PARK SCIENCE

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Shenandoah NP Pilots Air Quality Advisory

By Rolf M. Gubler

An experimental Air Quality Advisory program, designed to increase public awareness of air pollution impacts on park resources and to alert visitors when ozone levels exceed EPA established health levels (.12 ppm) was undertaken by the National Park Service in 1990. Shenandoah NP, as one of the five parks that volunteered to participate in the pilot program, developed a parkwide ozone and visibility rating system and public advisory.

Shenandoah NP is located in a highly sensitive ecological area that is subject to air pollution originating from the industrialized areas of the east coast, midwest, and local sources within Virginia. The 1977 Clean Air Act Amendments designated Shenandoah as a "Class I" airshed and required the highest degree of protection for air quality related values. The amendments also gave the federal land managers responsibility for protecting the air quality values in Class I areas. The 1990 Clean Air Act Amendments left these provisions intact. However, in Shenandoah and other areas, continued urban and industrial growth is resulting in significant deterioration of air quality.

Visitors come to Shenandoah NP expecting majestic views of the mountains and valleys, but instead they frequently are treated to a heavy white haze shrouding the scenic vistas. Statistics show that summertime visibility in the Eastern United States has decreased roughly 50 percent in the last 40 years (the average current summer visual range is 15 miles). Seventy percent of the haze affecting visibility is due to manmade air pollution, mainly sulfate aerosols. This current chronic intense regionwide white haze condition is in direct contrast to the bluish natural haze historically associated with the Blue Ridge Mountains. Leaves of trees and other plants emit moisture and natural chemicals (e.g. terpenes) into the air, which react to form the natural bluish haze.

Another threat to natural resources and human health is the high concentrations of ozone during summer months. This threat can best be illustrated by the summer of 1988, when the park recorded two separate occasions during which the federal ozone standard established to protect public health was exceeded. At that time, we had no system for informing our visitors and employees of the potential health risks. With the park's new quantitative ozone rating system we can effectively alert visitors and employees when periods of unhealthy ozone levels occur.

To provide visitors with current ozone and visibility information, we have developed a parkwide Air Quality Rating System.

Every morning, ozone data are collected at the Big Meadows monitoring site and are polled via modem to the Natural Resources and Sciences Division Office. The highest one hour ozone concentration average is noted and converted into one of the three following classes: LOW 0.0 - 0.059 ppm, MODERATE 0.060 - 0.120 ppm, and UNHEALTHY 0.121 ppm or greater.

Our qualitative visibility indexes are determined at noon each day by noting the visual range to our western horizon. The observer is aided by the presence or absence from sight of known mountain ranges. The visibility indexes are: POOR = 0-10 miles, MODERATE = 11-30 miles, and GOOD = 31 miles or more. Visibility indexes are posted as visual ranges.

At 1:00 p.m. the ozone and visibility ranges are logged and transmitted via park radio to entrance stations and visitor centers. These locations represent our main public contact areas. Park rangers on duty there display the current ozone and visibility rating on the designated Air Quality Index signs and bulletin boards. If the ozone rating is unhealthy or becomes unhealthy, this information, along with an appropriate advisory, is broadcast parkwide as an administrative message. The health alert advisory urges healthy people to reduce their physical activity; the elderly and those suffering from respiratory ailments are advised to stay indoors.

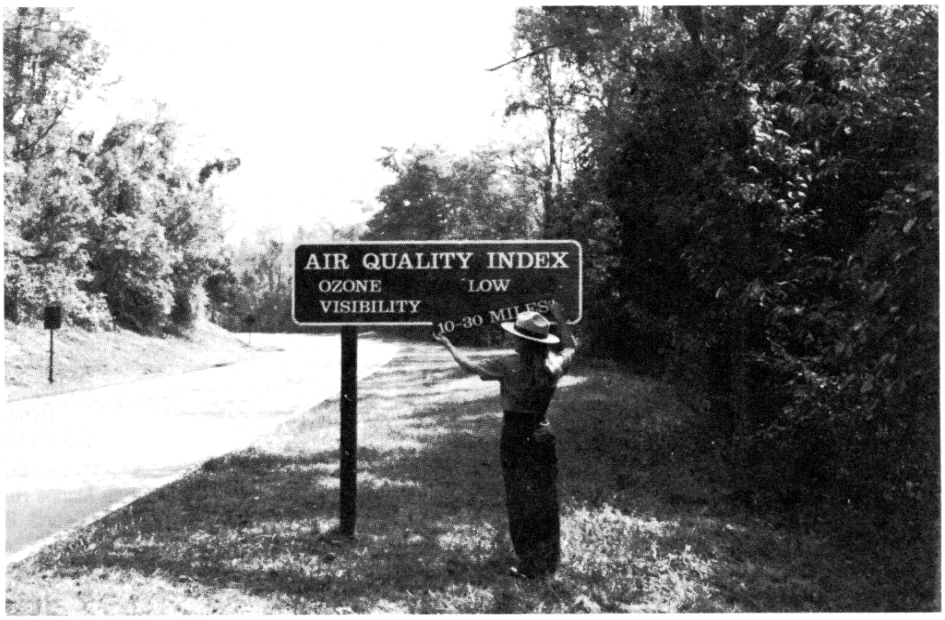
Our policy at Shenandoah states that it is at the supervisor's discretion to decide whether to modify an employee's work activity. During periods of high ozone levels, we feel it is essential to provide our visitors and employees with this basic information.

To further educate our visitors, we've developed informative exhibits, displays, and site bulletins explaining the implications and effects of acid precipitation, visibility impairment, and ozone pollution.

Air pollution is not always the responsible agent when poor visibility occurs. Spring and Fall often bring low-lying clouds and fog that obscure views. However, except when there is a storm occurring or distinct clouds are in the area, it is not always obvious whether the visibility impairment is caused by weather conditions or pollution. What may look like fog may in fact be haze, and the only way to be sure is to analyze the filters in the fine particulate monitors. The filters must be sent away for analysis, making the fine particulate monitors unsuitable for use in the advisory program. Therefore, it is not our practice at this time to differentiate between human-caused and natural visibility impairment.

The Air Quality Advisory Program has been well accepted by the park staff and the public. Thorough local news coverage of the new system provided an ideal showcase for the program and enhanced its educational value. Staff from all park divisions worked together to make our program feasible and cost-effective. By creating greater public awareness of environmental issues through our Air Quality Advisory Program, we have found that we can serve the visitor more effectively and at the same time promote protection of our natural resources.

Gubler is an Air Quality Technician at Shenandoah NP.



Current ozone and visibility ratings *for Shenandoah NP are displayed at entrance stations and visitor centers at 1 p.m. each day.*

PARK SCIENCE

NATIONAL PARK SERVICE

SUMMER 1991

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

ARTICLES

DEPARTMENTS

Park Science is feeling the (pleasant) pressure of information overload. If you have submitted an article that has not yet appeared, or if your article appears in drastically curtailed form, our reason is simply that we have only 24 pages, four times a year. If we go to more pages, we lose the attention of our busy readers, who tell me they can scan 24 pages, but would balk at the much larger number we could easily fill. At present, our only option is to cut, trim, chop, and agonize. In our effort to cover the entire System, we cannot give many of the articles the length they really deserve. So we try to give enough to provide "the gist," and leave it to you who want more, to contact the authors.

Who knows? Perhaps 24 pages more frequently than every third month may become an option, but until that happy day we have to beg for brevity. Your editor is least happy when cutting, so please, do your best to do it yourself. Thank you.

editorial

The Natural Resources Publication Program is on track and running! Its coordinator, Donna O'Leary, describes it in an article beginning on this page. It provides the means for achieving order and retrievability in a science program that is rapidly coming of age within the Service. Scientific research, its reflections in natural resource management, and its interpretation to the visiting public are undergoing perhaps the most exciting changes of depth and direction in the history of the Service. The knowledge that is proliferating at this time is bringing powerful new options to light, providing our stewardship with insights and tools it never had before – and never needed so desperately.

The trick is how to keep this information current Servicewide – how to inform the field about what is going on so that discoveries need be made only once, mistakes need not be repeated, and the enthusiasm of local triumphs can spread through the System like friendly wildfire.

The publication program is an essential process for keeping track of what we are learning and putting this knowledge to its best and widest use. The new handbook is recommended reading for all and required reading for those who wish to make their imprint on NPS resource management history.

The Natural Resources Publication Program: What is it?

By Donna O'Leary

The Natural Resources Publication Program is a result of an initiative that began in earnest in 1987. It was in response to a request from the Chief Scientists to the Associate Director, Natural Resources (AD/NR), to improve the quality and ensure the credibility of NPS natural resources publications. The initiative began with numerous questions. Within the natural resource organizations, who was producing what? How many and what kinds of series existed? Who were the audiences? How were publications being reviewed? Who was accountable for approving reports?

To answer these questions and others, a survey was conducted on natural resource publications produced in FYs 1985 and 1986 and those proposed for 1987. The findings were most informative. Washington divisions and offices, regional offices, cooperative park studies units, and parks, together were disseminating an average of 148 reports/year through 15 series. The extent of reviews and the exercise of quality control varied from series to series. Most of the publications differed in appearance, format, series numbering systems, and distribution. No database information was available. No process existed for selecting publication projects. The publication situation was fragmented and lacked a coordinate direction, purpose, and focus.

To review and evaluate this information and to recommend improvements, the AD/NR set up a natural resources task force of scientists, resource managers including a superintendent, and editors. They met first in 1988. During the same period in 1988, and parallel to the natural resources publication initiative, the Director requested that a workshop of NPS editors and publishers be conducted to review and evaluate the entire NPS publication program and to recommend improvements. Most of the issues identified at the workshop were the same issues of concern for natural resource publications, including the following: "The natural resource publication program requires priority focus because of its present fragmentation."

The natural resources task force concluded that a comprehensive publication program was needed to provide a Servicewide function in disseminating information on natural resources through publication. To meet this objective, the task force recommended that (1) only a small number of series be used: six series disseminated at the national (Servicewide) level and three of the six at the regional level; (2) a publications coordination function be formalized; (3) a formal selection process be instituted for publication projects; (4) an advisory board be established to continue making program recommendations to the AD/NR and Chief Scientists; (5) a bibliographic database be generated and maintained for new publications; and (6) a policy and procedural handbook be developed to consolidate existing Departmental and other authorities and regulations and to provide additional guidance where needed.

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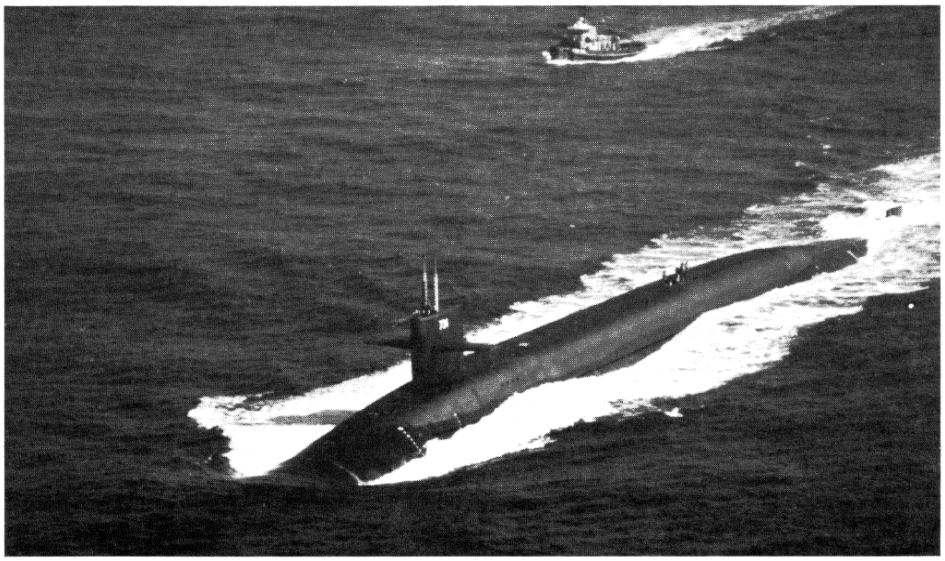
Biological and Physical Aspects of Dredging On Cumberland Island National Seashore

By Stephen V. Cofer-Shabica

Cumberland Island National Seashore (CINS), established by Congress on Oct. 23, 1972, is well known for its marine turtles, abundant shorebirds, dune fields, maritime forests, fishing, marshes and tidal creeks and flats, and historic structures. CINS is 25.7 km long and totals 13,342 ha, of which 6,821 ha are marsh, mudflats and tidal creeks. It was established to preserve the scenic, scientific, and historical values of the largest and most southerly island off the coast of Georgia (PL 92-536, 92nd Cong, S.2411.)

The Kings Bay Environmental Research Program was conceived in 1986 by the U.S. Departments of Interior and Navy to evaluate the relationships between submarines and their shipping channels, marshes, barrier island shorelines and dunes, notably those of CINS, Georgia and Amelia Islands (Florida), and tideflats. The Program focuses on the potential effects of the deepening, from 12.7 m to 15.5 m, of the Kings Bay Trident Submarine Base ship channel. The channel is almost 35.2 km long, extending from Kings Bay, through Cumberland Sound, out the St. Marys Entrance to the 15.5 m contour, 19.2 km offshore. The removal of approximately 26.8 million cubic meters of dredged material was required.



***Trident submarines** are almost 600 feet long, have a complement of 110 sailors, and carry 12 missiles each, armed with 10 independently targeted nuclear warheads. The U.S. has 30 Trident submarines, 10 of which are based at Kings Bay, GA, adjacent to Cumberland Island National Seashore.*

Coastal Monitoring Plan

A 5-year study (1988-1992) was set up to perform environmental monitoring in the area of Cumberland and Amelia Islands and Cumberland Sound. This Program, currently in its third year, is funded at $900,000 per year. The ecological aspects and overall synthesis of the monitoring program are the responsibilities of Interior, with the National Park Service as the implementing agency, Stephen Cofer-Shabica the Program director. Navy is responsible for monitoring the physical aspects of the study area with the Naval Facilities Engineering Command as the implementing command. The physical monitoring program includes both coastal and estuarine studies and is performed for the Navy by the U.S. Army Engineers.

The primary purpose of coastal monitoring is identification and quantification of any cause and effect relationships between the entrance channel modification and the ocean shoreline. A 3-fold study plan includes review of the historical setting and pre-project data to document the long-term evolution of the project area, data collection during the 5-year program to identify changes, and numerical modeling studies to extrapolate the measured process-response to scenarios beyond the measurement period of resolution.

Monitoring Activities

An intensive historical study gathered survey, sediment, geologic, aerial photography, map, dredging, wave, and process measurement data from numerous sources including the National Ocean Service, the States of Florida and Georgia, both area Corps of Engineers Districts, and the professional literature. The bulk of this study concentrated on evaluating the historic bathymetric surveys and shoreline change history in order to identify regional and local trends and anomalies. The historic sediment transport patterns, rates, and processes were conceptualized and a first order sediment budget developed.

Monitoring activities include (1) funding the 4.5 year operation of a 3-meter National Data Buoy Center offshore directional wave gage in 65 ft (20 m) of water at Wave Information Study station #57, (2) installation of nearshore directional wave gages off Cumberland and Amelia Islands, (3) annual surveys of beach profile and offshore lines on Cumberland and Amelia Islands, (4) winter or half-year surveys of about 15% of these lines, (5) annual surveys of the wetlands, shore and near shore on the soundside of Cumberland Island, (6) beginning and end of the 5-year period surveys of St. Marys ebb tidal delta, (7) aerial photography (joint activity with the NPS), (8) sediment sampling, and (9) annual data analysis and interim report preparation.

Estuarine Monitoring Plan

The estuarine studies consist of six main elements, but unlike the coastal studies these elements are planned as independent activities. Extensive physical and numerical model studies were performed and field data collected in support of the Trident channel design program. The scope of the estuarine studies was influenced by this existing study base and the interrelationship of the physical processes with the ecological studies which Interior had planned in the same area.

During the entire 5-year period there will be continuous monitoring of the tides, conductivity, temperature, salinity, and suspended sediments at six stations throughout the estuarine system. In addition, an intensive hydrodynamic sampling activity was conducted in 1990 over a 13-hour cycle. This study duplicates concentrated sampling studies conducted in 1982 and

(Continued on page 4)

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Effects of Dredging on Cumberland Island

(Continued from page 3)

1985. The Sediment Sources and Redistribution task modified the previously archived numerical model study of the estuary to include all elements of the "as-built" project and compare the base-to-plan condition to identify any sedimentation redistribution effects. In 1989 a preliminary statistical analysis of the Long-term Fernandina Tide Gage record was conducted to determine if there is any evidence over the 50-year tide record to relate changes in the tidal prism to historical channel expansion.

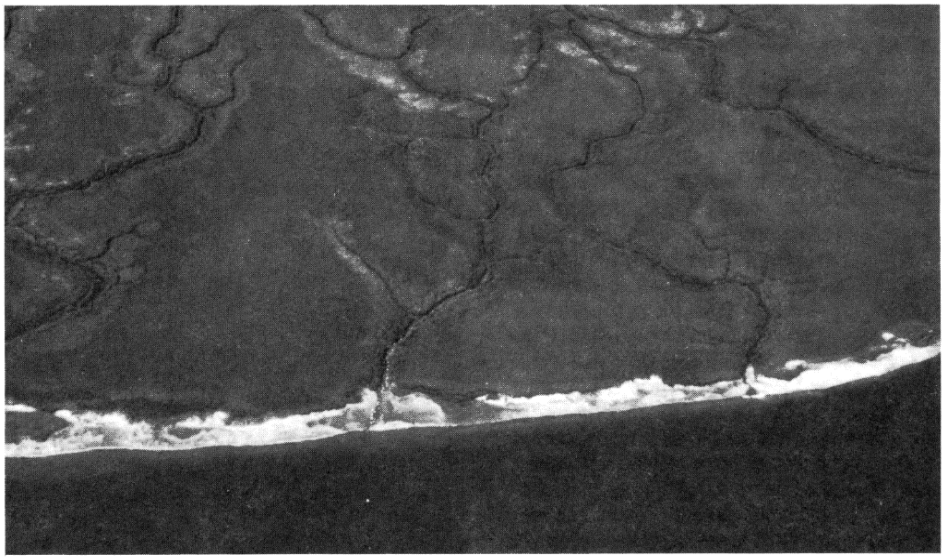
Biological Monitoring Program

Marsh, Mudflats and Tidal Creeks: The mudflats and tidal marshes and creeks are highly important to the Cumberland Sound ecosystem, providing habitat and foraging and shelter areas for numerous vertebrate and invertebrate species, including the endangered wood stork and manatee. These areas also are important in nutrient recycling. Interference with sediment deposition, both in terms of quantity and quality, could result in drowning of the marshes as sea level rises, and increase shoreline recession. The purpose of this study is to determine whether backbarrier dredging for the Kings Bay Submarine Base is affecting marsh habitat stability on Cumberland Island. Research was predicated on the hypothesis that if this operation is indeed exerting an influence on Cumberland Island, it will most likely be first perceived in the effect it has on the rates of supply and delivery of sediments to marches and tideflats.

Population Dynamics of the Hard Clam, Mercenaria mercinaria: It is possible that the construction and subsequent deepening of the entrance channel to the U.S. Navy's East Coast Trident Submarine base at King's Bay, GA, may have altered environmental conditions in Cumberland Sound sufficiently to affect native marine invertebrate populations. Possible changes could come from alterations in water quality, in sedimentation rates and types of sediments on the eastern and southern shores of Cumberland Island, erosion and steepening of the banks on the western shore, and changes in suspended sediment loadings. The hard clam, *Mercenaria mercenaria,* is being used in this study to compare historical and current growth rates, physiological stress, and reproductive effort between clams in "impact" (tideflats in close proximity to the ship channel) and "non-impact" control sites (tideflats far removed from the ship channel, but of similar physical and geomorphological characteristics).

Groundwater Hydrology: Channel development which intercepts the edge of the surface-water lens and/or the Pliocene-Miocene aquifer could result in loss of water confinement causing alterations in the groundwater resources for the island. Such changes include lowering of the surface- and ground-water tables, and salt water intrusion. Since the plant and animal communities of the island are dependent on the quantity and quality of the surface- and ground-waters, adverse changes in this resource would have adverse consequences for the Island's ecology. The placement of a series of shallow 4.5 m to 39.4 m water monitoring wells in the surficial and Pliocene-Miocene aquifers of Cumberland Island and the determination of the island's water budget will permit an evaluation of changes in the freshwater resources of the Island as they might be related to the deepening of the Kings Bay ship channel.

Manatee Presence in Cumberland Sound: Five radio-tagged manatees, three tagged in Brevard County and two in Nassau County, moved into the Cumberland Sound region during the summers of 1987 and 1988, and were tracked there. With Navy funding, tracking of manatees in Cumberland Sound was continued during the 1989 season. This is the first ecological study of the Florida manatee outside of Florida. Purpose of the study was to determine how long manatees stay in the Cumberland Sound region, and to determine if military activities, such as dredging or increased boat traffic, are likely to affect manatees or manatee habitat.



***Waves break** on the shoreline of a Cumberland Island marsh.*

Geologic History of Cumberland Island Marshes: The mudflats and tidal marshes and creeks are highly important to the Cumberland Sound ecosystem. Interference with sediment deposition, both in terms of quantity and quality, could result in drowning the marshes as sea level rises, and increased shoreline recession. In question is whether the deepening of the channel will affect the marshes of the Cumberland Island ecosystem. To answer this question it is necessary to know how the marshes existed in the past, how they evolved, and what environmental factors affected this evolution and development. Purpose of this study is to investigate and document the historical evolution and development of the marshes, mudflats, and marsh tidal creeks of Cumberland Island and vicinity for the last 3,500 years.

Aerial Photographic Surveys: Using high resolution metric A0Aaerial photography to establish the current state of the beaches and barrier island seashores, future changes can be identified through additional aerial photographic surveys. This annual series of photography is also being used to evaluate marsh productivity. All photography conforms to pre-set flight lines and includes all of Cumberland Island and the shoreline of Amelia Island. Aerial photographic missions are flown by NASA using the high altitude ER-2 aircraft. The plane flies at 19,400 m and provides distortion-free stereo photographs. The aircraft is equipped with the RC-10, 9" x 9" format camera, the HR 732 Hi-con, 9" x 18" format camera with 24-in. lens, and the Daedalus Thematic Mapper Simulator. Products are color, color infrared, and black and white photographic transparencies, negatives, and prints.

Wading Bird Habitats and Populations: The breeding population of Wood Storks *(Mycteria americana)* in the U.S. declined from an estimated 20,000 in 1930 to less than 5,000 just 50 years later. With the continued destruction of the Florida Everglades, Wood Storks have been reported breeding on the Georgia Coast since 1977. The habitats used by Wood Storks for foraging are subject to disturbance by island visitors and by the dredging activities in the vicinity. Of particular concern is the possibility that dredging induced changes in hydrology and/or erosion may reduce the availability of Wood Stork foraging habitat. The study's purpose is to determine the relative use of various habitats as foraging areas by Wood Storks, and to investigate the factors involved in foraging habitat choice.

Program Review and Oversight

A technical Review Committee composed of representatives from the Naval Facilities Engineering Command, the NPS, the States of Georgia and Florida, and university consultants meets twice yearly to review project and program progress and direction. Recommendations are made to an Interagency Steering Committee (from Interior and the Navy), which then makes final decisions.

In summary, the goal of this research is to document the potential for short- and long-term changes on the resources of Cumberland Island and Cumberland Sound estuary. The monitoring program has been in effect for approximately three years for the Navy (2 years for Interior), and immediate data sets and analyses can not be used at this time to summarize or identify any trends.

Cofer-Shabica is an oceanographer at the NPS/CPSU, Institute of Ecology, U/GA, Athens 30602; (404) 542-1438.

Global Change Funds Allocated

Six biogeographic areas have received base funds and funding for one or more research projects under the Global Change program. The six are Colorado Rockies, Glacier NP Area, Olympic Peninsula, Ozark Highlands, Southern and Central Sierra Nevada, and Western Lake Forest.

A GIS Assessment of Barrier Island Impacts

By Samuel Patterson and Richard Dawson

Coastal landforms are the interface between aquatic and terrestrial ecosystems; as such, they tend to be dynamic in terms of geomorphological change. Changes in coastal and barrier island landforms range from the impacts of storms and tidal action to human-induced changes brought on by dredging and other coastal engineering projects.

For the most part, national parks located on barrier islands or coastal lands have been managed with little definitive knowledge of the regions outside of park boundaries, or of the impacts development of adjacent areas have had on the ecological integrity of the parks. It is becoming increasingly apparent that national parks, whether they are located on barrier islands or coastal lands, are not discrete, isolated landscapes unaffected by development of the surrounding regions. Although they often are perceived as undisturbed refuges, national parks are being impacted negatively by adjacent private development and government sponsored projects.

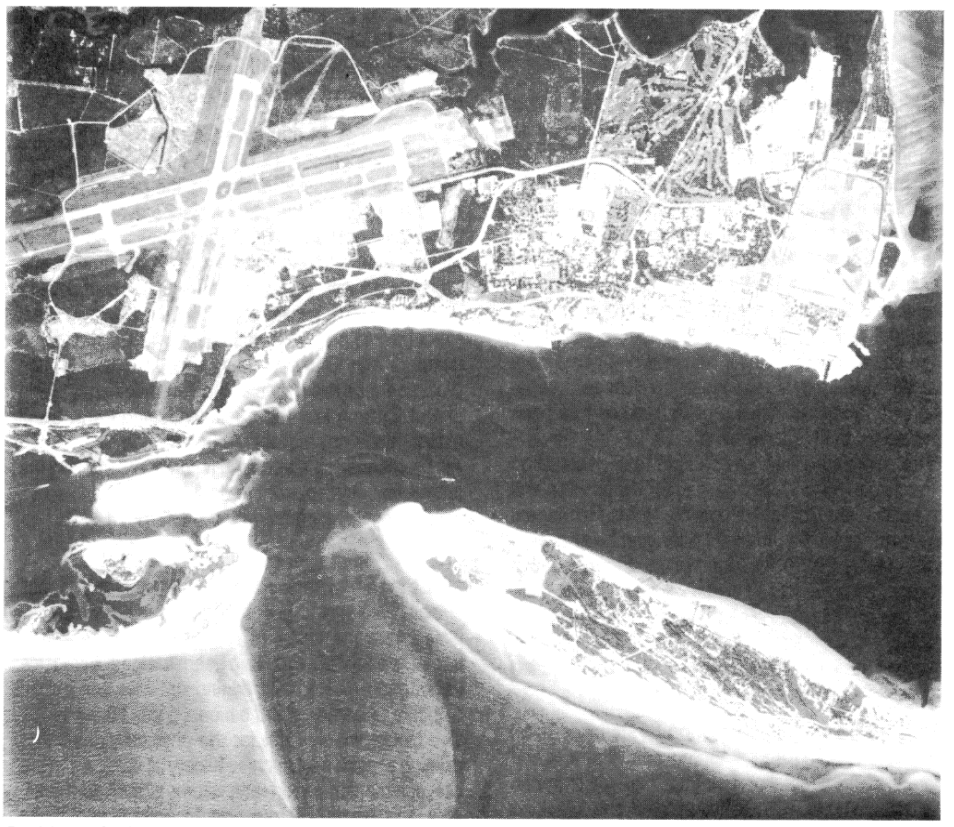
Particularly damaging to coastal and barrier island NPS areas have been large-scale dredging and spoil disposal, coastal engineering projects (Dean 1988) and oil spills. In many cases, accurate and quantifiable assessment of these impacts to coastal and barrier island geomorphology, hydrology, shoreline erosion, aquatic and terrestrial ecosystems has been inadequate or incomplete.

The proximity of NPS barrier islands to major dredge and disposal operations, oil drilling, and oil transport, has necessitated the involvement of the Service's Southeast Regional Office (SERO) in long-term inventory, monitoring, prediction, and evaluation of impacts. Examples of national seashores impacted by such projects are Cumberland Island (St. Marys Inlet/Kings Bay Naval Submarine Base), Cape Hatteras (Oregon Inlet), and Gulf Islands National Seashore (Pensacola, Pascaguola, and Gulfport channels). Preproject evaluation of and response to the short- and long-term impacts associated with these projects and with oil transport is critical for the continued viability of coastal and barrier island national parks.

SERO has recognized the need for a comprehensive system that can incorporate both regional and park monitoring data, scientific research, hard copy maps, digital information, aerial photography, digital imagery, databases, predictive models, and decision tree responses under one, integrated, turn-key approach. The SERO and the University of Virginia Department of Environmental Sciences are developing a coastal barrier island remote sensing, monitoring, and GIS program to function in concert with existing scientific research and resource management databases. The program also is fine tuning several sediment transport models and developing a decision tree response model for oil spills to function with the GIS.

Global Positioning Systems

National parks in these coastal areas pose several problems for researchers conducting field work and for GIS specialists creating an accurate park geographic information system. Scale related phenomena become very important on coastal lands and barrier islands as evidenced by vegetation communities, which tend to occur along narrow, linear bands that can be as little as 3 to 5 meters wide. To create a GIS with multiple themes, development of data bases within the following areas are required to provide robust themes and analytical models.



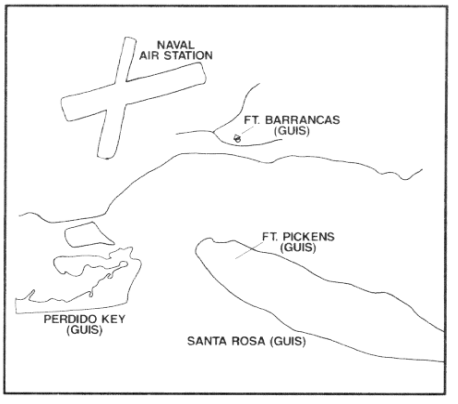
Problems facing barrier island managers *can be seen at Pensacole Channel (Gulf Islands N.S.). Need for increased navigational access, Naval Air Station (top center); protection of significant historical resources, Fort Pickens (right); and, preservation of natural features threatened by increased erosion due to channel dredging, Perdido Key (left).*

Before the aerial photography could be flown, another significant problem had to be addressed. Because barrier islands tend to be isolated and due to their dynamic geomorphology, they possess few identifiable ground control points. In some areas, georectification of barrier island aerial photography can be very difficult due to the paucity of permanent structures, roads, and other identifiable land features.

A comprehensive network of mapped and registered ground control targets and permanent monuments whose accuracy exceeded USGS National Map Accuracy Standards was installed, to provide ground control points for rectification of the aerial photography. Precise registration of the ground control points was effected by a Trimble Surveyor global positioning system (GPS). When present, permanent structures also were registered by the GPS for later use in the georectification process.

Remote Sensing

The SERO remote sensing missions are being flown by NASA from 1990 to 1993 and consist of several high performance cameras, three film types (black and white, color infrared, and color), and a Daedalus 10 band digital scanner. The cameras employed on these missions (HR-732 and RC-10) and Daedalus digital scanner have a ground resolution of approximately 1 meter, 3 meters, and 20 meters, respectively.



Unlike smaller remote sensing platforms, the ER-2 aircraft carries all 4 imaging devices simultaneously. The variances of altitude, sun angle, time of day, time of year, and different flight dates thus are eliminated in this multi-platform vehicle. Simultaneous platform imaging removes some very critical problems and biases that usually plague development of accurate spectral classification ranges in image processing of scanned aerial photography. Photographic ecological atlases of each barrier island park are being developed from the 3-meter resolution aerial photography.

The NPS areas incorporated into this remote sensing, mapping, and GIS program, include Assateague, Cape Lookout, Cape Hatteras, Cumberland Island, Canaveral, Biscayne, Timucuan, Virgin Islands and Gulf Islands. The NASA flight missions will be repeated over the next 2 years to monitor impacts from dredging, and to assess changes in island vegetation and migration (accretion and prograding) of the islands. The

(Continued on page 6)

A GIS Assessment of Barrier Island Impacts

(Continued from page 5)

imagery also will be used to create digital GIS change detection maps for temporal and spatial analyses.

Image Processing

NASA aerial photography of the barrier islands from the summer of 1990 is being converted digitally by an Optronix scanner at a resolution of .8 meters (2000 dots per inch). Extensive testing was conducted to determine the optimal spatial resolution for delineation of the narrow barrier island vegetation communities. The NASA photography is of such high resolution that individual trees from the same community can be differentiated. Scans of such high resolution can create problems when performing supervised or unsupervised image classifications, because one community may be broken into several identified classes. A vegetation classification scheme of 20 classes has been adopted for the NPS barrier islands.

The scanned aerial photographs are georectified with coordinates derived from the GPS ground control targets that were laid out prior to the flights. Permanent structures visible on the aerial photographs also were registered by the GPS for use in the georectification process. The georectified scans will be edge-matched and "zipped" together. Following supervised classification of the vegetation communities, all the individual scans will be joined seamlessly to create a georectified vegetation data layer of each barrier island.

Geographic Information Systems

Remote sensing and mapping analysis of island migration and vegetation composition over time can give scientists and resource managers an outlook on barrier island previously not possible. The incorporation of remote sensing imagery with other digitized GIS data layers can provide unique insights into island dynamics and interactions between the hydrology, ecology, geomorphology, and human impacts. GIS data themes can be viewed as a single data layer or as part of a composite overlay format.

The major themes of the GIS are: vegetation (derived from image processed aerial photographic scans, National Wetlands Inventory Maps, and NOAA seagrass maps); geomorphology (from current photographs, shoreline erosion, beach profiles, and digital line graphs); fauna (from USFWS Ecological Inventory maps), adjacent land use (from Minerals Management Service Ecological Characterization studies); and cultural resources (from NPS Cultural Sites Inventory and List of Classified Structures).

Digital Line Graphs

Digital line graphs (DLG) at the 1:24,000 scale are needed for assessing change in the geomorphology and the location of the barrier islands over time. Most DLGs for coastal areas of the Atlantic and Gulf of Mexico were mapped in the early 1960s. Storms and dredging operations have significantly altered several of these islands. Availability of these maps in a digital format would provide researchers a 1960s window to compare with 1990 data being derived today. Change detection analysis between the two dates could yield useful information about island position and areal extent. Maps not available from USGS in DLG format will be scanned by automated techniques retaining the topological elements of the data theme(s) of interest, which then are inported into the GIS (Fain 1989).

Inlet Dredging Impact Model

Historic aerial photography, shoreline erosion, spoil disposal sites, and geophysical data are being collected from the Corps of Engineers for coastal and barrier island inlets that have been dredged. Extensive information exists on dredging projects conducted adjacent to barrier island national parks (Dean 1988). The model will account for the physical parameters existing at each inlet such as history of dredging at the site, sediment transport rate, volume of sediment available, and direction of transport. Incorporation of these parameters into the model will provide estimates regarding the effect of sediment removal (dredging) or sediment interruption (jetty) on the "downstream" island in terms of area affected. Once this affected area has been identified then data from the various GIS themes will be listed to display the resources that would be impacted.

Oil Spill Decision Model

The SERO and the Department of Environmental Sciences at U/VA are developing an oil spill decision support model (Psaraftis and Ziogas 1985) that is based on contingency planning and response (Etkin 1990), and impact prediction and damage assessment (Psaraftis et al. 1986). Detailed information regarding oil types, estimation of flow volume and direction, time of year, climatic variables, sources of abatement/cleanup equipment and personnel, and response protocol (mechanical devices, dispersants, bioremediation, etc.) will be included in the decision support system model.

The Gulf region model will be assessed in terms of reponse capabilities and limitations, hierarchy of rapid response teams and contacts, environmental sensitivity of the shoreline to oil types transported through the Gulf, and relevant economic factors. The model will be validated by current risk assessment data derived from actual oil spill data and will be tested against low, mid, and worst case scenario spills for oil type and volume, from least to the most susceptible islands.

Conclusion

Remote sensing and GIS technologies, when coupled with other sets of information and field data, represent a powerful tool for quantification of impacts to coastal and barrier island national parks. The future of effective impact forecasting in dynamic areas like barrier islands resides in the use of predictive GIS models that have been updated with monitoring data and tested against historical suites of monitoring data and scientific research.

Patterson currently is a graduate student in the Environmental Sc8iences Dept., U/VA, Charlottesville, VA 22903; Dawson is with the NPS Southeast Regional Office, 75 Spring St. SW, Atlanta, GA 30303.

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Ecological Restoration Research: Applications Manual

By Destry Jarvis

The Student Conservation Association (SCA), with more than 30 years experience in the field, is researching and preparing a manual for ecological/disturbed site restoration. This manual will be designed for use by managers and restoration practitioners of uplands and wetlands throughout the country and will incorporate restoration research with practical application methods. Case studies of representative physiographic sites will be included. The manual, to be published in the spring of 1991, will provide principles, methods, and examples for effectively restoring disturbed sites.

Restoration increasingly is viewed by researchers and managers (though perhaps not by environmentalists as a group) as a paradigm for land management. As the traditional conservation movement evolves into a more broadly based environmental perspective, so too has the traditional conservation goal of wise use given rise to modern prescriptions. Currently, the environmental movement is working predominantly toward the goal of preservation – the prevention of further resource and amenity degradation. Yet within certain communities, degradation has occurred to such an extent that restoration becomes an important conceptual tool for normative policy and managerial use.

SCA's disturbed site restoration manual will survey the historical, philosophical, and social structure of the current ecological restoration movement. It will advocate that restoration does not compete, but rather augments, the traditional environmental goal of preservation.

Previous land management paradigms have included reclamation, rehabilitation, reforestation, and remediation. These often have been practiced without the ecological worldview that restoration adopts. Thus, SCA's manual on ecological/disturbed site restoration will make use of illustrative ecological principles such as "associations," "diversity," and "productivity." The restoration ecology worldview espoused in SCA's manual will advocate the beneficial use of native species, integrated pest management, and appropriate methods for sensitive ecosystems.

Recent research regarding the ecological constraints of restoration will be surveyed, as will representative techniques and applications by physiographic regions. Physiognomic characteristics as they relate to specific restoration plans will be highlighted.

An advisory committee of restoration ecology scientists and restoration practitioners will oversee the drafting and content of this manual. Communication from interested individuals is encouraged. In addition, case studies of hand-tool scale restoration projects are solicited for inclusion. These should be no longer than 4 double spaced pages and include detailed methods.

Submissions cannot be returned and are subject to editing. Address inquiries to Douglas Olds, Manual Editor, SCA, 1800 N. Kent St., Suite 913, Arlington, VA 22209.

Jarvis is Executive Vice-president of SCA.

Arid Veg Management: A Multi-Agency Look

By Jean Matthews

Arid vegetation management – three precise words that encompass a myriad of imprecise problems – recently brought together a congeries of the Northwest's premier practitioners in state-of-the-art revegetation principles and techniques.

A May 14-15 workshop, hosted by the John Day Fossil Beds National Monument (JODA) in eastern Oregon, featured expert leadership from the Bureau of Land Management, the Soil Conservation Service, Oregon State University, the NPS/CPSU at U/ID, Nez Perce NHP, Whitman Mission NHS, NPS Pacific Northwest Regional (PNR) headquarters, and the JODA park staff. Participants spent two days sharing data, techniques, theories, and field results, discovering one another's unique capabilities for developing and implementing effective arid lands management.

Steve Gibbons, PNR Natural Resource specialist and workshop coordinator, kicked off the proceedings with a run-through of NPS mandates and management policies – a recurring subject as field managers described the practitioners' views on these imperatives.

Prudent flexibility in the evolution of both policy and practices emerged as an efficient working process. If policy says that something can't be done, but practice finds that it **must** be done, then creative management that is true to the spirit of policy mandates seems to be evolving as the pragmatic path to desired results. Merging perspectives – from variously involved agencies at federal and state levels, from universities, and from local "participants" in the managed land scene – have brought both wisdom and workability to the sometimes agonizing process of restoration.

Larry Larson and Boone Kauffman, from the OSU Department of Rangeland Resources, led the workshop discussions and field trips on weed control and fire ecology research, respectively. Sue Burnworth of the Soil Conservation Service (SCS) described "Native Plants for Parks," a cooperative program between the SCS and NPS that makes available to NPS the expertise and plant materials from 26 SCS plant materials centers around the U.S.

Rocky Beavers, NPS Technical Advisor for revegetation projects, (at the NPS Denver Service Center) will contribute an article on plant materials for the fall issue of ***Park Science***. Kauffman and Larson have promised to deal in some detail with the art of returning disturbed areas to native plants and the role of fire in restoring natural ecosystems.

A return to native grasses *at Whitman Mission NHS was accomplished thanks to the flexibility of NPS management policy that now allows the use of plant materials "historically appropriate for the period or event commemorated." Basin wild rye grass – the original stand – was impossible to achieve following the pigweed, cheatgrass, and yellow starthistle invasions that had resulted from years of human disturbance at the site. But native bunchgrasses and fescues, shown here, give much the same aspect to the site as the original stands of basin wild rye. (Walla Walla Union-Bulletin Photo by Jeff Horner)*

Historic Landscape Restored

Historic landscape restoration is underway at Wilson's Creek National Battlefield. The aim is to return the historic core of the park, after 100 years of farming, to the mosaic of oak savanna, limestone glades, and riparian forest that formed the landscape in 1861. Park staff will concentrate on 330 acres in the park's northwest section, which contains the most significant cultural and natural resources and is a focal point of visitor use.

Restoration will rely on fescue eradication and seeding of savanna species in pasture areas, Osage Orange removal in successional forests, and forb introduction in established warm season grass plantings. Because periodic burning played a role in maintaining the savanna landscape, prescribed fire will be used extensively in the restoration.

Jordan's View of Restoration

"A botanist walking through the John Curtis Prairie today couldn't tell it from the original prairie. That's partly because no botanist today has ever *seen* an original prairie. The original tall grass prairies exist only in books, and these books are an important part of the DNA for ecological restoration."

The speaker was William Jordan III, editor of ***Restoration Management Notes***, executive secretary of the recently formed Society for Ecological Restoration, and keynote speaker at the Feb. 22, 1991 opening day of Cascadia Conference for designing, maintaining, and restoring natural landscapes. The conferees, gathered in Portland, OR, were listening to Jordan describe the restoration of a 60-acre prairie plot at the University of Wisconsin/Madison Arboretum.

"In tiny plots, here and there, we found – still clinging to existence – scraps of 'the living dead'," Jordan said. "The cryptic prairie, in the form of glacial relics, is still struggling along in the shade of oaks. These scraps can be brought back by cutting the trees and burning the prairie. The pieces of the puzzle still exist and we can coax them back into sturdiness and put them together. By doing so, we can build our soils, preserve the plants, and bring back some of the original regional flavor," Jordan said.

Not only can restoration by the use of native plants save on labor, fuel, and exercise, Jordan noted, but such restoration is the basis for creating a healthy human relationship with nature. Aldo Leopold called restoration a mutually beneficial relationship. Thoreau, in ***Walden***, exhorted mankind to "reenter Nature."

Jordan described three types of relationships with nature: personal, historical, and celebratory. By participating in ecological landscape restoration, he said, one can become a functioning, working *part* of the landscape, "inhabiting it in an ecological way."

The process of restoration traces, in a way, our human history, Jordan said. It begins with hunting and gathering the relict species, evoking the primitive "hunter/gatherer" psychology. It progresses to the agricultural/gardener stage, and finally it reaches the scientific level, where it explores the deep human cultural past in its ritual entirety. "It tells us," Jordan said, "that restoration is a performing art, and that in the performance, we discover our reciprocal relationship with nature. When it is complete, we will have learned to DO it, and to CARE about doing it."

Tallgrass Prairie Site Studies

The NPS has completed a special resource study of the Z-Bar Ranch – a 4,409 ha cattle ranch near Strong City, KS, which contains extensive tracts of tallgrass prairie and several buildings listed on the National Register of Historic Places. The study, in response to a request from the Kansas delegation to the U.S. House of Representatives, was conducted in two phases: a study of significance and a study of alternatives.

The significance study found that the natural and cultural resources of the ranch qualified it for both National Historic Landmark and National Natural Landmark status and therefore made it suitable as a potential addition to the National Park System.

The study of alternatives identified five, under which the NPS believes the ranch could be managed: (1) no action, continued private ownership; (2) Flint Hills/Z-Bar Ranch National Historic Site; (3) Flint Hills Prairie National Monument; (4) Protection of the Z-Bar Ranch by State or Local Government Agency, and (5) Private Conservation Organization Reserve. The NPS takes no position on which alternative should be pursued.

Mountain Goats in Yellowstone: The Horns of a Dilemma?

By John W. Laundré

In the 1940s and '50s, personnel from what was then the Montana Fish and Game Department introduced mountain goats *(Oreamnos americanus)* into several areas north of Yellowstone NP, primarily to increase recreational opportunities for hunters. Little did the Montana personnel of that day dream that their actions would result in a major dilemma for the National Park Service.

Mountain goats are part of the native fauna of several mountain ranges in Montana, Idaho, and Washington, but by all available information they did not occur historically in the Greater Yellowstone Ecosystem. Because of the transplants made by Montana personnel, there are now goats in the Yellowstone Ecosystem and descendents of these transplants now are on the verge of colonizing the park.

Goats moving into the park present a major conflict with NPS mandates that stipulate the preservation of native faunal and flora complexes. Introduction of "exotic" species into an area usually occurs at the expense of native species; consquently, exotic introductions are viewed as a threat. Because of this negative impact, NPS policy stipulates exotic species must not be allowed "to displace native species if this displacement can be prevented by management." (Anon. 1988).

So the decision would seem to be straightforward: Goats are exotics; as such, they should not be allowed to become established in the park. However, it turns out not to be as simple as it seems. Two factors complicate the issue. Goats ARE historically native to areas as little as 60 km to the west of the Yellowstone Ecosystem – areas ecologically similar to the Ecosystem. It remains a mystery why the relatively high mountain passes would have acted as a barrier to "natural" movement of goats to the east.

Regardless, mountain goats cannot be considered ecological exotics to the faunal and floral complexes found in the Yellowstone area. Animals and plant species similar to those found in the Ecosystem have evolved with goats in close proximity. One might argue that the specific animal and plant populations in the Yellowstone Ecosystem didn't evolve with goats and so may not have developed the defenses found in populations sympatric with goats.

However, this brings us to the second point of the dilemma. Goats may not be historic *natives* to Yellowstone, however, based on fossils from the Palisades, Idaho area, they were Pleistocene residents of the Greater Yellowstone Ecosystem approximately 30,000-70,000 years B.P. No more recent evidence of goats has been found in the area, but as little as 10,000 B.P., goats extended south to Mexico and east to central Wyoming (Mead 1983) with the proposed dispersal route being through the Yellowstone area (Mead 1983). The more southern prehistoric populations are designated as a separate species, *Oreamnos harringtoni*, Harrington's mountain goat. However, the specimens from central Wyoming are classified as the same species that is currently native to areas a few kilometers from the Greater Yellowstone Ecosystem.

All this clouds the issue of whether goats truly are native to the Yellowstone Ecosystem. However, the question still remains: what will be the impact of mountain goats on the current fauna and flora of Yellowstone NP if and when goats become established, or reestablished. To determine their impact, I perused existing data to use in developing an environmental assessment of goats of the Greater Yellowstone Ecosystem. There were two major emphases. First, I tried to determine the potential number of goats we can expect to inhabit the park. This is a critical point because it could determine the impact goats would have on park vegetation. Workers in Olympic NP found it wasn't so much that goats were selectively eating rare plants but that the sheer numbers of animals increased their impact

on *all* plants, including the rare and endemic ones. They also found the wallowing behavior of goats, exacerbated by their numbers, caused extensive plant destruction and soil erosion. All these impacts would have been less severe if goat numbers had not become so high – 14 goats/km2 (Stevens 1983).

Goat densities vary from area to area. The lowest density of goats I found reported in the literature was 0.2/km2 in British Columbia (Herbert and Turnbull 1977) and the highest was 15.4/km2 in Glacier NP (Singer and Doherty 1985). Swenson (1985) found a density of approximately 0.4 goats per km2 in the mountains just north of Yellowstone NP. This is near the lowest estimate reported, so I used this density to estimate a low population level.

Based on the range of densities reported for areas similar to Yellowstone, I came up with a high estimate of 1.9/km2. The next step was to determine, *a priori*, how much goat habitat might exist in the park. As an estimate, I used the amount of current bighorn sheep habitat, 250 km2. Based on these figures, I estimated a low population of 95 and a high of 475 goats.

At the low density of goats, no major impact on park vegetation is expected. It is uncertain what impact the goats might have at the higher density. To determine the impact of higher densities of goats, I visited Glacier NP. In the area near Logan Pass, where goats are at a density of approximately 2.8 goats/km2 (Chadwick 1974), no measurements were taken, but no obvious signs of overgrazing or erosion from wallowing were evident. So, at the projected high density of goats for Yellowstone, no major impact of goats on the vegetation is expected. This is in contrast to what has happened at Olympic NP. Perhaps the higher density of goats at Olympic, their greater wallowing because of the warmer climate, and the intensification of these factors by high amounts of rainfall, all contributed to the goats' negative impacts there.

The second emphasis of my work was to determine the potential impact of goats, regardless of their numbers, on their nearest ecological relative, bighorn sheep *(Ovis canadensis)*. Bighorns traditionally have been considered the symbols of Yellowstone wilderness. Unlike other ungulates such as elk, deer, or bison, sheep live in the high elevations and rarely are seen by the casual visitor. To see a sheep means either that you had the fortitude to hike to their haunts or that you are extremely lucky. To lose this charismatic species would diminish the park's wilderness value.

To determine the potential impact of mountain goats on sheep, I estimated how much their food and habitat requirements overlapped by using existing data to calculate resource overlap indices (Lawlor 1970). Based on data from unrelated studies for general food categories (grass, forbs, and shrubs), goats and sheep diets would seem to overlap extensively (Fig. 1a). Even separation of diets into more specific categories would lead to the same conclusion (Fig. 1a).

However, comparison of diets from independent

(Continued on page 9)

Woodland Caribou Studied

Wildlife Biologist Jean Cochrane has been investigating for the last year and a half the feasibility of restoring caribou to their historic home on Isle Royale. Caribou and Canada lynx roamed the island archipelago for thousands of years, long before moose or wolves colonized the park after 1900. Caribou disappeared in the late 1920s, following a century of regional decline line due to overhunting, increased predation, and brainworm disease.

Prospects for caribou restoration are improved by the current decline in wolf numbers. Wolf predation would likely limit a caribou population to 20-50 animals dependent on secure "escape habitat."

A rare plant survey in 1992 will assess the potential impacts of caribou on Isle Royale's unique rock shore plant communities.

Peregrine Falcon Releases End

1991 will mark the fifth and last year for peregrine falcon releases on Isle Royale. Thirty-eight young falcons have been hacked from two sites in the park since 1987; 12 more will be released this year. While no birds have yet returned to nest, two birds have returned briefly and one has taken residence in Milwaukee, where she nested and raised young three years in a row.

A pair of hacked peregrines is nesting this spring in Michigan's Keweenaw Peninsula near the park's mainland headquarters, but biologists and birders have not yet been able to see the band numbers to determine whether they are Isle Royale birds. Falcons also will be released this year, for the second year, at Pictured Rocks National Lakeshore.

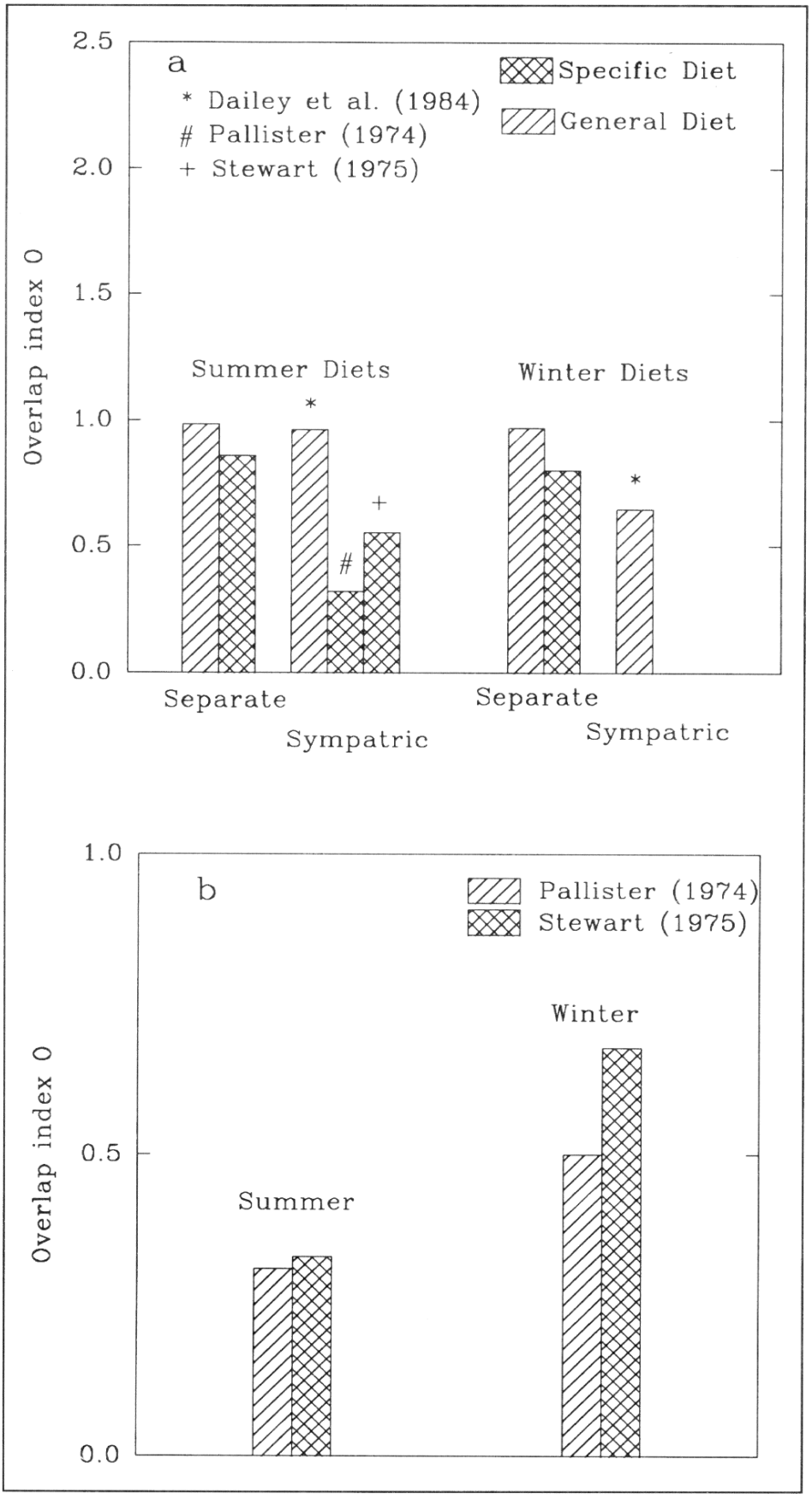

Figure 1. *Niche overlap indices for food habits (a) and selection (b). Overlap indices for food are for pooled data from separate studies and data from comparative studies and are based on either general (grass, forbs, shrubs) or specific (to genera) food classifications. Indices for habitat selection are all from two comparative studies of sympatric sheep and goat populations.*

studies present problems relative to food availability and presence or absence of competitors. The best way to determine the amount of actual overlap between goats and sheep is to compare diets of sympatric populations. Three investigators have done this. Dailey et al. (1984) compared general diets (grass, forbs, and shrubs) of sympatric goats and sheep in Colorado. Based on their data, the resource overlap index for summer diets was similar to unrelated studies (Fig. 1a). However, during the winter, resource overlap reduced substantially (Fig. 1a). Pallister (1974) and Stewart (1975) compared specific plant species used by goats and sheep in the Beartooth mountains just north of Yellowstone. Based on their data, the resource overlap indices were only half of what separate unrelated studies indicated (Fig. 1a).

Relative to habitat requirements, the only reliable comparisons that can be made are from studies of sympatric populations. Again, data from Pallister (1974) and Stewart (1975) indicated substantial habitat separation (Fig. 1b). It is important to note that the studies by Dailey et al. (1984), Pallister (1974), and Stewart (1975), were of "exotic" goats that had been transplanted into native sheep range. Thus goats and sheep are seemingly able to coexist, even when goats are "non*native" introductions, and goats will likely not exclude sheep from Yellowstone NP. Whether goats will significantly reduce sheep numbers is unknown at this time and will depend on which population level scenario proves accurate.

So, in conclusion, whether goats are to be considered exotics or prehistoric natives is a decision to be made by NPS personnel, luckily! If left uncontrolled, goats will continue to colonize Yellowstone NP and will reach a population of between 100 and 500 animals. The potential impact of mountain goats on Yellowstone flora is estimated to be not as severe as it was in Olympic NP. The presence of goats in the park also is not expected to affect adversely the continued survival of bighorn sheep. Some changes, however, likely will occur as Yellowstone adjusts to the return of one of its prehistoric residents.

Laundré is an Adjunct Professor in the Department of Biological Sciences at Idaho State University, Pocatello.

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Cape Cod's Atlantic White Cedar: Managing a Unique, Natural (?) Community

By Glenn Motzkin and William A. Patterson III

Cape Cod National Seashore (CCNS) contains the only NPS administered Atlantic white cedar (AWC; *Chamaecyparis thyoides*) wetlands (NPS internal documents). Although AWC occurs in four locations at CCNS, the 5-hectare Marconi Atlantic White Cedar Swamp (MAWCS) is the largest and most significant site, containing one of the few examples of an old-growth AWC stand in the northeastern United States. Management of the MAWCS poses unique challenges because the Swamp lies in a rapidly developing landscape that is substantially altered from its presettlement condition.

Atlantic white cedar is an early successional species that requires some form of disturbance to become established. In the absence of disturbance, it is thought to be replaced by more tolerant hardwood species (Buell and Cain, 1943; Little, 1950). The MAWCS is currently protected from fire and timber cutting and therefore is potentially threatened by these successional trends. We investigated both modern and prehistoric vegetation and disturbance patterns at MAWCS to determine the processes that have controlled vegetation development over the past thousand years. In this paper we present the results of this investigation and discuss management alternatives in the context of NPS objectives and cultural constraints.

Cedar first arrived at the Marconi site approximately 3000 years ago and has persisted in varying abundance since (Belling, 1977). Fine-resolution pollen and charcoal analyses of peat representing the last 1000 years of the Swamp's history indicate that fires, many of which probably were set by Indians (Patterson and Sassaman, 1988), were frequent in and around the Marconi site in the centuries prior to European settlement (Figure 1). Most fires probably ignited in the highly flammable oak-pitch pine forests on the upland and burned as intense surface or crown fires until they entered the Swamp. Cedar pollen percentages during this period appear closely linked to fire occurrence, suggesting that fires burned through the Swamp destroying existing cedar stands and regenerating new ones.

Past Fire Frequency Higher

Periods of dense shrub, herb, and moss cover, as evidenced by high pollen percentages for these taxa, suggest that open cedar stands unlike the one encountered today regenerated after presettlement fires. When increasing cedar pollen percentages indicated closing canopies, fires burned through the Swamp and initiated a new cycle of cedar regeneration. At no time in the several hundred years prior to European settlement did cedar pollen percentages reach the sustained levels (80-90%) that are evident since settlement.

Significantly, the high post-settlement percentages of cedar pollen are accompanied by low charcoal values, suggesting that few if any fires have burned in the Swamp since the time the surrounding uplands were settled (about 1650 A.D.). Higher fire frequency prior to European settlement apparently prevented the development of mature, dense cedar stands at MAWCS, whereas a lack of fire since settlement has allowed the current mature stand to develop.

Plots that we sampled within the MAWCS currently are dominated by cedar, with ratios of cedar to red maple basal area typically exceeding 4 to 1. Age-structure analyses of the modern vegetation indicate that AWC and red maple both occur in distinct age cohorts, with establishment of both species limited to episodes of recruitment associated with timber harvesting (Motzkin, 1990).

Most of the Swamp is dominated by a 100- to 150-year-old cedar stand, with red maple stems scattered throughout. In portions of this stand, little or no establishment of tree stems has occurred in the last 80 to 90 years. Elsewhere, light selective cutting 10 to 50 years

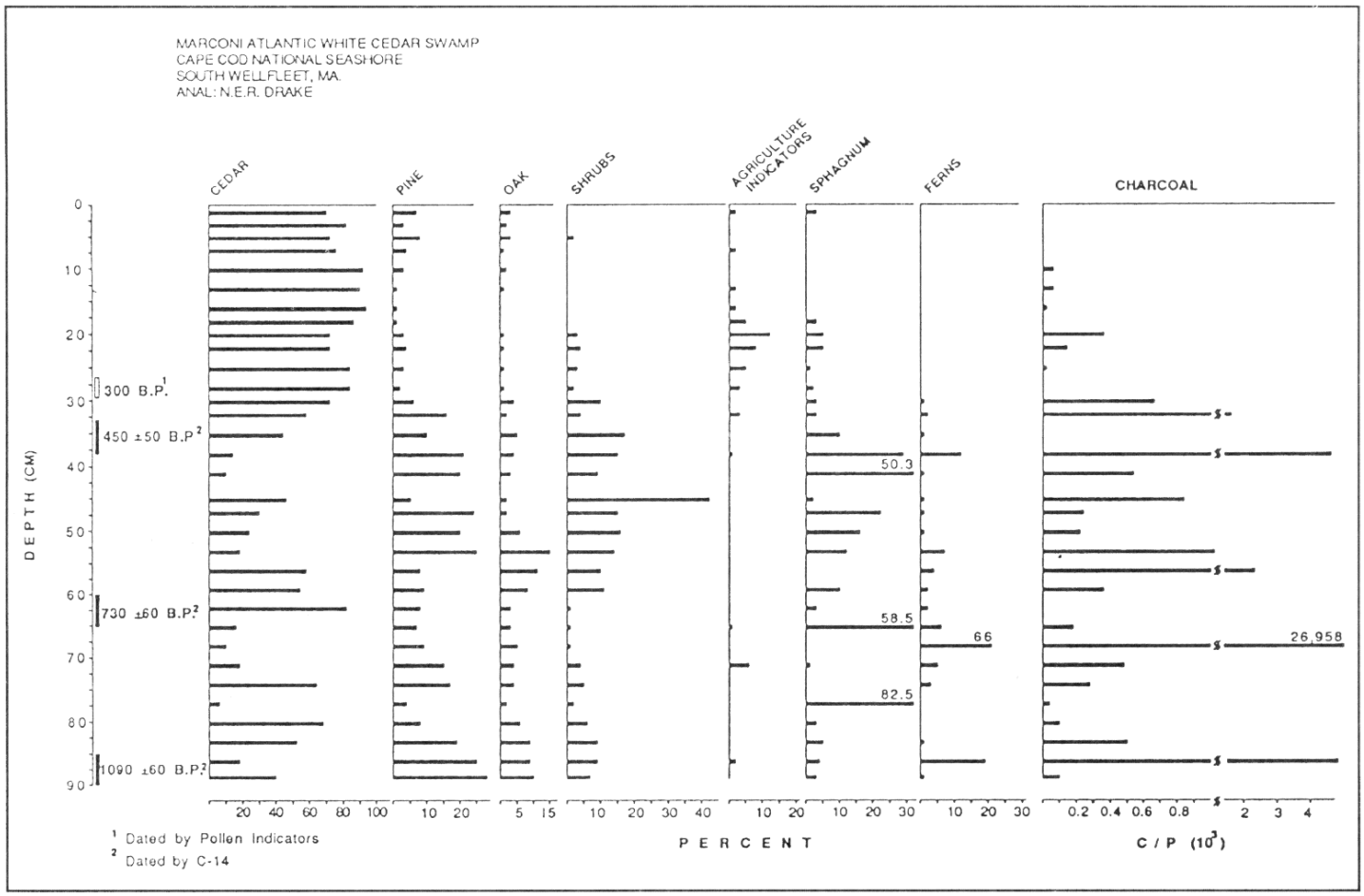

Figure 1. Pollen and Charcoal profiles for the Marconi Atlantic White Cedar Swamp, Cape Cod National Seashore.

How Does One Maintain An Early Successional Species?

prior to establishment of CCNS (in 1962) allowed cedar and, especially red maple, to regenerate. A few small, dense stands of young and intermediate aged cedar regenerated after more intensive cuts. In none of our plots did cedar or red maple continuously establish to form all-aged populations.

Disturbance-dependent Recruitment

Results of our investigation of both current and past vegetation indicate that disturbance factors have strongly influenced vegetation patterns at MAWCS. Establishment of cedar and maple occurs during distinct episodes of recruitment associated with disturbance events. In the past 80 years, timber cutting has been the primary factor influencing regeneration, with light thinnings favoring red maple and more intensive cutting favoring cedar. Prior to 1650 A.D., fires destroyed existing cedar stands but allowed for subsequent cedar regeneration. Fire frequency prior to settlement apparently was high enough to prevent development of dense stands of mature cedar like the one that currently occupies the site.

In the absence of disturbance it is unlikely that significant amounts of cedar or maple will regenerate beneath the existing mature stand. As this stand ages and canopy gaps are created by death of individual trees, portions of the stand lacking young maple or cedar but with abundant shrubs probably will experience increases in shrub cover. Subsequent regeneration of either cedar or maple at these shrub-dominated sites probably will depend on gap size and local site conditions.

Because light thinnings in the past favored establishment of maple over cedar throughout much of the Swamp, maples may increase gradually in importance relative to cedar as the existing stand breaks up. Cedars are likely to outlive red maples, however (Fowells, 1965), so cedar may again increase in importance as the young stems of both species age and maples die at a younger age.

A Future of Dense Shrubs

Such a scenario eventually would lead to a Swamp dominated by scattered old cedar above a dense stand of shrubs. Although cedar dominance may be greatly reduced in the Swamp as a whole, the presence of several small, 30- to 70-year-old stands suggest it is unlikely that cedar will be completely extirpated from the Marconi site within the next few centuries.

NPS management policies (NPS, 1988, p 4:2) note the importance of change as "an integral part of the functioning of natural systems," stressing also that "ecological processes altered in the past by human activities may need to be abetted to maintain the closest approximation of the natural ecosystem where a truly natural system is no longer attainable." Current Seashore policies of wildfire suppression and preservation of existing plant communities rule out fire and timber cutting as factors likely to influence future vegetation development in MAWCS. Because outer Cape Cod is now densely populated and highly developed, recreation of the pre-settlement disturbance regime of frequent, catastrophic fires would be impractical. The NPS might, however, adopt one of several management practices for this site, recognizing that none of them will duplicate pre-settlement conditions.

If current protection is continued, there probably will be a reduction in the importance of AWC relative to red maple and shrubs in the next century. The dense, old-growth character of the present mature stand will disappear. If NPS chooses to maintain a cedar-dominated stand at MAWCS, human intervention probably will be required. As the existing stand breaks up, small clearcuts could be established to regenerate dense, young stands of cedar (Roman et al, in press).

Management Options

In evaluating management options, the cultural and ecological value of maintaining a cedar-dominated stand should be considered. The Marconi Atlantic White Cedar Swamp is valued as one of the best remaining examples of the Coastal AWC vegetation type on Cape Cod. With good public access provided by a raised boardwalk, the Swamp is visited annually by many who appreciate its aesthetic qualities, including the dense, old-growth aspect of the cedar-dominated vegetation. Our results suggest that this stand is, in fact, unlike that which existed prior to settlement, and that, in the absence of disturbance, its long-term maintenance is in doubt. This site thus presents the interesting paradox of a highly valued resource that is in one sense "unnatural" while at the same time difficult to maintain in its present condition.

We have demonstrated that cedar is not immediately threatened by a management strategy that favors protection over active management. In fact, cedar trees probably will survive for a very long time at Marconi, but in a community that is different in structure, species abundances, and ecosystem processes than the one existing at the site prior to European settlement.

A similar conclusion may apply to many natural areas preserved for the unique species or communities they contain. Management of these areas must take into consideration not only current vegetation dynamics, but those of prior communities occupying the site as well. However, complex ecological processes and modern constraints to management may limit our ability to achieve the objective of maintaining a "close approximation of natural ecosystem processes."

Patterson is a professor and Motzkin is a Departmental Assistant with the U/MA Department of Forestry and Wildlife Management.

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letters

To the Editor:

This is with reference to "A Commentary on Visitor Statistics" (***Park Science***, Spring 1991, p. 17).

I did not expect to read an ode to killing under the above title. Surely Mr. Lovaas, as a Regional Chief Scientist, is far from needing the flesh of pristine wildlife to feed himself, no matter how tender the flesh of the creatures he kills.

Did it ever enter his mind that reveling in "being alive," flexing his muscles, etc., might have been equally enjoyed by the "fine bull moose" he killed? Not only does he verbally exult over what he destroys, he vicariously exults over what he might have killed – "a gorgeous, rolicking grizzly bear."

Such sentiments are philosophically out of context for the National Park Service. Such self-congratulatory prose and policies cause the public to question whose hands the fate of our wildlife is in, as they are increasingly doing with the so-called National Wildlife Refuge System.

Sincerely,
Mary Kelly Black
Park Service Employee

Al Lovaas Replies

Hunting is not philosophically out of context for the National Park Service, at least not on millions of acres where it is legally mandated. Ms. Black aims her anti-hunting sentiments at the wrong target; I don't make the rules.

Ms. Black obviously cares deeply for wildlife and I am disturbed she apparently believes I do not. I was trying to convey my respect, admiration, and love for wildlife and its habitat, to which I have devoted a long career, and I regret I was unable to express those feelings adequately.

Taking wildlife for food only deepens my respect. During every meal of moose flesh my thoughts return to the wild spirit of the animal I killed and of the wilderness which nurtured it. The previous year I contemplated similarly the deer I had killed in the old growth forests of the Tongass near Sitka. To tell the truth, however, I was never really sure just which of the six was represented on the platter at any particular meal. (The season bag limit was reduced to five in 1990 and four in 1991 because the population decreased after two tough winters and overbrowsed range).

As for the National Wildlife Refuge System, it was initiated in 1903 by President Theodore Roosevelt, a mighty hunter.

'Partners' Workshop

A workshop entitled "Partners for Research and Resource Management was presented to the NPS Resource Management Trainees class in Denver on March 11 by Dr. Sarah G. Bishop, President of Partners in Parks.

Dr. Bishop and the NPS Training Division are preparing a training package on the subject of building partnerships. It will consist of a reference manual and guidelines for presenting the information in a workshop or training course. Class evaluation of the course will be incorporated into the final version of the reference manual, which will be completed by June 1991.

The work of Dr. Bishop's organization is to find opportunities for individuals and organizations to assist National Park research and management programs through ongoing partnerships.

regional highlights

Western Region

Christine Schonewald-Cox, research scientist with the NPS/CPSU at U/Cal/Davis, has the following articles in press: "Cross-boundary Management Between National Parks and Surrounding Lands: A Review and Discussion," (with Marybeth Buechner and Raymond Sauvajot of the U/Cal/Davis Institute of Ecology and Bruce Wilcox of the Institute for Sustainable Development, 3000 Sandhill Rd., Bldg. 1, Suite 102, Menlo Park, CA 94025) in ***Environmental Management***; "Scale, Variable Density, and Conservation Planning for Mammalian Carnivores," (with Rahman Azari of the U/Cal/Davis Division of Statistics and Stephanie Blume of the NPS/CPSU at U/Cal/Davis) in ***Conservation Biology***; and "Park Protection and Public Roads," with Buechner in ***Conservation Biology: The Theory and Practice of Nature Conservation, Preservation and Management***, 1991. Chapman Hall, NY, NY; editors Peggy Fiedler and S.K. Jain.

Recent publications already in print, and her co-authors, include "The role of interagency cooperation in managing for viable populations," with Hal Salwasser of the USDA Forest Service, and Richard Baker of the U/Cal/Davis Dept. of Environmental Studies, in ***Viable Populations for Conservation***, 1989. Cambridge Univ. Press, edited by Michael Soule'; "Biological Diversity and Global Change: Habitat Fragmentation and Extinction," with Thomas J. Stohlgren of the NPS/CPSU at U/Cal/Davis, in ***Proceedings of the Second US-USSR Symposium on Air Pollution Effects on Vegetation Including Forest Ecosystems***, USDA Forest Service, Northeastern Forest Experiment Station, Broomall, PA, 1990; "Wilderness and the Protection of Genetic Diversity," with Thomas Stohlgren of the NPS/CPSU at U/Cal/Davis, in ***Wilderness Benchmark 1988: Proceedings of the National Wilderness Colloquium***; USDA Forest Service Southeastern Forest Experiment Station Gen. Tech. Report, SE-51. Asheville, NC, 1989; and "Boundaries in the Protection of Nature Reserves," in ***BioScience***, Vol. 38 No. 7, pp 480-486.

* * *

From Mark Sogge, Biological Technician at the recently established CPSU at Northern Arizona University in Flagstaff, come the following two items:

A pair of endangered Peregrine falcons nested last summer along the border of Walnut Canyon National Monument. Tom Ferrell, District Ranger, suspected nesting activity on a cliff near the monument's border with Coconino NF. Mark Sogge verified the presence of two adult and two immature Peregrines at the cliff site in August. Biologists with the AZ Dept. of Game and Fish later rappelled from the cliff to the nest site and found Peregrine eggshell fragments and prey remains (scrub jays and nighthawks). This cliff is the smallest in the state to support nesting Peregrines, and reflects the positive status of Peregrine populations in Arizona.

* * *

Charles van Riper III and Mark Sogge of the CPSU at Northern Arizona State U, Flagstaff (CPSU/NAU), have conducted a series of meetings with the AZ Dept. of Game and Fish (ADGF) to initiate a cooperative study of Pronghorn on state and NPS land in northeastern Arizona. Petrified Forest NP and Wupatki National Monument have been selected as study areas. ADGF has studied Pronghorn population biology in the past, but research on NPS lands can contribute information not available elsewhere, such as the effects (at Petrified Forest) that paved roadways without associated cattle fencing have on Pronghorn movements. At Wupatki, researchers can study Pronghorn reproduction and mortality in grassland areas that are not grazed by cattle.

* * *

Elena Fraire, a Biological Technician at CPSU/NAU spent nine weeks in 12 of the 20 NPs and Monuments in Arizona. She gathered information on the natural resource databases in Casa Grande Ruins NM, Coronado N Mem., Fort Bowie NHS, Grand Canyon NP, Montezuma Castle NM, Organ Pipe Cactus NM, Petrified Forest NP, Saguaro NM, Tonto NM, Tuzigoot NM, and Walnut Canyon NM – all as part of Phase I of the Western Region Inventory and Monitoring Project headed by Tom Stohlgren, ecologist with the CPSU at U/CA/Davis.

She met with Superintendents and worked with Resource Management staff at each NPS unit. As anticipated, many of the parks lack baseline data for mammals, plants, reptiles and amphibians. In smaller parks, only checklists are available, many of which have not been updated since the early 1970s.

The CPSU/NAU will respond to the CPSU/UC/Davis findings by focusing baseline projects in the Colorado Plateau parks. The CPSU/NAU will enter data for a computerized bird list for the Grand Canyon NP based on the data structure set-up by the CPSU at UC/Davis. The CPSU/NAU will produce a computerized plant list for Montezuma Castle NM and Tuzigoot NM based on past studies. Ultimately, all these databases will be tied to a GIS that will be housed at the CPSU/NAU.

* * *

The CPSU/NAU is hosting the First Biennial Conference on Research in Colorado Plateau National Parks July 22-25 on the NAU campus in Flagstaff. Topics will cover but are not limited to air and water resources, grazing impacts, endangered species, introduced or alien species biology and control, inventory and monitoring, single species ecology, GIS, human impacts, climate and climate change, archeology, and riparian resources. Portions of the proceedings may be published.

* * *

Julie Pickering is the editor of a new quarterly newsletter for research and resource management of Colorado Plateau National Parks, titled ***Colorado Plateau***. The second issue (Spring 1991) features bald eagle research downstream on the Colorado river from Glen Canyon Dam and the effects of rainbow trout introduction on eagle populations. The increased numbers of bald eagles seen in winter months since the large winter spawning runs of trout became a factor raises a question of the importance of the non-native trout as a food source for the endangered bald eagle. It also highlights the management dilemmas that arise when established management goals seemingly conflict ... in this case, the welfare of an endangered species appears to be dependent on continuation of an altered ecosystem.

Pacific Northwest

The U.S. Forest Service formally unveiled on Feb. 25, 1991, the results of a two-year mapping project, showing that 4.3 million acres of old-growth trees remain on national forests west of the Oregon and Washington Cascade crests and in northern California. The Wilderness Society simultaneously released its own maps showing 3.8 million acres of "ancient forest" remaining on a similar but not identical land base.

Jean Durning, Seattle director for The Wilderness Society, called the ability to look at various old-growth types across the landscape the most useful outcome of the mapping program. "The big story comes," she said, "when you look at the maps themselves and look at what's on the ground. I think there are very important reasons to differentiate the vegetation types. Mountain hemlock is not interchangeable with ancient forest or spotted owl habitat."

The two studies used computer analysis of satellite imagery but employed different definitions of old growth and slightly different land bases in arriving at their numbers. The project identified 607,000 acres of old-growth forest in the Mount Rainier, Olympic, and Crater Lake NPs.

Rocky Mountain Region

A small population of the rare orchid *Spiranthes diluvialis* is the object of current research underway at Dinosaur National Monument in Colorado. NPS Water Resources Division hydrologists Bill Jackson and Joel Wagner, who participated in a multidisciplinary assessment of the Hog Canyon riparian system in the Monument, found that the alluvial fan at the mouth of Hog Canyon has been subjected to a variety of impacts including overgrazing and stream channel excavation/relocation. The rare orchid persists along a perennial, spring-fed stream, and research is attempting to determine how best to enhance its habitat.

Steve Petersburg, the Monument's natural resource management specialist, is conducting an evaluation of current hydrologic, geomorphic, and vegetation conditions, preparatory to developing ways of restoring pre-settlement hydrologic/geomorphic processes and vegetation communities. The work is being done along with an overall botanical survey, in cooperation with the USFS and the U.S. Soil Conservation Service.

* * *

A new program, established in the Region in 1990 to provide funding for natural resource mitigation, preservation and restoration projects, was made possible through increases in the regional base. Over 30 parks competed for FY 91 support, resulting in 17 new projects. They ranged from restoration of natural air flows at Wind Cave NP to the design and construction of watergates to prevent escapes of bison and elk at Theodore Roosevelt NP. The program is helping implement projects that often are too small or non-controversial to be funded through other regional or servicewide programs, especially at parks with limited base funding.

* * *

Impending development outside the Great Sand Dunes National Monument has created an urgent need for better understanding of the Dunes. Several research projects are underway to determine the impacts on park resources from outside development: Dunes coring, (by Adams State College); dating of the quartz sand in the dunes, (by the USGS); location of faults and mapping of surface and subsurface geologic structure, (by the Colorado School of Mines Geophysics Field School); loss of Medano Creek surface flow study, (by Utah State University); dunes vegetation, (by the USFS Shrub Sciences Lab in Provo, Utah); dunes insects, (by the University of Colorado); and sand migration. Once collected, the information will be put in GIS format to provide a tool for understanding and managing the complex dune system.

regional highlights (Cont'd)

Yellowstone NP had begun a test of 25 bison for the *Brucella* organism, to determine the potential for infectivity. Blood and tissue samples from bison in the Mary Mountain herd were to be tested for the relationship between brucellosis serological positivity and actual infectivity in the Yellowstone sample tested. The project began April 8, 1991, when three bison were dispatched before a temporary restraining order was issue to halt the research due to litigation filed in Federal court by the Fund for Animals. This delay caused the NPS to miss the optimal period for conducting the research and the proposal was therefore withdrawn.

The park needs this scientific data for preparation of a long-term bison management plan. Yellowstone and the Regional Office are reviewing options to continue this research at a later date, taking into account alternatives for data collection, biological factors, public concern, visitor safety, logistics, protection of park resources, and possible legal challenges.

Midwest Region

Students in a U/WI graduate seminar on Ecology in National Parks conducted research on such topics as dynamics of toxic chemicals in food webs of boreal parks, reintroduction of wolves in Yellowstone, and exotic vertebrate invasions in South Florida parks. The spring semester course began with presentations by Walter Loope (Pictured Rocks National Lakeshore), Ron Hiebert (Chief Scientist for the NPS Midwest Region), and James Bennett (Great Lakes Cooperative Park Studies Unit).

* * *

Researchers and Resource Management Branch personnel of Indiana Dunes National Lakeshore are using the park's GIS to determine the frequency of wildfires occurring in a given area of the lakeshore and to document areas subject to a large number of wildfires. The information from the analyses will be used to defend various aspects of the lakeshore's fire management plan, now being revised, and to better manage lakeshore resources through proper application of prescribed fire.

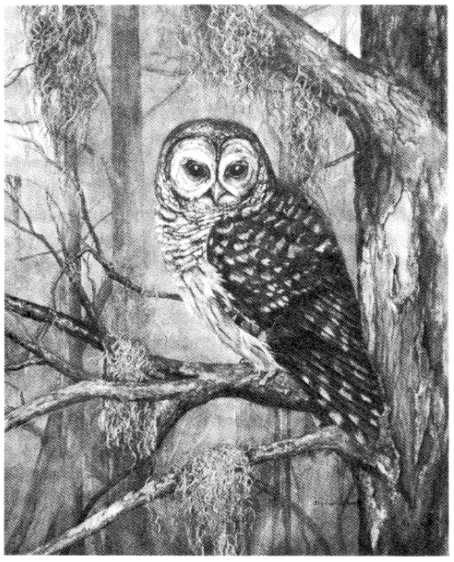
* * *

Apostle Islands NL held its 12th annual research conference in Bayfield, WI on Oct. 24-25, 1990, providing an annual update on research at the Lakeshore. Presenters related their work to management issues posed by Lakeshore managers. Topics ranged from submerged cultural resources, sea kayakers, and spit geomorphology to black bears, eagles, and data management. Some 56 scientists, park managers, and interested public attended.

Southeast Region

A barred owl sitting on a pine limb in Congaree Swamp National Monument (NM) is the subject of the South Carolina Wildlife Federation print of the year. The Monument was chosen for the painting because the barred owl is found in the state's wooded swamps, river bottoms, and wetlands. The Federation is working in South Carolina to promote wetland conservation and policies that will protect wetlands. Congaree Swamp NM will serve as a host site for the Federation to feature in 1991 during efforts to educate the public about the valuable functions wetlands provide for wildlife habitat, flood control, pollution reduction and ground water recharge.

A print of the painting by artist Jann Rattray Twork is available, unframed, for $50 from the SC Wildlife Federation, P.O. Box 61159, Columbia, SC 29260.



Out on a limb

Mid-Atlantic Region

Gary Machlis, Sociology Project leader at the U/ID NPS/CPSU; Dick Ring, superintendent at Delaware Water Gap NRA; and Jeff Marion, CPSU unit leader at Virginia Tech presented a social science plan developed by Machlis for the Delaware Water Gap to the Northeastern Recreation Research Conference. The plan reviewed previous social science research relevant to the Water Gap, evaluated and summarized needed research, and outlined a four-stage action plan for obtaining the needed research. Copies of the plan are available from Beth Johnson, Delaware Water Gap NRA, Star Route 38, Milford, PA 18337, (717) 296-6952. An article describing the plan is being prepared for ***Park Science***.

Also at the Northeastern Recreation Research Conference, Malcolm Ross, Resource Management Specialist at the Upper Delaware Scenic and Recreational River, presented a paper titled "Environmental Glasnost: Protecting a Resource You Do Not Own," describing the challenges faced by managers at the Upper Delaware in achieving agency objectives through work with local governments, state and federal agencies, and area residents.

* * *

Shenandoah NP recently held a second meeting of its Science Advisory Board, at which board members reviewed the park's Long-term Ecological Monitoring program, a new Resource Management plan, and discussed prospects and application procedures for nominating the park as a new Biosphere Reserve. This year marks the third and final year of Peregrine falcon releases.

* * *

The Mid-Atlantic Region welcomes new resource management staff and says farewell to some migrating friends. Welcome to Pat Lynch, GIS Program manager at Shenandoah NP; Keith High, GIS Specialist shared by Delaware Water Gap and the Upper Delaware Scenic and Recreational River, and John Perez, Resource Manager at Fredericksburg and Spotsylvania Battlefields. Farewell to Kathy Jope, Regional Resource manager, to the same position for the Pacific Northwest Region; Rick Potts, Shenandoah Resource manager to the same position at Katmai NP, and Meg Weesner, New River Gorge National River Resource manager to the same position at Saguaro National Monument.

* * *

Delaware Water Gap NRA recently hosted a 25th Anniversary Symposium. Topics included natural science, public policy, park administrative history, and regional cultural history. Copies of the Symposium Proceedings are available from the Superintendent, Delaware Water Gap NRA, Bushkill, PA 18324.

* * *

Jeff Marion, Virginia Tech CPSU unit leader, reports completion of a cooperative USFS/NPS study titled "Results from the Application of a Campsite Inventory and Impact Monitoring System in Eleven Wilderness Areas of the Jefferson National Forest." Significant improvements in impact assessment procedures, including a more accurate and precise Variable Radial Transect method for measuring campsite size, a comprehensive manual of monitoring protocols, and menu-driven dBASE IV databases also are featured in the report.

Marion is working on a servicewide I&M manual for managers seeking to develop recreation site impact monitoring systems. The Jefferson NF report is available from Marion at the NPS/CPSU, Virginia Tech, Dept. of Forestry, Blacksburg, VA 24061-0324 (703) 231-6603.

Wildlife and Vegetation Division

Three members of the Division participated in the International Conference on Science and the Management of Protected Areas held May 14-19, 1991 in Wolfville, Nova Scotia. Mike Ruggiero, on behalf of himself and co-authors Tom Stohlgren and Gary Waggoner, presented a paper, "Towards a Biological Survey of the US National Park System" to a session on Management Strategies. Nape Shelton gave a paper on "Removing Bottlenecks in the Transfer of Park Research Information" to a session on Putting Policy into Action. Pete Comanor, on behalf of himself and co-author John Dennis, presented a poster session and paper titled "US National Parks: Benchmark Contributors to Long-term Global Change Research" in a session on that subject.

* * *

NPS-77, the NPS's first comprehensive guideline on natural resources, has been completed and is in printing.

Alaska Region

The US-USSR Beringian Heritage International Park planning team met April 22 through May 6. The joint team toured northwest Alaska, Denali, and Kenai Fjords NPs, and conducted meetings at the Alaska Regional office and the Denver Service Center. Legislation is to be introduced on both sides in 1991. Targeted completion of the International Park is 1992.

* * *

Reports published in the Region recently are:

Racine, C.H. and G.M. Ahlstrand. 1991. Thaw response of tussock-shrub tundra to experimental all-terrain vehicle disturbances in South-central Alaska. Arctic 44:31-37.

Wesser, S.D. 1991. The effects of light and moisture on two species from contiguous communities of south-facing bluffs in Interior Alaska, USA. Arctic and Alpine Research 23:99-103.

Three Australian scientists, after 20 months of research in the South Pacific, have confirmed a connection between plankton gas emissions and cloud-seeding sulfur compounds. While other correlations of the Gaia hypothesis remain unproved, the results, they suggest, lend weight to the idea that the planet and its life forms collectively constitute a self-regulating "superorganism."

Plankton are known to excrete a gas rich in sulfur compounds, and those compounds in turn create "cloud condensation nuclei" – the seeds of clouds. When the Earth's temperature rises, plankton growth increases, causing more gas emissions into the atmosphere and thus more clouds. The clouds block sunlight, reducing air temperature, restricting plankton, and thus maintaining planetary equilibrium. So goes the theory proposed two decades ago by British climatologist James Lovelock and U.S. biologist Lynn Margulis and named for the Greek goddess of Earth.

⁂

Leslie Roberts, editor of the News and Comments section of ***Science***, devoted his section in the March 15, 1991 issue to discussing the fallout from the government's massive acid rain program. NAPAP (National Acid Precipitation Assessment Program) involved some 2000 scientists and half a billion dollars over a decade to create "an impressive body of scientific research," Roberts said, but in terms of policy, he quotes one congressional aide as calling it "totally irrelevant." Others have said that although NAPAP may have fallen short of its policy goals, its scientific research helped define the parameters of the debate early in the decade.

Roberts suggests that the program never really recovered after publishing a 1987 interim report "that was widely perceived as a biased attempt to downplay the problem – a sobering reminder of just how fragile credibility can be when dealing with such a highly emotional issue as acid rain. More than that, however" Roberts adds, "NAPAP strove for scientific perfection and lost policy relevance in the bargain."

"Scientific overkill?" asks the caption next to a picture of the five feet tall stack of 6000 pages – the final NAPAP report. James Mahoney, who directed the program, says that with the benefit of hindsight, he would have directed some of the resources away from NAPAP's enormously complicated atmospheric transport model toward "simpler models that could have provided answers sooner" and warned the interagency Committee on Earth and Environmental Sciences that "Global change is driven by too much raw science." The NAPA scenario, he indicated, is already repeating itself in the new federal climate change program.

⁂

Paleontologists have identified the 135 million-year-old fossil remains of a bird from northeast China that documents an important step in the evolution of avian flight. Paul C. Sereno of the University of Chicago announced the find at the October 1990 meeting of the Society of Vertebrate Paleontology in Lawrence, KS. The still-unnamed sparrow-sized specimen is the earliest known example of a bird with modernized flying ability – about 10 to 15 million years "younger" than the oldest known bird, *Archeopteryx*, and shows several flight features that its crow-sized predecessor lacked. The fossil, described in ***Science News***, (138:16, p. 246) "shows an intriguing mix of modern avian features and primitive characteristics retained from reptilian ancestors." It had flight-specialized shoulders and a shortened set of tail vertebrae fused into one bone – an avian adaptation called the pygostyle. It also had claws that were long and curved, allowing better perching ability than its ancestors.

⁂

Peter Olson, a geophysicist who conducts convection experiments in oil-filled tanks at Johns Hopkins University in Baltimore, likens a fresh cup of hot coffee into which a liquid creamer has been poured to the mantle of the planet Earth. Both the coffee and the mantle stir themselves by a process called convection. As heat escapes at the top of the mug, the upper layer of coffee cools and grows denser, sinking toward the bottom in sheets. The descending currents force warmer liquid to rise.

The earth's mantle warms mostly from within – some 80 percent of its heat coming from the decay of radioactive elements distributed throughout the mantle layer. "The remaining fraction of heat comes from the core below," according to Richard Monastersky in an offbeat little piece in the December 1, 1990 issue of ***Science News***. "At the top of the mantle, heat escapes upward through the tectonic plates that form a thin, broken shell encasing the mantle. These plates continuously rearrange their positions on the surface, bumping and grinding against each other with Earth-shaking consequences."

In the mug, after addition of the cream, you can witness a miniature imitation of the grand geophysical process – where sheets of cold ocean floor sink into the hot mantle, a process called subduction. Volcanoes grow over subduction zones because some of the oceanic rock melts as it plows down into the hot mantle, causing molten magma to rise and then erupt at the planet's surface.

"Of course, java is not lava," Monastersky admits, "and you can carry the mug/mantle analogy only so far. Given that geophysicists have difficulty simulating mantle and plate motion even with complex computer models costing a million dollars, how much can you expect from a 60-cent cup of coffee?"

⁂

Park Science readers who were intrigued by Jim Wood's article, "Technical Writing As a Tool – an Art" (***Park Science*** 11:1, p. 13), might want to check out the piece by George D. Gopen and Judith A. Swan, "The Science of Scientific Writing," in ***American Scientist*** (Nov/Dec 1990, pp 550-558. The authors expand on the thesis that if the reader is to grasp what the writer means, the writer must understand what the reader needs. Gopen is director of writing programs at Duke University; Swan teaches scientific writing at Princeton.

⁂

A startling botanical conversion, totally unexpected, is the dense blanket of knee-high grass that now stands where formerly patchworks of scraggly shrubs and parched earth existed in the Chihuahuan Desert. The transformation is the result of a study begun in 1977 by James H. Brown, an ecologist at U/NM in Albuquerque, to assess the ability of native kangaroo rats to compete with native ants for the area's supply of large plant seeds. It began with exclusion of these rats from small plots of shrubland in southeastern Arizona. Eight of the original 24 small plots (2500 square meters) were surrounded by fine-mesh fences, adjusted to exclude either all rodents or at least three species of the kangaroo rats native to the sites. The finding documents for the first time, according to R. Cowen writing in ***Science News***, Vol. 138, p. 391-392, "that the collective actions of several related types of animals – not just the behavior of a single species – can dramatically alter the fate of an ecosystem."

"People are only worried about the much more comprehensible and simple question of conservation – whether a species is there or not," comments marine ecologist James A. Estes of U/Cal/Santa Cruz. "But if an ecosystem is tied together by a guild rather than a single species, our emphasis ought to be on conservation of the guild rather than the species."

⁂

"Is a warm-water cycle stripping corals of their lifeblood?" asks Robert N. Langreth in a ***Science News*** Dec. 8, 1990 article, "Bleached Reefs." Weeks of abnormally warm water have caused the usually colorful Puerto Rican corals to expel the algae that give them their hues. A former commercial fisherman who now assists marine botanists at the University of Puerto Rico in Lajas, says: "Some people say this is normal. I'm 42 and I've been working in the water all this time, and I've never seen something like this before."

Apparently, scientists have known about coral bleaching for at least 75 years, according to Langreth, but the phenomenon became widespread only in the last decade. The summer and fall of 1987 brought the world's most extensive bleaching on record. In past years, most of the faded reefs recovered during winter, but this year many researchers worry that corals, weakened by repeated bleachings, may actually die.

The issue has drawn the attention of the Senate Committee on Commerce, Science and Transportation. At an October 1990 subcommittee hearing, reef researchers ventured the disturbing prediction that the current coral fadeout may signify the beginning of the expected global greenhouse warming.

⁂

Michael Glantz, a senior scientist at the National Center for Atmospheric Research in Boulder, CO, describes (in an article for ***Knight-Ridder News Service***) a new category of international refugee: environmental refugees ... people who have fled their homes to other parts of their country or across international borders because of environmental degradation and changes. Processes like desertification, deforestation, and prolonged droughts have caused them to seek a new homeland in order to feed their families," Glantz writes. "Like those fleeing from a local war (refugees) or in search of a better life (economic refugees), they too have no official status as refugees."

The UN Environmental Programme, Glantz reports, is concerned about this development, believing that future climate change will increase the numbers of such refugees by tens of millions. With no provisions for such a scenario, Glantz suggests that it is time for a new concept of refugee and for countries to "face up to their obligation to assist refugees in their moments of need."

⁂

"Keeping anglers happy has a price," is the title of an article by Science Writer Billy Goodman in the May

1991 issue of ***BioScience***, pp. 294-299. Goodman recaps recent findings on the ecological and genetic effects of stocking fish – findings that again point out the fallacy of thinking of some consequences as "effects," and others as merely "side effects." Introduction of game fish has been found to have a variety of deleterious effects on local species. They may outcompete them, causing their extinction; they may hybridize with a rare local relative, imperiling the rarer species' genetic integrity; they may interbreed with local populations of the same stock and disrupt the local stock's adaptation to its environment.

The key to understanding what happens when hatchery fish are planted on top of wild fish, according to Richard Vincent of the Montana Department of Fish, Wildlife, and Parks, is to understand the different behavior patterns of wild and hatchery fish. Fish raised in a hatchery have lost their territorial behavior. Hatchery fish don't recognize territorial signals of the wild fish; the wild fish don't fight for the food as hatchery fish do – they simply move to other parts of the stream where cover or food may be poorer.

A sidebar box, with this article, describes the steps that Washington state hatchery managers are taking to minimize genetic impoverishment and domestication of captive-reared fish. Some hatcheries are using automatic feeders to reduce fish contact with humans, thus preserving the flight response of wild fish. They also are returning to the wild for new brood stock every several generations, thus infusing new genes into the hatchery population and breaking selection for domestication.

⁂

An article in ***BioScience***, Vol. 40 No. 9, pp. 640-642, by Jill Baron and Kathleen A. Galvin, describes how ecosystem science can be used to address the myriad environmental problems. "Future Directions of Ecosystem Science" describes the growing awareness of global-scale environmental degradation and the three levels of environmental concern – local, regional, and global.

The questions inherent in this approach were tackled at a conference at Pingree Park, CO, in October 1988, by a workshop funded by the National Science Foundation and comprised of 40 prominent women scientists. The ***BioScience*** article addresses both the scientific issues and women's status in science.

"... there is more to becoming a successful professional scientist than university coursework and Ph.D. research," the group concluded. "Women must assertively seek out successful graduate experiences ... (and) must develop enough self-confidence and knowledge of their limits to be able to say 'no' when the demands become too great."

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Jill Baron, a research associate at the Natural Resource Ecology Lab, CO/State/U and a research ecologist with the NPS Water Resources Division, is co-author with Alisa Mast and James Drever of an article in the December 1990 issue of ***Water Resources Research***, titled "Chemical Weathering in the Loch Vale Watershed, Rocky Mountain NP." The article examines the source of solutes to surface waters draining the Loch Vale watershed in the Front Range of Colorado and concludes that the surface waters there are susceptible to acidification should acid deposition from the atmosphere increase.

notes from abroad

Editor's Note: David Parsons, Research Scientist at Sequoia/Kings Canyon NPs, represented the NPS Global Change Program Committee at an international workshop, "Earth system response to global change – northern and southern hemisphere contrasts," held in La Serena, Chile Nov. 30 to Dec. 4, 1991. The workshop was sponsored by the Chilean Academy of Sciences; the American Assn. for the Advancement of Science (USA); the Chilean, US, and Canadian IGBP (International Geosphere and Biosphere Program) Committees, and the McArthur Foundation. His report follows:

By David Parsons

The meeting brought together experts from such diverse fields as atmospheric science, oceanography, wildlife, vegetation, forestry, hydrology, biogeochemistry, and human geography to discuss the potential effects of global climate change on the west coasts of North and South America. Paired presentations were made on each of the above disciplines by leading scientists from each hemisphere.

The obvious similarities between Chile and the west coast of North America (located on the west coasts of continents, influenced by major oceanic current systems, similar climates, vegetation, and topography) provide many natural comparison bases. Differences in land use history and the ratio of land to ocean surface area in the two hemispheres lead to some differences in the projected impacts of increases in greenhouse gas concentrations on air temperature.

The Chilean scientists, with whom I was most impressed, and I identified many areas of potential collaboration between NPS sites in the western U.S. and sites in Chile. I was one of only two U.S. government representatives at the workshop, highlights of which follow.

The potential for using El Nino events as a surrogate for anticipated global warming was discussed. In 1968 and 1983 El Nino events (the two largest such in recent history) resulted in a 2 to 3 degree warming in the California Current and a shifting of currents to the north; thus shifting storm tracks as well. Unfortunately, the existing Global Circulation Models (GCMs) do not include ocean circulation patterns. There was much discussion as to whether increased CO2 might increase the frequency of anomalous events such as El Ninos, droughts, floods, etc. The shift in currents, ocean temperatures, biota (which will respond quickly), etc., might provide an interesting basis for work at Channel Islands NP or other west coastal sites.

Warming will not be uniform across the globe, and in fact, cooling might well occur in some areas. Faster and larger temperature responses can be expected over land than over the ocean and thus the relative amount of land and water will influence the rate of climatic response (e.g. temperature increase can be expected to be faster in the northern hemisphere where there is greater land mass). (Kevin Trenberth, INCAR, Boulder).

The best estimates show the global mean surface temperature has increased 0.5 C. over the past century. In the northern hemisphere this increase was largely before 1940. Decreases occurred in the 1960s and how a recovery to a new high point has occurred in the 1980s. (Trenberth).

Discussions of hydrology and projected increases in evapotranspiration demand on water identified the interior west and southwest of U.S. as most vulnerable to climate change. (Rick Lawford, National Hydrology Center, Canada).

The presentation on intertidal systems (Jan Lubchenco, Oregon State) was a particularly clear outline of the sensitivity of these highly productive and diverse systems to predicted changes in sea level, sea and air temperature, and nutrients. I was struck with many implications for NPS coastal areas. Lubchenco also suggested that research programs may need to focus on targeted species: species at risk, species important to the system, or species important to global processes. She suggested attention be directed at the edge of species distributions (especially the thermal limit), at long lived species, at species with short dispersal distances, at pathogens, and at multiple stresses and rare events. These suggestions may be important for other ecological systems as well. (Note: Lubchenco is the next president of the Ecological Society of America – a valuable contact.)

Discussion of the importance of modeling the impacts of global change emphasized the importance of clearly articulating the questions being asked and the need to include process models. Problems of scaling and disturbance were emphasized. (Carlos Prado, U/Catolica, Santiago).

Wide ranging discussions of vegetation and plant responses included paleoecological analogs, documented changes in treeline, life cycle characteristics, dispersal modes, genetic constraints, and human impacts. I see several potential areas for collaboration with the Sequoia/Kings Canyon program. (Sterling Keeley, Whittier College; Hal Mooney, Stanford; Mary Arroyo and Juan Armesto, Univ. de Chile; Carolina Villagran, U/Catolica).

An excellent model of what could happen to animal species subjected to temperature increases (no change, evolution in place, migration, or extinction) was presented by Jim Brown (U/New Mexico). He developed a specific example of the predicted extinction of small mammals on mountain tops in the Great Basin.

An evening discussion focused around the recent announcement of the U.S. government to support the concept of up to five regional research centers for global change, and that one of these should be located in Latin America. Despite obvious points in favor of Brazil for such a center, it was agreed that Chile could offer much as well, and that this would be pursued through appropriate channels. Discussion also focused on the value of developing a filter, or mechanism, to help determine what species, communities, and functional groups should be concentrated on for monitoring and process studies. A similar approach might be of great value to the NPS global change program.

Following the workshop, I met with faculty at both the Universidad de Chile (Drs. Arroyo and Juan Armesto and students) and the Catholic University (Dr. Eduardo Fuentes) regarding future collaboration. There was great interest in cooperation toward applying similar methodology to address questions of plant population biology, dispersal mechanisms, ecotone stress, climate and fire history, and developing comparable methods for long term monitoring.

I feel that my participation in the workshop was of value to the other participants, to the workshop products (which I helped write up), and to our global change program. The contacts made have potential for valuable spinoffs.

GIS Used to Develop Fire Management Strategies

By Carl Douhan, Randy Knutson
and Kenneth L. Cole

Researchers and resource management personnel at Indiana Dunes National Lakeshore (NL) are using the lakeshore's geographical information system (GIS) to determine wildfire frequency in given areas within the lakeshore. The information from the analyses will be used by lakeshore staff to refine the Fire Management Plan, currently being revised, and to better manage lakeshore resources through the proper application of prescribed fire.

A linear park located on the southernmost shore of Lake Michigan in urban Northwest Indiana, the lakeshore is the meeting place of the western prairie, northern boreal forest, and southeastern hardwoods and is noted for its biodiversity. The area has been heavily impacted by modern human activities. Transportation and utility corridors, drainage ditches, industry, and communities divide the lakeshore into isolated segments. Mining of sand, logging of timber, draining of wetlands, and suppression of wildfires have vastly altered the plant composition of the area.

Despite these impacts, Indiana Dunes has an unusually high plant diversity, currently third highest of any area in the National Park System, with 1,445 species of vascular plants (Pavlovic and Cole, In Press). It also possesses 29 percent of the state's threatened and endangered plant species (Bowles et al 1986).

The lakeshore experiences an average of 29 wildfires annually, all human caused, with the majority occurring in its western portion. Based on information from past fire reports, the fires were divided into spring and fall burns, and the perimeters of all fires for which accurate maps existed were digitized into the GIS data base. The staff was able to digitize approximately 90 percent of the reported wildfires that occurred between 1982 and 1989, and 100 percent of the wildfires occcurring after 1989. However, wildfires as large as 100 acres that occurred prior to 1989 were not entered into the data base because their mapping format could not be digitized. Although attempts were made to reconstruct the fire maps, in some cases too much time had elapsed for accurate reestablishment of the fire perimeters on appropriate maps.

The work has resulted in a reasonably complete digitized record of the wildfires in the lakeshore since 1982 and the data base will provide researchers and members of the Resource Management Branch with a highly credible statistical sample.

The data can be used in a variety of ways. For example, the annual occurrence and location of each reported wildfire, when combined with similar fire maps from other years, provides investigators with a much clearer picture of fire frequency for different park units. Over a period of time, these overlays can be used with a high degree of confidence to test statistical hypotheses. For instance, the staff has found that some areas of the lakeshore have burned at least six times between 1982 and 1990. This combined wildfire data was overlaid with a digital map of the fire-dependent vegetation types. When the two were compared, the lakeshore areas that experienced the highest frequency of burns closely matched the distribution of fire dependent plant species and community types.

The lakeshore is in the process of developing a new fire management plan and will use the various outputs derived from the GIS data base to recommend courses of action to management and to identify trends. These outputs, in a variety of combinations, will be used to determine the size and location of burn units, complete a fire prevention and risk analysis, identify and rank values at risk, verify fuel models, and recommend optimum burn frequencies for the different plant communities in the lakeshore.

High flames penetrate *into a thicket of aspen sprouts in the wet prairie.*

Igniters work around the perimeter *of prescribed burn area using drip torches.*

The lakeshore's Research Division has been conducting studies for the past eight years to determine historic fire frequencies and to develop an understanding of the effects of fire and other natural phenomenon on existing plant and animal communities. Based on these studies, the following premises have been developed concerning the effectiveness of fire as a management tool at the lakeshore:

– Oak savanna and prairie communities will best be maintained by a fire interval of from two to eight years, depending on the unit history, specific goals, and year-to-year climatic variations (Cole et al, 1990; Taylor, 1990; Henderson and Long, 1984).

– Annual fires are not recommended for either restoration or maintenance of oak savanna as these burns often have little fuel and may damage sensitive herbaceous species.

– Remnants of the oak savanna/prairie community must be burned at least every 15 years or they may be lost because of the increasing diameter of saplings (Cole and Klick, 1990) and the increase in canopy cover.

– Spring burns seem to be the most cost effective because the appropriate climate windows occur more predictably during this season.

– The fire dynamics of marshes and wet prairies are

(Continued on page 17)

Fire Strategies *(Cont'd)*

complicated by additional factors such as water table fluctuations and herbivores and are in need of further study.

The results of this research have formed the basis for future fire management activities at the lakeshore. Beginning in 1991, members of the resource management staff are using the data displayed on the combined burn frequency overlays to locate monitoring plots designed to document the effects of fire frequency on species composition and fuel loading, especially for fuel size distribution. Attempts also will be made to compare areas experiencing spring and fall burns.

Results of these studies will be used to validate the results of the research conducted thus far, including effects of fire on threatened and endangered plant species.

To date no attempt has been made to integrate burning conditions of past fires. However, starting in 1991, observed weather conditions at wildfires over five acres in size are being recorded. The observed conditions are being entered into BEHAVE, a fire effect program. The results will be used to categorize the severity of the burn to verify past output values from BEHAVE. A limited amount of pertinent information concerning each fire will be entered into a dBase file, which may be utilized by GIS.

Summary

The proper utilization of the GIS, when combined with research and monitoring activities, will greatly enhance the understanding of the effects of fire on plant and animal communities and provide researchers and managers with creditable data to make management decisions that will stand up to public scrutiny and peer review.

Douhan and Knutson, at the time of writing, were resource management specialists at Indiana Dunes NL. Knutson is still there in that capacity, while Douhan moved in May 1991 to the NPS National Capital Region as a fire management specialist. Cole is a research ecologist with the Indiana Dunes Research Division.

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Loon Survey Conducted

A 1990 loon survey on Isle Royale revealed the presence of 22 successfully nesting loon pairs, apparently saturating the inland lake habitat. Loon chick production on Lake Superior, however, was down approximately 62 percent from a 1985 survey. Lake levels are down and boaters are up in the five intervening years, making it impossible to tell whether or not the two data points signify a trend. The Lake Superior portion of the loon survey will be repeated in 1991 to give a third data point.

meetings of interest

1991

July 21-15, WORLD CONGRESS OF LANDSCAPE ECOLOGY, meets for the first time in North America, at Carleton College, Ottawa, Canada, featuring six symposia selected by an international panel of reviewers and addressing topics of current intellectual and practical significance. Contact: James F. Thorne, Dept. of Landscape Architecture, 119 Meyerson Hall, Philadelphia, PA 19104-6311; (215) 898-6591.

July 22-25, FIRST BIENNIAL CONFERENCE ON RESEARCH IN COLORADO PLATEAU NATIONAL PARKS, at the Northern Arizona University campus, Flagstaff. Contact, Charles van Riper III or Mark Sogge at the NPS/CPSU, P.O. Box 5614, NAU, Flagstaff, AZ 86011.

Aug. 16-25, DENDROECOLOGICAL FIELDWEEK, an 8-day program at the H.J. Andrews Experimental Forest near Blue River, OR, combining field research activities, lectures, and informal personal interaction. Recognized experts will lead small groups through exploring the usefulness of tree-ring analysis in multi-disciplinary research. Contact: Paul J. Krusic, P.O. Box 75, Nottingham, NH 03290.

Sept. 16-17, FIRST BIENNIAL SCIENTIFIC CONFERENCE ON THE GREATER YELLOWSTONE ECOSYSTEM: Theme, Plants and Their Environments; NPS host agency; at Mammoth Hot Springs Hotel, Yellowstone NP. Contact: Conference Committee, c/Research Division, P.O. Box 168, Yellowstone NP, WY 82190.

Oct. 7-10, OUR NATIONAL PARKS: CHALLENGES AND STRATEGIES FOR THE 21st CENTURY, a symposium on the occasion of the 75th anniversary of the National Park Service, in Vail, CO, exploring park issues and opportunities and charting future courses for management of the National Park System. Contact: NPS Employee Development Division-DSC, 12795 W. Alameda Pkwy, P.O. Box 25287, Denver, CO 80225-0287.

Oct. 16-20, 45TH NATIONAL PRESERVATION CONFERENCE, "Historic Preservation for the Next 25 Years," at the St. Francis Hotel, San Francisco; sponsored by the National Trust for Historic Preservation, the NPS, and the Advisory Council on Historic Preservation. Contact: National Trust for Historic Preservation, 1785 Massachusetts Ave., NW, Washington, Dc 20036.

Nov. 3-8, THIRD GLOBAL CONGRESS OF HERITAGE INTERPRETATION INTERNATIONAL – JOINING HANDS FOR QUALITY TOURISM, in Honolulu. For registration and travel/housing information, contact Ray Tabata, UH Sea Grant, 1000 Pope Rd., MSB 226, Honolulu, HI 96822 USA; (808) 956-2866; FAX (808) 956-2858.

Nov. 16, NEZ PERCE ART EXHIBITION, "Sapatqayn: 20th Century Nez Perce Artists," opens at the Nez Perce National Historical Park, Spalding, ID, featuring 50-100 pieces of traditional contemporary art, some never before seen by the public; with documentary catalog, guest speakers and demonstrations by Nez Perce artists. To run through Jan. 12, 1992. Contact: Nez Perce HNP, P.O. Box 93, Spalding, ID 83551; (208) 843-2261.

1992

Feb. 19-22, SOCIAL ASPECTS AND RECREATION RESEARCH SYMPOSIUM, Theme: "Social Aspects of the Wildland/Urban Interface," at the Clarion Hotel, Ontario, CA. Contact: Debbie Chavez, USDA Forest Service, 4955 Canyon Crest Dr., Riverside, CA 92507.

May 17-20, FOURTH NORTH AMERICAN SYMPOSIUM ON SOCIETY AND RESOURCE MANAGEMENT, in Madison, WI. Contact: Donald R. Field, 1450 Linden Dr., Madison, WI 53706.

Agricultural Pest Scouting Tried

This summer the agricultural program at Cuyahoga Valley NRA will attempt to use the State of Ohio Agricultural pest scouting program as a means of applying integrated pest management principles to crops of sweet corn, field corn, and soybeans.

The park's technical assistance preservation staff (TAPS) oversees the agricultural field leasing program. The Midwest Region Natural Resources Division is funding a contract between Cuyahoga Valley NRA and county extension agents to monitor agricultural fields and write "prescriptions" for the application of herbicides. The prescriptions are based on distribution of weed seedlings and the economic impact forecasted by the weed crop, and will trigger the pesticide use approval form (10-21A). The prescriptions are a method of quantifying this year's post- emergent weed crop to aid in this season's herbicide treatment or next year's crop rotation. It is hope that this scouting program will develop and eventually be worked into the fair market value of agricultural leases at the park.

Bald Eagle Studies

Apostle Islands NL is conducting a cooperative pilot study on bald eagles with the Wisconsin Dept. of Natural Resources and the USFWS. Productivity of bald eagles along the Lake Superior shoreline is less than that of birds on the mainland. Levels of organochlorine pesticides are elevated in Lake Superior eagles and have been hypothesized to be the cause of reproductive impairment. However other factors such as climate conditions and food availability have not been well studied. Turnover rate also has not been documented but is suspected to be high.

This pilot study will set a framework for determining the cause(s) of lowered productivity in Lakeshore eagles. Direct observations of Lakeshore and mainland nests are being conducted; blood will be drawn from young eagles for toxic analysis; video cameras will be used, and a limited amount of climatic and food availability information will be gathered. A proposal currently being considered by the Great Lakes Protection Fund would continue and expand the current study.

Restoration of Farm Woodlots at Gettysburg NMP

By Stephen E. Fairweather
and Cecile M. Cavanaugh

In the first three days of July 1863, the farm fields and woodlots of Gettysburg, Pennsylvania were the scene of one of the bloodiest battles in American history. In all, more than 50,000 men lost their lives in the fight that historians refer to as "the greatest battle of the Civil War."

Accounts of the battle of Gettysburg make it clear that the farm woodlots played an integral role in the fighting, providing cover, cool drinking water, and landmarks for orientation of the troops. Before the battle, the woodlots were an important feature of the landscape from a natural resources point of view, providing building materials, windbreaks, and cover for cattle.

Recognizing the importance of the farm woodlots, a study was begun at Gettysburg National Military Park in the summer of 1989 to develop a set of recommendations for "restoring" the woodlots, i.e. for managing them in such a way that they would appear much as they did prior to the famous battle.

Using a variety of information sources, including land survey records, battle accounts, photography, and our perceptions of the use of the woodlots, we determined that the typical farm woodlot was comprised mainly of oak and hickory species, and was uneven-aged. Each woodlot had to be uneven-aged in order to provide a continuous flow of products for the landowner. Such a woodlot would feature trees in all size classes, from seedlings to saplings to large mature trees. Typically, an uneven-aged woodlot has the "reverse-J" distribution of trees by diameter class (Figure 1), with a very large number of small trees and decreasing numbers of larger trees.

Extensive field work in the summer of 1989 and 1990 in each woodlot confirmed that, indeed, the woodlots were still uneven*aged, but that problems were developing. First, the species composition of the woodlots was slowly changing, such that the oak predominance was being replaced by a mixture of other species, including hickory and ash. Secondly, the numbers of seedlings and trees in the smallest diameter classes were fewer than was needed to sustain the uneven-aged nature of the stands (Figure 1). This probably was due to a combination of factors, most notably a lack of cutting (to create openings and promote regeneration) and a very high density of white-tailed deer. Much of Pennsylvania is experiencing difficulty in regenerating oak, and excessive deer browsing is considered to be a leading cause.

In our final report (Tech. Report NPS/MAR/NRTR 90-049), we recommended a controlled mixture of timber harvesting, tree planting, and forest protection in order to regain and maintain the nature of the 1863 woodlots. Light harvests, on the order of 15 percent of the trees in all size classes ever 10 years, will be needed to perpetuate the uneven-aged structure once it is restored. Removing a number of trees now will allow some sunlight to reach the forest floor and promote seedling growth. Those seedlings must be protected from deer browsing, either through individual shelters, large area fencing, or reduction of deer density. Supplemental planting (in seedling and/or sapling size classes) will be necessary in order to regain the oak species dominance. Spraying to minimize the impact of gypsy moth defoliation also will be important for maintenance of the woodlots.

Finally, regardless of management actions, the woodlots must be closely monitored to track changes in their size distribution and species composition. We recommended establishment of permanent plots for this purpose. Related studies by other Penn State researchers concerning vegetation and deer management also will help to insure the successful restoration and maintenance of the farm woodlots at Gettysburg.

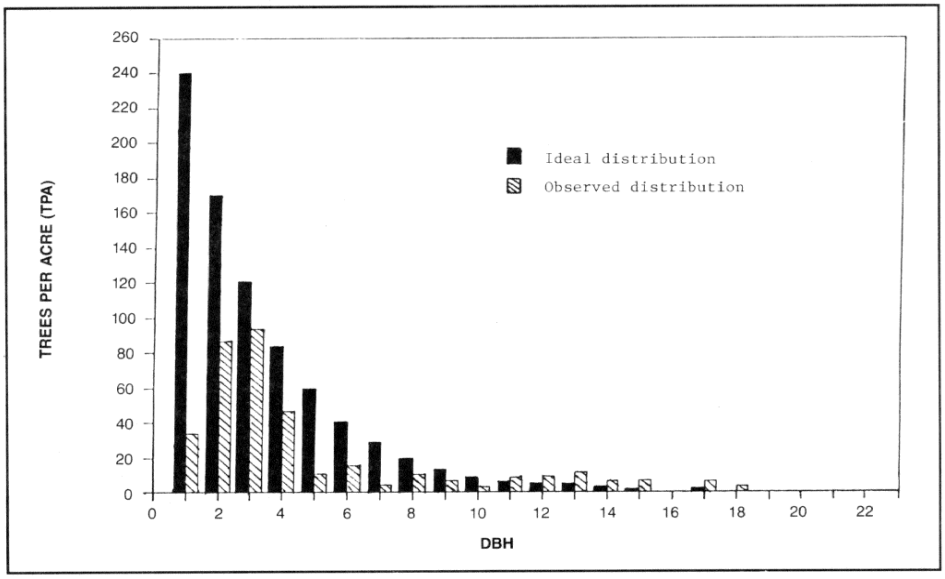

Figure 1. *"Inverse-J" uneven-aged diameter distribution and actual distribution in one woodlot at Gettysburg.*

Fairweather is a professor of forestry and Cavanaugh a graduate student at Pennsylvania State University.

mab notes

An exceptionally promising place joined the biosphere reserve family in March, when the MAB Bureau approved **Land Between the Lakes Area** (LBL) in Kentucky and Tennessee. Managed by the Tennessee Valley Authority (TVA), LBL is 95 percent surrounded by impoundments on the Tennessee and Cumberland rivers. This provides an opportunity, rare in the BR network, for studying land-reservoir relationships.

Four watersheds of about 500 ha each and numerous smaller forest stands will serve as the core area. The buffer zone will consist of the rest of the largely forested 68,800 ha national recreation area, on which carefully managed timber harvesting, hunting, and other recreation, agricultural use, and a strong program of environmental education and conservation demonstrations are held. Research projects sponsored by nearby universities are underway.

To coordinate the MAB regional program, a cooperative along the lines of the Southern Appalachian MAB Cooperative is planned. Proposed members include TVA, the U.S. Army Corps of Engineers, Tennessee and Kentucky state agencies, colleges and universities, four Area Development Districts, conservation organizations, and the Land Between the Lakes Association, which can develop public support and raise funds.

The U.S. biosphere reserve network will be further strengthened if **additions to two existing BRs** are approved. Four areas – Bodega Marine Lab (UC/Berkeley), Jasper Ridge Biological Preserve (Standord), Audubon Canyon Ranch in Marin County, and the Cordell Bank National Marine Sanctuary petitioned to join the Central California Coast BR. In the Southern Appalachians, Mt. Mitchell State Park and Grandfather Mountain petitioned to join that BR. This would bring state (North Carolina) and private sector representation to the Southern Appalachian BR for the first time. All the above add-ons have been recommended for nomination by the MAB National Committee but must wait nearly a year for the next meeting of the MAB Bureau to gain approval.

Use of and communication among BRs has been made easier by publication in January of the **Directory of Biosphere Reserves in the United States.** Compiled by Leslie Bord and David Figlio of the NPS Wildlife and Vegetation Division, the directory lists basic information for each BR, including names, addresses, and phone numbers of site managers, administrative staff, and professional staff. Copies may be had from the Executive Director, U.S. MAB Secretariat, Dept. of State OES/EGC/MAB, Washington, DC 20520-7818.

A briefing on the **Southern Appalachian MAB Cooperative** (SAMAB) was held at the Department of the Interior on April 25. Tommy Gilbert (filling in for Blue Ridge Parkway Supt. Gary Everhardt), Bjorn Dahl, supervisor of North Carolina national forests, and Hubert Hinote, executive director of SAMAB, presented their views on the cooperative's progress. The greatly increased communication among SAMAB members was seen as a primary benefit of the program. Ongoing projects focus on important regional resource issues such as dogwood anthracnose, the overharvesting of native plants, and the demonstration of ecologically and culturally appropriate alternatives for development.

A plan for Pittman Center, TN, has been completed with support from the Economic Development Administration, as a model for environmentally sound community development in the region. The SAMAB Foundation planned to hold its first fund drive in Spring 1991 to help support SAMAB projects.

Book Review

Little Islands Floating in Seas of Indifference?

NATURE RESERVES; ISLAND THEORY AND CONSERVATION PRACTICE 1990. by Craig L. Shafer. Smithsonian Institution Press. Washington and London, 189 pp. ISBN 0-87474-805-4.

Nature reserve design acts as the link that connects conservation with the sciences of biogeography, ecology, conservation biology, landscape ecology, evolution, genetics, demography, and more. Our use of this link has made it possible for us to examine such subjects as park shape and consequences of insularity. It has made it possible for us to study park capacity for protection, dispersal, emigration, population viability, and extinction. The production of technical literature contributing to various aspects of conservation, including facets of reserve design, has accelerated.

Park boundaries confine protection administratively but not necessarily ecologically; in addition, certain species, communities and processes are affected deleteriously or beneficially by this confinement. The complexity of these processes and the superimposed forces associated with human presence have been the object of controversy. A clear review and translation of available knowledge is badly needed, equally for managers and researchers interested in the conservation of natural areas.

Shafer's book presents these matters, focusing on what it is to conceptualize and design a nature reserve. He goes further to question whether we have any solid guidelines for reserve design. He reviews existing guidelines, and attempts to show a least-biased view of whether these are fine prescriptions or rules of thumb. He has designed his sections so that they are short, and easily read. The book's design simplifies reading for those who face interruptions or who wish to digest the information-loaded work, one small portion at a time. Throughout the book within sections, he immediately states the point and purpose of his writing and clearly summarizes his material so that it provides an excellent teaching, review and reference tool. The summaries also function as useful tests to judge whether one understands the essential messages delivered in the often complex arguments and controversies he describes.

The clarity and thoroughness of Shafer's style is refreshing and sorely needed. The benefit is not only for his primary intended audience, but for the community conducting research in contributing fields. Of special interest to managers and friends of U.S. National Parks: the author grasps and communicates all too well the impermanence of the "vignette." He uses writings of Leopold and Company effectively, providing interpretations that show considerably more depth than those previously made available.

The author focuses his attention on where lies the body of evidence that supports or conflicts with theories and hypotheses proposed in the literature. He recognizes the shortcomings of having a poorly documented institutional body of knowledge, and points out works having too little "real" documentation. Yet, his argument for stated shortcomings of the available theory also rests to a large extent on institutional experience. To this extent he permits himself reasonable editorial license. To do this conservatively, as he does, allows the body of managerial experience to serve as the testing platform for ideas. Ideally he could also use it as a stimulating mechanism for new research.

As the author of a major review he is in a good position to use his knowledge to produce the type of synthesis that would provide such a stimulation. But, he seems to have stopped short of this, perhaps intentionally. He holds tightly to his primary purpose of review and translation and, avoids jeopardizing the effectiveness of his translation effort. This may be disappointing to those reading this work for more than review or reference value. The author missed a unique opportunity to move forward, tying together the best of the professional literature and professional experience.

The subject treatment generally is exhaustive. He re-stresses that planning for nature reserves needs to consider cross-boundary processes, that buffers are necessary elements of protection, that reserves should be planned and designed with regional not just localized planning in mind. No less important is the need for human considerations, including population growth, economics, and social conditions, to be integral parts of the analysis. Yet, on having seen a section title for paleontology, I had expected to see a discussion of species associations and concepts of community as recent studies in paleoecology have treated them. The studies he represents do not include this subject area and the chapter lacks a discussion of changing insights regarding climax and stability of species associations.

Except for this minor point, the review is the most thorough and clearly presented one I have yet seen on the subject of nature reserves. While I may differ slightly in some interpretations, there are no subjects where I have clear departures in thought from the author. Shafer uses existing knowledge upon which to base his judgments, rather than trends in the popularity of concepts. Few of us can boast such a good handle on our material.

The section, "General Guidelines" in the end of his work (pp. 142-3) is an effective summary of the material. It rests on a basic foundation of knowledge, and fills a real need for review and translation. However, it is very much a collage of other similar lists of recommendations on reserve protection, design or management. It reflects his conservative approach, and shies away from synthesis. One of the most valuable messages the author stresses throughout, first caught my eye in his Preface. "The overall context of individual nature reserves, in relation to one another and to their modified landscapes and their people needs more careful concern." The guidelines provide observations that underscore this as a subject the designers of parks ought to focus upon.

Shafer's book will make an excellent reference and teaching tool, and will perhaps to be used more broadly than he anticipated. His work is a good introductory and refresher text on the uses, developments, applications and alternative hypotheses on nature reserve design. The 189 pages that report Shafer's review, comprise only the fine polished surface of what has been clearly a painstaking effort. The psychological analog he borrows for describing parks, as "Islands of pain in seas of indifference," sounds harsh, but is well chosen.

A footnote: For those who enjoy Shafer's book and are interested in more self-education on conservation of natural areas, I recommend John Perin's (1989), ***A Forest Journey; the Role of Wood in the Development of Civilization***. Published by W. W. Norton and Co., N.Y. This is a different type of review, a thorough historic analysis. It widened my perspective on the uniqueness and durability of 20th Century parks, beginning with Mesopotamia forests (4000 B.C.) and their subsequent depletions. History does recapitulate itself and, Schafer's book causes me to ask myself how the present differs from the past.

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Neotropical Migratory Bird Conservation Pact Signed

A Memorandum of Agreement for a Federal Neotropical Migratory Bird Conservation Committee was signed on May 14, 1991 by the USFWS, the USFS, the BLM, NPS, the Agency for International Development (AID), and EPA, and soon will be signed by the Department of the Navy.

The agreement establishes a Committee to identify priority conservation needs for neotropical migratory birds and to coordinate cooperative programs developed to address those needs. It also provides for establishment of affiliated working groups of technical experts from public and private sectors to determine needs for and to coordinate research, international population and habitat monitoring, information and education, and management programs being conducted by partnerships of federal, state, and local governments in the U.S., Canada, and Latin America, working together with private entities.

Neotropical migratory birds, those that nest in North America and winter in Latin America and the Caribbean, are in an overall state of population decline. Some species are so depleted they have been federally listed as threatened or endangered. These declines are the result of human activities – fragmentation of breeding grounds in the U.S. and Canada, and loss of wintering habitat in Latin America and the Caribbean.

A December 1990 workshop involving state and federal government agencies and a large number of conservation organizations proposed the conservation program and discussed activities and approaches similar to those already underway in an NPS pilot activity. This activity has been conducted for several years in the Southeast and Western NPS regions, aimed at establishing a Migratory Bird Watch that links park research, monitoring, and educational programs both nationally and internationally, according to the migratory birds shared by the parks.

The NPS has designated two Committee members and nine working group representatives, who will meet with two others in mid-July to draft an action plan for Service participation in the conservation program. NPS personnel include Mike Ruggiero, John Dennis, Ted Simons, Paul Buckley, Milford Fletcher, Richard Cunningham, Kyle Jones, John Peine, Rick Wilt, A. R. Weisbrod, Mike Britten, Norm Reigle, Jr., and Susan Savage.

John G. Dennis, Ecologist
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Relict Vegetation Sites: Urgent Inventory Need for Desert Parks

Editor's Note: This article is in partial fulfillment of a Cooperative Agreement between the Western Regional Office of the Nature Conservancy and the NPS Rocky Mountain Regional Office.

By Nicholas Van Pelt and Joel S. Tuhy

On the Colorado Plateau of Arizona, Utah and Colorado, an appreciable fraction of the land surface and its vegetation is in a pristine state. This results from the innumerable buttes and mesas so characteristic of this exceptionally scenic ecoregion. Most such terrain "islands", along with narrow canyons and steep, rocky slopes, are inaccessible to livestock, vehicles, and even humans. The plant communities of these "relict areas" have entirely escaped the influence of the major land uses of the Plateau: fossil-fuels extraction, hard-rock mining, firewood and post cutting, cattle grazing, and dispersed recreation.

The 13 national parks, monuments and recreation areas of the northern Colorado Plateau have their share of relict sites, but no verification of their existence and description of their features was undertaken until recently. Since 1986, The Nature Conservancy's Great Basin Field Office (GBFO) and the Rocky Mountain Region (RMR) have surveyed potential relict sites within NPS units in Utah and western Colorado. The first of two projects, requiring much helicopter time, yielded thorough descriptions of 22 sites within Glen Canyon NRA. The second phase involved all other units of the northern Plateau, from Zion in southwestern Utah to Curecanti in west-central Colorado. The more southerly units, in Arizona and New Mexico, have not yet been surveyed (University of Arizona scientists identified several sites within Grand Canyon in the late 1970s).

A Precious Resource

Almost all desert parks had sustained nonconforming uses before establishment. Several units, such as Capitol Reef, still support authorized grazing or cannot fully exclude trespass livestock. Accordingly, relict sites are a precious and limited resource, intrinsically valuable and useful for gauging departures from "naturalness" caused by grazing in particular. Today's inquisitive recreationists have sought out and affected a few sites, such as Canyonlands' Virginia Park.

Because relict areas are indeed remnants of pristine landscapes, and could be lost through park development, trespass, or inappropriate visitation, the Conservancy and the RMR felt that it was imperative to learn about and safeguard as many as possible. Some sites will contribute to state-based or plateau-wide Research Natural Area (RNA) networks maintained in concert with other federal agencies. Given Service-wide initiatives in climatic change monitoring and assessment, the relict sites afford secure places where monitoring equipment, sampling protocols, and photographic stations could be placed – with assurance that these will remain undisturbed. Most importantly, the sources of vegetational and faunal changes over the coming decades will not be confounded with influences present elsewhere in the same parks.

74 Catalogued Sites

The 74 sites visited and catalogued range in size from five to several thousand hectares. The largest and therefore most diverse of them occur in Canyonlands, Glen Canyon and Zion. The vegetation present ranges from blackbrush (*Coleogyne*) semidesert shrubland through a great variety of pinyon-juniper (*Pinus edulis-Juniperus osteosperma*) woodland subtypes to montane or subalpine ponderosa pine (*Pinus ponderosa*), Douglas-fir (*Pseudotsuga menziesii*) and Engelmann spruce (*Picea engelmanii*) habitat types. Four bristlecone pine (*Pinus longaeva*) forests, all with endemic plant concentrations, were surveyed. One, comprising the only montane forest area in Capitol Reef, will receive its first dendrochronological evaluation this year by the Laboratory of Tree-Ring Research.

Following completion of the Glen Canyon phase, the Conservancy compiled a master vegetation classification for the Colorado Plateau. The units in the forest, woodland, shrubland, grassland and "other herbland" series included were used as a checklist in the surveys, which turned up additional types. However, the sites do not constitute full samples of the vegetal types present in any of the parks, with the exception of Glen Canyon. There, it is possible for resource managers to revisit and intensively characterize pristine examples of nearly all rangeland communities affected by the NRA's grazing program.

Photo Stations Installed

A key adjunct of the largely qualitative surveys was the installation of permanent, unobtrusive photographic stations. Surveyors acquired 50- to 400-mm color slide panoramas with a professional camera and tripod set up at measured distances above the station nadirs. The resulting pictures afford a vivid and repeatable record of vegetation and surfacial features. Trees and shrubs are frequently identifiable, making some of the 740 images useful for long-term, individual-plant-based studies. The photographs are archived in three final-report volumes (one each for southwestern/south-central Utah, western Colorado, and Canyonlands). Directions for rephotographing the scenes (perhaps in 10 years) are included. The project has therefore substantially augmented the collective portfolio of desert landscape photographs that can be reliably matched in the future. They can be used to complement more specialized, data-based resource monitoring and research efforts. In the 1990s, ecologists and photogrammetrists may devise novel ways of extracting insights from conventional photographs, especially those that are carefully matched.

Surveys Inexpensive

These surveys of parklands typifying "base conditions" are timely and comparatively inexpensive. They also respond to the Park Service's mission of retaining a sample of pristine natural environments for inspiration, upper-level education, and both park-based and academic research. Some relict sites can become RNAs, but in any case all can be better understood and more knowledgeably managed with the information, data, and photographs the Conservancy and the Park Service have acquired. The site writeups will appear in three volumes (companion to the photo archives) this winter, and both project phases will be described in a forthcoming ***Natural Areas Journal*** article.

The project originators envisioned a third phase involving northern Arizona parks and monuments, plus Chaco Canyon in northwestern New Mexico. Grand Canyon and Petrified Forest are the most likely to harbor significant relict vegetation occurrences. Still other parks, in the Mojave and Sonoran deserts, could likewise benefit from surveys (augmented with repeatable photography) that are performed before anticipated global-warming effects on drylands begin to register. The relict sites within NPS lands in the southwest could well be crucial in meeting the challenge of understanding and controlling these effects, plus those of steadily increasing visitation.

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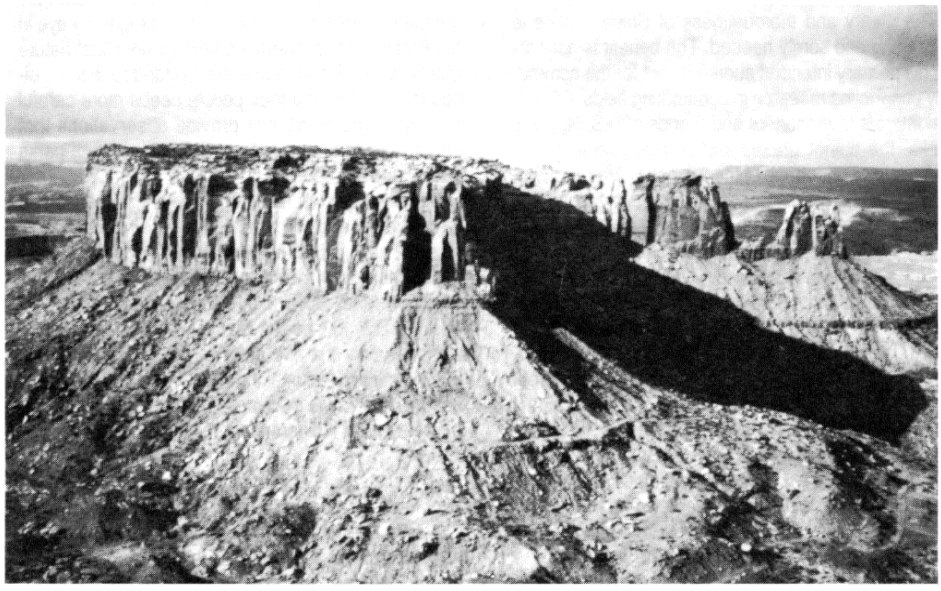

Junction Butte, *Canyonlands National Park, Utah. A relict area showing differences in plant composition in comparison to the nearby "mainland." Photo by Charles Schelz.*

Seeing the Forest for the Trees: An Analysis Of Cumulative Impact in Environmental Documents

By Ron West

The other day I glanced through a random back issue of ***Park Science***. Several articles and resource issues caught my attention: Urban Development Near Parks; Man and the Biosphere; The Boundary Approach to the Analysis of Nature Reserves; Biodiversity Task Force; and Ecosystem Management in the Parks.

All of these current topics are ultimately concerned with the analysis of cumulative impact. Each, in its way, is an attempt to grapple with a bigger picture; each considers a holistic approach to park resources and the multitude of influences that affect them.

Many of these relatively new issues, however, are theoretical or conceptual in nature – few are solid enough to be dealt with in our day-to-day, working world. My day-to-day working world often deals with environmental compliance, primarily compliance with the National Environmental Policy Act (NEPA). An analysis of cumulative resource impacts in the environmental assessment (EA) process would be a relatively down-to-earth way to tackle some of these bigger-picture concerns. What's more, it's a legal requirement to do so.

Cumulative Impact and NEPA

Attempts at analyzing cumulative impact are quite new, and no one has written the definitive book on how to go about it. The NPS, USFS, BLM, and numerous states are currently trying to deal with cumulative impact in the planning process. Major planning efforts in Big Cypress, Denali, Wrangell-St.Elias, and Yellowstone all have addressed recently the cumulative impacts in controversial arenas.

The new interest in cumulative impact analysis has come about largely through intervention of the courts. Numerous agencies have been handed a court order for a cumulative impact analysis and/or an Environmental Impact Statement incorporating such an analysis. In virtually every court case I've read about, if the plaintiffs ask for cumulative impact analysis then the court has ordered it. The reason for this is that the need for such an analysis is cited numerous times in the NEPA regulations. Although these regulations date from 1979, this language is only now being discovered.

The Council on Environmental Quality's (CEQ's) definition of cumulative impact, as stated in the NEPA regulations, is at the heart of the matter. The definition states that cumulative impact is "the impact on the environment which results from the incremental impact of the action *when added to* other *past, present*, and reasonably foreseeable *future* actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7; emphasis added).

To say the least, this is a rather comprehensive definition.Nearly anything which has or will affect the resources of concern needs to be examined and considered. A simple way of defining the analysis of cumulative impact, sometimes mentioned in the literature, is that the analysis should cover all impacts over both *space* and *time*.

Cumulative Impacts and Olympic EAs

In 1988, four development concept plans were completed for four areas on the west side of Olympic NP. An attempt was made in the environmental assessments for these documents to address cumulative impacts on particular resources. The most important resources of concern were elk, anadromous fish, and old growth forest stands. Cumulative impact was addressed in two, somewhat related areas: 1) in the presentation of existing resource conditions and impacts *outside* of the park boundary; and 2) in the presentation of *past* resource impacts.

1) Resource Conditions and Impacts Ouside the Park Boundary

From an ecosystem perspective, the park boundary was considered to be almost meaningless. Elk and salmon do not recognize the administrative boundary in their movements. Old growth stands don't migrate, but existing old growth harvesting policies outside the park are isolating remaining old growth communities in the park. Politically, of course, the park boundary is quite real. How far one may go in the EA in presenting external concerns depends on the particular park, and its local politics.

In dealing with trans-boundary, cumulative concerns we presented information in three ways.

A) *Relevant Region-Wide Resource Information.* Stating the simple fact that salmon move up the river into the park leads the reader to an understanding that "park" fish can be (and are) impacted by downstream non-park actions. Elk also move in and out of the park. We simply tried to show that the park is not an island – that there is a common, regional resource base. Apparent enough to us, perhaps, but often not understood by readers. It needs to be spelled out.

B) *Watershed Information.* In an attempt to present more realistic resource "boundaries," we presented the percentage of a watershed that was inside and outside the park. This was simply done by outlining the four major river watersheds on a regional map and computing the areas both inside and outside the park. This information was presented, for example, by stating that: "In the Quinault River watershed, 52% of the land area is within the park; 48% in other ownership." The idea being that the NPS, even under the most preservation-oriented management of resources, can only influence 52 percent of the land base on which the resources depend.

Presenting watershed information makes sense for anadromous fish; for elk and old growth even a watershed "boundary" is artificial, however, it comes much closer to portraying an ecological unit than a straight park boundary created along section lines.

C) *Graphics.* We tried to visually portray a cumulative impact approach. A map of existing conditions included extensive areas outside of the park boundary. Any "external" human activity which contributes to impacts on a common resource base, even if the details of the impact are sketchy, can be presented graphically, e.g., areas of oil and gas development, sub-divisions, upstream dams – all can be germane to the issues being examined in the EA. The areas don't have to be precisely located on the map, either. A bubble diagram approach, showing the general area and the type of impact could be adequate. In the Olympic case, the biological isolation of detached park units could be visually portrayed by surrounding the unit in a sea of precisely mapped clear cuts.

2) Past Resource Impacts

Documented, past resource impacts, and the subsequent current resource conditions resulting from them, also were presented. The critical thing that this information does is to establish a historic or "pristine" baseline from which to measure additional impacts stemming from the NPS proposal. For example, in one watershed, harvest figures for sockeye salmon declined from 25,000 to 30 (or a 99.8% reduction) from 1949 to the present. Although harvest figures do not necessarily represent population figures, this sad fact goes a long way in saying that we better be darn careful that NPS impacts do not add any more reductions to the runs.

To me, this baseline is perhaps the most important factor that cumulative impact analysis can contribute. Hypothetically, we might currently have a sockeye run of, let's say, 100 fish. With this information, standing alone, it could be said that an estimated "small" reduction from an NPS proposal would not be considered a significant impact. But when looked at in a historical perspective, knowing the run used to have, say, 10,000 fish, it's quickly apparent that there has already been a significant past impact, and any additional impact from our proposal would compound an existing significant impact.

The presentation of past impacts should avoid fixing "blame," but the causes for the impact, such as "reduction of spawning habitat due to siltation from roading and logging activity," should be brought out. In some cases, years of continuous impact were presented: "significant change in natural forest vegetation has resulted from extensive logging over the past 90 years." The extinction of species in the ecosystem, the ultimate past impact, was stated as well (for wolf).

It might be an uphill endeavor to convince supervisors, superintendents, or regional staff of the necessity of a cumulative impact approach to EAs. The resource protection arguments are the strongest to me, but the legal/CEQ argument mentioned here might convince others. I believe that the result, however, is worth the effort – the more NPS people and public reviewers that are thinking in a bigger picture, the clearer the bigger picture will become.

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Coastal Barriers Focus of BioScience Articles In May 1991 Issue

Five articles focusing on coastal barrier ecosystems and on the Biosphere Reserve concept make up the bulk of the May 1991 issue of ***BioScience***. For a well-rounded look at these resources, the management challenges they pose, some proposed tools for their management, and the need for public education, the May issue is recommended reading. The articles and their authors are: "Establishing Biosphere Reserves for Coastal Barrier Ecosystems," by G. Carleton Ray and William P. Gregg, Jr.; "Long-term Research at the Virginia Coast Reserve," by B.P. Hayden, R.D. Dueser, J.T. Callahan, and H.H. Shugart; "The Biosphere-Reserve Concept: Needs for a Network Design," by M.I. Dyer and M.M. Holland; "Public Education for Protecting Coastal Barriers,"by Gary W. Mullins and Hans Neuhauser, and "Management of Coastal Barrier Biosphere Reserves," by John R. Clark.

Ecological Effects of Stocked Trout On North Cascades Naturally Fishless Lakes

By William J. Liss and Gary L. Larson

One generalization that has emerged from research into the ecological role of fish in aquatic communities is that fish can play an important role. When stocked in historically fishless bodies of water, fish have the potential to eliminate or severely reduce in abundance indigenous species of invertebrate and vertebrate prey organisms and thus dramatically change aquatic community composition and development. In general, management concerns center on balancing recreational opportunities provided by stocked fish and conserving the integrity of aquatic communities that have developed for thousands of years in the absence of fish.

The lakes of North Cascades National Park service Complex in northern Washington were formed by glacial activity thousands of years ago and, until relatively recently, were devoid of fish. Some lakes were stocked with trout in the early 20th Century, long before establishment of the park in 1968. At present, of the 160 or so significant high mountain lakes, about 61 contain fish, either through natural reproduction or by periodic stocking. The major species are cutthroat and rainbow trout.

Park staff now face the difficult task of deciding the future of fish stocking of lakes within park boundaries. This research was undertaken to clarify the ecological role of stocked trout and their potential effects on the biological communities of naturally fishless high mountain lakes. We have completed two of three scheduled field seasons and are analyzing data collected during the second season. This paper then, is an interim report and deals primarily with our accomplishments prior to beginning field work and during our first field season.

Before the start of each field season we meet with a peer review panel of limnologists, all with research experience on lake communities, to review our work of the past year and our research proposal for the succeeding field season. This has provided constructive reviews and had a significant impact on research directions. Park staff, especially Jon Jarvis, Gary Mason, and Bob Wasem, have provided logistic support and personnel assistance. Beth Deimling, Bob Hoffman, Gregg Lomnicky, and Bob Truitt, all research assistants at Oregon State University, have major responsibility for conduct of field work, processing samples, and data analysis. Collaboration of our colleague, Dave McIntire, also is appreciated.

A Diverse, Dynamic System

The park is a diverse, dynamic system--an area of steep, rugged mountains, some reaching elevations of over 2500 meters, with many permanent glaciers. The mountains and valleys were shaped by glacial activity over the last 10,000 years. Prevailing weather patterns are from the Pacific Ocean, about 50 miles west of the park. Precipitation is highest west of the Cascade crest, which runs through the park. Most of the glaciers are found on the west side; areas east of the crest are much drier.

The park's high mountain lakes are generally rather small, most having a surface of less than 10 hectares, although some are quite large. They occur at elevations ranging from less than 500 m to over 2000 m. Lower elevation, west slope watersheds have well-developed soils and are heavily forested. Higher elevation watersheds may have little soil development and be very sparsely vegetated; many of the highest watersheds are largely rock and ice. The park's oldest lakes probably are thousands of years old, but new lakes are forming even today as the glaciers recede.

Our research began with a literature review of the ecological impacts of fish on aquatic communities (Goetze et al 1989), and development of a watershed and lake classification system for the park (Lomnicky et al 1989). The literature suggests that vertebrate predation can alter aquatic community structure and organization. **Structure** of aquatic communities can be defined as the kinds of species composing a community, their abundances, distributions, and average sizes. This structure is simply a description of the "form" of a community. **Organization** involves interactions or interrelations, at least partially inferred, among species or groups of species that give a community its cohesiveness and ultimately underlie its "form."

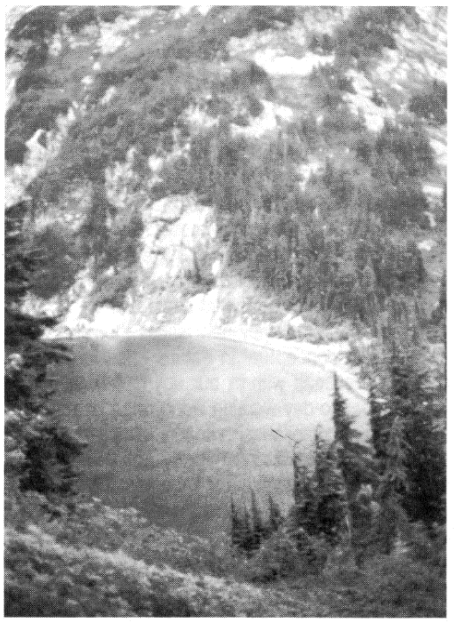
Fish have been shown to alter the size-structure, species composition, and species abundances of crustacean zooplankton. Fish may selectively prey on the largest or most visible species, eliminating these species or severely reducing their abundance and causing the zooplankton community to be dominated by smaller forms (e.g. Zaret 1980). These changes are thought by some researchers to alter grazing rates on phytoplankton and cause changes in the species composition, size-structure, and abundance of these minute algae (Carpenter et al 1985). Fish may change the biomass and relative proportions of taxa composing benthic macroinvertebrate communities (Gilinsky 1984; Walters and Vincent 1973; Andersson et al 1978; Tuunianen 1970). Elimination of benthic species has been reported (Macan 1966a,b; Reimers 1979). Fish also may alter the behavior and abundance of salamanders (Efford and Mathias 1969; Taylor 1983; Semlitsch 1987).

Many Factors Involved

While there is considerable evidence suggesting that stocked fish can alter communities in naturally fishless lakes, the results often are not clearcut. Community structure and organization are by no means determined solely by presence or absence of vertebrate predators. Species that successfully colonize a lake and make up a community must, at some time, have originated in other lakes, streams, and bodies of water. The system of aquatic communities that provides colonists to a lake is the species pool. The composition of species in a lake depends heavily on this pool of available colonists.

In addition, the physical and chemical characteristics of the lake habitat influence the kinds of species present and the nature of species interrelationships. Lakes with different kinds of habitats may have somewhat different communities, even within the same species pool, and these communities may respond differently to fish stocking.

Prey refuges, which can mediate the effects of predation, are a component of habitat (Crowder and Cooper 1982; Timms and Moss 1984). Fluctuations in chemical and physical conditions may reduce, enhance, or override effects of fish predation. Impacts on the community also may depend upon the species, density, and age and size structure of vertebrate predators (Stein et al 1988).



***Doubtful Lake** is a subalpine lake formed in a glacial cirque in North Cascades NPS Complex. (Photo by Beth Deimling)*

Most high mountain lakes of the North Cascades are oligotrophic, that is low in nutrients and poorly productive. Yet there is considerable diversity in characteristics of lakes and their watersheds, which may give rise to diversity of aquatic community types. Watershed and lake classification provide a useful tool for identifying, ordering, and understanding diversity of aquatic habitats and communities. Lakes, like all aquatic systems, reflect characteristics of their watersheds.

Lakes within the park are classified or grouped according to climatic, geologic, topographic, and vegetative aspects of their watersheds, and by watershed area, lake elevation, lake morphometry (surface area and relative depth), and type of inlet and outlet. All these characteristics may influence lake habitat including chemistry, hydrology, length of ice-free period, seasonal temperature patterns, and type of bottom substrate.

The classification, then, allowed us to begin to define different aquatic community habitats within the park, and associate these habitats with watershed characteristics. In addition, the classification system provided a basis for selecting comparable lakes for study and will serve as a tool in developing a lake monitoring program.

Research Season Limited

Field research began in the summer of 1989. Field seasons are relatively short, extending from June into September for the lowest elevation lakes. Many high lakes may not become ice-free and accessible until mid to late July. Lakes often are located in rugged, remote terrain and so present severe logistical difficulties for the researcher transporting sampling equipment. Access to nearly all lakes is either by backpacking or helicopter.

The goal of research is to evaluate the impacts of

stocked trout on the structure and organization of aquatic communities in naturally fishless lakes. The components of the aquatic community on which we focused included benthic macroinvertebrates, crustacean zooplankton, rotifers, phytoplankton, and amphibians--particularly salamanders. Fish were sampled to determine size structure, food habits, and relative abundance. Lake chemistry and temperature profiles were taken and components of the benthic substrate were identified and mapped.

Since very little was known of the structure of aquatic communities within the park, our first field season task was to conduct an extensive survey of lakes. The 1989 field season was devoted to assessing the general limnological characteristics of 52 lakes, which represented a wide range of lake classes. Most were sampled only once that season. The survey afforded some important understanding of the species composition of aquatic communities and species distributions among communities within the park, and led to some hypotheses concerning fish impacts, which directed further studies and provided context for more intensive field studies conducted in ensuing years. Analysis of the 1989 survey data led to the tentative view that predation impacts on aquatic communities in the park may be dependent on the density and size structure of vertebrate predator populations and may vary with lake class.

Vegetation zone (alpine, subalpine, and forested) and aspect (east/west) are components of the classification system that emerged as important indicators of local climate, soil conditions, and limnological characteristics of lakes (Liss et al 1990). Physical and chemical properties of lakes and benthic habitat characteristics varied among vegetation zones. In general, taxa of zooplankton, benthic invertebrates, and phytoplankton were more diverse in forested lakes than in subalpine and, particularly, alpine systems. Many taxa, some of them relatively rare, were found exclusively in forested systems. This suggests that analysis of fish impacts should be partitioned by vegetation zone.

Fish Effect on Salamanders

Important vertebrate predators within aquatic systems in the park are fish and salamanders. Both prey upon benthic macroinvertebrates and zooplankton. Fish seem to affect the abundance and behavior of salamanders. When fish were not present in a lake, salamander abundance was relatively high. Salamanders were observed to move freely within the lake during daylight hours, suspend in the water column, and bask openly on submerged rocks and logs. When fish were present, abundance of salamanders appeared to be reduced and they were far more secretive, lying hidden in crevices of submerged boulders during the day, perhaps emerging to feed at night. Salamander larvae were found in fish stomachs. Preliminary observations suggest that post-hatch mortality of larval salamanders is very high in lakes with fish. We will be performing experiments during the 1991 field season to determine the extent to which this mortality may be attributable to fish predation.

Both reproducing and non-reproducing fish stocks are present in the park. Reproducing populations are composed of individuals of different ages and sizes. Park lakes with highest fish densities tend to be composed of reproducing fish populations. Our initial observations suggest that these may be the lakes in which fish impacts on salamanders and invertebrates may be most evident. Lakes in which fish do not reproduce are stocked periodically with fry. Fish in these lakes tend to be of more uniform size and age. Since fish may change their feeding habits as they age

... predation impacts ... may be dependent on the density and size structure of vertebrate predator populations and may vary with lake class.

(Rabe 1967; Hansen 1971), a cohort of stocked fish may have different impacts on the community when it is composed of numerous small fish than when it is made up of few, large fish. This raises the possibility of cyclic changes in aquatic invertebrate community structure as a cohort of stocked fish matures.

Unraveling Complexities

Research during the 1991 field season, as in the 1990 season, will be directed toward unraveling the complexities of interactions among components of the aquatic communities. Two types of approaches will be employed. One involves comparison of communities in lakes with different levels of vertebrate predation within each vegetation zone. In the subalpine, this will entail comparison among lakes in which no vertebrate predators are present, lakes in which only salamanders occur, and lakes with low to high densities of fish. In forested lakes, the same design will be employed, although we have not found any lakes in this vegetation zone that do not have some type of vertebrate predator. For each community we will focus on assessment of species composition, average body size of major species, relative species densities, and habitat utilization. Lakes will be sampled two to four times per season, depending on elevation. Alpine lakes will not be studied extensively because few are stocked with fish.

The second approach pertains primarily to lakes with non-reproducing fish. Community structure in two subalpine and three forested lakes, each with only a few, large fish remaining within the cohort, was determined. Predation intensity, particularly on zooplankton, may be rather low in these systems. The large fish then were removed by intensive gill-netting (only relatively small lakes that afford high probability of removing nearly all fish were chosen). The lakes were restocked with fry toward the end of the 1990 season. These smaller fish may be more intensive planktivores than larger fish and so have a greater impact on zooplankton and the pelagic community.

Community structure will be determined again during the 1991 fields season and compared to structure from 1990. Sampling these systems we hope can continue during a monitoring phase of the project to evaluate whether some form of cyclic change in communities associated with periodic stocking can occur.

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***Pelton Basin** in North Cascades National Park Service Complex. (Photo by Beth Deimling)*

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The Natural Resource Publication Program

(Continued from inside cover)

Based on these recommendations, and after extensive field review, the AD/NR approved *The Final Plan For Designing and Operating the National Park Service Natural Resources Publication Program* in March 1989. The approved plan established the foundation of the publication program. The "nuts and bolts" of the program would evolve over the next two years of implementing recommendations for the plan and writing, reviewing, and revising the procedural handbook.

How has the program evolved and what is it today?

The program, under the administration of the AD/NR, provides a coordinated direction, purpose, and focus for disseminating natural resource information through (1) NPS natural resource publications, (2) other NPS publications, and (3) publications outside the NPS.

Five NPS report series and the quarterly ***Park Science*** bulletins are available at the national level to disseminate natural resources information. The five report series are the Scientific Monographs, Transactions and Proceedings, Technical Reports, annual Science Reports, and Natural Resources Reports. The AD/NR funds and approves manuscripts disseminated through the national report series. The Publications Coordinator coordinates the selection and approval processes and the editorial and publishing services. Three of the six series are available at the regional level to disseminate natural resource information. The three report series are the Technical Reports, annual Science Reports, and Natural Resources Reports. These series are optional; some regions may use all three, others only one. Approval authority for a regional series is at a Regional Director's discretion. No other natural resource series may be used or developed, and parks must disseminate information through an established natural resource series at a regional office or a cooperative park studies unit.

Some of the common program elements which link the national and regional series are: (1) National and regional series are managed in accordance with publication management and printing authorities, statutes, and regulations. (2) Both levels of series are managed under the same objectives, management strategies, and general publication policy. (3) Each series is clearly defined as to the purpose, audience, content, type of review, format, and review procedures, with each having a consistent series numbering system and an NPS reference number. (4) Identical information is presented on the covers, the inside front covers, the title pages, and the inside back covers for each series report, national and regional.

What has the program accomplished so far?

The planning process that allows for competing needs, long*term scheduling (for editing, reviewing, producing, and printing), and long-term budgeting for national series has been successfully implemented, and manuscripts published, since last year. Funding also has been provided for page charges and reprints to support scientists publishing in outside journals. The Advisory Board, formerly the task force, has met every year since the initiative began; it recently addressed the issues of the new NPS Science Editorial Review Committee and priorities for program resources. The Technical Information Center at the Denver Service Center maintains a bibliographic database for natural resource publications; and a procedural handbook, following extensive reviews, has finally been completed.

Almost everything you wanted to know, but until now were afraid to ask, about disseminating natural resource information through publication is contained in the ***Natural Resources Publication Management Handbook***, including guidelines for NPS publications outside the NPS. Completing this handbook is a significant accomplishment and would not have been possible without the continued support and contributions of the Chief Scientists, the Advisory Board, and dozens of reviewers.

The handbook is available from the Chief Scientists or the Publication Coordinator, Natural Resources Publication Office, P.O. Box 25287, Denver, CO 80225-0287; (FTS) 327-2156 or (303) 969-2156.

O'Leary is NPS Publications Coordinator.

Attention Authors!

Your editor welcomes your work on floppy discs, but they have to be in Word Perfect 5.0. Also, my machine doesn't read high density discs. Sorry to be so backward, but that's how it is.

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