health, all stressed the need to better educate the public and decision makers about what we **think** we know, and more particularly to educate them about what we **don't** know. Only the session on economics left this observer wondering if most economics isn't really in the realm of guesswork.

Some 65 or more speakers generally stressed the need for more holistic thinking by managers, more cooperation among agencies, and a more informed body politic. Many speakers recognized that good science is necessary in the practice of resource management, but that science alone is not sufficient.

William H. Oberteuffer
Smilin' O Ranch
Elgin, OR

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Closer Ties Sought

The goal of the 1993 Cultural and Natural Resources Workshop scheduled for April 18-23 at Death Valley National Monument is to strengthen the cultural and natural resource programs in Western Region parks and to promote closer ties between cultural and natural professionals by developing interdisciplinary approaches to problem solving. "Sand, Stampmills, and Sidewinders" is the title chosen for the week-long workshop.

New Mountain Journal Originates in Slovakia

From Cliff Martinka, Senior Research Scientist at Glacier NP, comes word of a new journal, *Oecologia Montana,* which originated in 1992 at National Park High Tatras in Czecho-Slovakia. Dr. Marian Janiga of the park's Research Coordination Center, is editor-in-chief. The journal's aim is to protect mountains and learn how interactions between human development and mountain ecosystems can be better managed.

Oecologia Montana will publish articles ranging from forestry to alpine research. It will be an international medium in all fields of mountain ecology and will include information about both "Eastern" and "Western" ecological research.

Martinka is represented in Vol. 1, No. 1, with an article entitled "Conserving the natural integrity of mountain parks: Lessons from Glacier National Park, Montana." In it, he reviews the history of Glacier NP and describes recent peripheral development, ecological isolation, landscape fragmentation, and special designations posing risks and establishing values that call for a new management paradigm--one based on a regional ecosystem model. He points to the prospect of global change as adding the dimension of permanent environmental change to the increasing complexity of park conservation.

Manuscripts within the journal's scope will be reviewed by at least two referees and authors generally will be notified of acceptance or rejection within three months. The journal's language is English. Dr. Janiga's address is High Tatras NP, Research Coordination Center, 059 60 Tatranska Lomnica, Czecho-Slovakia.

Meetings of interest

1993

April18-23 WESTERN REGIONAL INTEGRATED CULTURAL & NATURAL RESOURCES WORKSHOP, at Furnace Creek Ranch, Death Valley National Monument. WRO Contacts: Jonathan Bayless, (415)744-3968, and Gene Wehunt, (415)744-3957.

May 17-21 NATIONAL INTERAGENCY WILDERNESS CONFERENCE, Tucson, AZ. Focus on 3 stewardship themes: (1) Wilderness Restoration--minimum tool use in alien plant species control and reveg; (2) Complementary Management of wilderness and archaeological, historical, and cultural resources, and (3) Emerging Challenges: cultural diversity, demographic trends, adjacent land uses, day use, outfitter policies, and access for the disabled. Contact: Alan Schmierer, WRO (415)744-3959.

June 22-25 CONSERVATION IN THE WORKING LANDSCAPES, the 1993 Natural Areas Conference, at Univ. of Maine, Orono, ME. Symposia topics: Biological diversity in working landscapes (total perspective and institutional perspective), conservation in marine ecosystems, inventory and monitoring natural landscapes in working landscapes, conserving endangered species and natural communities in working landscapes, and managing natural areas in working landscapes. Contact: Hank Tyler, Maine State Planning Office, Station 38,. Augusta, ME 04333; (207)624-6041.

Aug. 24-26 12th WILLIAM T. PECORA REMOTE SENSING SYMPOSIUM, "Land Information from Space-Based Systems," Sioux Falls, SD. Sponsored by the USGS in cooperation with other federal agencies. Contact: Dr. Robert Haas, Symposium chair, 605-594-6007 or Dr. James W. Merchant, Program chair, 402-472-7531, FAX 402-472-2410.

1994

June 7-10 FIFTH INTERNATIONAL SYMPOSIUM ON SOCIETY AND RESOURCE MANAGEMENT, CO/State/U, Fort Collins, CO. Michael J. Manfredo, Program chair, has issued a call for papers, to be submitted by Nov. 1, 1993, to Manfredo, Human Dimensions in Natural Resources Unit, CO/State/U, Fort Collins, CO 80523.

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Pacific Northwest Region

An article by Seth Tuler, Gary Machlis, and Roger Kasperson, "Mountain Goat Removal in Olympic NP: A Case Study of the Role of Organizational Culture in Individual Risk Decisions and Behavior," appeared in the Fall 1992 issue of *Risk: Issues in Health & Safety. Risk* is a refereed, interdisciplinary quarterly that explores basic policy issues related to public and private efforts to manage science and technology for net reduction in the probability, severity, and aversive quality of health and safety impacts on individuals and institutions. Reprints of the article are available from Dr. Machlis at the NPS/CPSU, Dept. of Forest Resources, University of Idaho, Moscow, ID 83843.

* * *

A listing of recent publications relevant to natural resource issues in the Region is available at irregular intervals from the PNR Library. Kathy Jope, PNR Resource Management Specialist, compiles the list and contributes abstracts of many of the titles. Those interested in being on the mailing list for the Current Literature lists may contact Jope at (206) 553-5670.

* * *

The Olympic Natural Resources Center on the Olympic Peninsula adjacent to Olympic NP is now issuing a quarterly bulletin, **Update**, started in Summer 1992 and edited by Kathym A. Kohm, Olympic Natural Resources Center, U/WA, AR-10, Seattle, (206)685-4802. The Center was created in 1989 by the Washington State legislature, which envisioned the Center as both a program and a facility. The 1991-3 state budget provided funds to build the research facility. Olympic NP Supt. Maureen Finnerty is a member of the Governor's Policy Board; Dr. Jerry Franklin is the Center's Director. For information on the facilities' plans, contact Gordon Smith, U/WA AR-10, Seattle, WA 98195; (206) 685-4802.

* * *

Mount Rainier NP has given Carolyn Driedger Mastin of the USGS David A. Johnston Cascades Volcano Observatory a monetary award in recognition of the superior support she has provided the park for the past decade. Driedger Mastin has assisted in geologic, geomorphic, and glaciologic resource information since the mid-1980s, providing annual training to park interpretation and natural resource divisions. She continues to give technical advice in the park's monitoring of the Nisqually glacier and has prepared an updated interpretive bulletin on the status of park glaciers.

* * *

A draft science plan for the Mount Rainier Decade Volcano has been submitted to the National Academy of Science for initial review. No decisions have yet been made about future activities. The draft science plan contains a section on mitigation, including discussions on living safely in the shadow of Mount Rainier and the Washington State Growth Management Act. At least 8 of the 40 pages are devoted to studies related to social consequences of a Mount Rainier eruption. It is intended that a series of "spin-off" meetings devoted entirely to sociologic studies will occur after the completion of the final science plan, which should be published by April 1993.

Rocky Mountain Region

Dr. Stanley Ponce has been named A/D for Resources Management and Research in the Region. His focus is on issues related to both natural and cultural resource management and research, and he believes strongly in "programmatic" management. He feels that much of the NPS effort presently is "issue" based and lacks continuity from year to year. "A good program," Ponce said, "requires sound information about the condition of the resources, an understanding of the processes associated with these resources, the potential threats to these resources, and capable people who can interpret this information and manage the resources effectively."

* * *

Three of the Region's new Global Climate Change research initiatives approved for FY 93 are for Colorado Rockies, Glacier, and Central Grasslands. All three complement existing projects and provide the means to merge RMR programs with other regions and agencies.

* * *

In order better to address resource management and research needs, the Regional Office has reorganized as follows: The cultural and natural resource management and research functions have been combined into a new Directorate of Resource Management and Research, comprised of three divisions: Cultural Resource Management, Natural Resource Management, and Research. A Directorate Office of Resource Data Management and GIS serves the needs of all three Divisions as well as RMR parks and other RMRO directorates.

The Directorate currently is developing a Strategic Plan, a basic philosophy of which is that parks are shareholders and customers of the Directorate, and that the Directorate will strive to provide them with outstanding, proactive, professional products and services. Recommendations from the Vail Conference report and the National Research Council's Science and the National Parks report are being used to develop the Plan and as guidelines for the new RMR Directorate.

* * *

To improve park research as recommended by the National Research Council, the RMR is strengthening and expanding its CPSU program. CPSUs will be developed to meet the needs of groups of parks within the same ecosystems and/or as thematic research centers. The tri-regional CPSU at Northern AZ/U will retain its focus on Colorado Plateau parks. The CO/State/U CPSU will focus on sustainable ecosystem management issues at park units in the Central Rockies and Grasslands. The old (1974) U/WY NP Research Center will be reshaped as a "traditional" CPSU, with focus on the Greater Yellowstone Ecosystem. The unstaffed units at MT/State/U and U/MT will be staffed with unit leaders and former park research positions. The MT/State/U CPSU will cooperate with the U/WY in focusing on the Greater Yellowstone Ecosystem while the U/MT will focus on the Northern Continental Divide Ecosystem, primarily Glacier NP. Each CPSU in the Region will have a biogeographical focus as well as an issue-related theme.

* * *

Researchers Ken Driese and Don Roth recently completed a baseline study of the vascular flora, mammal fauna, and human disturbance level on the tower summit at Devil's Tower NM. They identified and quantified coverage for 21 plant species. Total cover for the 9 grass species, 8 shrub species, and 4 forb species was 51 percent. Although summit vegetation was dominated by grasses, bare rock comprised the greatest cover class.

During the three June through September monitoring periods, the percent of disturbed vegetation was 9, 13, and 16 percent. Three small mammal species were identified. Populations were estimated at 45 deer mice (*Peromyscus maniculatus*) and 12 bushy-

tailed woodrats (*Neotoma cenera*). Only three yellow-pine chipmunks (*Eutamias amoenus*) were trapped, too few to estimate the population.

Southeast Region

South Florida will be served by two new CPSUs, each operating within its particular academic specialty areas. Florida International University (FIU) and the University of Miami (UM) have been designated as unit locations. FIU will act as lead unit, with Mike Soukup as director, supervising and coordinating activities at both university units.

* * *

Bob Warren, Director of the U/GA CPSU, gave a presentation in Washington DC to the International Assn. of Fish and Wildlife Agencies' subcommittee on Wildlife Contraception. This group's task is to advise state and federal wildlife agencies on regulatory concerns and the practicality of applying contraceptives to free ranging wildlife populations. Dr. Warren was added as a subcommittee member.

* * *

John Peine of the U/TN CPSU has received a certificate for 20 years of continuous service as an NPS Research Ecologist.

* * *

Recently published reports include:

Bythell, J.C., E. Gladfelter, and M. Bythell. 1992. Ecological Studies of Buck Island Reef National Monument, St. Croix, U.S. Virgin Islands: A Quantitative Assessment of Selected Components of the Coral Reef Ecosystem and Establishment of Long-Term Monitoring Sites, Part 2. USDI, NPS, Island Resources Fdn., St. Thomas, U.S. Virgin Islands, and West Indies Lab, St. Croix.

DeVries, D. and R.F. Doren. 1992. Melaleuca Annual Report. S/FL Research Center, Everglades NP.

Lauritsen, D.C. 1993. Assessment of the Hard Clam, Mercenaria, in Cumberland Sound, GA. Kings Bay Environmental Monitoring Program Report, U.S. Dept. of the Navy, Naval Facilities Engineering Command, Washington DC, KBEMP-91-03. U/GA CPSU, USDI, NPS.

* * *

Articles published recently are:

Bratton, S.P. Alternative Models of Ecosystem Restoration. Published in Ecosystem Health: New Goals for Environmental Management, edited by Robert Constanza, Bryan G. Norton, and Benjamin D. Haskell. Island Press, Washington DC; Covelo, CA.

Miler, S.G., S. Bratton and John Hadidian. 1992. Impacts of White-tailed Deer on Endangered and Threatened Vascular Plants. Natural Areas Journal, Vol. 12(2).

* * *

The following reports were received:

Johnson, B.R. 1992. Mitigation of Visitor Impacts on High Montane Rare Plant Habitat: Habitat Protection Through an Integrated Strategy of Design, Interpretation and Restoration, Craggy Gardens, Blue Ridge Parkway, NC. U/GA.

Sargent, R.A. 1992. Movement Ecology of Adult Male White-tailed Deer in Hunted and Non-hunted Populations in the Wet Prairie of the Everglades. U/FL.

Boulay, M.C. 1992. Mortality and Recruitment of White-tailed Deer Fawns in the Wet Prairie/Tree Island Habitat of the Everglades. U/FL.

Western Region

From Malinee Crapsey, editor of **Sequoia Bark**, an intermittent publication of Sequoia and Kings Canyon NPS, come three recent issues highlighting research on Emerald Lake (aimed at determining if acid rain is a threat to Sierran lakes), tree rings research (to determine whether, in the light of a 1000-year record of temperature and precipitation in the Sierra Nevada, the current conditions constitute a drought or whether the current drought constitutes the norm), and "techno-mapping" (a look at both the dark and bright sides to Geographic Information Systems and particularly at the "adolescent" stage of Sequoia and Kings Canyon NPS' version of GIS.) Dave Graber, NPS Research Scientist who authored the latter article, describes the state-of-the-(GIS)-art at the parks and how additional information from many different investigators will revolutionize monitoring, caring for, and understanding "the incredible landscape preserved here."

To be put on the mailing list for **Sequoia Bark**, write Malinee Crapsey, Editor; Sequoia and Kings Canyon, Ash Mountain Box 10, Three Rivers, CA 93271.

* * *

Alaska Region

Dave Stevens has been assigned Branch Chief of Research in the Regional Office. He came to the Region from Rocky Mountain NP, where he led the research program from 1968. He will supervise the 3 scientists assigned to the Regional Office, administer the natural science program, technically advise park-based scientists and coordinate research in all the Alaska NPs.

* * *

Bruce Dale has been selected to fill the Region's new permanent Wildlife Biologist position. Dale has worked as a temporary for many years, assisting with much of the wolf and caribou research in the Region. He recently completed a study of winter wolf predation in Gates of the Arctic NP. In addition to continued involvement with Regional research programs, Dale will be primary contact for such wildlife management issues as the state of Alaska's wolf management planning effort.

* * *

Brad Shults, who has worked for the Region as a temporary Wildlife Biologist since 1987, accepted a permanent position with Northwest Alaska Areas in Kotzebue. Shults has assisted with much of the wolf and caribou research and recently has been conducting a study of marten demography in Yukon-Charley Rivers National Preserve as part of a Master's degree program at U/AK-Fairbanks. He will continue to oversee marten research to completion in 1994, while taking on new duties as the Wildlife Biologist fot the 4 northwest Alaska NPS areas managed out of the Kotzebue office.

* * *

The Regional Office welcomes Mark Schroeder, formerly Chief of Resource Management at Glacier Bay NP and Preserve, to the Natural Resources and Science Division. Schroeder will coordinate a variety of field projects throughout the Region, focusing primarily on neotropical migrants, coastal resource/marine mammal, and external threats issues.

A National Research Council report, "Protecting Visibility in National Parks and Wilderness Areas," found widespread air pollution across the country drastically diminishing visibility in even some of the most remote parklands. The report, cited in the Feb. 6, 1993 issue of *Science News*, calls current efforts to improve visibility inadequate, and in some cases "doomed to failure."

In the Western states, researchers found that people can see only half to two-thirds of the 230 km range that would be possible without pollution. In the east, average visibility is only one-fifth the natural range of 150 km. The vista-diminishing pollution comes from coal-burning power plants, diesel- and gasoline-fueled vehicles, residential and forest fires, and even livestock farms, the report states. It faults the EPA, Agriculture, and Interior for being slow to carry out responsibilities for accomplishing the goal of reducing haze in large national parks and wilderness areas, mandated by Congress in 1977.

"In particular," the *Science News* item notes, "it (the report) faults current efforts to improve visibility by targeting just individual polluters, a tactic the National Park Service used in a recent case involving a coal-burning power plant near Grand Canyon NP. The report calls instead for strategies that consider the various sources in a region that contribute to the haze."

* * *

A "miracle grass," called vetiver--native to India--was given the nod by the National Research Council in an NRC report released in late January 1993 and reported in the February 6 issue of *Science News*. A tall stiff grass that grows into a dense hedge when planted in lines along the contours of slopes, vetiver can slow runoff and prevent soil from washing off slopes, the report said.

For centuries, vetiver's roots have provided an oil used to scent perfumes and soaps. It is grown in 70 countries, but few use it for erosion control. Worldwide, 20 billion tons of soil disappear each year--the equivalent of about 6 million hectares of arable land. Vetiver's stiff stems and leaves and deep roots enable it to function as a virtual dam, even when dormant, and it survives for decades. Thus far, it has not spread or become a pest as have other plants, such as kudzu, introduced to stop erosion.

The report cautions that only domesticated vetiver from South India, which produces no seeds and spreads by vegetative propagation, should be used. The NRC report suggests that researchers evaluate whether this grass will prove useful as foliage along footpaths, railroads, and road cuts.

* * *

"What We've Learned About GIS: One Park's Experience" is the title of an article by Chuck Rafkind, Hugh Devine, John Karish, and Patti Dienna, that will appear in a future issue of the George Wright Society's **Forum**. The article was prepared as an answer to the dozens of questions received by Colonial National Historical Park with regard to the park's implementation of a park-based PC GIS. It summarizes both the positive and negative experiences of the park over the past three years in developing data themes under cooperative agreements with NC/State/U, the College of William and Mary, VI Institute of Marine Science, and the U.S. Soil Conservation Service. It also describes park development of GIS Standard Operating Procedures to guide development of new geographic and database files, database management, data dictionary, and cartographic map output.

* * *

"Through time and generations, certain patterns of thought and behavior have been accepted and developed into what can be termed a Western tradition of environmental thought and conservation," according to Arturo Gomez-Pompa and Andrea Kaus in their April 1992 **Bio-Science** article, "Taming the Wilderness Myth" (pp 271-9). But are these necessarily correct? "Scientific truth" is always subject to replacement by another "truth" in the light of new information that does not fit the old paradigm, say the authors, and they point to "equilibrium" and "climax" as two concepts that few ecologists defend today.

The concept of wilderness as "untouched" or "untamed" is seen as "mostly an urban perception," and the authors suggest that "we must learn how local inhabitants in rural areas understand their environment and must bring this vision into both the urban and rural classrooms." The fundamental challenge, they conclude, "is not to conserve the wilderness, but to tame the myth with an understanding that humans are not apart from nature."

* * *

In the April 3, 1992 issue of **Science**, three authors who are with the Finnish Forest Research Institute in Helsinki look at the biomass and carbon budget of European forests from 1971 to 1990 and conclude that while severely polluted areas (such as found locally in Montshegorsk in northwestern Russia) have suffered total tree death, moderate pollution may result in a general increase of forest resources. Their work points to fertilization effects that override the adverse effects "at least for the time being" in Austria, Finland, France, Germany, Sweden and Switzerland. "Biomass was built up in the 1970s and 1980s in European forests," they write. "If there has been similar development in other continents, biomass accumulation in nontropical forests can account for a large proportion of the estimated mismatch between sinks and sources of atmospheric carbon dioxide."

* * *

The upper forest canopy as viewed from an atmospheric perspective is the subject of a **BioScience** article (Vol. 42:9, pp 664-70) by Geoffrey Parker, Alan Smith and Kevin Hogan. This primary interface between the atmosphere and the forest is a reservoir of biological diversity and understanding of it is far from adequate, according to the authors.

"Access to the Upper Forest Canopy with a Large Tower Crane" is the title of the report, in which they describe observations made from the canopy as suggesting a wide diversity of functional behaviors of overstory leaves and a complex upper canopy structure. The large tower crane from which they made their observations, installed in a forest, allows repeatable sampling in three dimensions, unprecedented control for observations, and experimentation within the canopy space of the forest.

* * *

A surprising new database of the climatic history of the arid Southwest is described in the March 27, 1992 issue of **Science:** a stand of centuries old Douglas-fir trees recently discovered in the lava fields of El Malpais National Monument in western NM. One of these trees (dubbed "1062") is the oldest accurately dated living member of that species and is deemed by dendrochronologists to have sprouted 4 years before William the Conqueror invaded England in 1066.

The sites is protected both from fire and from competitors by the lava fields that surround it and may well spur dendrochronologists to search other lava flows--such as those in Oregon, Idaho, and California--for old trees. Ecologists will be encouraged to probe for the secrets of the trees' survival in what is for most plants a very hostile environment.

* * *

Restoration Ecology, "the first complete scientific journal for restoration ecologists," is a new, peer-reviewed quarterly journal, published for the Society for Ecological Restoration by Blackwell Scientific Publications, Inc. The journal will not distinguish between basic and applied research, and encourages all contributors to consider both the practical and the more fundamental implications of their work. The editors encourage submission of manuscripts that emphasize an holistic approach and that deal with the highest level of biological integration--the human ecosystem. The editor is William A. Niering, Botany Dept., Connecticut College, New London, CT 06320. To subscribe or request a sample issue, contact Blackwell Scientific Publications, Journal Fulfillment, 238 Main St., Cambridge, MA 02142

* * *

Jared Diamond, who teaches physiology at UCLA Medical School and practices conservation biology in Indonesian New Guinea, asks a tough question--"Must We Shoot Deer to Save Nature?"--in the August 1992 issue of **Natural History**. "Alas," he answers himself, "nature can't manage most nature reserves without our help." His article stems from "a magically beautiful, but painfully upsetting day in Fontenelle Forest near Omaha," where the author found nothing but mature oak, hickories and lindens. "I saw no seedlings," he writes...a sight that was "like visiting an apparently thriving country and suddenly realizing it was inhabited mainly by old people, and that most of the infants and children had died."

Fontenelle exemplifies the paradox underlying a bitter policy dispute; the paradox being that the twin goals of noninterference with nature and of preserving pristine natural habitats are incompatible. He considers the case of Yellowstone: whether to bring in wolves and outrage neighboring ranchers, or outrage the public by "culling" elk and bison. Diamond admits he is happy not to have to explain to the public why they can't pick flowers in a reserve where deer are shot. Managing for biodiversity is a goal with many problems left to be solved.

* * *

The entire matter of conflict of interest in science--especially with regard to reviewing articles in refereed journals--is considered in the July 31, 1992 issue of **Science**. The editor, Daniel E. Koshland, Jr., describes the policy improvements **Science** will use henceforth to "improve our previous procedures." He adds, "One of the problems of conflict of interest is the degree of sanctimoniousness attached to it.." Koshland vows to be "aware of intellectual as well as financial and social conflicts," and reports that **Science** is "adapting guidelines that have been used by the National Science Foundation over a number of years.

A special section addresses several facets of "conflict of interest," including the potential financial conflicts at the cutting-edge areas of biology (by Marcia Barinaga) and the much older and more pervasive form--"intellectual conflicts of interest" (by Eliot Marshall), in which a researcher's overriding investment in a particular hypothesis can lead either to boon or disaster.

* * *

A 91-page document, richly informative about the 500 years of environmental change since Columbus "discovered America" is available from its author, Richard L. Cunningham, Chief of Interpretation for the NPS Western Region. In *The Biological Impacts of 1942: Some Interpretive Thoughts*, Cunningham describes the native people of the West Indies, the decimation of the Indians, early biological impacts, a history of extinctions and endangered species, introduced animals and other organisms, biohistories of Haiti and Jamaica, threats to the Caribbean terrestrial and marine environments, and how all this "applies to my park," (with suggested topics, outlines, and slide show sources for developing your own park's program.)

In his Conclusions, Cunningham writes: "Columbus did not discover a 'New World'. Instead he found another old world with cultural and biological riches different from but as rich as those from the Europe he left. Columbus linked these two worlds into a common heritage that is still evolving. ... The continuing legacy of the Columbus event is not just historical, not just cultural, it is and will always be biological."

The Columbus paper, and another by Cunningham, *The Biological diversity of Food Plants: Some Interpretive Thoughts*, (52 pages), may be had by contacting Cunningham at NPS Western Regional headquarters, 600 Harrison St., Suite 600, San Francisco, CA 94107; (415)744-3910.

* * *

On Feb. 23, 1993, President Clinton announced the nomination of George T. Frampton, Jr., to serve as Asst. Sec. of the Interior for Fish and Wildlife and Parks. Frampton has been president of The Wilderness Society since 1986. Prior to that, Frampton was a partner in the Washington, D.C. law firm of Rogovin, Huge & Lenzner.

From 1973-75, he served as Assistant Special Prosecutor on the Watergate Special Prosecution Force and was a member of the team that conducted the grand jury investigation and trial of the Watergate Cover-Up case against President Nixon's chief aides.

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Figure 1. Dall sheep rutting habitat.

Dall Sheep Trophy Hunting in Alaska's Parks and Preserves: Biological Implications

By Francis J. Singer

The Alaska National Interest Lands Conservation Act (ANILCA) of 1980 designated 5 new parks and 5 new preserves that supported populations of Dall sheep, and added lands to a sixth, pre-existing park. As a result of this Act, about a quarter of the state's 70-75,000 Dall sheep were found within NPS boundaries. Subsistence hunting by local rural residents was permitted in the new areas and sport hunting was allowed in the preserves.

Congress mandated that wildlife populations in the parks be managed in a healthy and natural state, but Congress used these terms conceptually rather than definitively. Alaska continued to set seasons and bag limits, but with federal oversight to assure that the mandates were met. Concern was expressed that designation of the new parks, with their greater hunting restrictions, would focus greater hunting pressure on the remaining herds.

Dall sheep breed and spend the winter on open, windblown mountain slopes in Alaska (Fig. 1). Breeding takes place in early winter (mid-November through mid-December). Maintenance of adequate fat reserves following the stressful rut is essential to both males and females for survival through the remainder of the harsh, northern winter.

Lambs are born in mid-May. Inadequate fat reserves for ewes equate to lighter birth weight in lambs; smaller lambs survive at a lower rate. Timing of lambing also is critical. Early-born lambs can perish in late winter storms, while late-born lambs may not obtain sufficient body size and mass to survive their first winter.

During this study in 1981-85, the State of Alaska permitted limited, all-age subsistence hunting of Dall sheep in a few park areas, and unlimited hunting of 7/8-curl or larger rams in national preserves. The scientific community proposed several hypotheses concerning potential negative effects of sport hunting removals of only the oldest rams:

1. The social disruption hypothesis: Most breeding by males is restricted by dominance hierarchy to the largest-horned 7 year old or older rams. The older rams court ewes in a more ritualized, less hurried, less aggressive fashion (Fig. 2). When older rams are harvested, the younger rams may harrass ewes, thus wasting valuable energy reserves needed to survive northern winters.

2. The magnet effect of older rams on younger rams hypothesis: Rams will court ewes outside of the breeding season, and expend critical energy reserves; but rams typically segregate from ewes into separate habitats. This hypothesis states that older rams do not remain with ewe/young groups following the rut, and that younger rams will follow older rams rather than remaining with the ewes.

3. Immature ram incompetence hypothesis: Younger rams may breed ewes later or pregnancy rates may be lower than is the case with older rams.

4. Depressed survivorship in young rams hypothesis: Younger rams might die at a higher rate in hunted herds as a result of their increased role in breeding and depletion of critical energy reserves (Fig. 3). When older, more dominant rams are present, younger rams are excluded from most courtship and breeding activity.

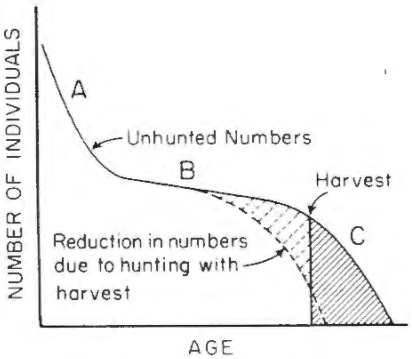

Figure 3. Generalized survivorship curve for Dall sheep rams. A: juvenile phase; B: immature phase; C: mature phase. If all mature rams are harvested, Geist's (1971) hypothesis predicts that the accelerated mortality associated with behavioral maturity (phase C) would be shifted to younger age classes.

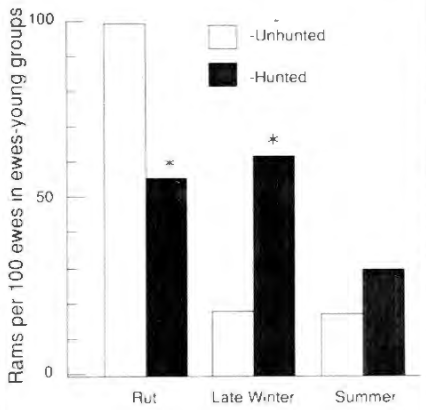

Figure 4. Young rams remained in ewe/young groups outside of the rut in late winger and summer significantly more in the hunted than in the unhunted herd, thus providing evidence for the magnet hypothesis.

Observations

Between 1981-85, with co-workers Ed Murphy (U/AK), Karen Laing (then of NPS), and Lyman Nichols (AK Dept. of Fish and Game), I studied demography, survivorship, and breeding behavior in hunted and unhunted Dall sheep herds in Alaska. Our studies were conducted in two areas that were not hunted--Denali NP and Alaska's Cooper Landing Closed Area. Each area had nearby area where all legal (7/8-curl or larger) rams were removed each season by hunters as soon as they reached legal horn size.

We observed that young rams harassed ewes slightly more than did older rams. Young rams performed twice as many butts, one-half as many twists (a ritual display), and chased ewes more than did older rams. Ewes were twice as likely to run away from an approaching young ram as from an older ram. However, actual energy expended by ewes, expressed as courtship time per hour of observation, was identical between hunted and unhunted herds, since (as a result of the ram harvest) proportionately fewer rams per ewe were present in the hunted herd.

We observed evidence for the magnet hypothesis; more young rams remained with the ewe/young groups throughout the winter in the hunted herds (Fig. 4).

Figure 2. Dall Sheep in twist display toward adult ewe, Usibelli Mine study area, Alaska.

No evidence was observed for immature ram incompetence. Lamb production and survival to yearling age were identical in hunted and unhunted herds. Lambing dates were nearly identical.

No evidence of depressed survivorship of younger rams was observed in hunted herds.

Conclusions

We concluded that under the 7/8-curl harvest regulation, Dall sheep populations in national preservesin Alaska met all the presumed criteria of a healthy population. Ewe energy expenditures, young ram mortality rates, and production of young were equivalent between hunted and unhunted populations. Some elements of natural selection, however, were missing from the hunted populations. There were fewer rams per ewe and thus less competition among rams for breeding opportunities. Ewes consistently accepted the courtship activities of the largest-horned rams in all groups, and this sexual selection likely had strong adaptive significance. For example, breeding with a dominant ram may increase the prospects of the lamb's also being a dominant individual with better survival chances. Removal of all the large-horned rams in a herd, therefore, may minimize male competition for mates and thereby influence natural selection.

Since completion of this study, the state of Alaska has raised the minimum size for harvest from 7/8- to full-curl in all the state except for the Brooks Range, thus further reducing concerns for the health of hunted Dall sheep populations in national preserves.

Singer is an NPS Research Ecologist, stationed at the Natural Resources Ecology Lab, Colorado State University, Fort Collins, CO 80523.

Reports Available from Singer

Murphy, E.C., F.J. Singer, and L. Nichols. 1990. Effects of hunting on survival and productivity of Dall sheep. J.Wildl.Manage. 54:284-290.

Singer, F.J., E.C. Murphy, B.A. Cooper, and K.K. Laing. 1991. Activity in a hunted and unhunted herd of Dall sheep in Alaska; a review of the biological and management implications. Biennial Sym-posium of Northern Wild Sheep and Goat Council (in press).

Singer, F.J. and L. Nichols. 1992. Trophy hunting of Dall sheep in Alaska: A review of the biological and management implications. Biennial Symposium of Northern Wild Sheep and Goat Council (in press).

Singer, F.J. and K.K. Laing. 1992. Effects of tropy hunting removals of rams on rut behavior of Dall sheep. Unpublished ms.

Recommended Reading

Geist, V. 1971. The evolutionary significance of mountain sheep horns. Evolution 20:558-566.

Using GIS to Assess Potential Impacts Of Gypsy Moth Infestations at Great Smoky Mountains NP

By Hope R. Barrett and Stephen C. Nodvin

The gypsy moth (*Lymantria dispar*) (Fig. 1) is an insect pest whose larvae feed on tree foliage. Populations of gypsy moths often cause extensive defoliation of forests which sometimes results in tree mortality. Over the past 100 years, gypsy moth populations have spread south and westward from Massachusetts, the site of accidental release, and have produced one of the most serious forest pest management problems in United States history. By early next century, the expanding portion of North America that is infested with gypsy moth populations is expected to include the Great Smoky Mountains National Park (GRSM). The park, a 207,500 ha natural area on the border of North Carolina and Tennessee, serves as a center of biodiversity and is the most visited national park in the United States.

This study to assess the forests of GRSM for potential impacts from the inevitable moth invasion. A personal computer version of Earth Resources Data Analysis System (ERDAS) was the geographic information system (GIS) used to model forest defoliation and tree mortality events in the park. The three objectives of this study were to rate forests of GRSM for: 1)defoliation potential, 2)sensitivity to environmental stress, and 3) tree mortality potential. Evaluations of forest susceptibility, sensitivity, and vulnerability were completed during the rating process.

The term "susceptibility" refers to the potential that a forest will become defoliated given gypsy moth invasion. The assessment of susceptibility in GRSM forested areas was achieved using a three step modeling approach. The first step involved the development of a selection index. Forest types in the park were classified and mapped using satellite data and image processing (MacKenzie 1991). Forest types were then ranked for their likelihood of defoliation according to their tree species composition relative to species preference of gypsy moths (Table 1). Ranks were based on published studies of gypsy moth susceptibility in the northeastern United States.

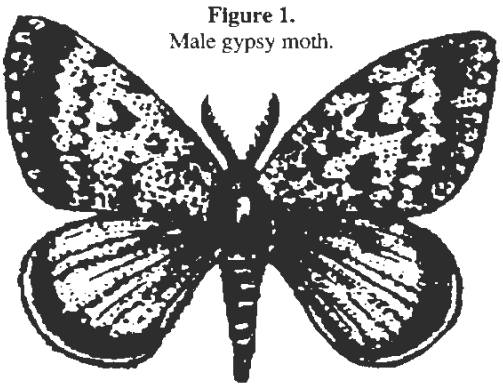

Figure 1.
Male gypsy moth.

The second step was initiated by delimiting sites in the park where gypsy moth introduction would be influenced by humans. These sites include: developed campgrounds, environmental education centers, visitor centers, picnic areas, and heavy or medium duty roads. A GIS was then used to delineate a zone around the sites which indicated expected gypsy moth expansion and defoliation within the first two years after their introduction into the park.

The third step involved using a GIS modeling program to ascertain susceptibility ratings for each forest type. Areas of susceptibility to defoliation within two years after gypsy moth introduction were delineated by finding forest types that were ranked for gypsy moth preference within the zone of gypsy moth expansion. The results of the susceptibility evaluation indicated that 64 percent of the park (131,972 ha) is projected to experience some tree defoliation within the first two years after gypsy moth introduction.

Forest sensitivity is the relative likelihood of tree death after forests are disturbed. It was assumed that forest types would be most sensitive to disturbances (*e.g.*, gypsy moth defoliation) at the extremes of their ranges along the topographic gradients of elevation, slope, and aspect. These three topographic variables were used to create map layers from a digital elevation model. Each map layer was cross tabulated with the nine forest types which generated frequency distributions of elevation, slope, and aspect for each forest type. The distributions were then evaluated for normality, and confidence intervals were located on each Gaussian distribution. Forest sites outside of the 95 percent confidence intervals of fitted Gaussian distributions were classified as sub-optimal. Forested areas of high, moderate, and low forest sensitivity to disturbance were identified by combining the sub-optimal sites of the elevation, slope, and aspect map layers (Table 2). A high sensitivity rating represented sites that were determined to be sub-optimal in all three map layers, while a moderate sensitivity rating represented sites that were sub-optimal in any pair of the three map layers, and a rating of low represents sub-optimal sites in a single map layer.

Vulnerability is the relative risk of forest mortality following defoliation. Vulnerability ratings of forest types were ascertained by finding every possible combination of susceptibility and sensitivity. The combinations were then assigned a descriptor that indicated a significance value (vulnerability rating) of high, moderate, or low. The results of the vulnerability evaluation indicated that 15 percent (30,416 ha) of the park is projected to be at some risk to stand mortality within two years after gypsy moth defoliation (Table 3).

Results from these evaluations are being provided to NPS staff to assist in development of management strategies prior to gypsy

Continued on page 27

Table 1
Gypsy moth preference ratings for forest types of the Great Smoky Mountains National Park

Preference	Forest Type
Highest	Mesic oak
High	Pine-Oak
High	Pine
High	Xeric Oak
Moderate	Northern Hardwood
Moderate	Cove Hardwood
Moderate	Spruce-Fir
Low	Mixed Mesic Hardwood
Lowest	Tulip Poplar

Table 2
Sensitivity ratings, and their hectares and percent composition of the Great Smoky Mountains National Park

Sensitivity Rating	Hectares	Percentage of GRSM
High	662	0.3
Moderate	8,852	4.3
Low	38,293	18.4
Total	47,807	23.0

Table 3
Hectares and land percentages of GRSM forests that are either high, moderate, or low in vulnerability to mortality within two years of gypsy moth introduction

Vulnerability Rating	Hectares	Percentage of GRSM
high	349	0.17
moderate	18,279	8.81
low	11,788	5.68
total	30,416	14.7

Moth continued from page 26

moth infestations. Strategies can be developed to protect against early infestations, and to focus protection efforts on those stands that are both vulnerable to mortality and considered critical natural resource areas. In addition, interpretive materials and programs can be developed from the results of this study to educate the public on the inevitable consequences of this exotic insect moving into the region and the efforts that the National Park Service will take to minimize the resulting damage.

Barrett is a Research Ecologist with the USFS at Morgantown, WV; Nodvin is with the NPS/CPSU at U/TN, Knoxville.

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Crater Lake Study Peer Review Panel Meets

A technical report on Crater Lake Limnological Investigations, mandated by the Congress in 1982, was presented Feb. 27, 1993 to a peer review panel at Oregon State University, chaired by Dr. Stanford L. Loeb of the University of Kansas Department of Systematics and Ecology.

The six panelists heard Principal Investigator Dr. Gary L. Larson review the program's goals and objectives and describe the lake's clarity, an integrated view of the lake's ecosystem, and the long-term monitoring program that is emerging. Dr. Robert Collier discussed lake circulation, hydrothermal processes, and particle flux; Dr. Peter Nelson presented the chemical solute mass balance picture; phytoplankton, zooplankton, and fish were discussed by Drs. C. David McIntire, Larson, and Mr. Mark Buktenica respectively.

Panelists' comments and critique will be presented within the next few weeks and incorporated as appropriate. The final report will be submitted to the NPS Washington Office by May 1993. In addition to Dr. Loeb, panel members are Dr. Raymond Herrmann, NPS, Fort Collins, CO; Dr. Hiram W. Li, USFWS, OR/State/U, Corvallis; Dr. Manuel Nathenson, USGS, Menlo Park, CA; Dr. Richard Peterson, Portland State U Biology Dept., Portland, OR; and Dr. John L. Stoddard, U.S. EPA Research Lab, Corvallis, OR.

Illegal Collection of Plants In Units of the National Park System

By Jenness Coffey

Fueled by the international market, the trade in medicinal plants has flourished over the last decade. According to a 1991 report by the World Wildlife Fund, (*Medicine from the Wild, an Overview of the U.S. Native Medicinal Plant Trade and Its Conserva-tion Implications,* by Douglas O. Fuller) some 600 medicinal herb species are commonly traded in the U.S. market, and a preference for wild-harvested over cultivated or artificially propagated plants has led to extensive collection from the wild. Incidents of illegal collection of plants in parks show that plants in the national parks are not immune to illegal collection for commercial gain.

Examples of the financial rewards for plant poachers include the following incidents:

- In the fall of 1990, organized groups illegally harvested mushrooms at Crater Lake NP. They were then air-shipped to Japan, where they sell for as much as $100 per pound.
- One of several illegal timbering operations inside New River Gorge National River in 1991 removed at least 10,500 board feet of hardwood timber with an estimated value of $6,000.
- Between Aug. 16 and Sept. 27, 1991, rangers made seven separate cases against poachers who were illegally taking ginseng from Great Smoky Mountains NP. The rangers recovered more than 800 roots that had been dug up illegally. Ginseng, valued in the oriental market as an aphrodisiac, sells in the U.S. for approximately $200 per pound and the price increases overseas.

A Native Plant Protection questionnaire was sent to the parks in 1992 to assess the extent and magnitude of illegal collection of native plants in units of the NP System. Since resource protection involves both law enforcement and natural resource aspects, the questionnaire was issued jointly by the Associate Director for Operations and the Associate Director for Natural Resources. Replies from 9 of the 10 NPS regions, showed that 99 species of native plants were known to have been illegally collected in 37 NPS units in 1990, and 88 species were poached in 41 NPS units in 1991.

Because plant collecting activities are driven by both the national and international markets, some species of plants are more intensively collected than others. The individual species reported by the most parks as being illegally taken was ginseng; seven parks reported such collections from inside park boundaries both in 1990 and 1991.

In addition to ginseng, other plants that were most often reported poached from parks in the eastern U.S. included the land's slipper orchid, rhododendron, iris, and jack-in-the-pulpit. In the Pacific northwest, various species of trees and ferns are taken illegally most often. In the southwest, yuccas and cacti top the list, with at least 13 different species of cacti being reported as illegally collected in parks in 1990 and 1991.

Replies to the Native Plant Protection questionnaire indicate that collection represents a threat to some species of native plants in NPS units. Acadia NP reported that plant poaching most likely has resulted in extirpation of *Cypripedium regtinae*, the showy lady's slipper orchid. Moores Creek National Battlefield reported that the Venus fly-trap, a plant popular in the wild plant trade, has virtually disappeared from the park, although the cause is unknown. And monitoring of *Zephyranthes atamasco*, the Atamasco or Easter lily, at Congaree Swamp National Monument has shown a decline in numbers. Like the Venus fly-trap, the Easter lily also is very popular in the wild plant trade.

Of the plants reported by the parks as being illegally collected, at least 20 are federally listed as endangered, threatened, candidate species, and/or are species protected by state law.

A survey of wildlife poaching in units of the National Park System conducted in the spring of 1991 showed 105 species of wildlife being poached in 153 parks in 1990. Although plant poaching is occurring in fewer parks than wildlife poaching, the number of species of native plants being poached is not significantly lower than the numbers for wildlife poaching in parks.

Coffey is a Natural Resource Specialist in the NPS Washington office, Planning and Information Branch, Division of Wildlife and Vegetation.

Genetic Diversity and Protection of Alpine Heather Communities in Mount Rainier National Park

By Regina M. Rochefort and David L. Peterson

The term biodiversity is frequently used to describe the number of taxa in a specific geographic location, however, it also refers to the genetic diversity of populations within a species. Genetic diversity is a basic component of all other levels of diversity (species, landscape, and process levels). It varies across space and time reflecting each species' life history traits and environmental and evolutionary history. Protection of genetic diversity is necessary for the long-term survival of species and populations because it provides them with the resources to respond to changing environmental conditions, regardless of the cause of that change.

Increased visitation in some parks may result in increased off-trail hiking and camping, potentially causing plant mortality and fragmentation of plant populations. These changes within populations may also decrease genetic diversity of a species, thereby reducing its potential for long-term survival. Resource protection guidelines such as Limits of Acceptable Change (LAC) may be strengthened by utilizing an integrated approach that combines demographic, life history, and genetic diversity characteristics of targeted species. We are currently conducting research on two heather species (*Phyllodoce empetriformes*, *P. glanduliflora*) to determine how genetic diversity data can be utilized to improve resource protection guidelines in Mount Rainier National Park.

Human Use Patterns

Each year almost two million people visit Mount Rainier NP. The most popular destinations are within the subalpine and alpine areas. Approximately 70 percent of all visitors go to at least one subalpine meadow (Paradise), and 98 percent of all cross-country camping (minimum impact camping without developed campsites) occurs within subalpine and alpine areas. This concentrates use on just 35 percent of the park's land mass and on the vegetation least resilient to human use. Overnight use in subalpine and alpine areas has increased by 43 percent since 1984 and is expected to continue to increase as urbanization encroaches on the park.

Resource Protection Guidelines

Mount Rainier NP encompasses 95,389 ha, of which 92 percent is designated Wilderness. Resource protection is addressed through overnight camping limits, LAC standards, and restoration projects. Maximum numbers of parties per night are designated for each crosscountry and alpine zone within the Wilderness. LAC standards for changes in landscape (vegetation) address the maximum number, size, and density of bareground areas, such as campsites, allowable within one wilderness zone. Restoration projects involve repair or protection of sites where noticeable damage has occurred following human use. Although these projects are usually initiated by development of at least one "severe" human impact (e.g. severe erosion or denudation), they usually address all impacts within an area. In this manner, restoration plans address areas of trampled vegetation and not just bareground sites (destroyed plant communities) addressed by LAC standards.

Mount Rainier's LAC standards currently focus on destroyed plant communities (bareground sites), which is the most severe form of damage from human use. Park staff now are trying to increase the accuracy of monitoring programs by improving methods for monitoring damaged plant populations. One method employs a qualitative assessment of plant health called "condition classes." Visual condition classes are a qualitative assessment of community "health." Condition classes are: 1) little change - no signs of human use; 1) definite change - some evidence of human use, broken or abraded plants, small bare areas, but minimal erosion; 3) severe change - uprooted plants, large denuded areas, severe, local erosion; and 4) habitat destroyed - all plants gone, extensive soil erosion. Recently, a survey documenting "condition classes" of plant cover, was conducted within the Muir Corridor alpine zone (approx. 16.8 ha). Each plant patch was mapped on an aerial photograph and assigned to one of the four visual condition classes. Although the zone meets LAC standards, survey results documented that 47 percent of the area shows definite change, 9 percent has been severely changed, and only 44 percent exhibits little change from human use (see photograph). Over half of the zone (56%) was damaged substantially and we are not certain how these levels of damage affect the potential for long-term survival of plant populations. We are studying the significance of different levels of human-caused damage on these plant communities and developing practical methods to monitor vegetation change.

Management of Genetic Resources

The USDA Forest Service (USFS) and Washington Department of Natural Resources (DNR) have identified conservation of genetic resources as a management objective. Specifically they use the concept of Genetic Resource Management Units (GRMU) to identify discrete components of genetic diversity within and between species populations. This concept is applied on a limited basis (Riggs, 1990) on some National Forests in California (Millar and Libby, 1991) and on many Washington DNR lands (Wilson, 1990). Each GRMU is composed of a core area and buffer zone. Size and location of GRMUs are based on:

(1) genetic diversity within a species population,

(2) reproductive and other life history traits, and

(3) species densities. Conservation plans for individual species include identification of several GRMUs.

The objective of GRMUs is to:

(1) conserve genes in an evolutionarily dynamic condition,

(2) maintain viable, genetically diverse populations of species, and

(3) provide control sites for monitoring (Millar and Libby, 1991).

They provide a tool for evaluating resource damage and developing LAC standards in Wilderness. Impacts from human use, air pollution, or other environmental stresses can be measured more effectively with GRMUs, because change can be detected more easily than at the population level in species or more complex levels of organization in ecosystems. In addition, they can be used to predict relative endangerment of species. Application of the GRMU concept is a recent development in biological conservation, and has been used as a management tool for only a few years.

Research Objectives

We are evaluating the concept of GRMUs as a management tool for protecting biological resources in Mount Rainier NP and its surrounding ecosystem, with an emphasis on genetic diversity of species populations (Rochefort and Peterson, 1991). This work is supported by funding from the Natural Resource Preservation Program. The research objectives for our study are:

(1) determine the genetic diversity of selected plant species in the subalpine/alpine zone of Mount Rainier NP,

(2) describe potential GRMUs for populations of these species, and

(3) develop resource management guidelines for application, management, and monitoring of GRMUs.

We are using a population genetics approach to address how the impacts of stress from urbanization and associated resource use can be identified in park ecosystems. We are specifically studying how these impacts affect the biological diversity of plant populations and how NPS resource managers can protect this diversity.

Research Methods

Our project utilizes basic genetic and ecological information in a framework that is directly applicable to resource management. Once data are collected and analyzed, management applications will be developed with a team of NPS and USFS resource managers and scientists. Our first step was to determine the geographic distribution and condition of two heather species: *Phyllodoce glanduliflora* and *P. empetriformes* populations. Heather communities are of particular concern due to their sensitivity to trampling, slow recovery rates, and length of time for community development. Specific heather communities within Mount Rainier NP have existed for as long as 10,000 years, although establishment of new meadows with continuous cover requires at least 200 years (Edwards, 1980). Populations were mapped on topographic maps and entered into the park GIS. Each population we monitor will be evaluated with regard to the severity of human impact using the park's visual condition class rating.

Currently we are working on the second step of our research-- surveying genetic and morphologic diversity of a subsample of populations of each species. Sample sites will be distributed at four general locations (north, south, east, and west sides of the mountain). At each of the four sites, paired populations will be sampled at the high and low elevation range of each species. At each population, 20-30 individuals will be sampled for genetic analysis and surveyed for several morphologic characteristics (needle color, angle, and size). Additional sample sites will be established within damaged populations in order to compare undamaged and damaged sites.

The third step will be to analyze genetic and morphologic variation with special emphasis on trends within and among populations and along geographic and elevation ranges. Genetic diversity will be determined using allozyme analysis (Allard, 1970; Asins and Carbonell, 1987). Allozymes are alternative forms of enzymes present as genetic traits on chromosomes, and provide standard yardsticks for making comparisons among populations and taxa. The greater the number of allozymes (that is, heterozygosity), the greater the genetic diversity of the organism. We also will determine if there are correlations between genetic diversity and morphologic and reproductive characteristics (Loveless and Hamrick, 1984).

Our final step will be to develop guidelines for the application of data on genetic diversity, demography, and life history to improve resource protection policies. Specifically, the GRMU concept will integrate NPS policies with scientific data as a means of protecting biological diversity within Wilderness.

Summary

NPS Service Management Policies direct us to protect biodiversity and state that we "... will strive to protect the full range of genetic types (genotypes) native to plant and animal populations in the parks by perpetuating natural evolutionary processes and minimizing human interference with evolving genetic diversity." (chapter 4:10). Policies also direct us to minimize our interference with gene pools during revegetation projects (chapter 4:9); however, there is little guidance available for resource personnel on how to apply this principle in the field.

Our study uses two high elevation heather species in Mount Rainier NP as a test case for how genetic diversity data can be integrated in the development of resource protection guidelines. This project will determine if quantifying genetic variation can provide additional protection to plant species beyond that contained in current regulations.

Rochefort is the Botanist at Mount Rainier NP and is currently on LWOP while working on her Ph.D. at the U/WA CPSU with Dr. Peterson. Peterson is Associate Professor and Research Biologist at the U/WA CPSU, Seattle.

Heather community in Mount Rainier NP. This community is estimated to be 10,000 years old and been severely changed (condition class 3) by human use.

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Nisqually Glacier Records a Century of Climate Change

Nisqually glacier on Mt. Rainier is shown at 1:24,000 in this NPS-contracted aerial photo. Paradise can be seen at lower right.

By Barbara A. Samora

There are 25 major glaciers on Mount Rainier and numerous unnamed snow or ice patches. The Emmons Glacier has the largest area (4.3 square miles) and Carbon Glacier has the lowest terminus altitude (3600') of all glaciers in the lower 48 states. The Nisqually has shown dramatic changes in dimension within the last century (Heliker, Johnson and Hodge 1983).

Global temperatures are increasing at a rate 10 times more rapid than the average rate of natural change. Climate change may be most quickly seen in glacier terminus fluctuations and changes in mass balance. Global warming may decrease the size of large glaciers and smaller glaciers may disappear.

Glaciers store information on temperature (Meier 1991, Raymond 1991) and past atmospheric composition (Lorius 1990). The estimated freshwater runoff from glaciers is significant--14 percent of the runoff in the conterminous states (Mayo and Trabant, 1986). Glaciers exert a significant control on the flow and water quality of park streams and rivers. Increased glacial runoff may have significant effects on flow, temperature, and sediment regimes in downstream areas. Reduced stream temperatures may eliminate or alter life cycles of certain invertebrate species.

The Nisqually Glacier on Mount Rainier has one of the longest and most complete records in the Western hemisphere of terminus position observations and ice-surface altitude measurements along specific profiles. A. Kautz first described the Nisqually Glacier in 1857. The USGS began research on park glaciers in 1896 when C. Russell recommended the glacier be studied and include photo stations, measurements indicating flow rates, and mapping of the glacier termini. In 1905, LeConte studied the flow rate of the Nisqually. Matthew of the USGS made the first accurate determination of glacier locations with his 1913 topographic map of the mountain.

Terminus position was recorded annually by the NPS beginning in 1918 and has been located using historical records, the earliest in 1857 as described by Kautz. In 1931, the Tacoma City Light Department and the USGS initiated measurements of surface elevation along profiles upon the lower Nisqually Glacier. They were concerned that the source of water for Alder Lake dam, the Nisqually Glacier, and every other glacier on Mount Rainier, was experiencing rapid retreat. Measurements were continued until 1985, when the USGS could no longer support the project.

In 1991, through partnerships with the Nisqually River Council, the Nisqually tribe, and with technical advice from the USGS, the park resumed monitoring of surface elevation profiles on the glacier.

The Nisqually has shown dramatic changes in dimension within the last century (Heliker, Johnson and Hodge 1983). Between 1857 and 1979 the glacier receded a total of 1,945 meters and advanced a total of 294 meters. Advances occurred from 1963-68 and from 1974-79. Ice surface altitude changes of as much as 25 meters occurred between 1944 and 1955. A significant thinning of the ice has occurred since the mid-1980s. The 1991 survey documented a loss of 22 meters of ice thickness from 1983 to 1991 in the lower profile; the middle profile showed a loss of 11 meters during the same period. The higher profile was not surveyed in 1991, but we would expect similar thinning of the ice to be occurring (Driedger, pers. comm.). The 1992 survey was conducted in late September and results are not yet available.

Implications of the more recent changes in the Nisqually glacier are that we will see additional cliffs and erosion at the margins, additional exposure of ice-covered moraine, and changes in runoff characteristics. Additional crevassing in areas such as the Muir Snowfield, the most popular route to ascend the mountain, is likely. More exposure of the ice-covered moraine would result in a greater source of unstable debris moving downstream in the event of an outburst flood or heavy precipitation. Subsequent changes in runoff characteristics may result in increased flow in summer and less in winter.

Mount Rainier's glaciers are important indicators of climatic change, major visitor interpretive objects, and sources of water for park aquatic systems, as well as hydroelectric and recreation pursuits outside the park. The volcanic-glacial interactions on Mount Rainier pose a major flood hazard to developed areas downstream extending almost to Puget Sound. Interpretation of wilderness features, wilderness travel safety, and glacier hazards are important management concerns. Greater understanding of past history and glacial processes is needed to address resource management needs of the park and surrounding communities.

Samora is a Resource Management Specialist at Mount Rainier NP.

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Resource Management Program Trains 117 in 10 Years

William H. Walker, Jr., Coordinator of the Natural Resource Management Trainee Program, reminds us that the program is currently in its 10th year of operation, with the 25 trainees of Class VI scheduled to finish their program in September 1993.

Of the five previous classes, 117 people have been graduated; of these, a remarkable total of 108 still are in the Service.

This year's graduating group and their current whereabouts are: Hubert Chakuchin, Denali NP, AK; Mike Tetreau, Kenai Fjords NP, AK; Elaine Furbish, Assateague Island NS, MD; Steve Rudd, Allegheny Portage Railroad NHS, PA; Pamela Benjamin, Pipestone NM, MN; Bob Daum, Indiana Dunes NL, IN; Charles Jacobi, Acadia NP, ME; Mary Starkey, Roosevelt-Vanderbilt NHS, NY; Susan Bloomfield, Great Falls Park, VA; Daniel Roddy, National Capital Parks-East, DC; Mark Buktenica, Crater Lake NP, OR; Leigh Smith, North Cascades NP, WA; Laurie Lee, Yellowstone NP, WY; Ralph Moore, Zion NP, UT; Thomas Ulrich, Grant-Kohrs Ranch NHS, MT; Jim Petterson, Virgin Islands NP, VI; George San Miguel, Big Cypress Nat'l Preserve, FL; Ted Waters, Chattahoochee River NRA, GA; Biil Fuchs, White Sands NM, NM; Cicely Muldoon, Buffalo NR, AR; Geoffrey Smith, Capulin Volcano NM, NM; Faelyn Jardine, Hawaii Volcanoes NP, HI; Chip Jenkins, Santa Monica Mountains NRA, CA; Michael Reynolds, Curecanti NRA, CO; Jonathan Paynter, WASO Natural Resources Office, DC.

MAB Notes

The **MAB International Coordinating Committee** (ICC) held its 12th session in Paris, Jan. 25-29, 1993. Representatives of 24 council member countries and 28 observer countries attended, including observers Mike Ruggiero, Chief of the NPS Wildlife and Vegetation Division, and Roger Soles, Executive Director of the U.S. MAB Secretariat. The ICC agreed on five priority theme areas for MAB:

- conservation and sustainable use of biodiversity
- exploring regional approaches to sustainable development
- communicating information on environment and development
- strengthening institutional capabilities to address problems of environment and development
- contributing to the global terrestrial observation system.

Biosphere reserves will play important roles in implementing these themes. The Council also recommended national reviews to strengthen biosphere reserve (BR) performance, integration of BRs into national biodiversity strategies, and emphasis on expanding databases on BRs.

EuroMAB expects to publish a directory in June 1993 that contains contacts and information on research programs and follows a slightly modified NPFauna format.

In 1992, UNESCO approved **additions to two US biosphere reserves.** Added to the Central California Coast BR are: Audubon Canyon Ranch (National Audubon Society), Bodega Bay Marine Laboratory (U/CA), Cordell Bank National Marine Sanctuary (NOAA), and Jasper Ridge Biological Preserve (Stanford U). The Central California Coast BR now has the largest number of units (14) of all U.S. BRs. Southern Appalachian BR additions are: Grandfather Mountain (private) and Mount Mitchell State Park (State of North Carolina).

Internationally, the **biosphere reserve network** now contains 311 units in 81 countries. These units represent 110 out of 193 terrestrial biogeographical provinces. The 47 U.S. units represent 13 out of 14 biomes in the U.S., 21 out of 25 terrestrial biogeographical provinces, and 9 out of 13 coastal/marine biogeographical provinces. Major gaps are the Colorado Plateau, Great Basin, Prairie Peninsula, Micronesia, Ozark Highlands, and the coastal/marine provinces Acadian-Boreal and Arctic Boreal.

In September 1992, **Northern Biosphere Reserve managers** from six Arctic countries--U.S., Denmark, Finland, Sweden, Russia, and Canada--met in Anchorage, AK to discuss possibilities for cooperation and communication among reserves. A subsequent preproposal developed by Marv Jensen, Superintendent of Glacier Bay NP, has now been approved by the U.S. MAB National Committee to go to final. The proposal includes developing computer databases on bibliography, research programs,and software/hardware capabilities, and developing an exchange program for northern BR managers.

All U.S. biosphere reserve managers should have received a letter regarding their interest in participating in a **MAB workshop** or series of workshops to finalize an action plan for U.S. biosphere reserves. Managers' interests and concerns will be used to develop a workshop agenda.

Napier Shelton, *NPS Wildlife and Vegetation Division, WASO*

Bill Gregg, *NPS MAB Coordinator, Washington Office*

Coral Colonies' Violent Chemical Warfare

The strange, silent world of the coral reefs, continuously engaged in internecine struggles, is currently the center of a scientific dispute between two schools of thought. One school holds that corals worldwide are seriously imperiled from global warming, overfishing, pollution, and reef destruction wrought by fishermen and tourists. The other holds that only a "case by case" study can describe what's actually transpiring worldwide on the coral front.

William K. Stevens of the New York Times News Service examined the evidence in a feature that appeared in papers nationwide in February 1993. He painted a grim picture of the violent reality underlying the seemingly dreamy tranquility of a healthy, normal coral reef –"colonies staging unrelenting chemical warfare on each other, their polyps stinging, dissolving and poisoning each other. Bigger reef creatures savage large chunks of colonies and fill the water with toxins."

But such competition–with no quarter asked or given–is the rule, he notes, in this interdependent but mutually hostile world. "When polyps in one colony come face to face with another in a constant competition for scarce space, they expand their bodies to engulf their rivals and exude digestive juices that turn the competitors to jelly."

Judith Land, a reef ecologist at U/TX's Memorial Museum, describes how polyps in the attacked colony grow "sweeper tentacles" studded with special stinging organelles that "zap the neighbors." Still other polyps enshroud their enemies in a sticky mucus that dissolves the tissues. Coral reefs, Stevens says "may be one of the most naturally poisonous environments on earth. On Australia's Great Barrier Reef, 73 percent of 429 species of exposed invertebrates were found to be toxic to fish.

Stevens quotes Drew Harvell, a coral reef ecologist at Cornell University, as seeing "tremendous potential" in these toxins as pharmaceuticals--as anti-inflammatory agents, as effective against AIDS, and even as anticancer drugs –"and that's just one class of organisms," Harvell said.

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