PARK SCIENCE

A Resource Management Bulletin

Volume 14 - Number 1 National Park Service U.S. Department of the Interior Winter 1994

10-Year Study of Crater Lake Underscores Need For Long-term Monitoring Program

Editor's Note: After looking over the Crater Lake Limnological Studies Final Report (NPS/PNRO/NRTR-93/03), the Editor of **Lake and Reservoir Management**, *Roger W. Bachmann, wrote to Gary Larson, the study's Principal Investigator, proposing use of the Report as the basis for a special collection of papers in the journal. Bachmann stated that "in keeping with the purpose of the journal" he would "like to see the work related to management as well." No date for the journal publication has been set, but the 730-page Report itself, edited by Larson, C. David McIntire, and Ruth W. Jacobs, is available from the Technical Information Center, Denver Service Center, PO Box 25287, Denver, CO 80225-0287; (303)969-2130.*

By Gary Larson

Limnological studies of Crater Lake were initiated by the NPS in 1982 in response to an apparent decline in lake clarity and possible changes in characteristics of the algal community. In the fall of 1982 Congress passed Public Law 97-250, which authorized and directed the Secretary of the Interior to conduct a 10-year limnological study of Crater Lake and to implement immediately such actions as may be necessary to retain the lake's natural pristine water quality.

The broad project goals adopted for the study were to:

1. develop a limnological base to be used for comparisons of future conditions of the lake;
2. develop a better understanding of physical, chemical, and biological components of the lake system;
3. develop a long-term monitoring program;
4. determine if the lake had experienced recent changes, and if changes were present and human-related; and
5. identify the causes and recommend ways of mitigating the changes.

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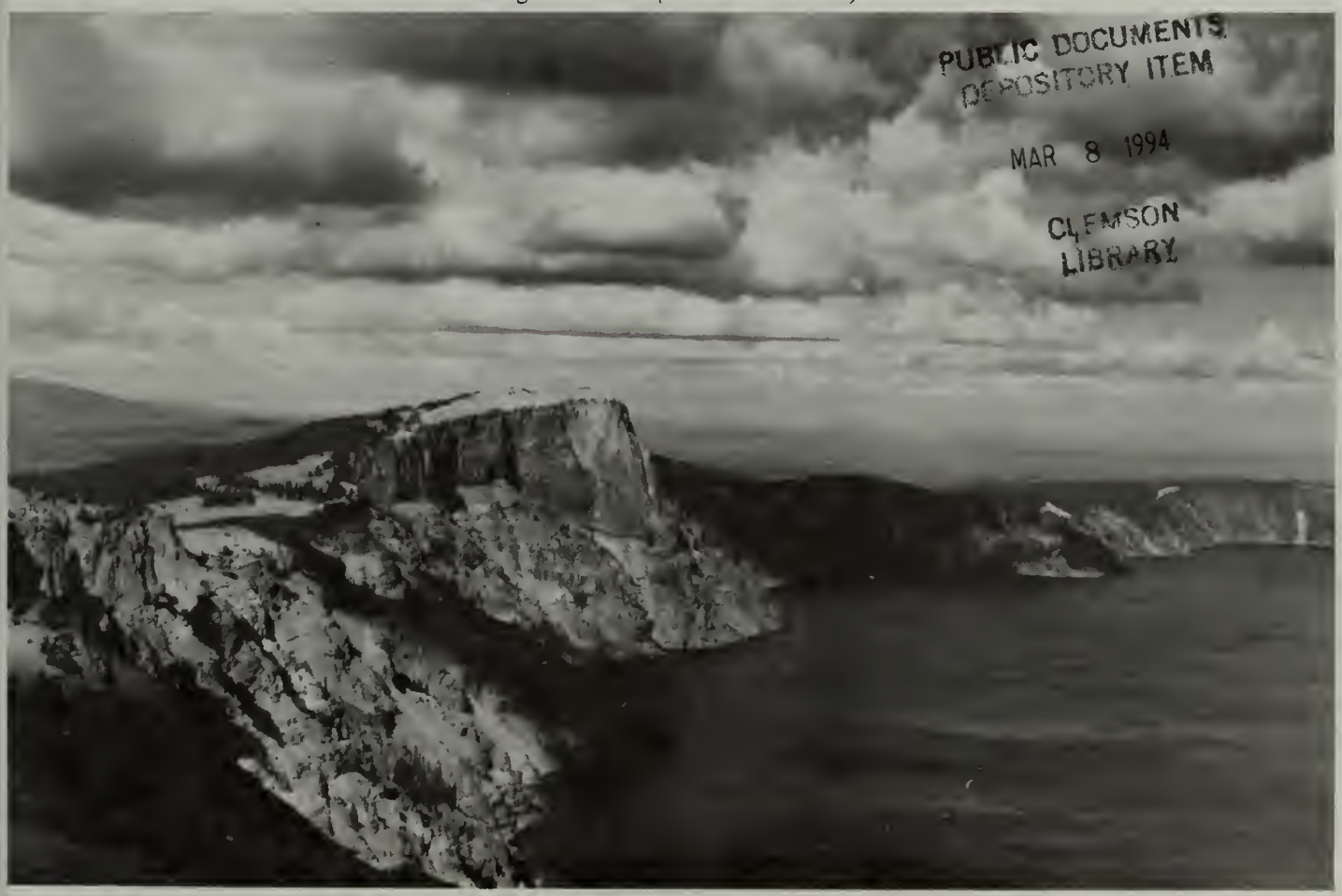

Crater Lake from the top of Watchman Peak, looking at Llao Rock. *(PHOTO BY DAVE MCINTIRE)*

PARK SCIENCE

NATIONAL PARK SERVICE

WINTER 1994

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

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DEPARTMENTS

Editorial

These are heady days of change throughout the National Park System...exciting, promising, and nervous. The Park Service is responding with the predictable mix of enthusiasm, hope, and anxiety.

Whole systems are among the toughest things in the world to change. When they do begin to alter, they "self design," in spite of the best intentions of those who are most instrumental in setting the process in motion. Hence the watchful waiting with which the Service (a "whole system" in its own right) watches as the rock-solid boulder begins to move. How will it travel? Once in motion, can it be guided? And where will it settle until the next set of circumstances again sets it in motion?

The changes now underway have been heralded for years. Mostly, the trumpets have sounded on deaf ears. But this issue of *Park Science* reflects almost the entire rainbow of a new dawn—from the Gary Williams article on I&M and the Gary Machlis piece on Extended GAP Analysis to the philosophic musings of Dave Haskell about the "why" of the NPS mission and the thoughtful letter to the editor from the Alaska contingency.

The words of Interior Secretary Bruce Babbitt, in reply to questions from the Hon. Robert S. Walker (R-PA) as quoted below, are a reassuring answer to the cloud of question marks that hang over the Park Service. They speak clearly of a strong hand at the helm of change and a warning to the encrusted "old ways" that a fresh and bracing wind is blowing.

Question: (*from the Hon. Robert S. Walker (R-PA)*) How will the National Biological Survey balance the need for scientific integrity with the need for relevance to natural resource managers of the science being conducted by the NBS?

Answer: (*from Interior Secretary Bruce Babbitt)* Scientific integrity and responsiveness to natural resource manager needs are not necessarily opposites that need to be "balanced." Scientific integrity entails credible procedures for the collection, analysis, and interpretation of data. Existing research projects that are transferring to NBS will continue according to their study plans. The needs of bureaus within Interior will continue to be met.

NBS will strengthen the overall support for bureaus by increasing the visibility of science; by combining research and inventory activities in a single organization; and by ensuring consistent approaches across bureaus, so that information can more readily be shared. The information transfer capability will make technical and scientific information more available in non-technical terms to provide information to managers.

Bureaus will continue to identify and rank their science needs, and will be actively involved in setting the NBS agenda and budget. This will occur at the headquarters level through the intra-departmental Policy Council, but also will happen in the field, as NBS managers and scientists interact on a day-to-day basis with client bureau staff.

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NPS Inventory and Monitoring Program Emerges From I&M Task Force

By Gary Williams

Editor's Note: Following is the first of three articles by Gary Williams, I&M Program Coordinator in the NPS Washington Office, dealing with development and implementation of a Systemwide I&M Program. In this issue, we begin with Inventory Status; the Spring issue will cover Monitoring; the Summer issue will deal with how the Program will interact with the National Biological Survey.

In 1989, the NPS Associate Director for Natural Resources appointed a special Servicewide Task Force and charged it with developing a workable plan for implementing I&M on a programmatic basis throughout the entire National Park System.

The group's development effort built on the 1987 "Evison Report," and it recommended a two-phase approach. During the first 10 years (Phase I) the focus was to: (1) prepare the parks for long-term monitoring, and (2) develop the expertise and experience to design and implement effective natural resource monitoring programs in individual park units; for Phase II, the long-term monitoring was to be extended to all natural resource parks in the NPS and continued in perpetuity.

NPS-75, a Servicewide policy guideline for designing and implementing I&M programs in park units, was published in 1992. The Servicewide I&M Program Coordinator will work directly with a National Technical Advisory Committee established to assist in program development and oversight and with all 10 Regional I&M Coordinators. The park units containing significant quantities of natural resources have been identified, and collectively they represent the NPS "I&M System."

Five Program Goals will guide Phase I of the Servicewide Program:
(1) Natural Resource Inventories (see Table 1); (2) Ecosystem Monitoring; (3) Planning and Management Technology; (4) Program Integration; and (5) Partnerships and Cooperation.

Status of Natural Resource Inventories

The acquisition of the natural resource data sets described in Table 1 for approximately 250 I&M park units can best be accomplished through implementation of a well-coordinated, systemwide data collection initiative. By such an undertaking, as opposed to requesting each individual park to obtain its own data, the Service can better insure that the inventory will satisfy a number of important criteria. For example, the information collected at the very least should contain the "core" set of data needed to deal with park planning and management. In a similar manner, the data collection effort must address the issues of long-term data compatibility and integrity. Baseline data must be collected and maintained in accordance with clearly defined protocols and quality assurance standards.

Cost effectiveness is another major consideration in data acquisition. To reduce costs, the Service will consider clustering park units to achieve economies of scale. Costs may also be minimized by negotiating agreements with sister Federal agencies. Thus, Phase I natural resource inventory will be conducted as a Washington Office initiative with strong regional and park oversight and priority setting.

(Note: This section provided by Dr. Sue Glenn)

Species Lists/Biodiversity

A major inventory effort in FY 1993 was completion of the **NPFAUNA.PC** databases compiled by U/CA under the direction of Dr. James Quinn. These databases contain checklists of mammal, bird, fish, herb, and plant species found in approximately 190 NPS units. Documentation of this information also is included and the Federal Status of each species has been updated.

All nomenclatural differences in species names among parks and regions were standardized; some of the databases were changed to reflect comments received from international review of the system. The data then were sent back to the regions for a final review before the data is distributed within and outside the NPS in FY 1994.

Through distribution of these data sets, the Service anticipates that other agencies and individuals with additional relevant knowledge of species occurrences in parks will come forward and make that information available. This may include biologists who have seen species in parks that do not appear in the database, as well as museums and plant herbaria with specimens to add to the database. Distribution of these lists also may encourage biologists to assist the parks in special inventories. Although the databases

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Table 1. Recommended minimal data standards for Inventory and Monitoring Park Units.

1. Bibliography of manuscripts, old maps and other historical information related to science and resource management. This information must be park specific.
2. Compilation of existing species lists. Should include ALL species lists available and an estimate oftheirquality.
3. Field inventory of species (plant and animal) of special concern.
4. Listing of Threatened and Endangered endemic or non-natives species.
5. Status and distribution of species and abiotic features of special concern.
6. Current (< = 5 years old) maps for:
   - Vegetation
   - Watershed boundaries
   - Topography (DLG and DEM preferable)
   - Hydrography (from topographic maps)
   - NPS Park Management Zones and Special Designations (e.g. Landmarks, RNA, etc.)
7. Location and Classification of:
   - Streams
   - Wetlands
   - Lakes
   - Groundwater
8. Basic Precipitation and Meteorological Data
9. Basic water chemistry factors for selected water bodies. Factors should include:
   - Alkalinity
   - Conductivity
   - PH
   - Dissolved Oxygen
10. Location of existing nearby ambient air quality monitoring stations
11. Atmospheric particulates
    - CA
    - MG
12. Visibility

will reflect only currently compiled information and are not meant to reflect a complete species inventory, they should be useful in planning future cost-effective species inventories.

(Note: This section provided by Drs. Dave Graber and Bill Halvorson)

Vegetation Mapping

Beginning in 1994, NPS and the National Biological Survey (NBS) will begin developing vegetation maps for approximately 235 NPS units and environs in the conterminous U.S. (Alaskan units will be mapped through a separate funding effort.) Contracting partners in the current multi-million dollar endeavor are the Environmental Systems Research Institute (ESRI), and a team of subcontractors including The Nature Conservancy (TNC).

Development of a vegetation/land cover map is one of the first critical needs for park management. Vegetation is considered a "fundamental" data layer for wildland stewards because, like terrain and hydrography, it is central to characterizing a landscape and is the driving variable for so much else, such as wildlife, fire dynamics, and even the movement of carbon and nitrogen through ecosystems.

The classification system proposed by the contractors (Table 2) is becoming a standard among land management agencies worldwide... a hierarchical system based on dominant plant physiognomy (morphology and phenology) at higher levels, and floristics—the dominant species—the lowest, "series" level. Thus an open stand of Douglas-fir (*Pseudotsuga menziesii*) would be classified as a terrestrial "Evergreen Needle-leaved Woodland with Rounded Crowns," Douglas-fir series. This system, adapted by TNC from an international classification that permits comparisons at different levels, already is in use by the USFWS Gap Analysis Program.

The vegetation mapping contract was developed to get the approximately 235 natural resource park units mapped at the series level and to provide information urgently needed by the NPS Washington Office and by a growing list of regional to international land management and conservation efforts. Not only can this information answer questions such as "How much short perennial bunchgrass is protected by the NP System?" it also can be integrated with data collected on other land ownerships to provide continent-scale information that can track such global phenomena as pollution effects or response to climate change.

Table 2. Proposed classification scheme for the National Park Service vegetation mapping project.

A. PHYSIOGNOMY

System: Terrestrial/Aquatic – (hydrological regime)
Class: Woodland – (spacing and height of dominant form)
Subclass: Evergreen Woodland – (morphological & Phenological similarity)
Group: Temperate Evergreen Needle-leaved – (climate, latitude, growth form, leaf form)
Formation: Evergreen Needle-leaved Woodland with Rounded Crowns – (mappable units)

B. FLORISTICS

Series (or Cover Type): Doug Fir Woodland – (dominant species)
Community (or Association) – (subdominant or associated species with similar ecological processes)

The mapping effort also will provide information at the park unit level and the tools to pursue more detailed questions. Mapping will be done at the series (dominant species) level with (1) a minimum mapping unit of 0.5 ha, and (2) precise registration to the USGS 1:24000 map series, making certain that at least 80 percent of the mapped units are classified and drawn accurately. The maps, with their detailed vegetation structure information, will give parks an excellent reference point for monitoring change caused by such disturbance factors as fire, insects, drought, disease, or weather; for analyzing wildlife habitat; and for determining site suitability for management activities.

Data will be provided foremost in the form of GRASS-format GIS files. Analog maps at 1:24000 scale, the aerial color photography used for type delineation, narrative descriptions of each vegetation class, and detailed information from field plots used in characterization.

The quality of the classification and mapping efforts will be increased by cooperation of park and regional office NPS staff and by the availability of related thematic data (such as geology, soils, or terrain). NPS staff should provide information and their own experiences for the process.

The NPS recommended to the NBS that the first parks to be mapped be in the midwest grassland park areas. It is expected that this first mapping and classification effort will require adjustments as the work proceeds. Input from many quarters at these early stages will ensure that the products will be usable and can easily be coordinated with other land management activities.

For additional information or comments about the vegetation mapping initiative, contact Mike Story at (303) 969-2619 or leave a message on cc:mail.

(Note: This section provided by Dean Tucker and Gary Rosenlieb)

Water Resources Data

A cooperative endeavor initiated in 1993 by the NPS Servicewide I&M Program and the NPS Water Resources Division (WRD), the NPS Baseline Water Quality Inventory and Analysis Project is a three year effort designed to characterize baseline water quality at all units of the NP System containing significant natural resources.

Specific objectives are to (1) retrieve water quality and related data from the EPA's STORET and other database systems; (2) develop a complete inventory of all retrieved data; (3) produce descriptive statistics and appropriate box and whiskers and time series plots of the water quality data to characterize annual, seasonal, and period of record central tendencies and trends; (4) compare park water quality data with relevant EPA national water quality criteria on a station-by-station basis; and (5) reformat the water quality and other related data for use with the park-based Water Quality Data Management System (currently under development in the WRD) and other appropriate analytical tools.

Every park unit participating will receive a detailed analog report and several hydrographic digital databases, including all water quality parameter data, 1:100,000 scale hydrography, surface-water quality monitoring station locations, stream gage locations, National Point Discharge Elimination System permit locations, and drinking water intake locations.

The results of this effort are intended to enable park resource managers and the WRD to compare and contrast water quality data collected as part of ongoing I&M programs with historical water quality trends and to design better park-based water quality I&M programs. One component of this project is

to demonstrate how the digital databases and anolog report can be used to determine where additional baseline water quality monitoring is needed. The park water quality databases produced by this effort will lay the groundwork for allowing regions and the WRD to generate regional and national assessments of the status of park water quality.

Completing the work will take approximately three years. Parks will be completed in the priority order established by regional water resource coordinators and the Servicewide I&M Program. Sevicewide review and comment already has been obtained on the draft Baseline Water Quality Inventory and Analysis for Rock Creek Park and revisions are being made. Once the new procedures are finalized, production of Baseline Water Quality Inventory and Analysis reports for all participating parks will commence.

For additional information or comments, contact Dean Tucker at (303) 225-3516, Gary Rosenlieb at (303) 225-3518, or leave a message for either on cc:mail.

Digital Cartographic Data

Digital cartographic products are being obtained through a 50:50 cost-sharing agreement with the USGS and will provide several of the basic data layers needed for park-based GIS. Standard products available under this cooperative agreement are topographic maps, digital line graphs, digital elevation models, and digital orthophoto products.

The cost share program benefits both NPS and USGS. In addition to obtaining important spatial data sets needed to support park management, research, and planning, the effort will accelerate population of the National Digital Cartographic Data Base, and enhance support for OMB Circular A-16, Coordination of Surveying, Mapping, and Related Spatial Data Activities.

In total, approximately $1.07 million of Servicewide I&M funds were made available in 1993 to acquire cartographic data sets for approximately 40 park units in 9 NPS Regions.

For additional information or comments about acquisition of digital cartographic products, contact Leslie Manfull at (303) 969-2964 or leave a message on cc:mail.

Prototype Programs Selected

During May 1993, the NPS Washington Office issued a Call for Proposals from which it could select competitively Prototype Monitoring Programs for the seven biogeographic associations (biomes) not currently represented in the NPS Servicewide I&M Program.

During the period of Nov. 2-5, 1993, an Interagency Evaluation Panel consisting of individuals from both the Servicewide I&M Advisory Committee and the NBS met in Denver to evaluate the submittals and develop implementation recommendations. The proposals selected and their corresponding biogeographic association are indicated below. These units will be added to the current Prototype Monitoring Programs in Denali NP (Arctic/Subarctic), Channel Islands NP (Pacific Coast), Shenandoah NP (Deciduous Forest), and Great Smoky Mountains N{ (Deciduous Forest) to complete the Phase I Servicewide Prototype Monitoring Program Network.

Biogeographic Association NPS Units

I. Atlantic/Gulf Coast Cape Cod NS

II. Caves Mammoth Cave NP

III. Coniferous Forest Olympic NP

IV. Lakes and Rivers North Cascades NP

V. Arid Lands Northern Colorado Plateau Cluster:
* Arches NM
* Canyonlands NP
* Capitol Reef NP
* Dinosaur NM
* Natural Bridges NM

VI. Grasslands/Prairies Great Plains Prairie Cluster:
* Effigy Mounds NM
* Homestead NM
* Scotts Bluff NM
* Agate Fossil Beds NM
* Wilson's Creek NB

VII. Tropical/Subtropical Virgin Islands Cluster
* Virgin Islands NP
* Buck Island Reef NM
* Dry Tortugas NP

NBS Signs Contract with Nature Conservancy

In what he called "the first of many cooperative agreements that NBS will make with the private sector," Interior Secretary Bruce Babbitt on Dec. 6, 1993, signed the Memorandum of Understanding with The Nature Conservancy (TNC) as a framework for future cooperative activities. Under the agreement, a working group will be formed to explore establishing a National Heritage Data Center in the National Biological Survey; ways to work with Natural Heritage Programs generally; and to discuss exchanging resources to improve the technical capabilities of both organizations.

The agreement also identifies several short term projects for further development, including TNC support in completion of NBS's first Status and Trends Report; completion of a national classification system for ecosystems; and initiation of joint development and testing of methods and protocals for the field and for data handling.

Vail Work Plan Reinvigorated

The good work begun at Vail, under the headings of Park Use and Enjoyment, Organizational Renewal, Resources Stewardship, and Environmental Leadership, are being "tweaked into a slightly different framework"—one that fits better the NPS administrative set-up and its areas of emphasis.

The new working groups will be called Resources Stewardship, Education, Partnerships, and Careers. The Careers Council, chaired by A/D Joe Gorrell, held its first meeting in September, by phone, and its second, "in person," meeting in Omaha, identifying its charter and establishing its priorities. The Council is guided by an Oversight Committee made up of NPS Deputy Director John Reynolds, R/D John Cook and A/D Ed Davis. Reynolds attended the Omaha meeting and charged the Council with developing "a comprehensive human resources management strategy for the NPS—a strategy that is fully responsive to the needs of the Service and that engenders a 'cradle to grave' concept of employee caring and employee support."

Reynolds stressed "a critical point:" The changes in name and shifts in priority "do not mean that we intend to lose a scrap of work or a bit of energy from processes already underway." NPS employees from across the Service are encouraged to volunteer for membership on the various committees responsible for affecting change.

Gap Analysis and National Parks: Adding the Socioeconomic Dimension

By Gary E. Machlis, Deborah J. Forester and J.E. McKendry

Editor's Note: The Oct. 16, 1993 issue of Science News *(pp 248-251) features an article by Elizabeth Pennisi, "Filling in the Gaps: Computer Mapping Finds Unprotected Species." The cover is a computer model of the state of Idaho, captioned "Mapping Biodiversity." It makes an informative companion piece to the article below.*

The conservation of biodiversity is an issue of growing concern to park managers, for the global system of protected areas is an important means of conserving biodiversity *in situ*. Four percent of the world's land area is protected in over 5,000 individual areas covering nearly 530 million ha (WRI 1990). In the US, national parks include a diversity of gene pools, populations, species, communities and ecosystems. The National Park Service (NPS) manages a *de facto* biodiversity reserve system, albeit incomplete.

Yet, national parks and the biodiversity they contain face threats from a variety of human actions (Machlis and Tichnell 1985; NRC 1992). Increased attention to the biodiversity values of parks is necessary in the face of human activity (such as economic development) and ecological challenges. Successful strategies will require 1) ecosystem-scale management that extends beyond park boundaries and involves other agencies and landowners, 2) better understanding of human actions that impact biodiversity, and 3) analytical techniques and practical tools for making land management decisions. One such technique is *gap analysis*.

Gap Analysis: A Brief Description

In order to identify underprotected yet critical areas of biodiversity, gap analysis uses geographic information systems (GIS) to map biodiversity and the location of protected areas. Elements of biodiversity including vegetation types and vertebrate species distributions are entered into the GIS; species richness maps are derived from these data. The resulting maps are overlaid with protection status such as national parks, wilderness areas, state parks and so forth. Locations with important biodiversity values and low protection status (the specific criteria can be adjusted) represent "gaps" in biodiversity conservation (see Scott et al. 1993 for a detailed description).

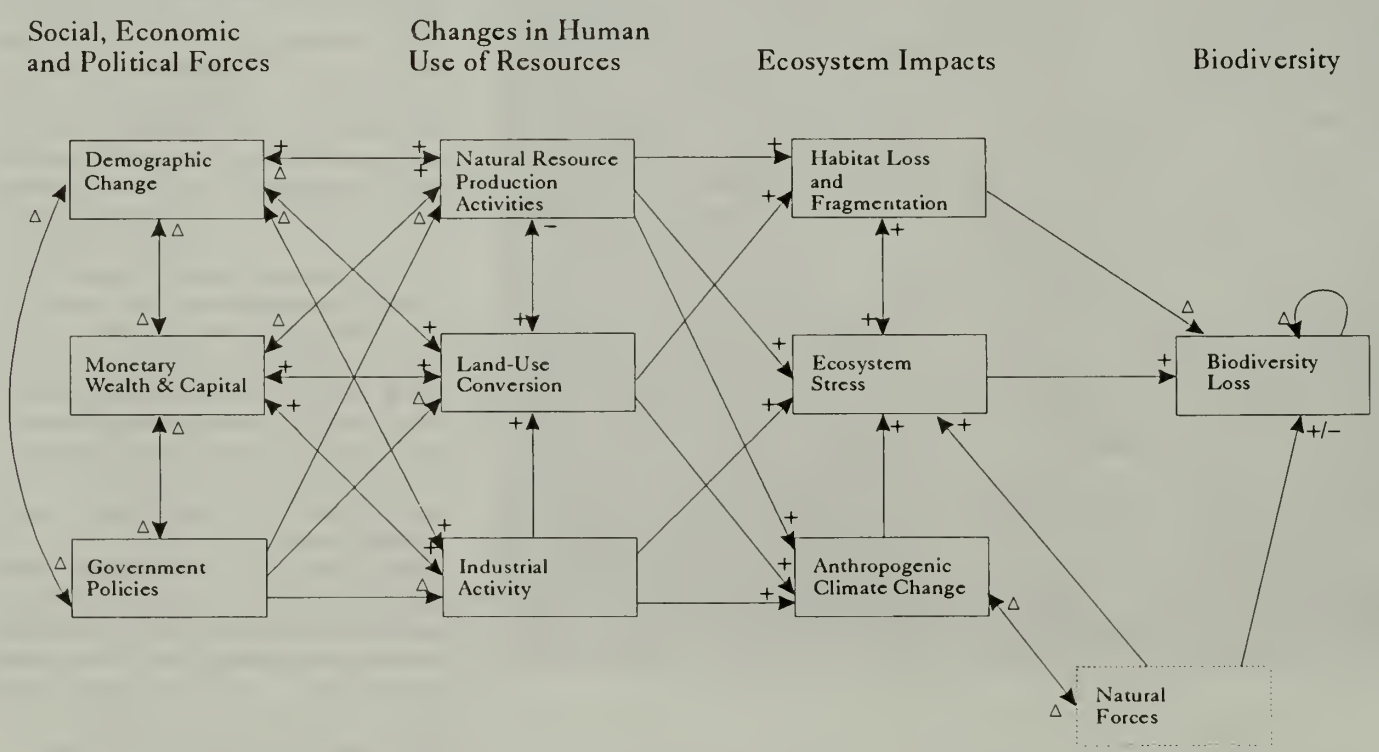
Gap analysis in its general form has been used in various situations, including USFS wilderness areas, tribal lands, Australian national parks, the Hawaiian Islands, California, Costa Rica, Ecuador and certain African protected areas (McKendry and Machlis 1992). A gap analysis program is now underway in 32 states in the US. It is anticipated that all states will be completed by 2009, and plans are being made to integrate state gap analyses into a national assessment (Scott et al. 1991). Gap analysis is likely to be an important component of the National Biological Survey.

Adding the Socioeconomic Dimension

Since human actions may increase the vulnerability of gap locations to future biodiversity loss, the University of Idaho's Cooperative Park Studies Unit (UI CPSU) Sociology Project has begun research extending gap analysis to include socioeconomic factors. A model was developed that identifies the major paths by which human actions impact biodiversity (see Fig.1; for a detailed description see Machlis and Forester, forthcoming). Social, economic and political factors are considered the driving force behind changes in how people use resources. Changing resource use leads to impacts on ecosystems, some of which may result in biodiversity loss.

Extending the gap analysis technique to include socioeconomic factors is relatively simple. Socioeconomic zones of influence are delineated around each biodiversity gap location. Based upon the model, indicators of human action are collected and entered into the GIS database (see Table 1 for examples). Related indicators are combined into

Figure 1. A Working Model of Human Impacts on Biodiversity.



indices, again based upon the model. Finally, an index of vulnerability is created, and each gap location is given a relative index score. The results are displayed in map form; the maps may be useful to managers, landowners, resource agencies, advocacy groups and interested citizens (for a description, see McKendry and Machlis 1993).

The Idaho Pilot Project

The potential of adding a socioeconomic dimension to gap analysis was tested through a recently completed pilot project in Idaho. The research was funded by the NPS and the State of Idaho; the UI CPSU Sociology Project, the Idaho Cooperative Fish and Wildlife Research Unit, and the Clark University Graduate School of Geography were cooperators on the project.

Native vertebrate species richness (excluding fish) was used as the basis for the biological analysis. Data for the state were aggregated by 635 km^2 hexagons developed for the EPA's Environmental Monitoring and Assessment Program. Gap locations were determined using a specific algorithm, or mathematical procedure. The hexagon with the highest number of species was identified, followed by the hexagon that added the highest number of species not already in the first hexagon. This procedure continued until all native vertebrate species were included in the set of hexagons. The result was the minimum number of hexagons containing all native vertebrate species in the state. Five hexagons were selected for further analysis. Together, the selected hexagons contained approximately 95% of all native vertebrates in Idaho.

Each of the five hexagons was identified as a "gap location," i.e., potentially important to biodiversity in Idaho. A map of these gap locations was overlaid with a map of protected area status in Idaho; areas were defined as having "complete" or "partial" protection based on The Nature Conservancy classification system (see Map 1, page 8). None of the hexagons are totally protected, though small portions of protected areas are present in several of the gap locations. (In the on-going gap analysis program, other biological criteria and more sophisticated algorithms are being developed to identify areas of important biodiversity. The techniques are evolving rapidly, as scientists gain more experience in gap analysis.)

Socioeconomic indicators similar to those listed in Table I were collected for the counties surrounding each gap location. Data were entered into the GIS database; dBase IV, pcArc/Info, and IDRISI were used as software for the analysis. Four indices were constructed and mapped: socioeconomic change, government policies, land development and ownership complexity. Map 2, page 9 (both maps are black and white conversions of their color originals) shows the results for socioeconomic change; the lower the index score, the lower the predicted level of future population and income growth. The four indices were then combined into an overall index of vulnerability. Based on the analysis, the gap locations were ranked as to their relative vulnerability to future biodiversity loss.

The results are presented in map form, with explanatory text. GIS and graphic design software used to produce the final maps included pcArc/Info, IDRISI, CorelDraw! and Micrografx Picture Publisher. A prototype atlas, *Idaho: An Atlas of Biodiversity* (Machlis et al. 1993) was prepared.

Next Effort: Puget Sound Gap Analysis

The UI CPSU Sociology Project has begun an effort to apply what was learned in the Idaho pilot project to the Puget Sound region of Washington. The research is supported by both the NPS (Pacific Northwest Region) and the EPA (Division of Strategic Planning and Management). The USFWS Washington Cooperative Fish and Wildlife Research Unit is a cooperator.

The Puget Sound study offers the opportunity to improve the integration of socioeconomic factors into the gap analysis technique. It allows for working at a different scale (ecoregion rather than state), and Puget Sound is a large, rapidly growing metropolitan area adjacent to several national parks. Additional socioeconomic indicators will be employed. Different presentation possibilities, including an interactive atlas on CD-ROM, are being explored. An advisory committee is being established, and will help assure the results are useful to managers and decision-makers.

Applications to National Park Management

While the technique needs further development, extending gap analysis to include socioeconomic factors could prove beneficial to national park managers and others interested in biodiversity conservation. Several potential uses are illustrated below:

• Gap analysis can help identify locations vulnerable to biodiversity loss. For example, locations where human population growth is leading to rapid land-use conversion and habitat fragmentation can be identified. Importlantly, the results could identify areas (1) high in biodiversity values, (2) vulnerable to biodiversity loss, and (3) not in national parks, yet which may impact the parks. South Florida and Puget Sound are examples of regions where such an effort may have merit.

• Once gaplocations and their vulnerabilities have been identified, long-term monitoring can answer such questions as: Are critical socioeconomic trends continuing? Have actions been taken to reverse those trends contributing to biodiversity loss? What indirect impacts might be resulting from human activity in or near the jap locations? Monitoring critical socioeconomic trends and landscape changes can (1) provide an "early warning system," (2) help clarify management challenges, and (3) suggest potential actions. Such monitoring for the Greater Yellowstone Ecosystem, or along the US-Mexico border may be useful.

• Threats adjacent to parks could be treated as significant factors influencing biodiversity within parks. Increased biodiversity loss outside of national parks may signal increased concern for protection within parks. Parkboundaries are permeable, and effective biodiversity conservation demands examining and understanding processe in the wider landscape of which protected areas are part. For example, the technique could prove critical to buffer zone and corridor planning; the North Cascades sNational Park Complex and certain historic battlefields (which may also preserve significant biodiversity values) might be appropriate sites.

• Gap analysis that includes socioeconomic factors can help to determine which unprotected areas of high biodiversity are at greatest risk of biodiversity loss. This can assist in determining which areas to consider for additional protection status or revised management regimes. For example, given one gap location with low risk of biodiversity loss and another with high risk, decision-makers may opt to provide protection to the area most likely to suffer biodiversity loss. In addition,

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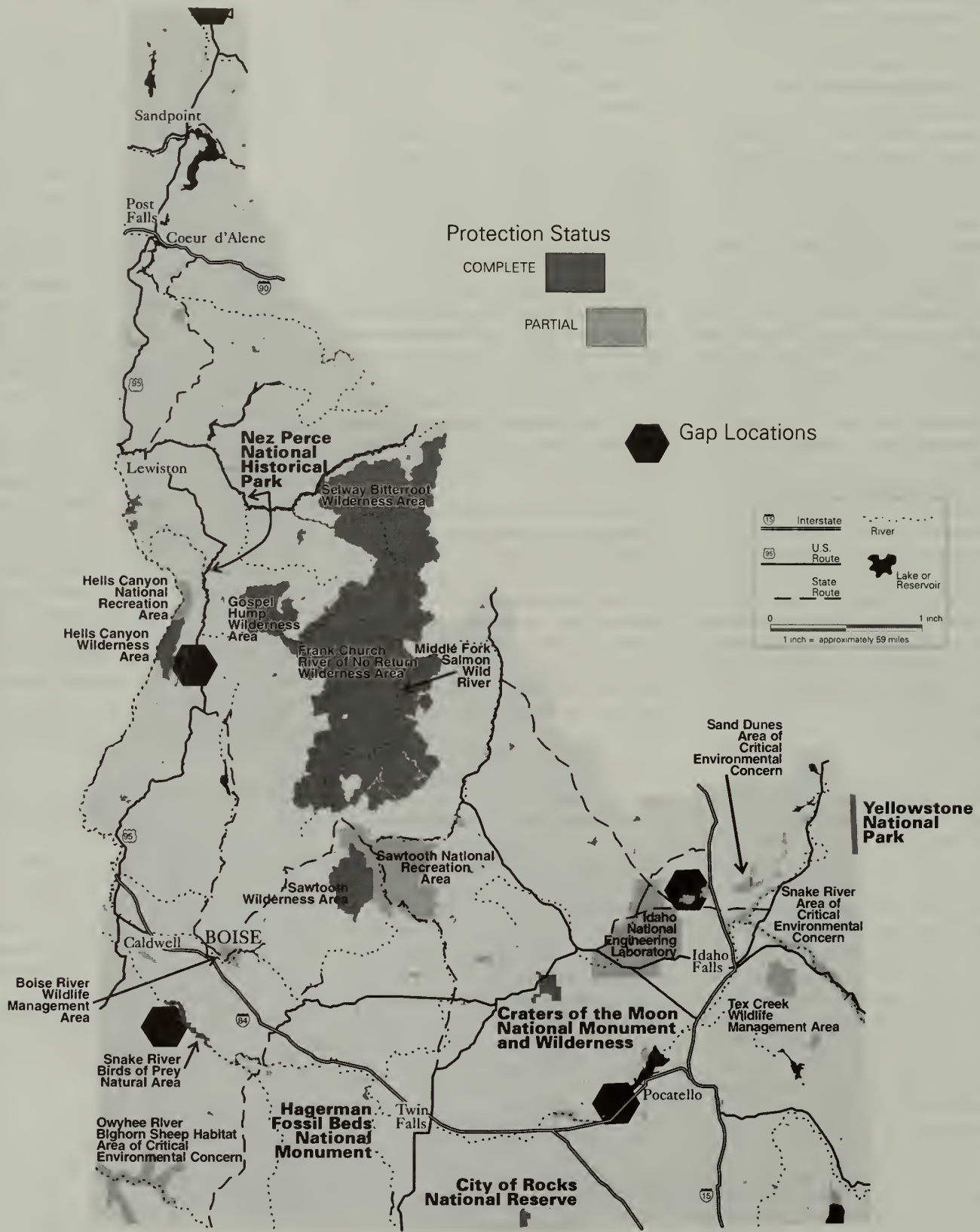
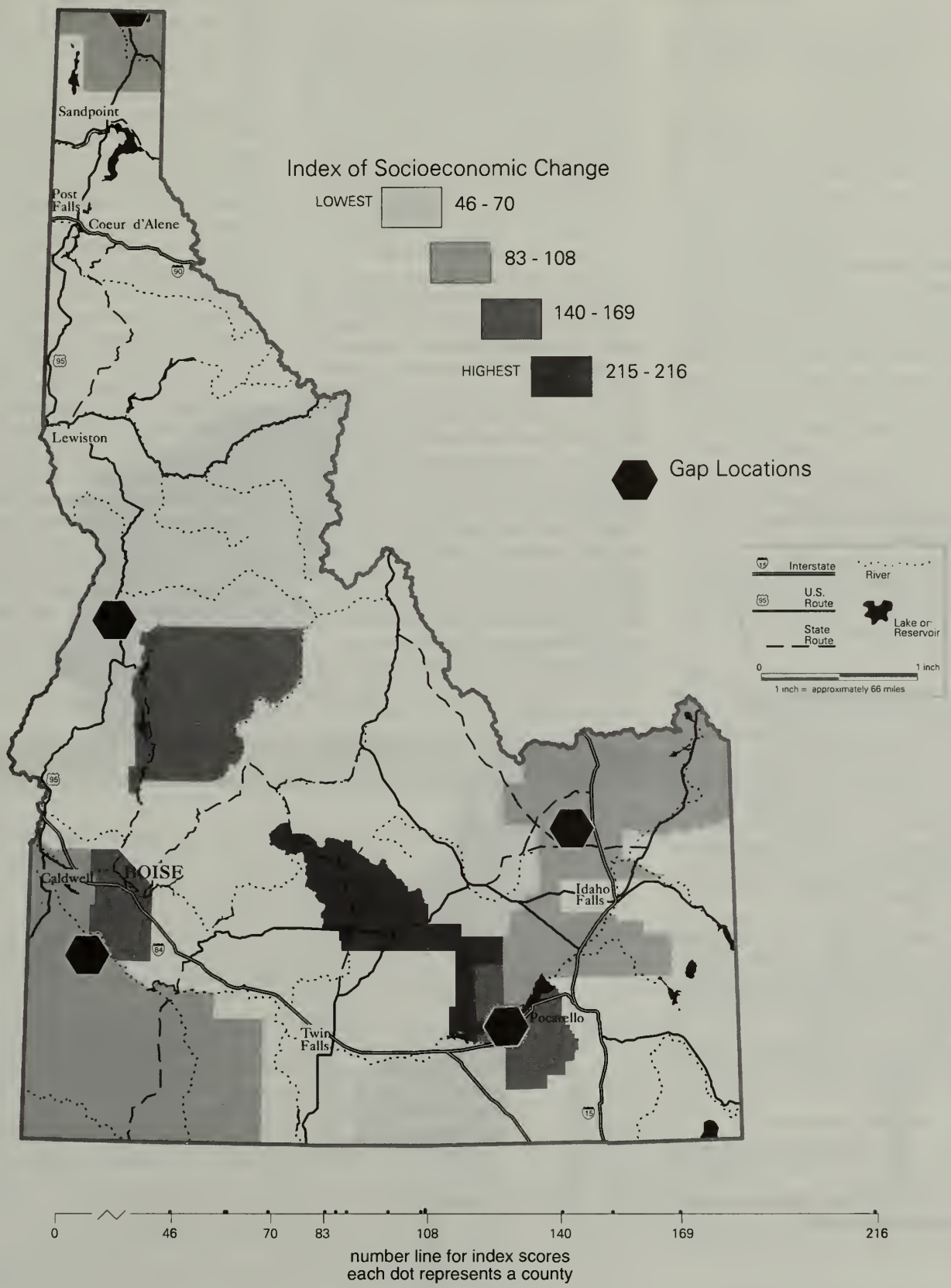
Table 1. Example Indicators for Extended Gap Analysis.

Air quality	Municipal solid waste
Defense lands and installations	Number of vehicles
Demographic forecasts	Occupation
Economic forecasts	Political units
Hazardous waste exposure	Population
Housing characteristics	Population and economic projections
Labor force projections	Population density
Land use regulations	Real estate transactions
Location of manufacturing	Residential construction

Map 1. Protected Areas and Gap Locations



Map 2. Socioeconomic Change and Gap Locations



Gap Analysis continued from page 7

gap analysis can help identify areas where careful development may minimally harm biodiversity values. Such information may be useful to non-governmental organizations with land acquisition programs, federal and state agencies, and private developers.

Conclusion

Gap analysis is evolving rapidly, and numerous state databases are being constructed. The technique likely will become an important conservation planning tool. Gap analysis can provide a systematic source of information for scientific analysis, professional management, and public dialogue. All are necessary for successful ecosystem management and the conservation of biodiversity. Extending gap analysis to include socioeconomic factors will further increase its usefulness and application. While much work remains before the technique is fully operational, park managers may soon benefit from its use.

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Watchable Wildlife Conference Shows Strength in Diversity

By Napier Shelton

The most exciting thing about the Watchable Wildlife program—its pulling together of people from many sectors of American life—was once again evident at the program's second national conference, held at Corpus Christi in November 1993. Besides managers and interpreters from numerous public agencies and conservation organizations, there were representatives from municipal offices, chambers of commerce, ecotourism, the military, universities, corporations, and the media—as participants. All were interested in how wildlife watching can lead to understanding, conservation, and ultimately the maintenance of biodiversity.

Some also were interested in the economic benefits. For instance, several staff members from Texas ranches, where cattle and abundant wildlife coexist, came to explain or find out how to make money from wildlife watching. (Bird tours regularly visit the King Ranch, where 434 species of birds have been seen—as many or more than in most states.) Participants also learned how corporations increasingly are contributing to wildlife habitat enhancement, thereby achieving better community relations, often a better bottom line, and heightened employee involvement.

The ethics of wildlife viewing received a lot of attention this year. How close should you get to wildlife? When is it OK to play tapes to attract birds? Where should we draw the line between the benefits of wildlife viewing and stress on animals? These questions need more research and continuous awareness.

Three NPS presenters (including one "defector" to the NBS) shared Park Service experience. Judd Howell from Golden Gate described the benefits to both park and people as volunteers assisted with raptor banding and vertebrate surveys. Ray Skiles explained how Big Bend attempts to prevent too-close encounters of people with mountain lions and black bears, under the NPS land management ethic. John Miller talked about birds and sea turtles on Padre Island.

The Park Service had nine attendees at the conference—up from six last year but still a disappointingly small number. The NPS has a lot to contribute to the Watchable Wildlife program, especially its interpretive/educational experience, and a lot to gain from working with the many groups involved.

Gary Graham, John Herron, and numerous colleagues from the Texas Parks and Wildlife Department and elsewhere are to be congratulated for a well-run, highly informative, friendly conference that made good strides toward bringing the public and private sectors together for wildlife conservation. Next year's conference will be held in Burlington, VT, in October. Y'all come!

Meetings of Interest

1994

Feb. 23-25 **2nd SYMPOSIUM ON SOCIAL ASPECTS AND RECREATION RESEARCH**, at San Diego, CA; hosted by USFS Pacific SW Research Station, BLM, and the Social Aspects of Resource Management Institute at CA State Polytech U, Pomona. Contact Lisa Maggiore, (909) 869-4591

Mar. 23-25 **5 YEARS AFTER THE EXXON VALDEZ OIL SPILL**, An International Conference on Prevention, Response, and Oversight; sponsored by the Alaska Sea Grant College Program, U/AK, Fairbanks. Contact Brenda Baxter, U/AK, Fairbanks, 99775-5040; (907) 474-7086.

May 4-6 **1994 GEOLOGIC SOCIETY OF AMERICA, ROCKY MOUNTAIN SECTION MEETING,** Durango, CO; Papers from a platform session on NPS Paleontological Research, chaired by Vincent L. Santucci, will be published in a symposium volume. Contact Santucci at Petrified Forest NP, PO Box 2266, Petrified Forest, AZ 86028, (602) 524-6228 x227.

May 16-18 **SECOND INTERNATIONAL CONFERENCE ON SCIENCE AND MANAGEMENT OF PROTECTED AREAS**, at Dalhousie U, Halifax, Nova Scotia; contact: Neil Munro, Parks Canada, Historic Properties, Upper Water St., Halifax, N S., CANADA B3J 159; FAX (902) 426-7012.

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

Aug. 28-Sept. 2 **6th ANNUAL INTERAGENCY WILDERNESS CONFERENCE,** tentatively scheduled for Santa Fe or Albuquerque,NM.

Getting a Handle on Visitor Carrying Capacity – A Pilot Project at Arches National Park

By Marilyn Hof, Jim Hammett, Michael Rees, Jane Belnap, Noel Poe, Dave Lime, and Bob Manning

Annual visitation to national park areas is now counted in the hundreds of millions. In the decade of the 1970s visitation increased by 30 percent; in the 1980s it rose 35 percent. If this trend continues, national park areas can expect a demand for an additional 60-90 million recreation visits by the year 2000. This presents the National Park Service with a huge challenge — maintaining the integrity of park resources and visitors' experiences.

In the past, the question of how much public use is appropriate in a national park has been framed in terms of "carrying capacity." This term/concept has come both from within the Park Service and from Congress —the 1978 General Authorities Act requires each park's general management plan to include "identification of and implementation commitments for visitor carrying capacities for all areas of the unit." Although Park Service management policies and planning guidelines acknowledge this responsibility, there has been little direction or agreement on a methodology for how to identify a park's carrying capacity. Indeed, there has not even been an agency-wide agreement on the meaning of the term "carrying capacity."

For the past several years NPS planners at the Denver Service Center and consultants at University of Minnesota and the University of Vermont CPSUs have been developing a process intended to help park planners and managers address visitor carrying capacity. The rest of this article summarizes this process, called the Visitor Experience and Resource Protection (VERP) process as well as discusses a pilot project at Arches NP.

The VERP Process

VERP defines carrying capacity as: *the type and level of visitor use that can be accommodated while sustaining the desired resource and social conditions that complement the purposes of the park units and their management objectives.*

In other words, the VERP process interprets carrying capacity not so much as a prescription of numbers of people, but as a prescription of desired ecological and social conditions. Measures of the *appropriate conditions* replace the measurements of *maximum sustainable use* that are often used to measure other types of carrying capacities (e.g., range capacity for domestic ungulates, wildlife habitat [Dassmann 1964]).

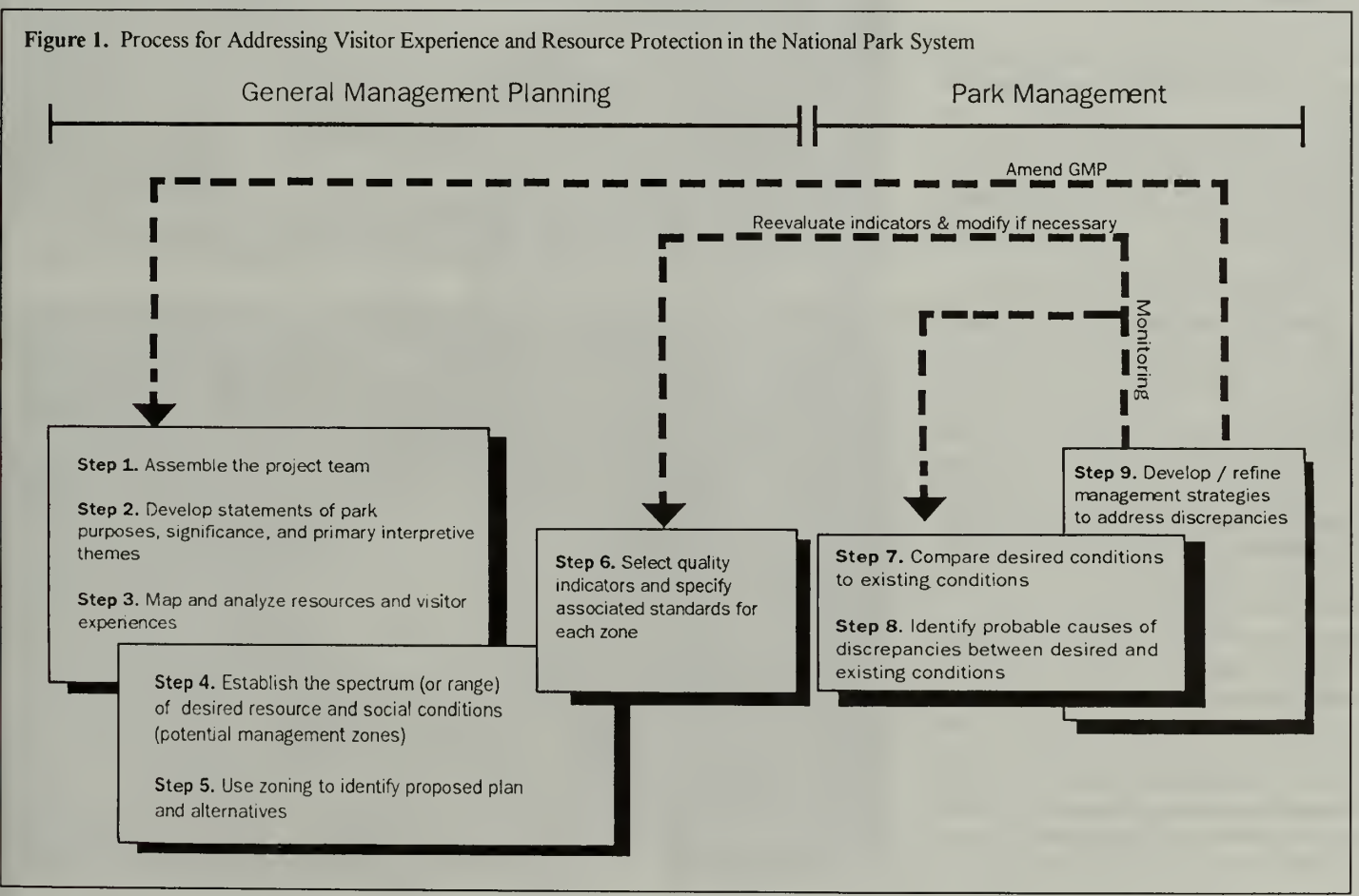
As conceived, the process will identify and document the kinds and levels of use that are appropriate, as well as where and when such uses should occur. The prescriptions, coupled with a monitoring program, will give park managers the information and the rationale needed to make sound decisions about visitor use, and gain the public and agency support needed to implement those decisions.

As shown in Figure 1, the VERP process consists of nine steps. The first six steps are requirements of general park planning, and ideally should be part of each park's general management plan. The later steps in the process require annual review and adjustment, and are accomplished through park operations and management activities.

The VERP process is based on many of the same elements and underlying logic included in the U.S. Forest Service's limits of acceptable change (LAC) and the National Parks and Conservation Association's visitor impact management (VIM) methodologies (Graefe, et al 1990; Lime and Stankey 1971). The primary difference between

Continued on page 12

Figure 1. Process for Addressing Visitor Experience and Resource Protection in the National Park System



Handle continued from page 11

Computer generated photographs showing three levels of social impact.

VERP and these other processes is that VERP is intended to be used in all areas of a park, both frontcountry and backcountry whereas LAC and VIM have primarily been used in wilderness settings.

A major premise of these methodologies and VERP is that management goals, which are qualitative in nature, must be translated to *measurable* management objectives through the use of *indicators and standards*. Measurable indicators will be selected for monitoring key aspects of the visitor experience and resources, then standards will be assigned based upon management goals. When standards are exceeded, land managers must take action to get an indicator back within its defined standard. In a complex park, the park will also be zoned to reflect management goals for different areas. Then, specific indicators and standards would be selected for each zone.

Indicators are divided into two types: *biological physical indicators*—those indicators that measure impacts to the biological or physical resources of a park; and *social indicators*—those indicators that measure impacts on park visitors that are caused by interactions with other visitors or with park or concession employees.

The underlying logic of indicators is easy to understand; however determining what standard to apply to different parts of the park is not so easy. It requires research, considerable thought, and considerable bravery on the part of managers! Since VERP is driven by indicators and standards, a considerable amount of effort has to be spent determining them.

VERP at Arches National Park

The VERP process is being pilot-tested at Arches NP. The purpose of this test application is to refine the VERP process and to provide a model for application to the National Park System. The process is currently between steps 5 and 6. The park has been zoned and the zones have been qualitatively described. The next step is the selection of corresponding indicators and standards. Below we describe research in progress by the authors aimed at defining these.

Research to Select Biological Indicators

During the past two summers, researchers have been evaluating potential indicators that might be used to measure impacts to park resources from visitor use. Nineteen indicators were evaluated in different habitats along trail corridors with high, moderate, and low use levels. Most of the potential indicators were discarded for a variety of reasons: they

were too difficult to measure, too costly, correlated poorly with changes in visitor use, too dependent on environmental variables such as rainfall, too slow to recover once impacts were reduced, or were not useable in different habitats.

However, three indicators showing considerable promise were selected:

cryptobiotic soil crust condition. This crust, which forms atop nearly all soils on the Colorado Plateau, is very important for nutrient cycling; it is very sensitive to visitor use; is easy to measure and quantify visually; and is indicative of overall ecosystem health.

soil compaction. Despite their sandy nature, soils of the Colorado Plateau are compactable, which adversely affects water uptake, nutrient cycling, and plant germination and growth. Again, this is a very easy indicator to measure and soils here recover from compaction fairly quickly once causal factors are removed.

formation of social trails. This indicator is an effective measure of off-trail use and indicates how much of an area away from designated trails is being trampled by visitors.

In addition to the above first tier indicators, which will be monitored on a weekly or monthly basis, a set of second tier indicators will be measured on a 5-year cycle. These indicators include cover and frequency of vascular plants by species, elemental tissue analysis of dominant plants, cover and frequency of ground cover (litter, cyanobacteria, mosses and lichens), soil characteristics (organic matter, bulk density, porosity, etc.). The purpose of these indicators is to measure more directly the ecosystem health, and also to check the validity and utility of the first tier indicators.

Research to Select Social Indicators

The social carrying capacity research program at Arches was approached in two phases. Phase I was conducted in the summer of 1992 and aimed at identifying potential social indicators (Manning et al. 1993). Personal interviews were conducted with 112 visitors throughout the park. In addition, 10 focus group sessions were held with park visitors, park staff and local community residents.

Phase I research was qualitative in nature; its purpose was simply to explore for potential indicator variables. Additional research, phase II, was needed to become more quantitative by asking respondents to rate the relative importance of these potential indicators. This required a larger and more representative sample. It also required some innovative sampling techniques based on image capture technology (Nassauer 1990, Chenoweth 1990, Pitt 1990, Lime 1990). Base photographs of park sites were taken and these images were then modified with computer software to present a range of impact conditions. A set of 16 photographs was developed for each attraction site and trail presenting a wide-ranging number of visitors present. An analogous set of photographs was developed for a range of environmental impacts caused by off-trail hiking. Respondents rated the acceptability of each photograph.

Data from the second phase of the research program are now being analyzed. Our expectation is that we will be able to identify the most important indicators of quality for each potential zone within the park and will be able to suggest visitor-based standards for at least some of these indicator variables. A program of monitoring will then be needed that focuses on these indicator variables. When monitoring indicates that standards of quality have been reached or exceeded, then carrying capacity will have been reached or exceeded as well.

Hof, Hammett, and Rees are planners at the Denver Service Center; Belnap is a research ecologist with NBS at Moab, Utah; Poe is the superintendent of Arches N.P.; Lime is a professor and researcher at the University of Minnesota; Manning is a professor and researcher at the University of Vermont.

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Jacksonville Science Conference Proceedings Now Available

Proceedings of the 7th Conference on Research and Resource Management in Parks and on Public Lands, held in Jacksonville, FL Nov. 16-20, 1992, are now available in a single 479-page (softbound) volume for "probably under $20." In addition to all the papers, summaries of the sessions, and a list of poster presentations, the book contains a Preface by William E. Brown, an Introduction to the Conference by Jean Matthews, and Gaylord Nelson's conference closing address.

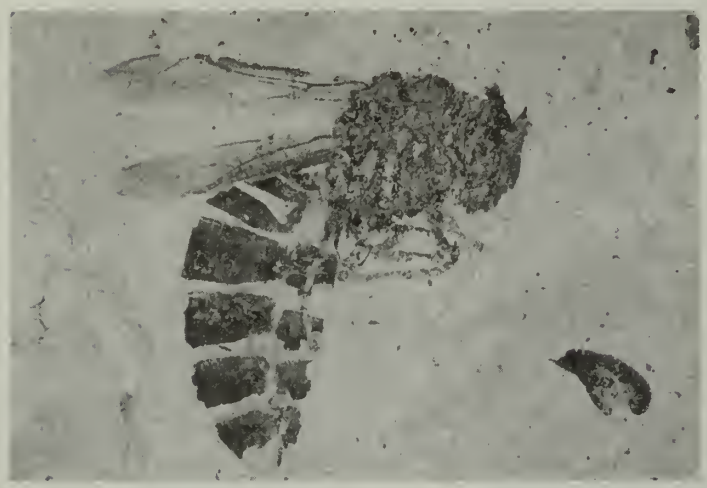
Orders will be invoiced and may be made by writing the George Wright Society, P.O. Box 65, Hancock, MI 49930-0065, by calling (906) 487-9722, or by FAX (906) 487-9405.

Battling Bees Here

An article in the latest *Inside Bajada* by Gloria Maender of the NPS CPSU at U/AZ reports the arrival in at least four NPS sites in Texas of swarms of Africanized honey bees (AHB)—the kind that was introduced into Brazil from South Africa in 1956. In addition to describing the swarms at Big Bend NP, Amistad NRA, Padre Islands National Seashore, and San Antonio Missions NHP, the article describes measures that at-risk NPS units should be taking:

- Become aware of the type of habitats within the park area where honey bees now nest and monitor the bee population.
- Use pheromone-baited swarm traps to monitor feral bees. USDA Agricultural Research Service traps are durable, inconspicuous, and popular with bees.
- Establish and maintain contact with local State Agriculture Department personnel responsible for AHB monitoring and information.
- Establish working relations with federal or UA honey bee research scientists.
- Train at least two personnel in handling of swarm traps and emergency procedures.
- Develop handouts for park visitors, calling on University extension services.

Creepy-Crawlys of Florissant's Eocene Time



Right: Ancient wasp (*Paleovespa Florissantentia*) probably resembling a modern day bald-faced hornet. This carbon imprint is some thirty-five million years old. *(PHOTO BY WALT SAEUGER)*

Left: Fossil butterfly (*Prodryas persephone scudder*), unique in the world, was carefully preserved for about thirty-five million years. *(PHOTO BY F.M. CARPENTER)*

By William A. Dexter

Did you know that today every fifth living thing in our world is a beetle?!

It is estimated that over one million species of insects are alive today. It is very possible that millions more remain to be identified. Add the number of extinct insect species and the total becomes astronomical. Insects were, and are, the most successful organisms ever to have lived on earth. With the exception of microscopic organisms, insects far outnumber all other living things combined.

Four insect orders have been around for more than 300 million years. Insect fossil parts have been found in Cambrian rock nearly 600 million years old! Fifteen insect orders had developed by 200 million years ago, at the time of the initial stages of Pangea, when continental drift started and the dinosaurs first appeared. Most major insect groups were established during Carboniferous times–the time of the coal age forests. Some Carboniferous dragon flies attained wing spans of over 30 inches; cockroaches grew to 12 inches in length.

Thirty-five million years ago, an overwhelming number of insect species flourished around and about ancient Lake Florissant, site of the present day Florissant Fossil Beds National Monument in Colorado. It is estimated that as many as 75 percent of all modern insect genera were present when the Florissant Fossil shale beds were laid down. Although there are representatives of modern genera and families at Florissant, all the individual species that lived in the Florissant area during Eocene times now are extinct.

Two of the most abundant insect orders prevailed during ancient Florissant times. One group includes the bees, wasps, and ants; the other includes the beetles. Snout beetles (weevils) and ground beetles are the most common beetle types found as fossils in the Florissant Lake deposits.

The great diversity of insects represents an astounding success story and rapid evolution. Why are insects so successful? Why were insects so numerous in and about Florissant's ancient lake?

We might look for answers first in the unique overall appearance that insects share in general. They all possess a chitonous exoskeleton or hard outer body parts. This body support system provides armor-like protection. Another unique property is that 99 percent of all insects have wings, which aid them in their pursuit of survival. Their relatively small size makes them unobtrusive. Their ability to hide under vegetation and rocks helps to promote their preservation, protection, and further success. Short developmental stages allow for rapid regeneration, fast adaptation rates, and thus an increased survival duration.

Insects in general have a variety of feeding habits. Some eat vegetation. Others are predacious or parasitic and feed on other animals. A few insects even devour one another, (probably not one of their survival skills).

Insects have a multitude of lifestyles, variously termed incomplete and complete metamorphosis. Grasshoppers, crickets, and roaches have incomplete life histories. This means that when they hatch from eggs, the young appear as miniature versions of adults. Complete metamorphosis occurs where the young develop by dramatic "leaps and bounds," not in a gradual manner and by means of various larval stages.

Some insects within the same species have different life forms. Ants, for example, have workers, queens, and winged members—the latter being sexually active and searching for mates; other forms of ants are sexless. Beetles, such as weevils and scavengers, are known to have foraged about the most productive areas of ancient Florissant Lake, hence would be more easily trapped by volcanic ash and dust. The variety of life cycles in the insect world increases their overall competitiveness and provides for successful life histories.

Those in subterranean habitats would have had little contact with poisonous volcanic gasses, such as methane and cyanide. All these various conditions collectively reflect the successful nature of insect behavior and ecology.

The insect story of the ancient Lake itself is a dramatic one. Insect fossils retrieved from the lake bed shales represent over 1,100 species, 19 orders, and 146 families. More insect varieties than from any other fossil formation in the world are found in these multi-layered shale beds.

Visitors to the Florissant Fossil Beds National Monument can read the fossil evidence, revealing a chapter of ancient life trapped in the paper thin pages of time–an epoch some 30 million years before the onset of humanity. To visit Florissant and then consult the yellow pages under "exterminators," is to realize that insects continue to make one of the strongest of Life's bids to "inherit the earth."

Dexter is Staff Paleontologist at Florissant Fossil Beds NM, Florissant, CO.

PARK SCIENCE INDEX VOLUME 13

Park Science citations by author

Park Science citations by keyword

Park Science citations by park code

Park Science citations by title

Information Crossfile

Frequent, abrupt changes in the climate of Earth have been the rule over the past 250,000 years, according to climate specialists' analysis of ice extracted from the full depth of the Greenland ice sheet.

Walter Sullivan of the **New York Times** wrote in mid-July that the "astonishing" findings suggest that the period of stable climate in which human civilization has flourished may be unusual and that the present climate may get either warmer or colder much more quickly than had been believed—"in spans of decades or even less."

J.W.C. White of the Institute of Arctic and Alpine Research at U/CO noted that whereas adaptation—the peaceful shifting of food-growing areas, coastal populations, etc.—seemed possible if change meant a few degrees in a century, the new studies indicate change of as much as 18 degrees in a couple of decades. The new results, reported in **Nature**, unexpectedly showed abrupt climate changes in inter-glacial as well as in glacial periods. The *Nature* article authors had no explanation for the rapid shifts, nor for the "mystery" of why the climate of the last 8,000 to 10,000 years has been "strangely stable."

* * *

Merck, Sharp and Dohme, the pharmaceutical company, has agreed to pay Costa Rica $1 million plus royalties from products developed as part of the on-going hunt for new chemicals in nature that may prove useful to human beings. The $1 million is being applied by Costa Rica toward its conservation effort, and represents industry's acknowledgement that helping to preserve biodiversity is a wise investment.

Thomas Eisner, Shurman Professor of Biology at Cornell Institute for Research in Chemical Ecology and a member of the National Academy of Sciences, was quoted in the July 6, 1993 issue of the **Oregonian** as having proposed creation of a Biotic Exploration Fund of about $250 million (the approximate cost of bringing a single pharmaceutical drug to market) to receive contributions from industrial and governmental sources. The fund would then help finance biodiversity institutes in developing nations and help create partnerships between those nations and industry. The donors would recover their investments from the new products developed; the developing nations would acquire the resources needed for conservation.

Only a tiny fraction of the millions of species of animals, plants and microorganisms on Earth have been tested for useful chemicals, Eisner said, "but the shelf of natural molecules is fast disappearin... being cut down, eroded away, lost to urbanization..."

* * *

Norman Myers, an environmental consultant in Headington, Oxford, UK, and a senior fellow of the World Wildlife Fund, US, is the author of an article titled *The Question of Linkages in Environment and Development* in **BioScience**, 43:5,302-310.

The article, based on an extended policy backgrounder for the secretariat of the UN Conference on Environment and Development, analyzes the character and prevalence of linkages, illustrates linkages through instances from several spheres of human activity, and concludes by considering the sorts of policy initiatives that would enable us to deal with linkages in a manner and on a scale to reflect the challenge they represent.

He describes our world view as "traditionally grounded in a practice of splitting it up into manageable components" that consider linkages as "an incidental factor too complex to be reflected (operationalized) through institutional responses," and concludes: "We will respond to linkages either by reactions of sufficient scope and character, or by salvage measures in a world impoverished by our disregard for linkages. Linkages will eventually be addressed, whether by design or by default."

* * *

Revelstoke, a community in the Columbia Mountains of interior British Columbia (and near Glacier NP), has developed a "vision statement," described by Jenny Feick and Dr. Albert Einsiedel, Jr. in **Research Links** (Spring 1993), Vol. 1, No. 1 of the Canadian Park Service, Western Region's Forum for Cultural and Social Studies. The authors question *Revelstoke's Vision: Will It Help Achieve Sustainable Development?* and describe the evidence supporting the notion that goals have a motivating effect on behavior.

Revelstoke has experienced a boom and bust economy based on resource exploitation of the Columbia River, its neighboring forests, and major transportation corridor. Community residents decided they wanted to shape their destiny rather than be subjected to the whims of transient developers and government. In 1992 an interdisciplinary team prepared a vision statement and in February 1993 the Revelstoke citizens voted to purchase the tree farm license north of Revelstoke "to gain local control of forest management, thus taking a first step toward making their vision a reality." Their stated goal is "achieving sustainable growth by balancing environmental, social, and economic values within a local, regional and global context."

* * *

From Cliff Martinka, NPS Senior Research Scientist at Glacier NP, comes word of a new book, **Parks, Peaks, and People**, compiled and edited by Lawrence S. Hamilton, Daniel P. Bauer, and Helen F. Takeuchi and produced by the East-West Center with assistance from the Woodlands Mountain Institute, the U.S. NPS, and IUCN's Commission on NPs and Protected Areas.

The book is an outstanding collection of papers arising from an international consultation on protected areas in mountain environments, held in Hawaii Volcanoes NP Oct. 26-Nov. 2, 1991. The book is available from East-West Center, Program on Environment, 1777 East-West Road, Honolulu, HI 96848. The cost is $5, and Martinka notes: "A good value nowadays."

* * *

The Pacific Northwest Region's Resource Management newsletter recently highlighted, from the 11/30/92 issue of **U.S. News and World Report**, a paragraph that deserves repetition. It appeared as part of a review of **The Diversity of Life**, by E.O. Wilson.

"A vital reason to protect biodiversity is to preserve the ecosystems that we depend on to enrich the soil, modify the climate, even create the air we breathe. Turning over a stump, Wilson pointed out the profusion of small and obscure life forms—a metallic blue beetle, a centipede, mites, a crane fly, slugs galore, and a riot of orange, white, and yellow fungi, topped by green and eggplant hued colonies of algae. These, he said, are the organisms that 'hold the world steady.'"

* * *

Henri Grassino-Mayer, a researcher from U/AZ, is working on his PhD studying trees at El Malpais National Monument in New Mexico and developing a tree ring chronology and climatic history of the area. A recent presentation at El Malpais by Grassino-Mayer for an audience of people from NPS, BLM, USFS, and Los Amigos del Malpais (an organization of volunteers who assist on park projects) was written up by J.D. Meisner and appeared in the **Cibola County Beacon** (Aug. 4, 1993) of Grants, New Mexico. Grassino-Mayer told his listeners that grazing, fire suppression, and logging showed up in his studies as having a solid impact on the natural record of fire and climate. His studies have provided what he called "the deepest fire

Continued on page 20

history ever obtained in the southwest" and showed that many trees had survived 20 to 30 fires in their lifetimes.

* * *

For an arresting evocation of landscape in the form of words, see Gary Dwyer's description of the three landscapes that have been "most influential/important" to him in his work. The piece appears on page 169 of **Landscape Journal** (Fall 1993), and Dwyer's No. 1 choice is a National Park System site—which shall be nameless here, so as not to spoil the punch line at the end of Dwyer's astounding word picture.

For contrast, read Carol Franklin/ Andropogon's essay (following Dwyer's) on the Russel Wright Garden of Woodland Paths, Garrison, NY... "an expression of the American landscape as opposed to imposing a European vision on it." She calls it "an ecological garden" because, as she says, Wright asked the question "What is this place?" and then brought the skills and the sensitivity of a designer to the task of discovering and dramatizing the patterns and processes of this landscape.

* * *

"They came, they multiplied, they conquered" is the opening of a **Science News** report (Vol. 144, p.20) on zebra mussels. These hitchhikers entered the Great Lakes in the ballast tanks of a transoceanic cargo ship and triggered one of the most disastrous ecological invasions in recent U.S. history. But they were only the first of many such invaders reaching saltwater ports, inland waterways, and marine estuaries "on a vast and largely unnoticed scale," says marine ecologist James T. Carlton of Williams College in Willamstown, MA.

Carlton (whose complete article appeared in the July 2, 1993 **Science**) studied the ballast water of 159 ships in Coos Bay, OR—ships that hailed from 25 Japanese ports—and found 367 different marine species, including shrimps, sea anemones, jellyfish, snails, clams, fish, flatworms, and a variety of microscopic life forms. These "invaders" are rarely noticed until, like the zebra mussel, they becaome a major nuisance. John Chapman, marine biologist at Oregon State University's Hatfield Marine Science Center in Newport, OR, calls it a lottery. "We can speculate," says Chapman, "but there are no data."

* * *

Biological Diversity: Conserving the Earth's Wild Wealth is the title of a poster-sized brochure produced by the NPS's Wildlife and Vegetation Division in Washington, DC, and the Harpers Ferry Center in West Virginia. The attractive, colorful design focuses on the history and diversity of the planet's life forms, as found and studied in World Heritage sites and Biosphere Reserves. Interspersed with maps and photos, the text describes the evolution of our present finely woven fabric of life and suggests that its current unraveling can "harm human civilization too, by foreclosing opportunities for spiritual, intellectual, social, and economic development."

* * *

"Some basic ideas about ecology are changing. A change in theory may end up profoundly changing the physical world." With that provacative subtitle, Steve Packard's *Restoring Oak Ecosystems* in the Summer 1993 issue of **Restoration & Management Notes**, tackles the emerging debate about the nature of ecosystems and of Nature itself.

"Conservation biology, natural areas management, and restoration ecology are emerging disciplines that have been generating new definitions, information, understandings, goals and values," he says in opening. He then summarizes the elements of earlier conventional wisdom and proceeds to try to "untangle some of the interrelated ideas" they involve. The 11-page article covers Natural vs. Artificial Succession, the Power of Definitions, and the Setting of Management Priorities, all within the context of Midwestern tallgrass savanna restoration.

* * *

Worth sharing (in the context of restoration) is this quotation from **The New Republic**, Dec. 28, 1992, carried inside the cover of the Summer 1993 **Restoration & Management Notes**:

"Break a vase, and the love that reassembles the fragments is stronger than that love that took its symmetry for granted when it was whole."

* * *

For readers interested in Old-growth forests of Eastern North America, the April 1993 **Natural Areas Journal** carries an article by Gregory J. Nowacki (U.S.F.S., P.O. Box 21628, Juneau, AK 99802-1628) and Paul A. Trianosky (Duke University School of the Environment, Durham, NC 27708) that gives 749 literature citations, listed alphabetically by author. Numbered citations are cross-referenced with broadly defined forest types and selected old-growth sites.

* * *

The New York State Parks Agency's **Fostering Environmental Stewardship Plan**, undertaken in response to Governor Cuomo's 1990 State of the State directive, presents a 10-year stewardship action plan that would strengthen preservation and maintenance efforts on behalf of the State Park System, and also would dovetail with recommendations in the 1984 *NPCA Adjacent Land Survey: No Park Is an Island.* The National Park and Conservation Association report stated that "Unless all levels of government mount a concerted effort to deal with adjacent land problems in a coordinated manner, the NPS mandate will be completely undermined."

New York State Parks Agency Commissioner Orin Lehman noted that "other state park agencies and the National Park Service are looking introspectively and recommitting to their stewardship responsibilities."

Copies of the 81-page report and its 37 pages of appendices, plus a 16-page executive summary, may be requested from Thomas L. Cobb, NYS Office of Parks, Recreation and Historic Preservation, Bldg. 1, Nelson A. Rockefeller Empire State Plaza, Albany, NY 12238. The summary was presented by Dr. Dobb at the 5th Annual Northeastern Recreation Research Symposium at Saratoga Spa State Park, Saratoga Springs, NY, April 18-20, 1993.

* * *

Pilobolus *Ecology: Fungal forests, fecal ecosystems, and the wild ride of lungworm larvae.* This is the intriguing title of an article by K. Michael Foos in the Spring 1993 issue of **Yellowstone Science** (Vol. 1, No. 3), complete with photos, charts, and maps. Also carried in the Spring 1993 issue is an interview with Pete Feigley, project coordinator/ zoologist and a staff botanist, on the new Greater Yellowstone Conservation Data Center—a Natural Heritage Program funded by The Nature Conservancy with logistical support from the NPS. The project's aim is to inventory and monitor a wide variety of species in greater Yellowstone in order to improve understanding of the status and trends in ecosystem health.

* * *

Resource Management Notes, the Florida Dept. of Natural Resource quarterly newsletter, noted in its July 1993 issue a new program to help address the conservation and management needs of neotropical migrants that occur in Florida. The state's Game and Fresh Water Fish Commission's research, survey, and educational activities

will focus on breeding species suffering widespread declines, key habitats that support rare breeding species, and migration counts in many coastal areas.

These activities will be undertaken in cooperation with the Partners in Flight program, a nationwide effort being promoted by several federal agencies, including the National Park Service.

* * *

From Giovanni Puggioni, Natural Resource Officer for the B.C. Ministry of Environment, Lands, and Parks, comes a copy of **A Protected Areas Strategy for British Columbia** and a 1-square-yard poster/foldout of maps/artwork/text. The Strategy describes the policies and process necessary to protect 12 percent of the Province on a representative basis.

Copies of the 40-page Strategy publication and the associated poster/brochure may be had by contacting Puggioni at the Ministry, 2nd flr, 800 Johnson St., Victoria, BC, Canada; V8V 1X4; (604)387-5002.

* * *

Environmental Concern Inc.'s **Wetland Journal**, (Vol. 5, No. 2) introduces a new feature into the journal: The DOs and DON'Ts of Wetland Planning. The correct procedures associated with planned wetlands that will assist and often assure the success of such work will be listed under DOs. The errors associated with planned wetlands that will jeopardize the success of, and often cause the failure of, such work will be listed under DON'Ts. Contributors to this Restoration Techniques feature will be acknowledged, according to Dr. Edgar W. Garbisch, president of the publication's environmental concern staff.

* * *

PEER: A Publication of Public Employees for Environmental Responsibility, began publication (Vol. 1, No. 1) in Summer 1993. Billing itself editorially as "a new voice for environmental ethics," the publication received national press coverage. Its first issue carried news of a new organization formed by employees of the Bureau of Reclamation in Denver—REOEI (Reclamation Employee Organization for Ethics and Integrity), and a white paper written by employees of the DI's Bureau of Land Management (BLM). The white paper is entitled *Grazing report: Gross BLM Mismanagement Cited*, and is available from PEER, 810 First St., N.E., Suite 680, Washington, DC 20002; (202)408-0041.

* * *

An article entitled *NPWS—licenced to kill!* in the **Australian Ranger** (Spring 1993) by Lorraine Donne, describes a new and successful line of attack by environmentalists against logging activities in New South Wales. Under the National Parks and Wildlife Act there, it is illegal to "take or kill" fauna without permission (licence) from the National Parks and Wildlife Service (NPWS). The court found that the forestry activities in northern NSW's Chaelundi State Forest fell within this definition and were both a direct and indirect threat to endangered fauna in the forest.

As a result, the Endangered Fauna/Interim Protection (EFIP) Act of 1991 and the Environmental Planning and Assessment Act of 1979 (EPA Act) were amended. A significant change is expansion of the definition of "take or kill" to include "hunt, shoot, poison, net, snare, spear, pursue, capture, disturb, lure, or injure..." and also includes "...significant modification of the habitat of the fauna likely to affect its essential behavioural patterns." (All spellings reflect British style).

* * *

Nature Conservancy, TNC's bi-monthly publication, devotes its Ecology Forum in the November/December 1993 issue to "Florida's Plumbing Problems," and contains a beautifully illustrated look by Greg Breining at America's once-vast savanna: "The Case of the Missing Ecosystem," where did it go and can we bring it back?

* * *

More than 5,000 miles of beach were scoured in 1992 by some 160,000 volunteers as part of an international litter removal program coordinated by the Center for Marine Conservation (CMC) in Washington, DC. Trash brigades in the U.S. and 32 other countries retrieved 5,328,000 pieces of debris, 58.8 percent of which was plastic (including styrofoam).

This depressing item is carried in the October 9, 1993 issue of **Science News**, page 235. The CMC survey points out that fishing paraphernalia (monofilament line, floats, and lures), while it accounts for only 1 percent of the retrieved litter, kills more marine wildlife than any other category of beach debris.

* * *

The upcoming "Pacific Salmon & Their Ecosystems" conference in Seattle, WA, Jan. 10-12, 1994 will look at the status of Pacific Northwest salmonids, regional trends, salmon policies and politics, technological solutions (cost effective restoration), and institutional solutions (effective long-term planning and management). One of the sessions is titled "Managing Resources with Incomplete Information: Making the Best of a Bad Situation"—surely an excessive redundancy!

The Portland **Oregonian**, editorializing on the salmon situation in the Nov. 21, 1993 paper, describes the "scientific consensus" for salmon recovery, beyond fishing restrictions: aggressive state and federal crackdown on salmon habitat destroyers—the logging, grazing, and mining practices that strip streambanks of vegetation and destroy spawning beds.

"Even more than freedom from fishermen's hooks or nets," the *Oregonian* editors wrote, "wild salmon need homes to return to."

* * *

Jack Ward Thomas, newly appointed Chief of the U.S. Forest Service, delivered his inaugural speech as chief to an overflow crowd at Oregon State University on Nov. 18, 1993...a speech that at least one reporter, covering if for the **Oregonian**, found to be "in an academic way, profound."

What Thomas talked about was the role of science in decision-making. "The public," he said, "should not expect too much from scientists because science is a *method*." He took aim at "professional gladiators" on both sides of the old-growth forest conflict—people who aren't interested in collaboration but are only in the fight to win. He understands that such people are a part of the political system, but they're not part of the approach Thomas sees evolving in the management of public lands. He characterizes this new approach as "an attempt to preserve biodiversity through ecosystem management at the landscape scale," with people an integral part of that landscape.

* * *

Wire service reports and work by the **Oregonian** staff describe how researchers at U/WA have cloned the insect juvenile hormone receptor—the cellular gateway that controls metamorphosis in caterpillars and butterflies. The receptor is the docking point in each insect cell for juvenile hormone, a protein substance that prevents the caterpillar from entering the pupal stage until its body has grown sufficiently. The insect matures only when the hormone is absent.

Hormone-based pesticides offer a way to control targeted bugs without hurting other creatures. Lynn Riddiford, a U/WA zoology professor who led the research, said the description of the receptor's biology will give the pesticide industry a road map for

Continued on page 22

designing dummy proteins that plug into cells of caterpillars, blocking the insect's natural hormone from the binding site and allowing premature metamorphosis.

* * *

The status and prospects for success of the Endangered Species Act (ESA) is the subject of an article in the Policy Forum section of **Science**, Nov. 12, 1993, pp 976-7. Four authors, two from U/ID, one from the USFWS unit there, and a research biologist for USFWS in Alaska, attempted to assess the validity of recent criticisms regarding the level of protection provided by the ESA and the recovery process.

They found that recovery plans all too often "manage for extinction" rather than for survival. "We need to be more realistic in setting biologically defensible recovery goals," they stated. If suitable habitat is severely limited, then habitat restoration should be included as a necessary component of recovery efforts.

They also pointed out that the ESA requirement that species should be recovered within their ecosystems "often may not be done." They propose "initiating an aggressive, proactive effort to save species while they are still common, viable parts of their self-sustaining natural ecosystems." An important step in that direction, they conclude, would be to ensure that a minimum of three viable representatives of each vegetation cover type are preserved in each ecoregion in which they occur.

* * *

A discussion of "sustainable use of renewable resources" in the Policy Forum section of **Science**, Nov. 5, 1993, pp 828-9, starts with the definition of sustainable use (as published in **Our Common Future**, Oxford Univ. Press, by the World Commission on Environment and Development): It is defined as use that "meets the needs of the present without compromising the ability of future generations to meet their own needs."

From there, five distinguished authors, (whose scientific expertise is mainly in fisheries), found that the challenges to sustainable use in the area of fisheries management are not insurmountable. "To meet these challenges," they write, "we must address fundamental economic biases against sustainability, particularly in open-access management regimes; continue the development and application of methods that directly integrate sources of uncertainty into scientific advice; and learn from past management failures and successes."

Their conclusion is that "Sustainable development is achievable if scientific advice based on biological, social, and economic considerations is an integral part of the development of policies for renewable resource use."

* * *

The Cowbird Peril: A Resource Management Problem and an Interpretive Story is the title of a 33-page paper, written and distributed to selected NP sites and personnel by Richard L. Cunningham, NPS Western Region's Chief of Interpretation.

Cunningham notes that the National Park Service is a signatory agency to the Migratory Bird Conservation Program (also known as Partners in Flight). In spite of the fact that migratory birds are an important part of the biological diversity of the National Park System and a resource the NPS is committed to conserve, too little is understood about one of the major threats—brood parasitism by cowbirds.

Three species of the cowbird now reside in the United States, and Cunningham has addressed his paper to NPS interpreters and resource management specialists to inform and educate park staffs and the public about the cowbird menace and methods for combatting it.

The paper while still in draft form prompted the Western Regional Office to prepare and submit an NRPP Proposal (WR-N-02, Neotropical Migratory Bird Population Management: Parasitic Cowbird Removal).

For copies of the paper or further information, contact Cunningham at (415) 744-3910.

* * *

The Oct. 15, 1993 issue of **Science** describes (on p 410-412) a 5000 year record of extreme floods and climate change in southwestern U.S. The regional paleoflood chronology, based on flood deposits from 19 rivers in Arizona and Utah, shows the largest floods in the region cluster into distinct time intervals that coincide with periods of cool, moist climate and frequent El Nino events.

* * *

Fire History and Climate Change in Giant Sequoia Groves, by Thomas W. Swetnam of the U/AZ Laboratory of Tree-Ring Research, describes how fire scars in giant sequoia (*Sequoiadendron giganteium*) were used to reconstruct the spatial and temporal pattern of surface fires that burned episodically through five groves in the past 2,000 years. Regionally synchronous fire histories demonstrate the importance of climate in maintaining nonequilibrium conditions. The article appears in pp 885-9 of **Science**, Nov. 5, 1993.

Thirteen New Titles Available

From Donna O'Leary comes word of 13 new titles, obtainable by writing to her:

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

1. Ecological effects of the Lawn Lake flood of 1982, Rocky Mountain National Park. Henry E. McCutchen, Raymond Herrmann, and David R. Stevens, editors. NRSM-93/21
2. Demography of grizzly bears in relation to hunting and mining development in northwestern Alaska. W.B. Ballard, L.A. Ayres, D.J. Reed, S.G. Fancy, and Kate Faulkner. NRSM-93/23
3. Proceedings of fourth conference on research in California's national parks. Stephen D. Veirs, Jr., Thomas J. Stohlgren, Christine Schonewald-Cox, editors. NRTP-93/9
4. Proceedings of first biennial conference on research in Colorado Plateau national parks. Peter Rowlands, Charles van Riper, III, and Mark Sogge, editors. NRTP-93/10
5. National Park Service paleontological research abstract volume. Vincent L. Santucci, editor. NRTR-93/11
6. Proceedings of fourth western black bear workshop. Jeffrey A. Keay, editor. NRTR-31/12
7. Proceedings of the Seventh Annual GRASS Users Conference, 1992. Gary W. Waggoner, editor. NRTR-93-13
8. Handbook for ranking exotic plants for management and control. Ronald D. Hiebert and James Stubbendieck. NRR-93/08
9. Permit application guidance for new air pollution sources. John Bunyak. NRR-93/09
10. 1992 highlights of natural resources management. Lissa Fox, editor. NRR-93/10
11. The Pacific Northwest Region resource database project: a synthesis. R. Gerald Wright. NRR-93/11
12. Problems and practices in backcountry recreation management: a survey of National Park Service managers. Jeffrey Marion, Joseph Roggenbuck, and Robert Manning. NRR-93-12
13. 1992 annual science reports

Data sorted by region and park: NRSR-93/08
Data sorted by field of study: NRSR-93/09

Letters

To the Editor:

This is a plea: **Don't Bury Resource Management!**

In the 1970s, several parks, including Sequoia/Kings Canyon and Yosemite, organized independent resource management programs. Management review reports over the past decade, from State of the Parks (1980) to the Vail Agenda (1992), have stated an urgent need for more and better trained NPS natural resource managers and better program focus. The Natural Resource Management Trainee Program was begun in 1983 in reponse to the identified need to increase the number of professional natural resource managers and to upgrade the effectiveness of NPS resource management.

Professional Parity – Protection/emergency services have become so complex that just sustaining full performance level skills and maintaining quality standards has become an arduous task for rangers. Rather than pursue a futile attempt to require rangers to do everything, the time has come to embrace the concept of professional parity between rangers and resource managers.

Certainly more individuals are needed who possess the knowledge and who are provided the time to contribute significantly to resource management activities. It is imperative that a corps of individuals is dedicated fulltime to resource management functions—to provide program direction, development, operation, and evaluation. Just as technical requirements for ranger proficiency have increased, so too has the need for educated, technically proficient and experienced resource managers to accomplish *scientifically valid* resource management.

Scientific Credibility – High-quality data are important for many management decisions and are *critical* to support controversial ones. Since the park ranger series has no science education requirements, its ranks lack scientific credibility. Such credibility is necessary for the NPS to participate effectively in complex resource management conflicts—especially when dealing with resource managers and scientists from other agencies, institutions, and private industry.

Science information is often too technical for managers to interpret alone, and the management implications may be unclear. The Vail Agenda stated, "Managers have little training and experience to learn the uses and needs of research outputs." Acceptance by management of the value of research results can go a long way toward promoting manager-scientist cooperation.

Parners in Park Management – Complex social, political, environmental, and ecological considerations warrant *interdisciplinary consultation*. The natural resource management component deserves Divisional status and presence at Divisional Chief meetings so that specific ecological implications of management actions can be communicated. The separation of professional resource management disciplines from decision making is unconscionable. The integration of natural resource information into park management decisions often depends on the manner in which it is communicated to park managers, and on the level at which such input occurs. It is high time to accept and recognize natural resource professionals as full partners in providing the National Park Service with *science-based* management. Everyone who works in a national park unit contributes, either directly or indirectly, to resource management. Rangers who are better educated in science will be able to contribute more. But program development, guidance, and evaluation must be provided by individuals educated and experienced in science and resource management and dedicated fulltime to those tasks.

Resource management is a *science*.

Gary Vequist
Brad Cella
Susan Mills
Ross Kavanagh
NPS Alaska Regional Office
Anchorage, AK 99503

To the Editor:

This letter is a response to *Campfires and Firewood: A Global Perspective* by Dick Cunningham (Fall 1993, p.32). I had a chance to read this paper earlier, as Chief of Interpretation and Education at Big Thicket National Preserve. Undoubtedly many would agree that the information presented in this paper is interesting and very well researched. I do feel, however, that a major piece of the deforestation equation is curiously missing—the growth rate of Human Population.

Deforestation is directly related to population growth. In the Worldwatch Institute publication *Vigal Signs—1993*, some of the countries Mr. Cunningham mentions show strong population growth. Interestly, the growth in non-industrialized countries is causing a decline in their populations' wellbeing. Latin America is second only to Africa as the fastest growing population area in the world. Guatemala and Honduras are seeing a 3 percent growth rate annually.

A recommended read for those wanting a calmly argued historical perspective on population expansion, natural resources extraction and exhaustion, and the human outcome, please read **A Green History of the World, the Environment, and the Collapse of Great Civilizations**, by Clive Ponting, 1991.

If I hear "Ranger, throw another log on the fire," I will respond with "That reminds me... I have some facts of history I want to share with you... something we humans need to be frequently reminded of..."

Respectfully,

Bob Valen
60 Candlelight Lane
Lumberton, TX 77656

In the next issue . . .

- Three articles on reveg: from Olympic NP (by Ed Schreiner), from Glacier NP (by Kristin Vanderbilt), and from Grand Teton NP (by Redente, Cotts and Schiller)
- "Ash Yellows and Defoliating Insects in Zion NP" by W.A. Sinclair, et al
- David Ek's "Notes From China"
- "Beaver Recolonization at Indiana Dunes NL" by Eddie Childers
- "How to Prepare Veg Overlays" (as done at Harpers Ferry) by Collins et al
- "Trail Conditions and Management Practices in NPS" by Jeff Marion
- ...and much, much more. Although, as readers may have noticed, some of this is tentative.

Western Region

Two recently published Technical Reports are available from NPS/CPSU at U/AZ: Technical Report NPS/WRUA/NRTR-93/01, **Case study of research, monitoring, and management programs associated with the saguaro cactus** (*Carnegiea* gigantea) **at Saguaro National Monument, Arizona**, by Joseph R. McAuliffe; and Technical Report NPS/WRUA/NRTR-93-09, **Review of the Air Quality Biological Effects Research Program, Saguaro National Monument, Arizona**, by Saguaro National Monument Air Quality Biological Effects Research Review Panel. To obtain copies write to NPS/CPSU/UA, 125 Biological Sciences East, The University of Arizona, Tucson, AZ 85721, or call 602-670-6885.

Water Resources Division

A revision to the NPS Floodplain Guidelines was formally adopted by the National Park Service. The new guideline maintains the policy of protecting life, property, and natural floodplain resource values by avoiding use of floodplains whenever possible. The principal changes in the new guideline are separation of Floodplain and Wetlands guidance and delegation of Statement-of-Findings approval from the Director to the Regional Director.

Additionally, the revised guideline is intended to be more concise and procedurally efficient than the previous guideline.

* * *

WRD staff traveled to Hagerman Fossil Beds National Monument in the Pacific Northwest Region to take part in a meeting of the Erosion Task Force. The Task Force is addressing the problem of continuing landslides that threaten fossil beds at the Monument. There was unanimous agreement that the landslides are caused by a buildup of the water table in perched aquifers caused by leakage from irrigation practices on the bench above the river. An article on this project will appear in a later issue of **Park Science**.

* * *

For a summary of programs, activity areas, and accomplishments involving the Water Resources Division in 1992, the **1992 Annual Report** of the Division is available from Judy Rouse, (303) 225-3502.

Pacific Northwest Region

The Regional headquarters have been moved, as of December 1993, to the following address: 909 First Ave., Seattle, WA 98104-1060; the telephone number has been changed to (206) 220-4798.

* * *

"Distribution and Status of the Fisher (*Martes pennanti*) in Washington" is the title of an article in **Northwestern Naturalist** (73:69-79) by Wildlife Ecologist Doug Houston (at Olympic NP) and Keith B. Aubry, USFS Pacific Northwest Research Station at Olympia, WA. The fisher is a marten-like animal almost twice the size of the marten.

Aubry and Houston determined the current distribution of fishers in Washington using sighting and trapping records and found their occurrence west of the Cascade crest to be strongly skewed toward low to mid-elevations. The animal still occurs in the Cascade Range and Olympic Mountains and in portions of the Okanogan Highlands, but apparently it is very rare. They predict that available habitat for fishers would be enhanced by minimizing forest fragmentation, maintaining high forest-floor structural diversity, preserving snags and live trees with dead tops, and protecting swamps and other forested wetlands.

Alaska Region

The 3rd Glacier Bay Science Symposium, "Creating Glacier Bay's Research Role Within Park, Regional and Global Contexts--a Plan for Action," was held in September 1993 at Glacier Bay NP and Preserve (GLBA) headquarters in Bartlett Cove. The conference was dedicated to the memory of Richard Goldthwait, one of the pioneer glaciologists to work in the bay, and was jointly sponsored by GLBA, Friends of Glacier Bay, and Northern Illinois University.

Dr. Daniel Engstom of the U/MN chaired the meetings. More than 130 attended, including scientists, members of the local community, and representatives from the new National Biological Survey (NBS). A series of technical sessions covered all aspects of research within the park—geology and glaciology, terrestrial and marine succession, and various species accounts, both botanical and zoological.

Five workshops, with participation from all attendees, brainstormed a vision for the future of science at Glacier Bay. The hoped-for result will be an action plan to help guide the park's science program as the NBS is created and as resource issues continue to face the park. Symposium proceedings will be published in 1994.

* * *

Larry Whalon has been selected as new Chief of Resources for Northwest Alaska parks (Cape Krusenstern National Monument, Kobuk Valley NP, and Noatak National Preserve). Whalon comes from the Bureau of Land Management, where he was a Natural Resource Specialist/Botanist. He holds a master's degree in botany (rare plants) from U/WY.

Mary Beth Moss has been named new Chief of Resource Management for Glacier Bay NP and Preserve. She comes from the USFS's Oregon Dunes NRA, where she was a Resource Management Specialist.

* * *

A panel of park and regional natural resource staff, appointed by the Regional Director, is evaluating the existing AK Region natural resource program and alternatives for its redesign. A professional outside facilitator, who has worked with several natural resource agencies, is guiding the process. The panel is focused on the natural resource functions needed for the *region*, as opposed to narrow subject areas. The intent is to develop an organization that provides management with strong science and natural resource information for use in their everyday decision making.

Southeast Region

From Bob Hickman, Resource Management Specialist at SERO, comes a 3-page single-spaced listing of the research scientists and employees who are transferring from the SE Region of NPS to the National Biological Survey (NBS). The detailed listing expresses appreciation and recognition for their contributions to the Region and the heartfelt hope for a continuing close relationship with the NPS. "They have been," he says, "and we hope will continue to be 'highlights' in the Southeast Region.

Hickman's submission is evidence of thorough research into the expertise and accomplishments of each of the fond-farewellers. Here, regrettably, we have space only to list their names:

Joseph D. Clark, Stephen Cofer-Shabica, D. Martin Fleming, Gary Y. Hendrix, William F. Loftus, Stephen C. Nodvin, Francis P. Noe, Charles R. Parker, John D. Peine, Michael B. Robblee, William B. Robertson, Jr., Caroline S. Rogers, Theodore R. Simons, James R. Snyder, Michael A. Soukup—all scientists. Also transferring to NBS are Michael Kunze, Janet Rock, Virginia Garrison, Ellen Gorman, Linda Grober, Holly Belles, and Marlena Hovorka. All will be missed and are wished well.

* * *

A recently published report from the Region is B. R. Johnson's **Mitigation of Visitor Impacts on High Montane Rare Plant Habitat:** An integrated strategy of design,

interpretation, and restoration at Craggy Gardens, Blue Ridge Parkway. NPS/SERBLRI/NRTR-93/07.

S. P. Bratton and S. Miller have had accepted for publication a report on **Historic Field Systems and the Structure of Maritime Oak Forests, Cumberland Island National Seashore, GA.**

Mid-Atlantic Region

For several years, Shenandoah NP has undertaken to control exotic brown trout populations in four park streams. More than two decades ago, exotic brown trout were introduced into the lower reaches of these streams outside the park boundary. Under an agreement with the VA Dept. of Game and Inland Fisheries (DGIF), the stocking of non-native trout in waters continuous with park waters was discontinued in 1985. The primary method of control is intensive electroshocking of known brown trout habitat in the park, and removal of browns during low water periods in late summer.

Despite five years of intensive efforts, significant populations persist; their range continues to expand upstream. In 1993, several hybrid brown/brook trout (tiger trout) were captured, indicating a new threat to the genetic purity of the native trout populations of isolated park streams.

* * *

A recovery plan for the Shenandoah salamander is in the final stages of development. No substantial change in park management appears to be required in order to implement this plan. The recovery strategy will be to protect the habitat from human disturbance. Some minor restrictions concerning trail maintenance and fireline construction may be necessary.

* * *

Shenandoah NP's Natural Resources and Science Chief David Haskell attended the final 1933 meeting of Virginia State Science Advisory Board for Air Pollution. Final reports from the committees on Adverse Impacts, Pollution Prevention, and Risk Assessment were presented and discussed. Also discussed were progress of the park's Air Quality Management Plan and the NPS Eastern Region's Air Quality Plan.

* * *

Concerns about excessive white-tailed deer populations in Shenandoah NP's eastern park units continue to be studied. Park resource management staff have been involved in a cooperative effort with the Virginia DGIF to assess deer health throughout the state. Analysis of parasites and fat storage from six park deer indicated the deer were in good health this summer, despite observations that deer habitat condition has been degrading for the past decade.

The reason for the good current health of these sample deer seems to be the recent increase in understory vegetation in response to gypsy moth-induced tree mortality. This sudden increase in forage may be improving deer health and thus increasing birth rates and the deer population in general. Concerns are that widespread tree mortality in the park could lead to a deer population explosion.

* * *

Colonial National Historical Park, working with VA Institute of Marine Science, has begun a parkwide urban groundwater impact study. Wells have been installed at 21 locations and first quarter samples are being analyzed. Quarterly sampling will include inorganics and organics over a 1-year period. Final results and available data will be analyzed and recommendations made for long-term monitoring and management.

Under a challenge cost share cooperative agreement with NC/State/U, the park is developing automated GIS applications dealing with wildfire analysis and planning, and wildlife observations. Also, fire management unit values-at-risk maps are being finalized using the GIS and integrating cultural, natural, and infrastructure information.
The park has contracted with the VA Division of Natural Heritage to prepare a detailed monitoring plan for the different natural heritage occurrences and habitats identified in a recent survey. This will include both state and federally listed species.

* * *

Michele Batcheller of PA/State/U has been hired as the wildlife biologist responsible for researching and developing the DEIS for white-tailed deer management at Gettysburg National Military Park/Eisenhower National Historic Site. Four chapters already are completed.

Gettysburg NMP/Eisenhower NHS has begun to inventory all its fauna. The research is being conducted by PA/State/U students Greg Keller, Ian Harrell, and Ron Rohrback under direction of Dr. Richard Yahner, wildlife management professor. Historical fauna research reports, park maps, and wildlife observation records have been investigated and field work began in Spring 1993. The study is expected to take several years. Although no state or federal rare, threatened, or endangered fauna species have been discovered within the parks, some species not previously known to occur here have been documented.

Piping Plover Protection Wins Cape Cod NS Worldwide Recognition

Cape Cod National Seashore recently gained international recognition for outstanding efforts to protect piping plovers, a federally listed species under the Endangered Species Act (ESA). In September 1993, the Western Hemisphere Shorebird Reserve Network (WHSRN) named Cape Cod NS to its Piping Plover Registry, making Cape Cod one of 13 sites in the U.S. and Canada approved as part of the Network.

The piping plover is a small shorebird that nests and feeds along sandy beaches. It has suffered greatly from increased development and recreational use of beaches on the Atlantic Coast since World War II, and habitat loss in the Northern Great Plains and Great Lakes regions. Despite its listing under the U.S. ESA in 1986, the bird has not shown strong signs of recovery. A 1991 survey by the USFWS Piping Plover Recovery Team came up with only 5,482 adult birds in an exhaustive search of 10 countries.

The WHSRN initiated the Piping Plover Registry to highlight the critically important roles played by individuals, public agencies, and non-profit groups who work to protect this bird. The Registry also will help facilitate information exchanges among sites working to improve conservation efforts.

Cape Cod NS has registered success in protecting piping plovers on the Seashore's beaches by working to minimize disturbance of nesting birds, conducting public education programs, and fencing nests from predators. Nesting success is closely monitored.

Beyond the Mission: An Essay On NPS Management

By David A. Haskell

The mission of the National Park Service, as stated by the 1916 Organic Act, has been the focal point of debate and discussion both within the NPS and by agency supporters and critics for several decades. The list of reports and commentary that have been prepared over the past thirty years in particular, repeatedly refer to the "dual mission of the NPS". Discussions have even referred to the Organic Act as being impossibly schizophrenic, a statement of mission that requires the agency to pursue two diametrically opposing goals; To protect park resources, and to provide for public enjoyment. The most recent public mention of this duality of mission can be found in the opening paragraph of the National Research Council Report, *Science in the National Parks* where the dual mission is referred to as "a losing battle". One would think that if a crest was designed for the agency the central feature would be a two headed eagle, a bird that sees all but can never get off the ground.

Presenting the NPS mission in a seemingly new, different, or novel light has been the hallmark of several NPS Directors since the stalwart leadership style of George Hartzog brought the agency the "Parks for People" program. We even momentarily set aside the NPS arrowhead in favor of the Parkscape triangle tie tac and the beloved buffalo gave way to the design of the century, the "You're in good hands with the NPS" badge. Many remember the day when the NPS badge was stripped away from all employees except those with law enforcement authority. We have had some interesting times, all in the name of clarifying the NPS mission.

Perhaps the most intensive mission analysis since the drafting of the Organic Act took place during the National Park Service 75th Anniversary Conference held in Vail Colorado, now known affectionately as the Vail Conference. The report that grew out of this landmark event, "National Parks for the 21st Century" (The Vail Agenda), brought an intense focus on professionalizing the NPS workforce. There was a particularly strong focus on improving the agency's capability to provide a science based resource management program. The message from and to the attendees was clear. In his closing remarks Director Ridenour emphatically stated that the very resources for which the parks were created were at serious risk and that we could no longer allow this to continue. In his words he stated that from now on, if we are to err, we are to err on the side of the resource. The order was clear, we were to protect the resources at all cost.

From the Organic Act of 1916 to the Leopold Report in 1963, and on to the NRC report on Science in the National Parks in 1992, there is general agreement that resource stewardship is the NPS mission. Passive protection can no longer be counted on to assure the continuation of resource integrity in this rapidly changing world.

We can finally put our minds at ease, the dual mission has been reduced to a single mission, resource stewardship, the eagle with the single head can now fly. These recent events have put the minds of many NPS employees at ease, or have they? Is this a complete picture or is something still missing here? What about the last word of the agency title, the National Park **Service**? What about the fact that the NPS is an agency funded by tax dollars in a democratic society where the government is expected to serve the needs of the public? In a manner of thinking, the American people created the parks for their use and enjoyment. Many fallen governments have failed to recognize the stark reality that what the people giveth, the people can taketh away. Governments that are not responsive to the people are eventually replaced. It is easy to lose sight of the fact that the existence of each national park is only one piece of legislation away from being voted out of existence! Does this realization change the mission? I think not, but it should cause us to look beyond the mission and ask ourselves the big question; WHY?

There must be something to consider beyond the mission of the National Park Service. **We must have not only have a mission, there must be a purpose.** When we think of what the NPS is all about, it may be easier to think in terms of both mission and purpose. The mission is what we do, the purpose is why we do it. In war, the mission is to win the battle, to win the war, but the purpose is to bring about peace. The battles are the action. Some of the action is not pleasant but it has to be done. Peace is the human value that is derived from all of the effort and sacrifice. What is achieved is cherished because it has a cost and a great value. In a way this is analogous to the preservation of the natural and cultural heritage of our people.

In the mission and purpose paradigm, the NPS mission is to preserve the natural condition of the national parks, the cultural resources and values of the historic, military, and cultural parks, and the recreational values of the national seashores, lakeshores, rivers, and recreation areas. In most cases, the values to be protected are identified in the enabling legislation for each unit. The purpose for doing so may not be quite so self-evident. Understanding the purpose is not just a philosophical exercise; it is essential to maintaining a focus on how we manage national parks. It order to stay on track in the complex world of today and into the near future, we have continually to ask ourselves, WHY ? Answering the why question often produces the most useful rationale for making difficult management decisions. Let's examine the purpose behind the mission.

In the simplest general terms, WHY we engage in the NPS mission is that the National Park Service is a public service agency of the U.S. Government. The Congress has stated via several pieces of legislation that they want the parks to be aggressively managed so that the resources are protected from significant damage. This enlightened public perspective was most eloquently stated in the 1970 Administration of the National Park Service Act (16 USC 1a-1-1c), "These areas, though distinct in character, are united through their inter-related purposes and resources into one National Park System as cumulative expressions of a single national heritage... Individually and collectively, these areas derive increased national dignity and recognition of their superb environmental quality through their inclusion jointly in one national park system preserved and managed for the benefit and inspiration of all the people of the United States". This message was again reaffirmed with similar language in the 1978 Redwoods Act (16 USC 1a-1). This wording describes the public value to be achieved in managing the National Park System. It speaks well to the WHY question, it helps to define the PURPOSE, at least from the legislative perspective.

Early American philosophers and students of the natural world such as Henry Thoreau and John Muir expressed the more passionate view that some of the natural world, as created by a force greater than ourselves, must be maintained in pristine condition. In these places humans would have a place to go where the mind and soul would not be bombarded with the sights and sounds of human activity. These would be places where the forces of nature reign supreme, and as mortals we must acknowledge our place in an order that is not dominated by man. When

the crazy world spins out of balance these are the places where we go to keep things in perspective. There are many people among us today who believe this to be an important part of the WHY question.

Perhaps a more mainstream public perspective that contributes to our understanding of the NPS PURPOSE is the realization and appreciation that preserving the variety of natural American landscapes, complete with their full complement of flora and fauna (the ecosystem) is important to maintaining our sense of national identity. Superimposed upon these landscapes is the story of the founding and growth of our nation that is being preserved as national historic parks, cultural parks, battlefields, and other sites that provide the window into our past. In the management of most units of the national park system it is impossible to separate the human history from the natural history. The relationship of the land to the American identity has been most profoundly exemplified by the culture and beliefs of the native Americans, who have perhaps, more than any other segment of the public, mourned the loss of the native American landscape. The national parks and federal Wilderness Areas will soon be all that remains of America not dominated by the works of human beings. They will indeed be not only the last of the great places, they will be the **only** great places. This is WHY their integrity can not be compromised.

Unfortunately not all segments of the public feel strongly about these values. A common trait among people of all nations is to be most concerned about today. Somebody else can plan for tomorrow. In democratic societies the people tend to delegate planning for tomorrow to their elected governments. In the early days of American democracy the first governments were charged with looking after the general public good. Government remains today as the constitutionally designated representative of the people, and thus must assume a great measure of responsibility for the future of the people. Imperfect as we may find government at times, there is no other group on the horizon that even seeks to fulfill that awesome responsibility. There is, therefore, no more fundamental purpose for the National Park Service, as a government agency, then to assume responsibility for the long-term preservation of the natural and cultural heritage of the nation.

These several facets of the NPS PURPOSE provide the strongest rationale for not allowing short-term public interests to compromise the effective long-term management and preservation of the parks. When faced with difficult mission-related decisions that pit the short-term interests and demands of certain segments of the public against the long-term stewardship mission of the agency, it may be more fruitful to present a defense based on PURPOSE rather than relying solely on a statement of mission. Even in the absence of Congressional or special interest public pressure it may often be less troubling for park managers to ask the WHY question that will reveal the PURPOSE which will be served. The view that is provided when mission is seen in conflict with purpose tends to give us a cross-eyed vision of our task. The use of mission and purpose **together**, in a focused way, could conceivably provide us with a new, stereopticon picture—one that would cast positive light from both directions and more clearly show us the way to good management decisions.

Haskell is the Natural Resources and Science Chief for Shenandoah NP.

Haskell Explores NPS "Commitment" in FORUM Essay

"Is the NPS Ready for Science?" is the question asked by David Haskell in a provocative essay appearing this month in the George Wright Society's FORUM. Haskell cites the shelved reports so ably discussed by Jonathan Jarvis in the Summer 1993 issue of *Park Science* (Vol. 13, No. 3, pp 6,7, and 10), and proposes one way to effect a change in the NPS science and stewardship paradigm.

Despite the plethora of reports and recommendations, Haskell states, the **will to change** has been notably lacking to date. He hails the recent line-up of favorable aspects for supporting ecologically and scientifically sound park stewardship, terming it "an astrological window," and adds: "This may be the only time in the history of NPS that the Service itself is the only obstacle to accomplishing this shift."

Haskell describes "the worries of a lot of park managers" at the transfer of all the biological science research personnel stationed in parks, CPSUs and central offices to the National Biological Survey. He muses on the fact that these Research Grade Evaluation (RGE) personnel have been relied on heavily by superintendents, because the resource management specialists ("although many of them are skilled and dedicated") are spread so thin that "they rarely have the time to address the larger strategic resource management needs of the parks." In addition, they can aspire to no more than a GS-11 grade and "very little training and career development has been offered to enhance the basic skills they have brought to the job."

The question now, Haskell says, is why—considering the repeated recommendations of past review commissions—the Service didn't start decades ago the process of building a scientifically credible resource management program carried out by park biologists and other "applied scientists." He cites "substantial institutional inertia (euphemistically termed 'tradition')" as perhaps *the* major obstacle to any meaningful change in the fundamental management strategy.

Haskell first asks "Is the NPS ready to adopt a resource stewardship paradigm based on science, that looks to the future and insures the ecological integrity of the parks?" and then presents some of the key recommendations that have been made to date—care-fully arranged as "stepstones" to the preferred new paradigm.

The essay in its entirety appears in the GWS's FORUM, Vol. 10, No. 4, due out in December/January.

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ISSN-0735-9462

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An ecosystem approach was used to develop the program. Conceptual models of the lake ecosystem were developed and used to guide research and analyses. Studies included quantity and chemistry of precipitation, lake level fluctuations, solar radiation, chemistry of intra-caldera springs, lake clarity, lake color, lake chemistry, particle flux, chlorophyll, primary production, phytoplankton, zooplankton, bottom fauna and flora, and fish. An extensive data base was assembled for each aspect of the study.

A Study in Complexity

Crater Lake was found to be a complex, dynamic, and oligotrophic (nutrient-poor) system. The volume of the lake responded quickly to changes in precipitation because the basin has no surface outlet. Water leaves the lake through seepage and evaporation. Although the lake level normally fluctuates about 0.5 m annually, the lake surface dropped about 3 m in elevation between 1984 and 1992. The lake was relatively high in dissolved salts, total alkalinity, and conductivity; pH ranged between 7 and 8. Hydrothermal fluids from the lake bottom contributed to the relatively high salt content of the lake. Phosphorus and nitrate were low in concentration, although the concentration of the latter increased substantially below a depth of 200 m. On an annual basis, atmospheric bulk deposition accounted for about 90 percent of the nitrogen and 30 percent of the phosphorus input to the lake. Recycling of nutrients was important to the internal nutrient budget of the lake.

Wind-driven circulation mixed the lake in winter and spring to a depth of about 200 m. Some deep-water mixing was indicated by high concentrations of dissolved oxygen at the lake bottom. The lake was thermally stratified in summer and fall. The interface between the warmed surface waters and the cold waters of the deep lake was at a depth of about 80 m.

Secchi disk clarity was in the high-20-m to mid-30-m range. The depth of 1 percent of the incident surface light generally was between 80 and 100 m. Seasonal changes in Secchi disk readings and the depth of 1 percent incident light were observed. In summer, a layer of near-surface turbidity was associated with changes in Secchi disk clarity. Lake color measurements indicated that the near-surface water was very blue.

Wide Ranging Water Chemistry

Water chemistry of the caldera inlet springs exhibited a wide range of chemical concentrations and total ionic compositions over short distances around the lake's perimeter. Calcium, magnesium, and sodium were the major cations; bicarbonate was the major anion. Contribution of nitrates to the lake from the springs was studied specifically because of concerns about a sewage drain field for visitor facilities located just outside the caldera wall. One spring located on the caldera wall near the drain field system exhibited relatively high nitrate concentrations but contributed less than 1 percent of the total annual input of new nitrate into the lake. Although an analysis of the water chemistry of the spring could not confirm the source of the nitrates, the drain field was removed in 1991 as a precautionary measure.

Crater Lake from the west rim, looking east to Mt. Scott with Phantom Ship at lower right. *(PHOTO BY DAVE MCINTIRE)*

Chlorophyll, phytoplankton, and zooplankton were distributed uniformly in winter and spring from the lake surface to the depth of mixing (maximum depth about 200 m), and maximum primary production occurred between 40 and 60 m. A deep-water chlorophyll maximum developed between 100 and 140 in summer and fall, and maximum primary production typically occurred between 40 and 80 m. About 96 percent of total primary production was associated with nutrients recycled in the euphotic zone. A sparse but complex phytoplankton community partitioned the water column to a depth of 200 m. A high density of phytoplankton typically developed in the warm near-surface waters. Cyclic seasonal and annual changes in chlorophyll, primary production, and phytoplankton density were observed. Periods of upwelling of nutrient-rich waters from the deep lake were thought to influence lake productivity.

In summer and fall the zooplankton community, which was comprised of 8 rotifer species and 2 species of crustaceans, partitioned the water column to a depth of 200 m. Zooplanton abundance in the upper 20 m of the water column was very low. Highest densities of zooplankton were located in the depth interval of 80 to 180 m. Closely related or competing species were found in different portions of the water column. The largest crustacean species was cyclic in abundance, and its abundance was related to lake productivity and fish predation. When it was abundant, rotifer abundances declined, and changes in the distribution of the other crustacean species were observed.

Trout and Salmon Persist

Two species of fish, rainbow trout and kokanee salmon, still persist in the lake. Both species were stocked many years ago, continued to reproduce in the lake, and had long-term effects on the lake system. Kokanee salmon mostly were pelagic and fed primarily on crustacean zooplankton and small-bodied bottom fauna. Abundance of kokanee was cyclic owing to the numerical dominance of one year class. Rainbow trout were found along the littoral zone of the lake and fed on terrestrial insects at the lake surface, large-bodied bottom fauna, and kokanee.

Benthic macroinvertebrate richness was moderate in Crater Lake and comparable to the richness found in other large, cold, oligotrophic lakes in the northern hemisphere. Densities of epibenthic macroinvertebrates on rocky substrates in the littoral zone were relatively high. Most taxa in the littoral zone were types common to streams and rivers in montane areas of western North America. Snails were common to a depth of 100 m. Oligocheata worms and chironomid midges were common in the deep lake.

A new species of aquatic mite, *Algophagopsis* sp., was found in the lake. Crater Lake remains the only known locale for this species. The mite was abundant on rock surfaces in association with aquatic

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Water Quality Litigation: An Update From the Everglades

By Michael Soukup

Nutrient enrichment of the Everglades by the Everglades Agricultural Area (EAA) had been reported by scientists since the 1970s. In 1988, the acting U.S. Attorney in Miami filed suit against the State on behalf of Everglades NP and Loxahatchee National Wildlife Refuge to compel enforcement of State water quality law. The Settlement Agreement reached between the State and Federal governments in 1991 obligated the State to construct wetlands in the EAA and to force the primarily sugar cane growers to reduce the phosphorus in their runoff by 25 percent.

When the State sought to effect this Agreement through implementation of a Surface Water Improvement and Management (SWIM) Plan (under the State SWIM Act), the agriculture industry filed more than 30 legal and administrative suits to block implementation. After six months of intensive preparation for trials set to begin in mid-1993, all parties agreed to enter into mediation. Mediation began in January 1993 and is still in progress.

The process began on two levels: Policy and Technical. Technical representatives from all parties met for several months to hammer out a consensus plan; the Technical Mediation Group went further than the SWIM Plan in attacking the water quality issue, including greater protection for the Miccosukee Tribal Lands and Lake Okeechobee, and added additional constructed wetland treatment capacity for Lake Okeechobee and C-51 (a suburban basin) water as a first step in restoring Everglades hydroperiods to pre-drainage levels. The new plan costs roughly $465 million in today's dollars (of which roughly $200 million covers the hydroperiod benefits.)

The Policy level group, with direct involvement of DOI Asst. Secretaries Frampton and Cohen, reached a financial agreement in July. The industry would pay $233 million over 20 years while increasing their on-farm reductions of phosphorus runoff gradually to 45 percent (or pay up to $322 million). This led to an announcement by DOI Secretary Babbitt and the other potential signatories of a Statement of Principles on July 13, 1993.

The Statement was not well received by environmentalists, largely due to a perception that the sugar industry was not paying its fair share, (their payments were not indexed for inflation, etc.), and some public lands in the EAA were to be used for cleaning Lake Okeechobee waters.

Since July, intense negotiations have attempted to produce a detailed agreement that includes some accommodation of the environmental position plus all the difficult issues not addressed in the broad Statement of Principles. Negotiations have been difficult, partly because the agriculture industry remains unwilling to admit in the agreement that there is a problem or that they are the cause. This posture preserves their rights to challenge the agreement if additional clean-up expense is necessary.

A good probability exists that a Phase II effort will be necessary to get down to threshold levels for phosphorus when such levels are experimentally determined. The exact level of phosphorus necessary to maintain the Everglades as it originally evolved, and the effectiveness of the proposed constructed wetlands, are important areas of research during the first 10 years of any eventual agreement.

The construction and operation of over 40,000 acres of wetland for low level phosphorus removal never before has been attempted. As with all Everglades projects, the problems and their solutions are grand in scale, and the potential reward for restoring and preserving the system is equally so.

Soukup is Director of the NPS CPSU at FL International Univ.

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lichen and *Nostoc* in the main lake, on filamentous algae in Emerald pool located on Wizard Island, and on the deep-water moss, *Drepanocladus aduncus*, with the deepest collection from 118 m.

Beds of macrophytes were found on some of the sand-gravel benches around the perimeter of the lake. *Drepanocladus aduncus* was present in dense beds in the lake in the depth interval of 30 to 120 m. Several species of diatoms were associated with the moss. Periphyton was collected from many sites around the lake margin, as well as from depths of 120 m or more.

Comparisons of limnological data collected prior to the study with data collected during the study did not reveal any major long-term changes in the near-surface water quality of the lake. Hydrothermal inputs were responsible for the stable concentrations of dissolved salts through time. The analysis of Secchi disk records collected between two time intervals, 1913-1969 and 1978-1991, suggested that the data sets were fairly comparable. However, this finding was insufficient to dismiss summarily the possibility of subtle long-term change to the lake. Changes in nutrient input from the atmosphere and potential local sources of nutrients may have some long-term roles to play in the productivity and clarity of Crater Lake.

Variability Factors Elusive

It remained difficult to separate the natural variability of the Secchi disk readings from any changes that may have resulted from human-related activities. Disk readings in the range of 39-40 m, which were recorded in August of 1937 and 1969, were not repeated in readings taken in August from 1978 through 1991. However, readings of 37 and 39 m were recorded in July of 1985 and June of 1988, respectively. The absence of extremely deep Secchi disk readings during this study may have been a sign of change, but a 33.5 m reading in August 1954, the only bona-fide August Secchi disk reading between 1937 and the late 1960s, illustrated the problem of separating the natural dynamics of lake clarity from any long-term decreases in clarity.

In general, the Crater Lake ecosystem was extremely reponsive and sensitive to environmental change and was judged to be pristine, except for the consequences of fish introductions. The study documented many of the components and processes important to lake clarity and the lake system as a whole. Knowledge of the relative importance of these components and processes was high in many instances, although the level of knowledge of any one of the complex features tended to be low to moderate.

The study also identified many questions needing further study. Long-term change could not be fully evaluated because very little historical data were available to compare with the detailed data base assembled during this study. The situation underscored the need for a long-term monitoring program to evaluate future change against the benchmark set in the 10-year study. Global climate change, air pollution, on-site auto and boat use, and non-native fish present the greatest potential human-related threats to the pristine nature of Crater Lake.

Additional studies would refine knowledge of the components and dynamic processes of the lake system as well as help to separate changing lake conditions caused by natural phenomena from those caused by human-related activites.

Larson is an Aquatic Ecologist with the National Biological Survey, stationed at the Oregon State University NPS CPSU.

A recent assessment of U.S. biosphere reserve regional programs by Sarah Bishop of Partners for Parks gives a good picture of how the biosphere reserve concept is faring. In general, most of the programs are showing results and appear to be growing, as participants gradually learn how to work together for mutual benefit and the regional good. As might be expected, however, the degrees of success vary widely.

The oldest regional program, that of the **Southern Appalachian Man and the Biosphere Cooperative** (SAMAB), which includes Great Smoky Mountains NP, probably has advanced the farthest. With about 10 federal, state, and private partners, and the SAMAB Foundation for fund-raising, the Cooperative has published a strategic planning process for tourist-based communities, acts as a regional clearinghouse for information on environmental education programs, and conducts many other research and education activities.

SAMAB enjoys the growing confidence of the public and increasing cooperation among members. "Tensions and suspicions have faded as SAMAB members learn more about one another's agencies and their missions and goals," according to Bishop. She finds the major problem to be a reluctance of regional and national agency administrators to support SAMAB efforts—support that is needed to supplement the thus-far modest fund-raising by the SAMAB Foundation.

The **Mammoth Cave Area Biosphere Reserve** in Kentucky consists of Mammoth Cave NP (core) and the groundwater recharge area that surrounds it (zone of cooperation). The Mammoth Cave Area BR Cooperative coordinates the BR program. It was established as an adjunct to the Natural Resources Planning Council of the Barren River Area Development District (BRADD). BRADD serves as the biosphere reserve secretariat. The basic issue is achieving sustainable development within the zone of cooperation that improves the economic and cultural well-being of local people while protecting core area values—especially the quality of groundwater, which is critical for cave biota.

Measures to achieve these goals are progressing, thanks to the nurturing of local trust. "Public acceptance was due in part to the early efforts of the park and BRADD to focus the BR program on meeting the needs of the surrounding community... and then assess the benefits to the park... In a region where the federal presence is viewed with suspicion [the park superintendent] has assumed the role of one who is willing to help solve the problems of others as the route to protecting park values."

The **Sonoran Desert Biosphere Reserve** in Arizona presently consists only of Organ Pipe Cactus National Monument, but the possibilities for a regional MAB program, including adjacent parts of Mexico, are growing. Concerns about the drawdown of groundwater for agricultural development in Mexico, the effects of changing U.S.-Mexico trade relationships, maintaining the traditional dryland farming and ranching practices of indigenous people, and other issues are drawing people on both sides of the border together.

Two developments in 1993 have boosted the process. The Sonoran Desert Alliance, with a board of directors consisting of four residents each from Mexico, the Tohono O'odham tribe, and the U.S., was formed to promote cooperation in improving the economic, cultural, and environmental health of the region. Mexico has established a large biosphere reserve with three core areas in northwest Sonora. Carlos Nagel, President of Friends of ProNatura, and Superintendent Harold Smith and the staff of Organ Pipe Cactus NM have played large roles in the ongoing development of the Sonoran Desert BR.

Many U.S. BRs were established as parts of clusters of areas that had differing missions. A need now with many of these BR clusters is to develop more coordination and cooperation among the member units. The **Glacier Area biosphere reserves**—Glacier NP, Coram Experimental Forest, and Waterton Lakes NP in Alberta—have separately developed BR programs that strengthen their relationship with adjoining land owners, but a regional BR program linking all three is not presently on the horizon.

Glacier NP has become involved in the Flathead Basin Commission to address regional water quality issues, and Waterton Lakes NP continues its modestly-funded BR program with its Alberta neighbors. Similarly, the **Chihuahuan Desert biosphere reserves** mostly go their own ways. Big Bend NP emphasizes research on sustainable conservation; the Jornado Experimental Range in southern New Mexico conducts range research; the Mapimi BR in northern Mexico focuses on studies of ecologically sustainable ways local people can use their desert environment more productively.

The Chihuahuan Desert Biosphere Technical Group, an informal consortium of scientists, educators, public lands managers, and interested private land owners, hopes to gain international support for the formation of a regional BR in the Chihuahuan Desert that will include the three existing BRs as well as other federal, state, and private entities. The **Central California Coast BR**, with its 13 member units, makes a greater effort at cooperative action, but not surprisingly encounters caution when an agency is asked to view its role more broadly than its basic mission. The CCCBR has been most successful with its research and education projects. Shared management concerns have been more difficult to identify and address.

The **Virgin Islands Biosphere Reserve** presently consists only of Virgin Islands NP. It "has conducted a remarkable research, monitoring, and resource management training program that will contribute most significantly to a broader based BR program when it is put in place." The challenge here is to bring other entities besides the park into the program and focus it more on ecologically sound economic development.

Perhaps the most unwieldy BR assessed by Bishop is the **Champlain-Adirondack Biosphere Reserve.** Development of this 3,990,000-ha BR is currently stalled, largely because of political and cultural differences between Vermont and New York, and concern of many Adirondack residents about infringement on property rights. Meanwhile, some BR goals are being addressed through the federally supported Lake Champlain Basin Program, which deals mainly with water quality issues.

The greatest need among U.S. biosphere reserve programs, as Bishop (and her informants) see it, is for workable administrative structures and increased funding for administration and projects. Her reports were to be used as background for developing a BR action plan at the U.S. Biosphere Reserve Action Plan Workshop in December 1993.

Napier Shelton
NPS Washington Office

High Tech Meets Old Bones: Accurate Location of Fossil Resources at Hagerman Fossil Beds

By Chris Force

A dilemma paleontologists and archaeologists have long faced is how to identify accurately but discretely a site's location. The staff at Hagerman Fossil Beds National Monument has found a high tech answer.

Hagerman Fossil Beds NM is located in south-central Idaho on the bluffs of the Snake River west of the town of Hagerman. These 500 foot bluffs, composed of the Glenns Ferry Formation sediments, produce a wide variety of fossils (over 100 species including vertebrates, invertebrates and plants) of Pliocene age. The sediments within the monument represent a floodplain environment composed of river channel sands, overbank clays and silts, highly organic pond deposits, volcanic ashes and basalt flows. These sediments are easily eroded and contain localized concentrations of small vertebrate fossils, as well as sites with larger mammal remains.

Bob Willhite, Hagerman's Chief Ranger, takes a sighting using the laser transit to pinpoint accurately the fossil site.

Although this area has been known throughout the world as rich in fossils since its scientific discovery in 1929, it did not receive status as a National Monument until 1988. From 1929-1988 several academic institutions collected fossils on what is now the Monument. Today we know of over 300 recorded fossil localities identified by these various institutions.

The Monument needs a completed baseline inventory to identify the exact location of these fossil sites. This baseline information will provide the framework for the development of the legislatively mandated research program at the Monument, and for its developing resource management plan and general management plan. Knowing the precise location of sites helps in planning for visitor access by indicating where to locate trails and facilities, and how to minimize the impact to the fossil resource. To document these sites, the NPS staff and volunteers are using the latest available technology, a Global Positioning System (GPS) and a laser transit.

The Global Positioning System was developed by the military to determine the location of military vehicles or units on the earth's surface. It utilizes satellites that send signals to a back-pack receiver, which computes the exact location. Using a special, high-precision Global Positioning System, surveyors from the Bureau of Land Management and NPS staff established a grid of 60 reference points throughout the Monument that are accurate within several centimeters.

A laser transit, the Criterion produced by Laser Technology Incorporated of Englewood, CO, is used to accurately survey each fossil site. It works by firing a laser beam at a mirror prism on a height-adjustable pole, and measures the reflected beam of light. A computer within the transit calculates the horizontal distance, azimuth, slope distance, percent slope, and inclination from the transit to the prism. Although the laser is designed to be hand-held, it is mounted on a tripod to capitalize on its precision limits.

Because readings can be done quickly, three replications are taken of each measurement to detect operator error. A limiting factor of the instrument is that directions are based on a magnetic azimuth. For this reason, staff has developed procedures focusing on distances and triangulation. By sighting at the fossil locality and two of the GPS reference points, the exact position of the fossil locality is computed using trigonometric calculations. By this process, the fossil site is located in space horizontally and vertically with a margin of error in tenths of feet. The fossil locality does not have to be physically marked, thus protecting the site's integrity.

Each site is given a unique identifier and a permanent locality code, and will be entered into a GIS system along with pertinent associated data such as species present, number of specimens, and sediment type. Such an accurate baseline inventory will allow us to discover possible patterns in site locations throughout the monument. Analysis of these patterns may help explain how these fossil concentrations formed.

The hand-held attribute of this laser will save substantial time when it comes time to relocate any documented site. It has a navigation function that uses as coordinates the closest reference points, and audibly tells the operator when the instrument is sighted on the fossil locality. The operator can then direct a field crew person to the exact location.

During the course of the baseline inventory for known fossil sites, numerous new sites have been found as well as significant individual specimens. One example is the most complete *Borophagus* (hyena-like dog) known from Hagerman. It's a lower jaw that contains the canine, fourth premolar and first molar. Also discovered were several new mastodon localities and a sandstone concretion with a high concentration of frog bones. It is not yet known how many individuals are represented in this concretion, but at least two species of frogs are present.

High tech measurements, such as those possible using this system, will play a major role in managing and scientifically evaluating the fossil resources at Hagerman Fossil Beds NM.

Force is a Museum Technician at Hagerman Fossil Beds NM

NAS Report Cites Urgent Need for National Biological Survey

The National Research Council, National Academy of Sciences, report, "A Biological Survey for the Nation," was released in early October. It proposed that the National Biological Survey provide leadership for a program that pulls together public and private organizations for gathering information to prevent costly environmental confrontations over the nation's plant and animal life. The federal government spends about $1 billion each year on environmental biology research, but the committee found "significant gaps" in the efforts of current national research programs.

"The National Academy of Sciences report underscores the urgent need for an agency within the Department of the Interior to provide leadership in the life sciences area; that agency is the National Biological Survey," said Interior Secretary Bruce Babbitt. "The report wisely focuses on establishing true partnerships and on the need to support and expand relationships with existing biological research organizations."

The report recommends that the many public and private entities involved in current research on biological resources should work together under the auspices of a new organization, the National Partnership for Biological Survey, to provide comprehensive information that will be useful for decision-makers at all levels of government and outside government.

"The NAS report will be extremely valuable to the National Biological Survey. The National Academy's support for a federal partnership with states, universities, and private organizations will ensure that the new agency becomes a truly collaborative effort," said George Frampton, Assistant Secretary for Fish and Wildlife and Parks, who also will oversee the NBS.

Although somewhat philosophically similar to current NBS implementation efforts, a number of the recommendations contained in the report are much broader in scope than can be covered by existing fiscal and personnel resources of the NBS. The recommendations of the NAS are still under review by Department of the Interior and NBS officials.

CRM Special Issue Highlights 'Tradition'

A special 64-page issue of the Culteral Resource Management bulletin, **CRM** (Vol. 16, 1993) contains articles many of which were prepared for two symposia dealing with traditional cultural properties, held at the 58th Annual Meeting of the Society for American Archaeology in St. Louis, MO in April 1993.

All the papers from the symposium titled "Take Me To Your Leaders: Archeologists and Consultation with Native American and Other Traditional Communities," are introduced by Lynne Sebastian and commented on in the concluding article by Thomas F. King, co-author of National Register Bulletin 38, *Guidelines for Evaluating and Documenting Traditional Cultural Properties*.

The papers by Patricia Parker and by Sally Thompson Greiser and T. Weber Greiser were prepared for a symposium called "Vanishing Spaces: Native American Sacred Places," organized by Thompson Greiser. Several papers prepared specially for this issue are included.

For copies, write Editor, CRM (400), U.S. Department of the Interior, National Park Service, Cultural Resources, P.O. Box 37127, Washington, DC 20013-7127, or call (202) 343-3395.

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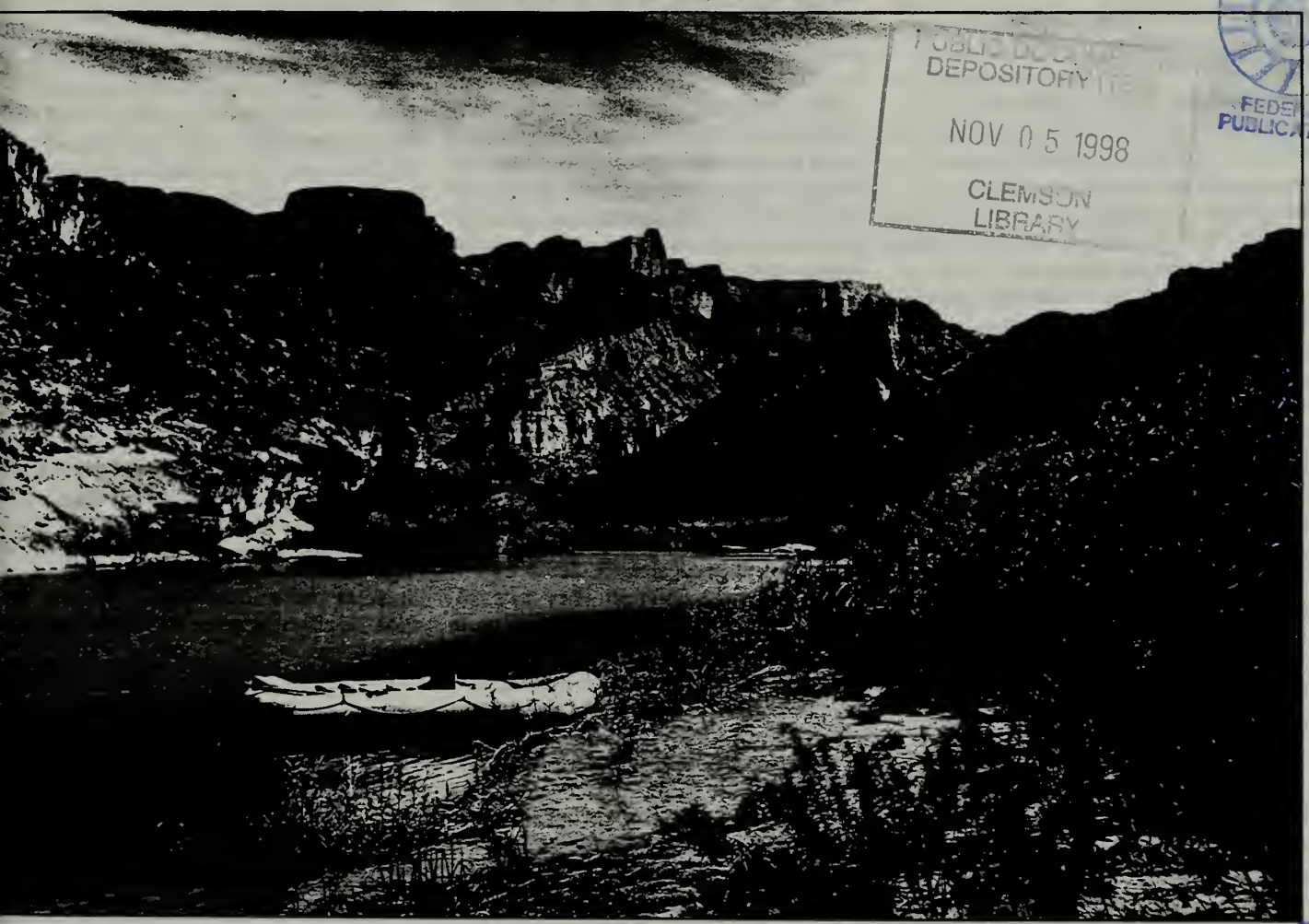
PARK SCIENCE

A Resource Management Bulletin

Volume 14 — Number 2 National Park Service U.S. Department of the Interior Spring 1994

User Study Contributes to Rio Grande Management

By W. P. Stewart, K. A. Yarborough, and J.R. Skiles



Raft in Boquillas Canyon, Big Bend NP. This river section is also part of the Rio Grande Wild and Scenic River. El Pico, of the Sierra Del Carmens, is the prominent peak in the background.

A recently completed user study of the Rio Grande in Big Bend NP, undertaken in pursuit of a river use management plan, comprised four areas of investigation associated with river users:

(1) a trend study of 16,500 river permits that documented river use from 1983 through 1992;

(2) a survey of boaters who obtained private river use permits;

(3) a survey of visitors who obtained overnight backcountry permits to camp at designated sites adjacent to the river, and

(4) a survey of patrons of commercial outfitters associated with float trips on the Rio Grande.

The forthcoming River Use Management Plan (RUMP) will be the first of its kind for the Rio Grande River in Big Bend NP. Big Bend's regulations pertaining to river operations heretofore have been contained in other types of management plans. The RUMP is being developed as a response to specific questions regarding river management objectives and use procedures.

It also is being designed to provide standard operational information to patrol rangers, resource management, and visitor contact staff. In addition to the user study, an ongoing study regarding recreation and trespass-livestock impacts to the riparian ecosystem will provide research-based information to the developing RUMP.

Continued on page 3

PARK SCIENCE

NATIONAL PARK SERVICE

SPRING 1994

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

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DEPARTMENTS

Editorial

Yo, field troops! A dispatch from the front.

Having heard, felt, even experienced some of the angst that currently is rocking the National Park Service field personnel, I can report that I approached the March 1-3 Regional Chief Scientists meeting in Washington, D.C. with equal parts of hope and fear.

After sitting through one full day of fairly frank and open discussion among key players in the National Biological Survey and the National Park Service, and two more days of even franker and more open thrashing over of the situation with NPS personnel only, my assessment is as follows:

The NBS is currently a non-negotiable fact of Department of the Interior life. The Secretary and the Director stand solidly behind its organization and implementation. The two most powerful players in its make-up—the U.S. Fish and Wildlife Service and the National Park Service—are doing their level best to make it work.

I saw good people from two very different science programs striving with good will and commitment to recognize one another's viewpoints and responsibilities. They acknowledged the difficulties they face in trying to meld their different skills and resources, and they gave evidence of being willing to tackle what must eventually become their **mutual** problems.

Promises and pitfalls are a natural coupling that occurs at all major crossroads; jitters are natural and understandable. Into the swirl of events that constitute "present conditions" must go not just the best-laid plans of the well intentioned, but also the human climate such conditions engender. The human perception today seems to range from supreme confidence, downhill through educated doubts, and ending in stark terror.

Also very present is "the butterfly wing effect." Given the extremely fluid state of the emerging new order, the softest bump from anywhere could tip the balance of direction. Frantic phone calls from the field during the March RCS meeting in D.C. emphasized the wisdom of keeping field personnel fully advised as to developments. Well meaning people are attempting to shape an approach that will be stronger, better armed, and more responsive to park management needs. The very real fears of resource managers need to be recognized, honored, and dealt with openly.

To pull off what is being attempted here would be a monumental task even in the best of all possible circumstances. To do so in straitened fiscal times is even more challenging. Small factors can have huge effects at times of "initial conditions." So grab the moment all you positive butterflies, and beat your wings!

Editor's Note: For additional thoughts on this philosophy, please refer to Book Review (page27), especially the portion dealing with Leadership and the New Science *by Margaret J. Wheatley on page 28.*

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Recreational Access

The Rio Grande is unusual among western ivers in that it can be accessed at several oints along its course. Within Big Bend NP, 118-mile stretch of the Rio Grande forms he international boundary with Mexico and uts through three deep, steep-walled, lime-tone canyons: 8 miles in Santa Elena, 6 miles n Mariscal, and 32 miles in Boquillas. Two on-canyon river segments are: (1) between anta Elena and Mariscal, referred to as the io Vista segment; and (2) between Mariscal nd Boquillas, referred to as the San Vicente egment. Paved and unpaved roads provide everal opportunities to access, launch-on, nd take-out from these 5 segments of the iver.

Results of the Trend Study

Of the 10 examined years, 1985 was the eak year for use. Approximately twice as any permits were issue in 1985 as for 1989, 990, or 1991. A general drop in total umber of permits since 1985 appears to be ttributable to a drop in the number of *private* compared to commercial) permits issued. The proportion of private to commercial use ermits in 1992 was about 50/50.)

Over the past 10 years, less than 4 percent f the permits issued were for more than one iver segment. In other words, most users ravel one canyon or segment at a time. The rend study indicates that the historic use atterns are different for each river segment. anta Elena has been the most popular can-on to float, and is associated with four times he number of annual permits issued for any f the other four river segments.

In addition, day-use permits for Santa Elena ncreased dramatically in the mid-1980s and ince have leveled off, whereas overnight ermits for Santa Elena have decreased since he mid-1980s. Commercial use is primarily ocused on Santa Elena Canyon. More than 5 percent of 1992 commercial permits were ssued for Santa Elena, whereas private use in 992 was spread evenly among the Santa lena, Boquillas, and San Vicente segments. rivate use levels in Mariscal Canyon, which accessed primarily by unpaved or primitive oads, is about one-third the private use levels f the other river segments (most likely due to s remote access points).

Results of the Visitor Surveys

The social setting varied across the five ver segments. Santa Elena Canyon was the egment associated with the most reported ontacts with other rafters: 56 percent of anta Elena private-permittee respondents ndicated seeing more than 10 non-motor-ized rafts. Bouquillas was second in terms of contacts with other rafts, with 41 percent of private-permittees indicating they saw more than 10 rafts. Mariscal segment was associated with the least number of raft contacts; just 9 percent of private-permittees reported greater than 10 raft encounters.

The importance of solitude and being alone varied across respondents from the different river segments. Boquillas floaters were most likely to report solitude as extremely important; Santa Elena floaters were least likely to report solitude as extremely important.

The importance of fishing also varied across the river segments. Rio Vista and San Vicente permittees were more than twice as likely to fish as Mariscal floaters, and they were more than five times as likely to fish as either Boquillas or Santa Elena floaters.

The type of trip planning varied, with Rio Vista and San Vicente floaters indicating the least amount of advance planning for their trips and the most flexibility regarding the whereabouts of their river recreational experience.

Trespass livestock (mainly equine) has been a longstanding problem along the Rio Grande corridor of the park. The user study provided information as to the social impacts of trespass livestock. The apparentness of livestock impacts (e.g., trampling, grazing, and manure) varied across the river segments. Rio Vista and San Vicente permittees were least likely to perceive evidence of livestock; Boquillas permittees were most likely to note such evidence.

The perception of livestock impact varied by season, with fall floaters noting the most impact compared to either spring or summer floaters. These social impacts correspond with a seasonal "recovery" period noted in the study of impacts on biota. Summer rains renew the grasses and "sweep" clean the river corridor. In fall and winter, the corridor is less resilient, due to the absence of rains and subsequent renewed vegetative growth.

Management Recommendations

The primary recommendation from the user study is to maintain and explicitly develop the diversity of recreation opportunities afforded by the Rio Grande.

Maintaining diversity of recreation experiences entails recognizing the variety of river recreation opportunities associated with each segment of the river and establishing distinct management strategies for each segment. The results of research indicate that the recreation experience differs across the various river segments, that use levels have differed historically across the segments, and that users recognize differences across the river segments.

In the past, management operations implicitly have facilitated the provision of differing opportunities. Providing for the long-run continuation of such diversity is an important directive for Rio Grande management. Compared to other western rivers, recreational use of the Rio Grande in the park is not considered too high; however, recommendations are offered in preparation for changing (increasing) use levels in the future, should such occur. They are:

a) Consider adopting a river permit process that allows for managerial control of private permittee use levels;

b) Consider an advanced reservation system for river use permits;

c) Insure that staff members issuing river use permits have field knowledge of the sites and conditions of the Rio Grande;

d) Continue to work with Mexican authorities to direct the coordination of river management; and

e) Insure the periodic clean-up of litter in the river corridor.

Development of the River Use Management Plan

A team has been developing the RUMP since June 1993 and the plan is scheduled for completion by fall 1994. Information from social and ecology-based research, commercial use licensees, private user groups, and Mexican authorities will contribute to its development. Following an in-house review, the first draft of the RUMP will be distributed for public comment by mid-1994. Workshops will be held to encourage public comments; information obtained from these workshops will be considered for incorporation into the plan.

For further information on the RUMP process contact Yarborough or Skiles, both at Big Bend NP, TX 79834; (915) 477-2251. For a copy of the user study technical report contact Stewart at College Station, TX 77843-2261.

Stewart is an Associate Professor at Texas A&M University, College Station, TX; Yarborough is Park Scientist and Skiles is a Wildlife Resource Management Specialist, both at Big Bend NP.

Abandoned Road Restoration Methods Tested at Grand Tetons National Park

By Edward Redente, Nicholas Cotts, and Robert Schiller

Every park, monument, and historic site within the National Park System has some disturbance that can be associated with either past or present anthropogenic activities. These disturbances alter both the structure and function of ecosystems and may result in landscape features that are aesthetically unacceptable. Disturbed areas also become ideal locations for establishment and spread of exotic plants and noxious weeds.

Restoration is the process of intentionally altering a site to establish a defined, indigenous, historic ecosystem. The goal is to emulate the structure, function, diversity, and dynamics of the specified ecosystem. Reclamation, on the other hand, has been defined historically as the process of returning disturbed land to a condition that approximates the original site conditions and is habitable by the same or similar plants and animals as existed on the site before disturbance.

Reclamation typically involves the restoration of certain processes or functions, but typically stops well short of restoration. It may however be viewed as an important step toward restoration. Restoration will be successful only if we (1) adequately understand how the disturbed system functions and what the limiting factors are, and (2) develop and apply the correct prescriptions. The restoration process is not simple and in most cases requires enough time to allow natural biological process, such as succession, to occur.

The NPS can use restoration techniques to treat disturbed sites so as to control erosion, remove exotic and noxious plant species, increase biodiversity of indigenous species, reestablish nutrient cycles, and improve aesthetic values. This report summarizes results from a research project designed to test the effectiveness of different restoration techniques on an abandoned road in Grand Teton NP. The specific objectives of this project were (1) to evaluate the effectiveness of various levels of site manipulation such as seeding, fertilizing, scarifying, topsoiling, and mulching, and (2) to compare the performance of seed from native species collected within the park to seed from native species obtained from commercial sources.

This research was part of a larger road construction project that included a seed collection and increase program in association with the Soil Conservation Service. Seed that was collected in Grand Teton was increased by the Environmental Plant Center in Meeker, CO, for restoration work in the park.

Test plot construction in the fall of 1988.

Abandoned road site at the north end of Timbered Island in Grand Teton NP. Seed in the area was collected to compare the effectiveness of indigenous seed vs. commercial seed.

The Study Site

The study was conducted within the disturbed tracks of an abandoned road at a 2,075 m elevation. Climate there is semiarid, with hot, dry summers and cool, wet winters. Average annual precipitation is 68 cm, with a mean annual temperature of 2.2 C. The soils of the area were formed on stream terraces and alluvial fans as well as glacial outwash materials from the Teton range. The soils are characterized as well drained, with moderate permeabilities.

The undisturbed community surrounding the study site can be classified as a low sagebrush/big sagebrush mosaic. The disturbed, abandoned road site consisted of highly compacted soils, low organic matter and nutrient levels, and absence of vegetation.

Methods

The study was begun in the fall of 1988. Over a four year period, 14 treatments were tested. A detailed description of them can be found in Cotts et al. (1991). Plant cover was measured by species during the growing seasons of 1989 through 1992. In addition, woody plant density was determined during the same time period and aboveground production was estimated, using a direct harvest method in 1992.

Infiltration and bulk density tests were conducted on scarified/non-scarified treatments and topsoiled/non-topsoiled treatments to assess the effect of soil scarifying and topsoiling on infiltration and bulk density. Aggregate stability analyses also were completed on the same treatments following the procedures of Kemper and Rosenau (1986) to understand the relationship between bulk density, infiltration, and aggregate size and stability of the treated and untreated soils on the site.

Results and Discussion

After four growing seasons we found that the topsoiled treatments supported the most plant cover and biomass, with 5 cm of topsoil providing more favorable results than 15 cm of topsoil (Fig. 1). Topsoil treatments that were seeded (to either indigenous or commercial seed) were dominated by perennial grasses, while non-seeded topsoil treatments were dominated by big sagebrush—the dominant species in the surrounding plant community.

Non-topsoil treatments had significantly less plant cover and biomass than topsoiled treatments, but those treatments that were seeded to the indigenous mixture showed good plant community development. Scarifying the original road substrate yielded better plant growth than non-scarifying, and mulching produced no differences in plant cover or production.

Infiltration and bulk density analyses were conducted to determine if compaction was a problem and if the selected treatments of scarifying and topsoiling improved the physical parameters of the road substrate. The undisturbed soil surrounding the road had the lowest bulk density, while the non-scarified road surface had the highest bulk density, confirming that the road had been compacted as a result of many years of vehicular activity.

It was expected the infiltration rates would be inversely correlated with bulk density; in other words, as bulk density increased, infiltration would decrease. The results of our testing showed that scarifying the road substrate reduced bulk density, but infiltration rates were not improved. Additional analyses of aggregate stability showed that the compacted soil from the road substrate had smaller and less stable aggregates than either the undisturbed soil or the topsoil used in the study.

We found that these less stable aggregates would disintegrate upon wetting, thus plugging macropores in the soil and reducing infiltration. It must therefore be recognized that although scarifying soil may reduce bulk

lensity and create more favorable seedbed haracteristics, it may not improve infiltraion if an aggregate stability problem exists. Aggregate stability will only improve with he addition of organic matter and after other oil building processes occur, such as soil nicrobial development.

Implications

Our research has shown that disturbances uch as abandoned roads can be restored uccessfully with a variety of approaches that ary in the level of resource inputs and also in me required for complete restoration to ccur. The applications of small amounts of opsoil (as little as 5 cm) in combination with eeding of indigenous seed will produce a lant community that will emulate the surounding undisturbed community in as little s 15 years in environments similar to that at ur Grand Teton study site.

We believe, however, that less intensive pproaches, such as soil scarification in combination with seeding indigenous species, will result in successful restoration in a time frame of 20 to 25 years. Since indigenous seed performed better than native seed obtained commercially, we recommend that restoration projects use seed from sources known to be adapted to the climate and soil characteristics of the area to be restored.

With respect to economic considerations, the cost associated with adding 5 cm of topsoil and seeding indigenous plant materials would be approximately $5,000/ha ($2,100/ac). These costs are based on estimates associated with restoration work in the Grand Tetons and will vary depending on site conditions, sources of topsoil, and distance required to transport soil.

Restoration is a long-term process that is dependent upon natural physical and biological processes to bring it to completion. It is therefore critical that patience be seen as a necessary virtue for all resource managers involved in such projects. Also, it should be understood that limited resource inputs can prove to be valuable approaches where the time frame for success is not a major restriction.

Redente is a professor in the RangelandEcosystem Science Dept., CO/State/U, Fort Collins; Cotts previously was a graduate student at Colorado State and currently is a reclamation specialist with Shepherd Miller, Inc., of Fort Collins; Schiller is Chief, Branch of Science in the NPS Denver Regional Office.

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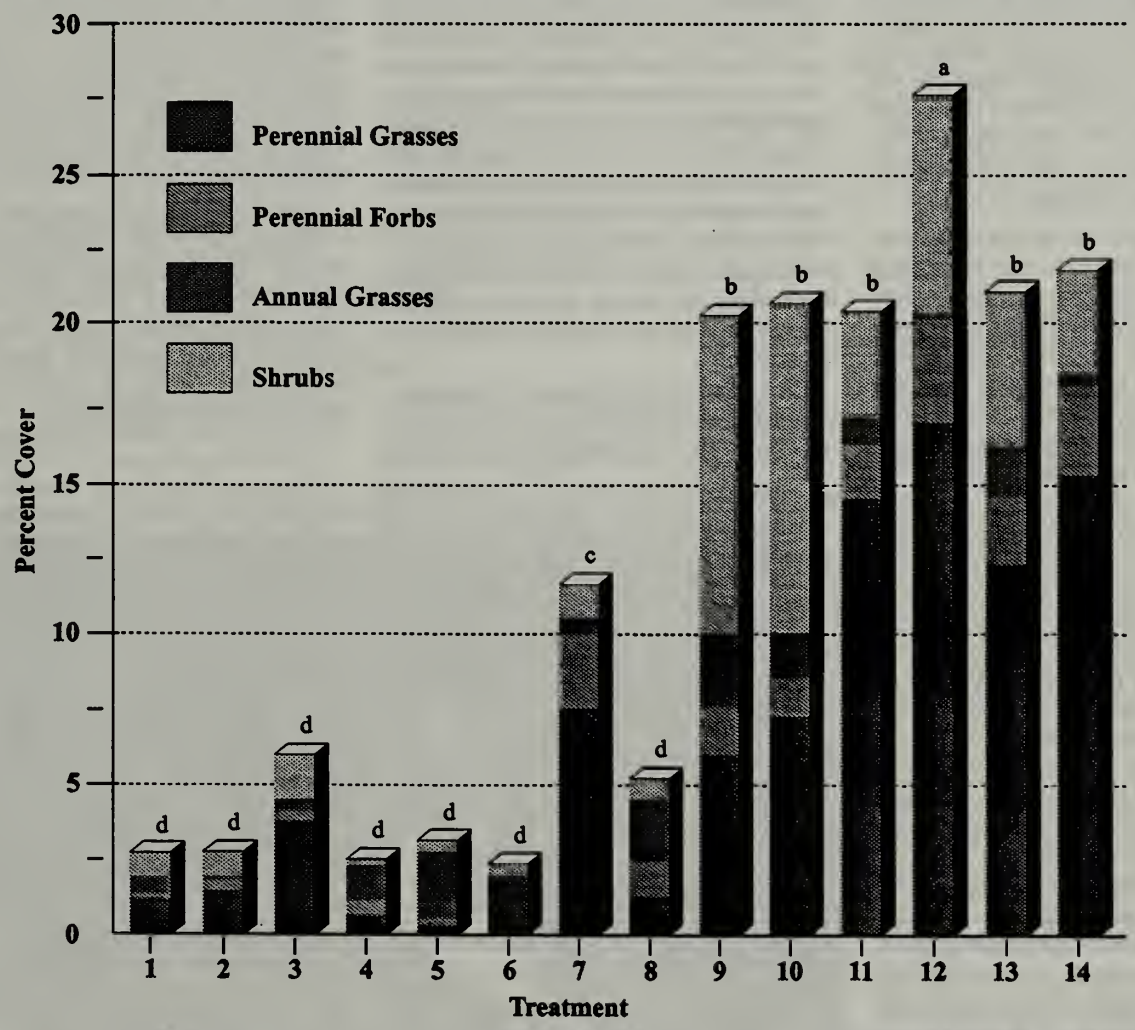
Figure 1. Total plant cover in 1992, four years following initial treatment. Treatments with the same letter are not significantly different at P<0.05.



1. Control
2. Control and Mulch
3. Indigenous Seed
4. Commercial Seed
5. Scarify, No Seed
6. Scarify, Rock Raking
7. Scarify, Indigenous Seed
8. Scarify, Commercial Seed
9. 15 cm Topsoil and Scarify
10. 15 cm Topsoil, Scarify, Fertilize
11. 15 cm Topsoil, Scarify, Indigenous Seed
12. 5 cm Topsoil, Scarify, Indigenous Seed
13. 15 cm Topsoil, Scarify, Commercial Seed
14. 15 cm Topsoil, Scarify, Indigenous Seed, Mulch

Glacier NP Undertakes Revegetation Monitoring

By Kristin Vanderbilt

Visitor impacts, facility maintenance, and road reconstruction in Glacier National Park present a continuously recurring problem of disturbed lands and the need for effective revegetation procedures. While roadcuts covered with native grasses and forbs point to some of Glacier's successes, areas of high exotic species density or bare slopes suggest that revegetation treatments were inadequate, or that it may be impossible to re-establish a native community on all disturbed sites.

In 1992, Glacier NP began a monitoring program to record the status of revegetated sites in order to evaluate possible sources of failure. Monitors describe target plant communities for project locations, against which overall revegetation success may be measured. Program objectives are to improve the methods and learn the limits of what revegetation can accomplish, so that realistic restoration goals may be established.

The monitoring program includes (1) a pre-disturbance visit to describe the site and establish goals in terms of a reasonable target community, and (2) periodic monitoring of revegetated areas to judge how well the seeded and planted species are faring and how satisfactorily long-term goals are being met.

Site Analysis

Effective revegetation efforts begin with thorough site evaluations. The monitoring program's Site Analysis procedure, loosely based on Forest Service ECODATA (Jensen et al, 1992) ocular plot methodology, provides a systematic framework for recording soils, microclimate, animal use, vegetation structure, and species canopy cover information relevant to revegetation needs.

Data on these characteristics are taken from a representative plot. Based on what vegetation is on the site, what grows nearby, and the management plan for the area, a target community is suggested. For example, a deleted roadside turnout in a lodgepole forest, which will be mowed yearly, may be targeted for the understory lodgepole low shrub and herbaceous community. Two site analyses frequently are conducted, one to describe the disturbed site to be revegetated, the other to describe an undisturbed plot that represents the target community.

Once goals for the area have been set, the site analysis involves making recommendations for plant material use, fertilizer application, mulch, plant salvage, and soil salvage. The site analysis procedure is structured to record current site and plant community conditions, set revegetation goals, and guide efforts to meet those goals.

Various staff members who conducted site analyses during the summer of 1993 have found this a valuable planning tool. The detailed record of species and their abundance in the target community is useful when seed mixes are prepared and nursery stock needs estimated. Soils and microsite information may suggest special planting and watering requirements, which are figured in during the planning process. The value of the site analysis will be realized fully many years down the road, when it will serve as a reference for determining how closely the product of revegetation and succession resembles the target community.

Revegetation Monitoring

Monitoring procedures utilize both microplot and ocular survey methods, and involve recording many of the same plot characteristics that site analysis does: Ground cover, species cover, erosion status, vegetation structure, and disturbance history. In the long-term, these data will allow successional trends to be followed to determine the timeframe in which components of target communities establish, or to reveal that the target community was not a reasonable goal for the area, given our methods. In the short-term, by systematically revisiting monitoring sites and recording, for example, exotic species presence, germination of seeded species, and vigor of planted shrubs, we will be able to identify areas where we need to improve our techniques.

Four monitoring schemes of increasing complexity have been devised, suited to different needs. The intensity of monitoring required for each area depends on the revegetation measures applied, site location, and likelihood of the site's being problematic due to factors such as continued disturbance, poor soil, or slope.

A backcountry campsite that has been blocked off, seeded, and mulched is appropriate for very basic Level I monitoring. The questions of interest here, rapidity of site recovery and exotic presence, are addressed readily by ocular plot estimates of ground cover and canopy cover of trees, shrubs, herbaceous species, and noxious weeds. No specific data about revegetation species are collected. This rapid site assessment is intended to flag any area that needs remedial action due to exotic encroachment, erosion, or continued disturbance.

Level II monitoring is the backbone of Glacier's program and has been used extensively. In addition to making a general evaluation of soil surface status and total vegetation cover, the monitor makes species lists of at least the dominant exotic and native species present. Mortality, growth, and vigor of planted shrubs and forbs is quantified, as are cover, density, and reproductive status of seeded species. This level addresses success of revegetation measures and may prompt changes in procedure. For example, numerous exotic species were recorded in monitoring plots on imported soil used at a construction site, while salvaged soil in the same area had very low exotic cover. These observations suggest the use of unpasteurized imported topsoil is questionable.

Continued on page 7

Rachel Potter, Biological Technician, collects microplot data from a roadside revegetation site.

Olympic Revegetation Efforts Continue to Evolve

By Edward Schreiner and Ruth Scott

Revegetation in the backcountry of Olympic National Park (OLYM) began in 1975 as a strictly seat-of-the-pants operation. We would judge which campsites and trails had unacceptable levels of human impact, close them, and move plants into the sites from nearby. The learning curve was steep—we had spectacular failures and moderate successes. We learned, among other things, that survival of transplants from nearby locations was variable, depending on plant size (i.e. neither too big nor too small) and weather conditions at the time of transpanting (i.e. best when cool and rainy).

Our early efforts, while well-meaning, have evolved into a more organized program. We now use native plants propagated in a greenhouse from seeds and cuttings. Most reveg work is conducted in the fall, resulting in higher survival rates. Revegetation priorities are based on parkwide surveys of human impact, visitor use levels, and wilderness classification. We use transplanted vegetation (that which is not produced in the greenhouse) only under limited circumstances such as small-scale fire line restoration projects (i.e. not on the scale of Yellowstone fire lines).

The OLYM revegetation program has improved from the early days, but new issues require resolution. Raising plants in a greenhouse has increased plant survival in restoration sites and also allows us to obtain materials for propagation from more locations, but the latter carries the risk that, however unintentionally, we could alter the genetic makeup of park ecosystems. Most debate seems to center around setting a maximum distance away from revegetation sites for collection of propagating materials.

We recognize that maintaining the genetic integrity of park ecosystems is an important and worthy goal. We also believe common sense needs to be part of the decision-making process. This means considering reproductive mechanisms, wind patterns, and the relative abundance of species selected for revegetation. For example, it makes sense to collect the seeds of common wind-pollinated conifers from sites with similar elevation in the same river valley as the reveg site. Equally, seeds of plants pollinated by insects with limited flight distances should be collected from very close to the reveg site. We feel that setting an arbitrary maximum distance away from revegetation sites for collection of propagating materials makes no sense.

We realize this view is not shared by everyone and that it is time to engage in serious dialogue to resolve the issue. However, we do not believe this complex problem has a simple answer. The entire matter raises questions that need intensive, informed thought:

(1) Should we be attempting to restore sites to look like the surrounding vegetation, or should we restore early successional (but native) species and let nature take over from there?

(2) Are non-native, sterile species (like sterile wheat) appropriate to help stabilize slopes prior to native species taking over?

(3) Is it appropriate to restore the soil profile, and if so, how many soil amendments are appropriate (fertilizer, peat moss, steer manure, etc.)?

(4) What should we use when fill material is required but only soil of different parent material and characteristics is available?

Ultimately, we would like to see revegetation develop in direction of restoration using the equivalent of silvicultural prescriptions. This could involve assessing expected mortality rates (by species) in advance. Thus, compensating measures such as planting at extra-high density could be taken. We feel that we and other parks have made significant progress, but we realize that much remains to be learned. The questions listed here might serve as a useful beginning.

Schreiner is a Plant Ecologist with the NBS; Scott is a Resource Management Specialist and runs the revegetation program at Olympic NP.

Revegetation Monitoring continued from page 6

A Level III monitoring procedure involves establishment of permanent microplot and shrub transects to collect data suitable for statistical analysis. This level has been utilized in deleted turnouts along the Lake McDonald section of Going-to-the-Sun Road, where half of each turnout was seeded and half was not. Data will be analyzed for (1) establishment and growth of seeded species, (2) relationships between native species seeding and exotic species cover, and (3) survival and growth of nursery stock (Potter, 1992).

In some circumstances, a Level IV experiment may be appropriate to evaluate effectiveness of various combinations of revegetation treatments. Two Dog Flats grassland in the St. Mary valley was disturbed by road construction in 1992, and the most effective means for restoring native vegetation along the roadside , while discouraging exotic establishment, was not known. A study presently is underway to evaluate the effects of (1) the slope-stabilizing nurse crop Re-green (a sterile wheat hybrid), (2) herbicide application, and (3) seeding of native species on the establishment of native and exotic vegetation.

This study is a collaborative effort between Dr. Rob Tyser of U/WI-LaCrosse and the park's reveg staff. Level IV monitoring methods are not standardized, but in this case rely on canopy cover data from randomly located microplots. Another Level IV study, investigating various mulches, is anticipated.

Management Implications

Although the monitoring program in Glacier is still in its infancy, the results of the first full season's monitoring efforts are promising. In the past, target communities have not been described in detail for use by park reveg planners. Resource managers' ideas and notes about the success of reveg treatments in various sites have not been recorded systematically.

This monitoring strategy compiles all data about the site, from both site analyses and post-reveg monitoring, into one computer database. Computer programs are being developed to facilitate rapid report generation. Years of records will indicate how long it takes for a revegetated site to begin to resemble the target community, or will reveal that our goals are not realistic. Data review with respect to reveg practices (species selection, mulch use, topsoil application, time of seeding) may prompt us to change our methods.

Glacier NP is trying to get away from practices that merely "patch up" disturbed areas and make them green again. By adding this dimension to our revegetation program, we hope to learn to fine-tune our methods and thus come closer to approximating the original pre-disturbance community.

Vanderbilt is a Biological Technician at Glacier NP.

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Jensen, M.E., W. Hann, and R.E. Keane. 1992. *Ecosystem Inventory and Analysis Guide.* USDA Forest Service, Northern Region, Missoula, MT.

Potter, Rachel. 1992. *Monitoring on the Lake McDonald Section of Going-to-the-Sun Road.* Glacier NP. In-park report.

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How to Prepare Vegetation Overlays as Accomplished at Harpers Ferry

By Fred C. Collins, Russell G. Combs, James L. Smith, and William Hebb

Harpers Ferry National Historic Park (HFNHP) is in the process of developing an extensive spatial database for its geographic information system (GIS). Aerial photography of the park and adjacent lands was obtained for the purpose of developing a vegetation overlay. Personnel in the Department of Forestry at Virginia Tech (VT), stereoscopically examined aerial photographs in order to identify and delineate vegetation types and prepare the vegetation overlays necessary for entry into the GIS. The purpose here is to describe the process we used to develop this vegetation information, and what we learned about this process for those who will perform similar tasks in the future.

Creation of Vegetation Overlays

The first step in any mapping project is to define a classification system. Seven classes were defined, covering forested and non-forested land. The Non-Forested classes included non-vegetated developed land, vegetated developed land, agricultural land, and water. The Forested classes included hardwoods, conifers, and mixed hardwoods and conifers. A Five (5) acre minimum mapping unit was specified. The selected classes are shown in Table 1.

The creation of the 37 vegetation overlays involved a number of steps. First, photo interpretation of the 1:24,000 scale normal color aerial photographs was performed. We had four sets of aerial photos available to create the vegetation overlays: 1:24,000 scale normal color leaf-off, 1:3,000 scale normal color leaf-off, 1:12,000 scale CIR leaf-on, and 1:12,000 scale leaf-off. Only the 1:24,000 scale normal color photos, however, provided complete coverage of the entire region of interest. Of the 17 normal color photos in the set, 6 were chosen that covered the area of interest. For each of 6 photos, mylar overlays were photo interpreted using an Old Delft Scanning Stereoscope. Photo mylar overlays are vegetative classifications traced on mylar over the photographs of the region of interest. Color, texture, shadow pattern, size, and shape of the region of interest were used to assist in classification.

Ground Survey

Next, a preliminary ground survey was conducted to evaluate the photo interpretation. From this initial ground survey, there appeared to be some error in the original interpretation of the photos, particularly in the differences between P and MIX and between MIX and UPH. Very little of what was initially called MIX on the photo appeared to be MIX on the ground. Most of what was called MIX was in fact UPH. Where available, additional CIR photo information was then used to re-examine these cover types.

The initial ground survey and examination of the CIR photos showed the need for a more extensive ground survey. A second field check was performed to re-evaluate the photo interpretation after the changes made following the first field check. During the field check, we concentrated mainly on areas that were classified as either P or MIX to determine their accuracy. The second field check resulted in changing a great deal of P and MIX areas on the photo mylar overlays to UPH. We determined that our errors in classification were due to a misinterpretation of hardwood (deciduous) species that had already leafed-out as MIX and P. In addition, some ground cover that had leafed out in the hardwood regions may have caused us to interpret some UPH regions as MIX. Changes in photo interpreted information were made according to the results of the second field check.

The photo interpreted information was then transferred to base maps of the park. A Bausch and Lomb Zoom Transfer Scope (ZTS) was used to assist in the transfer of the classified aerial photos onto the base maps. The ZTS was used because the transfer from the normal color 1:24,000 scale aerial photos involved both a change in scale and image geometry. The ZTS uses mirrors, back-lit screens, variable lighting, and optics to allow the user to superimpose and trace the vegetation overlay onto the desired base map. The vegetation overlays contain the same information as the photo mylar overlays at the scale of the base maps. The "zoom" and "skew" controls on the ZTS were used to match to scale of the photo mylar overlay with the scale of the base map and to account for geometric distortion in the photographic image.

Distortion Causes

Geometric distortion is the combined result of optical distortion from inferior lenses, tilt, aircraft motion; and relief displacement. Campbell (Campbell, James, B., "Introduction to Remote Sensing," The Guildford Press, 1987.) states that "the most important source of positional error [geometric distortion] in vertical photography is probably relief displacement." Relief displacement causes objects to appear to lean away from the center of the photograph as one moves towards the photo's edge. Uneven terrain, such as encountered at HFNHP, significantly increases relief displacement making the matching of vegetation overlays and bases maps difficult at times.

The ZTS used by Virginia Tech was slightly modified by raising the instrument approximately 6" on stable wooden blocks to increase the areas that could be transferred at

Table 1. Selected Classes

Class	Definition	Appearance on Normal Color Photo
DVC	Developed with Vegetative Cover	Some roads interspersed among the green textured areas. Some buildings visible as white rectangles.
DVN	Developed without Vegetative Cover	Interspersed with white lines and blocks representing roads and buildings. Little vegetation.
AGR	Agricultural Land	Regular patches of green and light brown, smooth in texture.
WAT	Water Areas	Dark, smooth textured areas. Sometimes bright or sparkled because of sunlight reflection.
UPH	More than 70% upland hardwood Species	Overstory brown or a light pale green. Coarse textured. Most prevalent category.
P	More than 70% Conifer	Dark green vegetative overstory. Coarse textured and irregular in shape.
MIX	Less than 70% of Conifers or Deciduous	Interspersed dark green, and brown overstory. Coarse textured and irregular in shape.

one time. This modification did not appear to increase distortion. Very little of the ZTS's "stretch" function was used in the transfer of the image as stretching did not appear to help in matching the two images. Manual alignment of the base map and the aerial photo followed by slight adjustments with the ZTS's controls worked best. Usually, one or two distinct man-made features such as a roads or buildings were used to align the two images. Where no man-made features were present on the base map, the matches and subsequent transfer were approximate at best.

Lessons Learned

The selected classification system must contain information relevant to the user and be achievable using the imagery at hand. These two goals were fulfilled through close cooperation and communication between those making the maps (Virginia Tech) and those using the maps (HFNHP). This step always requires some compromise. Having appropriate aerial photographs of the region of interest is important in the creation of vegetation overlays. For the Harpers Ferry Project, we had four sets of aerial photos available to create the vegetation overlays. Unfortunately, only the 1:24,000 scale normal color photos covered the entire region of interest. The additional photos in conjunction with ground surveys were used to verify the photo interpretation. Normal color aerial photographs were not as effective as CIR photographs for vegetative classification. Conifers and deciduous trees both had similar appearance on the normal color photos. In the CIR photos, the differences between conifers and deciduous trees was more pronounced. The second field check resulted in changing a great deal of conifers and mixed areas on the photo mylar overlays to hardwoods. Using CIR leaf-off photos from the onset would have reduced changes to the photo mylar overlays. Having CIR photos of the entire region of interest would improve the quality of vegetation overlays for use in GIS.

Film type, scale, and season of acquisition greatly influenced the effectiveness of the photo interpretation. The normal color, 1:24,000 scale photos suffered most from an early Spring acquisition where hardwoods were just leafing out. These hardwoods appeared similar to conifers in the photos and were a cause of error and confusion. Paine (Paine, David P., *Introduction to Aerial Photography For Natural Resource Management,* Published by O.S.U. Book Stores, Corvallis, Oregon, 1977.) lists the advantages of CIR films as:

1. Much better penetration of haze.
2. Emphasizes water or moist areas.
3. Good differentiation between hardwoods and conifers.
4. Sick, dying or vegetation under stress is more easily detected.

By studying aerial photographs of different scales, we concluded that scales between 1:12,000 and 1:18,000 would be optimal for vegetation classification of this type. The 1:3,000 scale photos were of too large a scale, had excessive relief distortion, and suffered from the same classification problems as the 1:24,000 scale photos. The 1:24,000 scale photos used in the study did not show enough detail to distinguish some vegetation types.

The leaf-on CIR photos were of acceptable scale, but in the leaf-on photos, most vegetation appears red. It is possible to distinguish between conifers and hardwoods by the color variations, but it is difficult and unnecessary. The CIR leaf-off photos differentiate between conifers and hardwoods distinctly. Hardwoods appear as dark brown while conifers appear as dark red.

Our recommendation for future photo interpretations is to procure CIR photos for the entire region of interest at a scale between 1:12,000 and 1:18,000 in Winter prior to vegetation leaf-out. The Normal Color film used in this study suffered from being taken at a transitional time where some hardwoods were just leafing out. Normal Color film maybe more effective if taken during a period of complete leaf off. The film types are summarized in Table 2.

In the Harpers Ferry Project, some vegetation overlays were classified from three or more photos. These overlays suffered from utilization of information near the edge of the photo effective area where relief displacement is greatest. The effects of this displacement was evident when edge-matching the 37 vegetation overlays. The large change in scale and relief distortion resulted in some lines being off by as much as .25" between two vegetation overlays. Where possible, the photo mylar overlays were consulted in an attempt to match the vegetation overlays. Forced edge-matching of the 37 vegetative overlays, while possible, would not reflect the data inaccuracies resultant from manual photo interpretation, scale changes and relief distortion. It is recommended that the maximum number of photos per vegetative overlay be two, and that one is ideal. In the Harpers Ferry Project, the overlays requiring the greatest number of photos showed the greatest relief distortion. As photo scale is reduced, the number of photos per overlay increases with subsequent increases in relief distortion. A trade-off can therefore be seen between increased detail and increased relief distortion.

Conclusions

Having aerial photographs of correct scale, film type, and date of the region of interest minimizes effort in the creation of vegetation overlays for use in GIS. In addition, ground surveys are critical to verify the photo interpretation. While the ZTS is an effective tool for the transfer of cover type information from photos to mylar overlays, where there are no identifiable man made features, the ZTS is not very helpful. CIR photos, leaf-off, were most effective for delineating among forest cover types. Ideally, CIR photos, leaf-off, of a scale between 1:12,000 and 1:18,000 should be taken for the entire region of interest. In choosing stereo pairs, care should be taken to limit the number of photos per overlay to two (2) where possible.

Collins and Combs are graduate students and Jim Smith is their faculty advisor, Dept. of Forestry, VA Tech. Hebb is Resource Management Specialist at Harpers Ferry HNP.

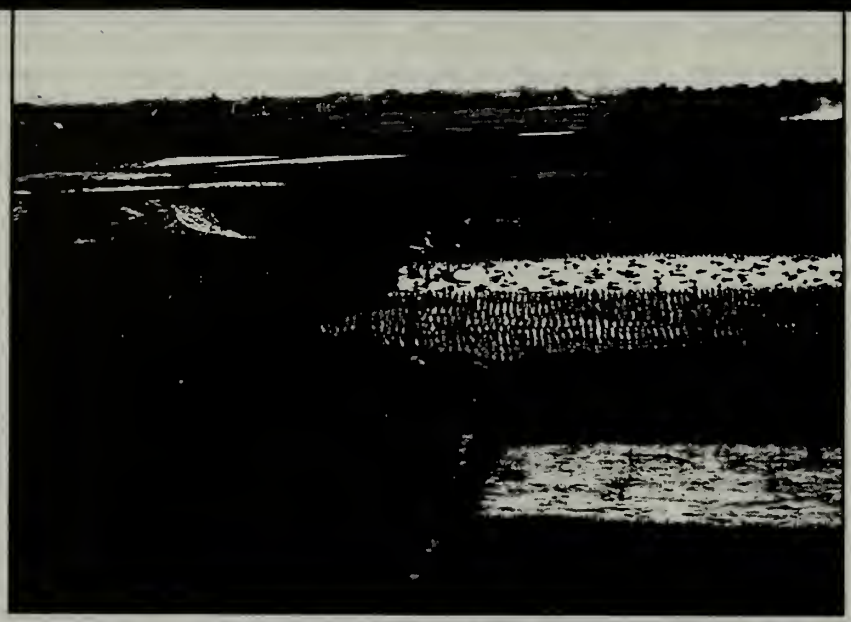
Table 2. Summarization of Film Types

Film Type	Scale	Season	Appearance of Conifers	Appearance of Hardwoods	Comment
Normal Color	1:24,000	Early Spring	Dark Green	Brown or Light Green	Not enough detail. Timing poor, hardwoods just leafing out —look like conifers.
Normal Color	1:3,000	""	""	""	Difficult to classify vegetation types. Relief distortion excessive.
CIR	1:12,000	Leaf-on	Light Pink to Red	Darker Pink to Reddish color	Difficult to distinguish between conifers and hardwoods.
CIR	1:12,000	Leaf-off	Pink to Red	Brown	Best of vegetative classification, easy to distinguish between conifers and hardwoods

Notes From Abroad

By David A. Ek

During the last two weeks of July, I participated in a 16-member cave and karst management delegation to the People's Republic of China. The trip was organized through auspices of People to People, Citizen Ambassador Program. My own money was used for this trip and I was granted annual leave from Fort Clatsop National Memorial, where I am the Resource Management Specialist. Prior to Fort Clatsop, I was Assistant Cave Resource Management Specialist at Carlsbad Caverns NP.



Villagers in southeastern China working in their fields. *(PHOTO BY DAVID EK)*

The trip's purpose was to foster and develop exchanges with professional counterparts and to build a broader perspective toward worldwide cave and karst concerns. We obtained official permission for the U.S. to conduct a cave exploration in Spring 1995. Information on the structure, organization, etc., of the Institute of Karst Geology also proved valuable.

The delegation leader was Cave Specialist Ronald C. Kerbo from the NPS Southwest Regional Office. Except for myself, the delegation members were from the National Speleological Society or the Cave Research Foundation.

Our delegation flew into Beijing, capital of the People's Republic of China, where we met with members of the China Association for Science and Technology, who hosted our visit. From Beijing, we traveled south by air and bus to Southeast China, stopping to visit developed caves, wild caves, and non-cave areas along the way. The non-cave areas included the Hunan Geologic and Mineralogic Museum, the Great Wall, the Ming Tombs, a Tao temple, the Forbidden City, a cruise on the Li River, many mighty fine (real) Chinese restaurants, and portions of the incredibly beautiful tropical and sub-tropical countryside of southeastern tropical and sub-tropical countryside of southeastern to east-central China.

Having the opportunity to see the country and visit with the people was a most rewarding aspect of the trip. I learned a little about the culture and experienced first-hand the rice fields near Chenzhou, the high-pressure souvenir booths along the Great Wall, eating pig lung and ears, eel, rat and chicken feet, and walking through the markets and back alleys of a city of 11 million.

Due partly to the large population, long human history, and poor economy, the caves, karst, and water resources of China have been highly impacted. Threats of particular concern include nearby coal mining and other resource extraction activities as well as pollution and siltation from agricultural practices. Unlike the situation in the U.S., most of China's karst regions lie in the valleys between the lowland cities and the agricultural areas on higher plateaus and hillsides. This condition allows all the chemicals, silt, and other agricultural by-products to pollute the caves. Since caves serve as efficient conduits to the groundwater, in a relatively short distance large aquifers and countless people are affected.

Dr. Ron Delano approaches Songjadong Cave. The cave entrance is out of sight in the bottom of the sinkhole. *(PHOTO BY DAVID EK)*

To begin to understand and deal with these many threats, China has created an Institute of Karst Geology research center in Guilin, China. The Institute has many knowledgeable and talented people associated with it; however, funding is very poor. For instance, they are awaiting their first computer and FAX machine.

While at the Institute of Karst Geology, our delegation presented five papers. Kerbo gave a paper on caves and cave management within the NPS. John French discussed a statistical model he developed for a karst area in Alabama that predicts cave entrance locations. Bob Handley presented a paper on historic explorations of the Organ Cave System in West Virginia. Ron Delano's paper dealt with recognizing and compensating for parallax diffraction while conducting cave surveys. My paper concerned biologic inventory and environmental preference investigations of epigean fauna within Carlsbad Caverns NP.

During one of our exchanges, we discussed the worldwide importance of cave and karst resources. Karst comprises approximately 12 percent of the world's landforms. The People's Republic of China and the U.S. contain some of the world's most extensive karst. As examples of their importance, China contains approximately 17 percent of the world's 20 million square kilometers of karst, while 25 percent of U.S. fresh water resources is held in karstic landforms.

China has for hundreds of years recognized the importance of caves and karst to water quality and the health and economy of the public. In China, unlike the U.S., the

primary interest in caves is for scientific (principally hydrological) research. In the U.S., the leading interest in caves is recreational. Much research is taking place in U.S. caves, but it does not come close to the scientific potential that caves hold. Many advanced research topics in hydrology, paleontology, biology, sedimentology, mineralogy, and global climate change are best answered in the unique environment of caves. Responsible research in caves at this level began only fairly recently. In spite of their wide distribution and scientific importance, caves have largely been ignored or misunderstood by the U.S. scientific community, and even at times by the NPS.

Caves are an important and unique biome within the National Park System. Sixty NPS units (17%) are known to contain cave resources. They occur throughout all Regions, particularly the Western, Rocky Mountain, Southwest, Southeast, and Pacific Northwest. The number of NPS positions created to deal specifically with these numerous and unique resources are: four to five at the park level, one at the regional level, and one with policy contact duties at the national level.

Impacts to caves are not unique to China. Coal mines in West Virginia and gas exploration in New Mexico are currently posing a tremendous threat to world class cave resources. Siltation from logging activities in Washington and Alaska are impacting caves and compromising their value for research. Entire cities in Kentucky have highly contaminated groundwater due to sewage and other contaminants being dumped into sinkholes. Significant archeological resources are being destroyed within caves in Arizona and Hawaii. The list goes on and on.

To deal effectively with these and other threats within the U.S., managers and researchers need to develop a more appropriate and responsible level of concern and attention toward caves and karst. More cave-related positions need to be established and a cave research facility and information repository developed. Still far behind China, the NPS is in the process of developing a Cave Research Institute in this country.

It was rewarding to visit Chinese caves, meet with fellow managers and researchers, and share information and ideas. Caves are a unique and much misunderstood resource. In light of the increasing threats to these resources in both countries, a more coordinated approach, at regional, national, and international levels, can be seen as necessary in order to deal with the complex issues involved.

Ek is Resource Management Specialist at Fort Clatsop National Memorial in Astoria, OR.

Tower Karsts just a few of the thousands located along the Li River in southeastern China. *(PHOTO BY DAVID EK)*

Isle Royale Wolf/Moose Update

The 36th annual wolf/moose winter monitoring program at Isle Royale, still in progress as the deadline for this issue of *Park Science* arrives, has produced surprising results.

When park staff left the Island last fall, only 11 wolves remained. Based on the last several years of intensive research and monitoring, the predicted future for the Isle Royale wolves was of eventual extirpation, primarily due to loss of genetic variability. In short, despite an apparent lack of disease problems and ample food supply, the wolf population was not rebounding from historic low levels.

Imagine the surprise and excitement of the park staff and principal investigator Rolf Peterson when 18 wolves were found in January. Even more importantly, for the first time since 1988, more than one pack successfully raised pups to winter. Two of the three packs produced young; the Middle Pack produced four pups, while the East Pack also produced four. The alpha male of the Middle Pack died in January, so the current count is 17, although there is a loner still unaccounted for on the Island. The eight pups surviving to winter represent the largest number of pups in several years.

Information on the moose population is less complete at this time, although the population is expected to be at similar levels to 1993—that of about 1,900 animals (the highest population in approximately 60 years).

Finally, another rare event—the forming of an ice bridge from Isle Royale to the North Shore of Minnesota and Canada (approximately 15 miles across Lake Superior)—has occurred during this severe winter, offering at least the potential for immigration of wolves to the Island. The original movement of wolves across the ice to the Island in the late 1940s, the foundation for the existing wolf population, was an extremely rare event. It would take another rare set of circumstances were it to happen again.

Jack Oelfke
Isle Royale Natural Resource Specialist
Dr. Rolf Peterson
Michigan Technological University

Regional Highlights

Southeast Region

The natural resource management program at Mammoth Cave NP received well-deserved recognition recently, when its staff swept all three of the Southeast Region Natural Resource Awards, and Supt. Dave Mihalic was named the Director's Superintendent of the Year for Natural Resource Stewardship.

Mammoth Cave Resource Mgt. Chief Jeff Bradybaugh earned the Region's Natural Resource Management Award. He has fostered a solid scientific approach to understanding the resources of Mammoth Cave NP, and has designed a comprehensive research program involving partnerships with universities, agencies, organizations, and individuals; he has professionalized the Division of Science and Resource Management and has coordinated an interagency effort to develop a program focused on protection of groundwater integral to cave resources.

Joseph Meiman was the Region's winner in the research category. Joe has sought to protect the integrity of the subsurface ecosystem of Mammoth Cave NP and the surrounding International Biosophere Reserve. Focus has been on the strategic acquisition of scientific information necessary to demonstrate impacts on groundwater quality and understand the mechanics of pollutant transfer. He has designed and completed numerous scientific studies since being hired in 1989.

Mihalic has addressed park resource management issues from a sustainable ecosystem perspective throughout his tenure at Mammoth Cave. In addition to initiation of an International BR, he has worked to protect, manage, and resolve issues affecting the aquatic ecosystem and has participated in local programs to improve the general welfare, health, and economy of the rural Mammoth Cave area. Supt. Mihalic and the park have received national recognition for these efforts in the form of the 1993 "Innovation Award" from the National Association of Development Districts.

* * *

Virgin Islands NP reports that 17 permanently buoyed anchors have been placed to reduce anchor damage to marine benthic communities. The U.S. Navy is assisting the park in installing 17 to 23 additional moorings. The park also has closed two bays on the south shore to anchoring. The "mooring only" areas allow visitor use while protecting important research sites, seagrass beds, and the endangered green sea turtle that feeds on seagrass.

The park also has established a DOS based GIS system manipulated by IDRISI and ArcCad software. Several major themes are digitized and ready for use, including vegetation, elevation, marine benthic communities, historic structures, archeological sites, endangered species, and transportation. Contacts for more information on the mooring program or the GIS system are Jennifer Bjork and Tom Kelley of Virgin Islands NP.

* * *

Recently published reports:

Boulay, M.C. 1992. ***Mortality and Recruitment of White-Tailed Deer Fawns in the Wet Prairie/Tree Island Habitat of the Everglades***. Master's thesis, U/FL, Gainesville.

Miller, K.E. 1993. ***Habitat Use by White-Tailed Deer in the Everglades: Tree Islands in a Seasonally Flooded Landscape***. Master's thesis, U/FL, Gainesville.

Sargent, R.A. 1992. ***Movement Ecology of Adult Male White-Tailed Deer in Hunted and Non-Hunted Populations in the Wet Prairie of the Everglades***. Master's thesis, U/FL, Gainesville.

Zultowsky, J.M. 1992. ***Behavioral and Spatial Ecology of Female White-Tailed Deer in the Everglades Ecosystem***. Master's thesis, U/FL, Gainesville.

Western Region

A recent publication by Dr. Lisa Graumlich (Professor at the Laboratory of Tree-Ring Research and Director of the Institute for Study of Planet Earth at U/AZ), "A 1000-Year Record of Temperature and Precipitation in the Sierra Nevada" (***Quaternary Research***, 1993; 39:249-255) has attracted attention with its documentation of extensive drought periods during previous centuries. Summaries of her findings and their possible implications for both park ecosystems and State water supplies were covered by local newspapers and by the *New York Times*. Dr. Graumlich is a principal investigator on the Sierra Nevada global change research program.

* * *

Research Scientist David Parsons has been asked to serve on an ad hoc committee on ecosystem management by the Ecological Society of America (ESA). NPS representation in such activities is critical in building the credibility of NPS science activities as well as in assuring the results of the committee are applicable to park issues. Dr. Parsons also has been asked to serve as a member of an independent science team appointed to assess the current status and management alternatives for old growth and associated ecosystems of the Sierra Nevada. This study is mandated by Congressional legislation.

Parsons continues to serve on the Board of Editors for the ESA journal, *Ecological Applications*, which is interested in publishing more articles related to NP resource issues. Potential contributors can contact Parsons at Sequoia and Kings Canyon NPs. Parsons currently is working on a special series of papers on threats to wilderness and parks, to be published in a special issue co-edited by David Cole of the USFS Wilderness Research Institute in Missoula, MT.

* * *

Under the direction of Dr. Bill Halvorson, the U/AZ CPSU has published ***Proceedings of the Fourth California Islands Symposium***. The symposium was held March 23-25, 1993 in Santa Barbara, CA. Copies may be purchased from the Santa Barbara Natural History Museum, 2559 Puesta del Sol Road, Santa Barbara, CA 93106, (805) 682-4711.

The following articles by A/AZ CPSU staff have been accepted for publication:

Christopherson, Gary L., D. Phillip Guertin, Michael R. Kunzmann, Kenneth L. Kvamme, and Thomas Potter, (1993). "Comparison of interpolation algorithms for digital elevation model generation and subsequent viewshed analysis," IN *Proceedings of the First Biennial Conference on Research in Colorado Plateau NPs*, pp 226-233. Available through NAU-CPSU, ISSN 0270-8655.

Kunzmann, Michael R., Peter S. Bennett, and R. Roy Johnson. "Riparian Ecosystems: Values and Functions." IN *Altered, Artificial, and Managed Wetlands: Agriculture and Forestry*, Proceedings of the Assn. of Wetland Managers, Berne NY.

Kunzmann, Michael R., Lee A. Graham, and Dana M. Slaymaker. "Cost effective global positioning systems and geolink field data acquisition techniques and applications in Arizona NPs and Wildlife Refuges," IN *Third International CPS/GIS Conference*, Seattle, WA, June 23-25, 1993. Available through GeoResearch Inc., Billings, MT.

Kunzmann, M.R. and P.S. Bennett, "Suppression of Saguaro cactus flower bud formation by roosting vultures in Arizona." *Southwest Naturalist*.

* * *

Dr. George Ball and Michael Kunzmann received a research grant from Southwest Parks and Monuments to continue work on the "Analysis of historic fire data using spatial modeling techniques for Chiricahua National Monument."

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Regional Highlights

Development of a prototype social science research plan is one of the Western Region's exciting new starts. Project workers include Bill Halverson, Jim Holland, Donna Chickering, and Liudyte Novickis. Their project is scheduled for summer completion.

* * *

For one of the livelier accounts of ongoing research and resource management anywhere in the Service, read Joan Ford's regular column in ***Bajada***, published (and free) three times a year by the NBS CPSU at U/AZ. Ford is an administrative clerk for the CPSU and obviously in touch with everything going on around there.

Mid Atlantic Region

Tom Blount, Shenandoah NP I&M Program Manager, along with four cooperating researchers from U/VA, presented papers at the Mid Atlantic Highlands Environmental Monitoring and Assessment Conference in Hershey, PA Feb. 23-25. Session topics included an overview of progress on the park's Long-term Ecological Monitoring Program and trend information gained from analysis of aquatic resource datasets.

* * *

Research and Resource Planning Division of Delaware Water Gap NRA and the Delaware River Basin Commission (DRBC) met with representatives of NC/State/U's Computer Graphics Center to continue development of a water quality model for the entire upper Delaware basin—over 4,000 square miles. This model will allow analysis of the effect on water quality of proposed developments within any of the more than 70 tributary watersheds in the upper Delaware basin.

The model will be linked to the Delaware Water Gap NRA's GIS at Peirce House. This linkage will allow examination of the effects of potential threats to the Delaware water quality anywhere in the upper basin, and will be a means by which water quality and resource management specialists, under the auspices of the DRBC Special Protection Waters program, can conduct long-term areawide water quality management.

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A pre-settlement-origin chestnut oak forest in French Creek State Park, adjacent to the Hopewell Furnace NHS boundary, was discovered in the course of a recent research project. The study investigated the community ecology of an old growth chestnut oak forest on a dry talus slope. Chestnut oaks up to 367 years old dominate the canopy layer. Ironically, this community is situated near the center of a 19th Century charcoal iron settlement, where area forests repeatedly were clearcut on short rotations for fuel.

This discovery permitted the construction of a 367-year living tree-ring chronology, which may be used in the future dating of historic structures at Hopewell Furnace NHS.

Pacific Northwest

On February 3, PNR representatives met with consevation organization leaders to discuss "Nature Has No Borders," the March 25-27 Conference on the Protection and Management of the Northern Cascades Ecosystem, on the U/WA campus in Seattle.

At that meeting, the Freeman Tilden Award was presented to Barb Maynes, District Interpreter at Olympic NP, and the Tilden Sponsorship Award was given to Supt. Maureen Finnerty for supporting interpretation activities at Olympic.

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Fort Clatsop National Memorial Supt. Cynthia Orlando was in Washington, DC the last week of January to brief the Oregon Congressional delegation on the draft General Management Plan/EIS for Fort Clatsop.

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Assoc. Reg. Dir. Mike Tollefson attended a January meeting in Virginia, called by Destry Jarvis, to help the NPS develop a Public Land Corps program, part of the National Service Corps, slated to be in place by this summer.

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The Region has been asked by the Student Conservation Assn. to help SCA put on "Earth Week Seattle" May 21, 1994. Regional Chief Ranger Reed Jarvis has been assigned as the Region's representative on the SCA steering committee. NPS will be a partner in providing logistical and staff support and will assist at some of the 1,000 proposed work sites in the City of Seattle. Focus of the event is to unify communities in urban environmental restoration and beautification projects while creating your-round support for SCA's education and work program.

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Managers from Olympic NP, Olympic NF and the WA Dept. of Natural Resources met Jan. 20-21 in Port Angeles, WA. The meeting, whose theme was "Reinventing Government on the Peninsula," afforded managers a chance to become better acquainted with one another's programs and to discuss ecosystem management, interagency cooperation, and providing better public service.

Southwest Region

The SWR's Division of Natural Resources held a week-long Resource Management Workshop in January. Over 130 attendees heard presentations on topics such as compliance and consultation, resource stewardship, the interrelationships between natural and cultural resources, how to write good proposals and project statements for park resource management plans, information on funding sources, and the role of Geographic Information Systems in resource management.

Maria Burks presented a session on resource stewardship and the Vail Agenda; Deputy Regional Director Mary Bradford opened the workshop with a talk on her views of resource management as part of park management and the relationship between the parks and the regional office; and David Simon, the keynoter, spoke on the purpose and role of the National Parks and Conservation Association and its administrative and legislative agendas.

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On January 31, the New Mexico State Director for the BLM signed a Record of Decision for the Dark Canyon Environmental Impact Statement. This EIS was prepared by BLM to assist them in deciding how to manage oil and gas leases adjacent to Carlsbad Caverns NP near the known passageways of Lechuguilla Cave. NPS was a cooperating agency in preparation of the EIS.

The decision made by BLM was endorsed by NPS; it sets a new standard for protection of cave resources by BLM. A cave protection zone was established and drilling for oil and gas in this zone will not be permitted. Outside this zone, special precautionary measures for oil and gas activities will be required. These measures also will be used by BLM in other karst areas to protect cave resources.

Midwest Region

In an effort to understand some of the more subtle, yet important, anthropogenic impacts on parks, Walt Loope, Research Ecologist focused on one lake in Pictured Rocks National Lakeshore to determine how it had been altered by placement of a lowhead dam across the outlet. The dam was installed in the early 1900s to raise creek and lake levels in order to float logs to Lake Superior.

He found that many of the lake's characteristics, previously attributed to natural phenomena, probably were caused by the dam. The report, titled "Evidence of Physical and Biological Change Within the Beaver Lake

Continued on page 14

Regional Highlights

Watershed Attributable to a Turn-of-the-Century Logging Dam," can be had by contracting Brian Kenner at Pictured Rocks, (906)387-2607.

* * *

All monitoring efforts in 1993 indicated that zebra mussels did not become established in waters of the Saint Croix National Scenic Riverway...an unexpected but very welcome outcome of the 1993 zebra mussel response program. The 1994 program, supported by a special appropriation from Congress, will include a critically needed assessment of the zebra mussel risk along the 405 - kilometer length of the St. Croix. The limited information available in scientific literature indicates that at least the upper reaches of the river may not have high enough levels of calcium to allow for zebra mussel establishment. Water quality characteristics of the St. Croix will be mimicked in lab tank studies to assess the risk of zebra mussel colonization in various reaches of the river.

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Twenty-nine Region employees attended the Georgraphic Information Systems October 1993 workshop at the GIS Field Technical Support Center (FTSC) at the U/WI-Madison. The workshop aimed to establish common ground for building a Regional GIS program. One goal of the FTSC is to involve knowledge and expertise at U/WI-Madison in park issues and projects, and toward this end workshop participants made presentations open to the university community on the cultural, natural, and recreational resources of their parks and the issues facing them.

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Regional Chief Scientist Ron Hiebert met with the Natural Resource Advisory Board for Haskell Indian National University Nov. 2-3 in Lawrence, KS, where the contributions of two NPS cooperative education enrollees and two interns from Haskell were recognized in an award ceremony.

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Dr. Robert Brander retired from the NPS Nov. 12, 1993. At a farewell dinner in Washburn, WI, on Nov. 9, he was presented with the Dept. of the Interior Meritorious Service Award for major contributions in ecosystem management and inter-agency/ international cooperation. He will continue to work, as a re-employed annuitant, on special designations—a part of the Lake Superior Binational working group.

MAB Notes

The most significant recent event on the U.S. MAB front was the workshop held in December 1993 at Estes Park, CO, to develop a draft **Action Plan for the U.S. Biosphere Reserve Program.** Developed by 83 participants, including representatives from 33 biosphere reserves, the plan forms the basis for establishing an integrated U.S. BR program and constitutes a resource for ideas and actions that managers can use in carrying out their own BR objectives. It is a blueprint for moving biosphere reserve reality ever closer to the BR concept. The goals and some of the actions in the plan are the following:

• **Develop the organization and leadership to carry out the mission.** Actions include: Establishing a national BR Directorate with a budget; convening an annual meeting of the U.S. MAB Program; supporting selected BRs to become models for implementing BR concepts.

• **Develop political support and funding for the biosphere reserve program.** Actions include: U.S. MAB communicating with White House offices to include BRs in their policy and planning activities; establishing a challenge cost-sharing and/or competitive small grant program; convening a primarily private sector National Support Group; establishing a Non-governmental Biosphere Reserve Foundation.

• **Foster partnerships and community participation.** Actions include: Developing new, formal and informal communication tools; promoting the "cluster concept" of partnerships among conservation, research, and multiple-use areas; using formal agreements to establish partnerships.

• **Conserve and manage biosphere reserve resources.** Actions include: Exploring the feasibility of adding areas to existing BRs to implement fully the BR model.

• **Improve understanding of relationships between natural and human systems in biosphere reserves.** Actions include: Establishing standardized monitoring techniques; including demographic and socioeconomic conditions and the values, attitudes, and perceptions of local people in BR inventory and monitoring programs; identifying and improving access to commonly used databases.

• **Promote public awareness and education on the value and benefits of biosphere reserves.** Actions include: Developing and using public media to support the U.S. BR program; developing an aggressive marketing strategy for BRs aimed at potential governmental and private sector sources of funding and in-kind support; establishing a BR communications system based on a worldwide electronic network.

At its January 24 meeting, the U.S. MAB National Committee accepted the draft Action plan and directed the workshop drafting committee under Joann Roskoski and Bill Gregg to prepare a final draft for Executive Committee decision in March. The National Committee also committed to creating a Biosphere Reserve Directorate with representatives from BR managers, agencies with BRs, and stakeholders from the wider community. Internationally, a number of countries, including Australia, Canada, China, Germany, Mexico, and Spain, are reviewing their BR programs to see how improvement can be made.

Bill Gregg, former MAB Coordinator with the NPS, continues his deep involvement with MAB as chief of the international division of the National Biological Survey. Each agency in the MAB program will continue to have a MAB representative. That responsibility in the NPS will reside in the Natural Resource Directorate or some part of the directorate's reconfiguration in the Washington Office reorganization now underway.

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ISSN-0735-9462

Potential Beaver Recolonization at Indiana Dunes Being Evaluated by Means of GIS Analysis

By Eddie L. Childers

The beaver (*Castor canadensis*) originally inhabited much of the North American continent and was a valued resource for many settlers and native Americans. Northwest Indiana supported large beaver populations throughout the 1800s as noted by Kubik (1993). Beavers were extirpated thereafter, following loss of habitat due to wetland drainage operations and exploitation by settlers, native Americans, trappers, and hunter.

By the early 1900s, beavers existed only in the most remote and isolated areas of North America, and the original presettlement population of 60 million had been reduced to an estimated 100,000 animals. The beaver, that had become a symbol of a wilderness species, had been wiped out in areas inhabited by people.

Since the 1900s, Indiana and many other states have restored the beaver to much of its original range where suitable habitat still exists (USFWS 1987). Beaver restoration efforts in the U.S. began in the early 1900s, with releases of live trapped animals in New York, California, and Missouri. More live-trapped beavers were released in West Virginia, Michigan, and Wisconsin in the early 1940s.

Federal aid in the form of Wildlife Restoration Funds was made available through the Pittman-Robertson (P-R) Act. The P-R Act taxed the purchase of hunting equipment and provided the initial source of funding for beaver restoration throughout the U.S. P-R monies have provided over $2 billion toward wildlife restoration and recreational wildlife use. With the influx of P-R funding, live-trapped beavers continued to be released in unoccupied U.S. habitats, specifically Arkansas, Maine, Idaho, Wisconsin, Mississippi, Washington, Iowa, Pennsylvania, Massachusetts, Wyoming, Alabama, Louisiana, Colorado, and Indiana.

Beaver populations had made dramatic recoveries by the mid-1950s, and by the 1970s populations were estimated at 15 million nationwide. Beavers now are present throughout the U.S. and their numbers and range continue to grow. Suitable habitat that includes preferred food and water resources appears to be the key limiting factor to beaver recolonization.

Beaver population growth and dispersal is influence by land use, hydrology, food availability, and predation. Potential beaver recolonization within Indiana Dunes National Lakeshore (NL) will focus on areas that provide adequate food resources, cover, and surface water. For example, beavers recently have been observed along the Little Calumet River in the NL and have been known to travel into other areas of the NL as well. This article focuses on the probably effects of potential beaver recolonization in the East Unit of Indiana Dunes NL, using Geographic information Systems (GIS) with emphasis on beaver habitat suitability and potential carrying capacity.

The GIS analysis used the 68 previously classified plant communities of the NL's East Unit and reclassified them into the food habitat category types, based on known beaver food preferences (Martin et al. 1961) that included: Poplar-Aspen-Willow; Birch-Maple; Emergent Vegetation-Forested Fen-Wetland; Crops-Fields-Orchards-Grassland-Revegetation Communities; Dogwood-Cedar-Tamarack; Mesic Forest-Mesic Successional-Floodplain Scrub; Upland Forest-Upland Scrub-Sumac-Vines, and other habitat types (e.g. open water).

The vegetation community reclassification and the total area for each of the beaver food habitat types were generated for the East Unit using *r.reclass* and *r.report* (GRASS 4.0, 1991), respectively. National Lakeshore surface water and beaver food habitat categories also were analyzed to determine the amount of preferred beaver food habitat within 100 meters of surface water within the NL using *r.mask* and *r.buffer* (GRASS 4.0, 1991).

The GIS analysis investigated land use, surface water, and food availability to determine optimum beaver density and habitat for the NL. Potential beaver density, or carrying capacity, is expressed as number of colonies per km2. Beaver colonies usually are made up of 8 to 10 individuals. Beaver density values reported in the literature range from 0.38 to 0.76 colonies per km^2 by Voight et al. (1976) working in Algonquin Park, Ontario, and by Aleksiuk (1968) working in the Mackenzie Delta, Northwest Territory.

Total beaver food habitat potential for the NL's East Unit is estimated at 42 km^2 (Table 2). This amount of preferred food is capable of supporting more than 40 beaver colonies. If 100 meter wide buffer strips adjacent to NL surface water are considered exclusively in the analysis, total preferred habitat is approximately 14 km^2. Buffer strips this size probably correspond to primary beaver movement perpendicular to watershed.

This amount of habitat should support more than 20 active beaver colonies assuming this area represents the East Unit beaver carrying capacity. However, since trapping is not permitted and the coyote is the only known significant predator to inhabit the NL, a much lower number of active beaver colonies probably would be a more realistic threshold level for optimum beaver density at Indiana Dunes NL. This conclusion reflects the knowledge that beaver has been known to be a nuisance species in many areas of the U.S.

Recolonizing beaver in the NL's East Unit would provide many positive ecological benefits: Soil erosion control, ground water recharge, restoration of the Great Marsh to original presettlement hydrology, and creation of high grade waterfowl, furbearer, and aquatic species habitat.

Beaver populations also could expand to areas outside the park through emigration, thereby providing trapping opportunities to residents on private lands in northwestern Indiana. Resource Management staff will monitor beaver populations at the national lakeshore to determine if threshold levels are being exceeded, and will apply appropriate management actions as necessary.

Childers is GIS specialist at Indiana Dunes NL, Porter, IN 46304.

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Trail Conditions and Management

By Jeffrey L. Marion

The author and colleagues Joe Roggenbuck and Bob Manning recently conducted a survey of NPS managers to describe visitor-related backcountry recreation management problems and practices. The survey and resulting NPS Natural Resources Report (available from Donna O'Leary—see references) address the following topics: (1) managers' perceptions of the types and severity of backcountry recreation management problems, (2) actions implemented to resolve problems, (3) managers' perceptions of the success of implemented actions, (4) managers' knowledge and application of carrying capacity models, and (5) the type and extent of monitoring efforts employed to assess impacts caused by recreational use.

Also available on request, is a computer diskette with dBASE III Plus databases containing information characterizing each park unit and the specific actions implemented to address backcountry recreation management problems. These databases are intended to facilitate communication of alternative backcountry recreation management practices. Instructions permit users to identify and list parks comparable to their own that employ specific backcountry recreation management actions. Contacts and phone numbers are included to facilitate dialog regarding implementation methods, administrative costs, supporting actions, effectiveness, and other factors which could not be characterized by the study.

This article presents selected results from the survey regarding manager's evaluations of trail resource conditions and the trail management actions they employ.

Management objectives for backcountry or natural zones call for the preservation of park resources and ecological processes in as natural a condition as possible. Visitor activities in these remote park areas tend to concentrate along trails, in scenic attraction areas, and on campsites. In particular, trails and trail networks play a significant role in shaping visitor access and distribution patterns in parks. Trails must support substantial traffic from both day and overnight visitors.

Trail impacts include a wide variety of problems, including loss of vegetation cover, incision and soil loss of the tread surface, widening of the tread, compaction of soil, proliferation of informal trails, and the results of various depreciative behaviors such as littering and cutting of trail switchbacks. Without proper trail maintenance programs these problems can alter natural patterns of water runoff, resulting in soil erosion and subsequent turbidity and deposition in streams and other water bodies. Trails concentrate visitation and provide an avenue for transportation. While some impact is unavoidable, excessive trail impacts threaten both the safety of trail users and the quality of their recreational experiences.

Study Methods

A mail-back questionnaire was sent to all NPS units judged to have substantial backcountry resources and overnight visitation. The park list was compiled from those parks specifically offering backcountry camping as described in *The National Parks: Camping Guide 1988-89*, and parks with significant backcountry overnight visitation reported to the NPS Socio-Economic Studies Office for the years 1986-90. Surveys were sent to park superintendents in September 1991 with a request that they be directed to park staff with responsibility for backcountry recreation management. The need for input from resource management staff was also noted. Compliance was high, with a return of 93 completed surveys for a 92 percent response rate. Additionally, 7 of the 8 non-responding parks were among the lowest in backcountry visitation. Completed surveys were input into dBASE III Plus databases and transferred to the SPSS-PC+ statistical package for analysis.

Results

NPS backcountry areas have a mean of 125 miles of official trail and 59 miles of unofficial trail (Table 1). However, these means reflect substantial trail systems in a few areas; for example, 9 parks had over 500 miles of official backcountry trails. The typical area (as reflected in median values) has 59 miles of official trails and 5 miles of unofficial trails. Interestingly, 17 percent of the backcountry areas in our survey had no officially recognized backcountry trails.

Table 1. Miles of official and unofficial backcountry trails.

Miles	Official Trails	Unofficial Trails
	Number of Parks	
0	15	17
1 - 25	22	23
26 - 50	13	5
51 - 100	16	3
101 - 250	10	3
251 - 500	3	1
Over 500	9	2

Official Trails: Mean = 125, Median = 35
Unofficial Trails: Mean = 59, Median = 5

Backcountry managers rated the perceived severity of 5 types of trail impacts using a problem severity scale based on the geographical extent of problems. Data from the two highest categories, "a problem in many areas" and "a problem in most areas" were combined, as presented in Table 2. Nearly one-half of all park managers reported that soil erosion on trails was a problem in many or most areas of the backcountry. Problems with trail widening was cited by 31 percent of parks, and 29 percent rated the formation of braided or multiple trails and the creation of undesired trails as serious problems.

Table 2. Managers' evaluation of the extent of backcountry trails impacts.

	Parks Where Impact is a Problem in Many or Most Areas	
	Number	Percent
Soil erosion	37	44
Trail widening	26	31
Braided or multiple treads	24	29
Creation of undesired trails	24	29
Excessive trail muddiness	21	25

The recreational activities that occur in backcountry areas vary in their environmental impacts to trail resources. backcountry managers were asked to indicate the extent to which they perceived day use, overnight use, recreation stock, off-road vehicles/all-terrain vehicles (ORVs/ATVs), and mountain bikes contributed to trail impacts. Three kinds of recreational use were predominant as causal agents for trail impacts: day use, horse use, and overnight use (Table 3). The percentages of parks citing these three uses as moderate or major causes were 47 percent, 43 percent, and 34 percent, respectively. Managers reported that day use is more common than overnight use in 70 percent of the backcountry areas and accounts for about 2/3 of all use. Also, while only 3 backcountry areas have more than 25 percent of their use made up by

Table 3. Managers' ratings of extent to which various recreation activities are a moderate or major cause of trail impacts.

Recreational Activities	Trail Impacts	
	Number	Percent
Day Use	39	47
Overnight Use	28	34
Horse Use	30	43
ORV/ATV Use	8	14
Mountain Bike Use	6	10

Table 4. Actions taken by park managers to reduce trail impacts — parks taking the action.

Action	Number	Percent
Discourage off-trail travel	44	47
Encourage off-trail travel	10	11
Teach minimum-impact hiking techniques	32	34
Discourage use of unofficial trails	42	45
Discourage trail use during seasons when soils are saturated	19	20
Relocate trails from fragile to durable soils or vegetation types	38	41
Relocate trails to avoid steep grades	40	43
Perform regular general trail maintenance	48	52
Delineate trail edges to keep visitors on a defined tread	23	25
Close or rehabilitate impacted trails	27	29
Close or rehabilitate undesired trails	41	44
Install trail bog bridges or corduroy	28	30
Seed or transplant vegetation on trails	15	16
Apply trail soil cement	1	1
Gravel trails	13	14
Other: install hardening/boardwalks over sensitive areas	2	2

rse users, 43 percent of the parks see horse e as a moderate or major cause of trail pacts.

Managers have implemented a variety of ions to address backcountry trail manage- nt problems. A comprehensive list of tential actions was provided to managers, o were asked to indicate which actions re currently employed in all or some por- n of their park's backcountry. Managers o had the option of listing additional ac- ns. Trail maintenance, visitor communi- ion/education, and trail closure were among predominant actions used to address trail oblems (Table 4). Surprisingly, managers orted that only 1/2 of all backcountry as receive regular general trail mainte- nce.

Communication is used at nearly 1/2 of the rks to discourage visitors from travelling f-trail or using unofficial trails. These ions concentrate visitor use and trampling pacts on formally designated and main- ed trails. In contrast, managers at 10 rks sought to minimize trail impacts through itor dispersal by encouraging off-trail trav- Education to promote minimum impact ing techniques was employed by manag- at 1/3 of the parks and 1/5 reported that y discourage trail use during seasons when ls are saturated.

Trail relocation is used by 41 percent of backcountry managers to shift trails from gile to more durable soils or vegetation es. Undesired or user-created trails are ively closed and rehabilitated at 44 per- t of the parks, a practice used by 29 rcent of the parks for highly impacted ils.

As previously noted, horse users were perceived by managers to cause trail impacts out of proportion to their numbers. Managers reported that of the 60 areas that were open to horses, 55, (or 92%) prohibit horses within certain areas or on certain trails in the backcountry. Furthermore, 39 percent prohibited, and an additional 10 percent discouraged horse use from off-trail travel. Managers limit horse numbers at 1/2 of the areas open to horses; number of horses/group ranged from 0 to 50 with a mean of 12 and a median of 10.

Another survey section asked managers to list and rate the perceived effectiveness of specific actions implemented in response to common problems that had been effectively addressed. Most of the highly rated actions implemented to address trail impacts involved some form of trail work. Such actions included trail maintenance and rehabilitation, boardwalk installation, and delineation of trail treads. Some moderately effective actions included temporarily closing and relocating badly eroded trails, designation of trails for different uses, and promoting dispersed hiking. Backcountry managers generally rated visitor communication and education actions, such as signing of informal trails and promotion of low impact trail use, as somewhat effective.

Finally, managers were asked to list and describe monitoring efforts used to assess the effects of visitor use on the condition of trail resources. Trail impact monitoring was conducted at only 8 parks. Monitoring approaches included rapid assessment rating and measurement methods for documenting trail width and incision and research methods employing measurements of vegetation and soil loss. Trail inventory surveys designed primarily for assessing trail maintenance needs were conducted at 12 parks. These are typically conducted by maintenance division staff for the purpose of setting trail maintenance priorities and directing work. Informal evaluations of trail impacts and trail maintenance needs, typically conducted by field rangers during routine patrols, were used by 18 parks.

Summary and Implications

Of 8 types of backcountry recreation impacts evaluated, park managers perceived trail impacts to be the most severely pervasive problem. A surprising finding was that day users were perceived to be the most common type of backcountry visitor and that 47 percent of park managers cited day use as a predominant cause of trail impacts. Currently few parks attempt to measure day use and only 8 percent of the parks require permits for day users. Horse users, a relatively small percentage of the total use in most backcountry areas, also were perceived to be a predominant cause of trail impacts. Additional management and research attention is needed for these types of uses.

The most common and, according to managers, the most effective action employed to address trail impacts was trail maintenance. However, managers at only 1/2 of the parks indicated that routine trail maintenance was conducted in all or some portion of their backcountry. Additional resources and attention to professional and volunteer trail maintenance efforts are needed to address the serious and widespread nature of trail resource problems. Finally, a primary limitation of this survey was its reliance on manager's perceptions of resource problems and the effectiveness of implemented actions. Little objective data exists for any of the backcountry recreation management problems identified in the survey. For example, trail impact monitoring is conducted in only 9 percent of the parks. Additional monitoring is necessary to provide more objective information about changing resource conditions and the effectiveness of alternative management actions.

Marion is Unit Leader for the NPS/CPSU at VA Tech in Blacksburg.

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For a mystery story as fascinating as any by Agatha Christie, read the News and Comment section of ***Science***, Nov. 5, 1993, pp 832-51. Extended coverage about the hantavirus outbreak in the southwestern U.S. includes several "side-bar" stories about deer mice and pinon nuts, "virology without a virus," a "rogues' gallery of hantaviruses," and how the whole lethal mystery was unraveled through a combination of luck, serendipity, alert scientists, and the polymerase chain reaction (PCR)—which amplifies viral genes from victims' tissue.

Researchers are still furiously in pursuit of a successful culturing of the hantavirus that caused the death of at least 26 people in the U.S. in 1993. They have its genes, they know where it hides, and they are desperately working to discover its modus operandi. One virologist and longtime hantavirus hunter in the National Institutes of Health lab is convinced that the hantaviruses are endemic in the U.S. and may have been causing disease for some time now. Even in the absence of a cultured virus, the PCR method has firmly established the identity of this virus, and deer mice appear to be the major carriers.

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The biggest news may not be the creation of a stunning 560,000 acre provincial park in the Coast Range 150 miles north of Vancouver, B.C. Glorious as is Ts'yl-os Park, centered on 30-mile-long Chilko Lake, spawning area of an internationally valuable salmon run, the headline worthiness of this event may lie in the task force that put together the park proposal. Its membership ranged from the International Woodworkers of America to the Federation of BC Naturalists. "It shows that as long as people are willing to sit down and give a little, you can reach agreement," said Bill Derbyshire of the woodworkers union.

The provincial government is pledged also to work with the nearby Nemiah Valley Indian Band in managing the park, which is named for the mountain above the lake—a mountain said to hold spiritual significance for the Indians who live in this isolated, undeveloped area.

Dr. Tom Perry, a provincial legislator who has explored the area, calls it "one of the most glorious in North America if not the world. Nothing I've seen in Nepal beats it, and it easily matches the finest scenery in the Andes."

* * *

"Grim" is the word that many headline writers in the nation's press used to describe the contents of the new edition of ***State of the World***, published Jan. 15, 1994 by Worldwatch Institute. The projection that justified the adjective was the serious slowdown in the growth of food production, on land and in the seas, at the same time the global population is growing "by leaps and bounds." Compared to the average increment of 70 million persons a year between 1950 and 1990, the next 40 years are projected to see an average annual increase of 90 million. Growth in the oceans' fish catch came to a halt in 1989. When you add the loss of momentum in grainland growth in the U.S. and Europe and the even more pronounced slowdown in the rise of Asia's rice yields, the balance between food and people "now depends more on family planners than on farmers," according to the report.

* * *

Areas of Africa rich in different species of plants and animals are described by Derek Pomeroy of Makerere University in Kampala, Uganda in the December 1993 issue of ***Conservation Biology***. "In the case of plants, the countries with the highest relative species richness are, in order, South Africa, Tanzania, Cameroon, Gabon, and Swaziland," he writes. In the case of mammals, it's Uganda, Togo, Kenya, Cameroon, and Zaire. Zaire heads the list for butterflies. Nonaquatic bird species tend to concentrate in the vicinity of Mt. Cameroon, the East African Highlands, and parts of Angola. Waterbirds flock to much of eastern Africa. Pomeroy reports that South Africa has probably the highest concentration of species of flowering plants in the world but only a handful of endemic birds.

* * *

St. Lucie Press has produced a new reference, ***The Everglades Handbook***, by Thomas E. Lodge, that contains a wealth of information on the entire ecosystem—upstream and down. Starting with a Marjorie Stoneman Douglas introduction, the book describes the region's geology and geography, plant communities and animal groups and their interrelationships and functional roles within the system, the impact of hurricanes, and the effect of humans on the Everglades environment. The 200 page, illustrated, 6x9 softcover (ISBN 1-884015-05-0) volume is available for $29.95 from St. Lucie Press, 100 E. Linton Blvd., Ste. 403B, Delray Beach, FL 33483.

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"Isolation of Remaining Populations of the Native Frog, *Rana muscosa*, by Introduced Fishes in Sequoia and Kings Canyon NPs," co-authored by David M. Graber, appeared in the December 1993 issue of ***Conservation Biology*** (Vol. 7, No. 4, pp. 882-888). *Rana muscosa*, (the mountain yellow-legged frog), was eliminated by introduced fishes early in this century in many of the lakes and streams in Sequoia and Kings Canyon NPs. In waters not inhabited by fish, *R. muscosa* also has disappeared at many sites in the past 30 years and it appears to have gone extinct in some drainage. The authors conclude that fragmentation of populations may have caused or contributed to these recent extinctions, because *R. muscosa* populations are significantly more isolated from one another by fish at present than in prestocking conditions.

Graber is a research scientist at Sequoia/Kings Canyon NPs.

* * *

The President's Council on Sustainable Development (PCSD), established by President Clinton in June 1993, held its first meeting outside of Washington, D.C. on Jan. 13-14, 1994 in Seattle, WA. The goal of the PCSD is to explore and develop policies that encourage economic development, job creation, and protection of natural resources. The Council is comprised of 25 high-ranking officials from industry, government, environmental groups, labor, and civil rights organizations, and is co-chaired by Jonathan Lash, President of the World Resources Institute, and David Buzzelli, Vice President of Dow Chemical Company.

The Council meets quarterly during the initial 2-year period and can be renewed by President Clinton for 2 more years. Its members serve on 6 task forces: (1) Defining principles of sustainable development; (2) Setting public dialogue and education activities in motion; (3) Redefining national energy policies; (4) Identifying models of sustainable manufacturing, pollution prevention, and other eco-efficient strategies; (5) Establishing guidelines to expand natural resource protection and management; and (6) Identifying examples and elements of sustainable communities.

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* * *

The Feb. 1, 1994 briefing paper from NPS Director Kennedy on Strengthening and Streamlining the National Park Service contains news of special interest to the field: "...the NPS will be delegating considerably more responsibility and authority to the parks and field-level programs, reducing layers of

anagement and review, and consolidating e remaining support functions in a smaller mber of central offices. The goals of this organization are to allocate people and oney toward park and project manage-ent, to the extent possible, in order to facil-te decisive, timely action to protect the tural and cultural resources that define our aracter as a nation and to make that heritage cessible to as many people as possible."

Together with downsizing and upgrading forts, the Director described "an intensive fort to recruit, retrain, and retain a highly ofessional and diverse cadre of people ca-ble of understanding the complexities of anaging America's heritage resources as rts of whole systems and skilled in working ith others, both inside and outside gov-nment." The intention, he stated, "is to engthen the Service and protect the Parks."

* * *

Gary Sullivan of the NPS Midwest Region rites to call *Park Science* readers' attention an article in ***Science***, December 1993, pp. 14-15, suggesting that the disappearance songbirds is a result of loss of woodland sting habitats and tropical wintering ounds as well as cowbird depredation, and at such depredation should be looked at refully before action against cowbirds is ken. The account downgrades the cowbird oblem from a continental scourge to a gional problem, with California and the per Midwest as areas of greatest concern.

In the next issue...

- "Neotropical Migratory Bird Workshop and Research" by Ralph Grundel and Theodore R. Simons.
- "Long-term Monitoring on a Shoestring at Apostle Islands" by Julie Van Stappen.
- A review of James K. Agee's *Fire Ecology of Pacific Northwest Forests* by Dave Perry, Oregon State University professor of ecosystem studies.
- "Animal Disease Issues in the National Park System" by Alonso Aguirre and Ed Starkey.
- "The Other Side of Gap Analysis" by Kathy Jope.
- A report on the Interagency Wolf Management Steering Committee's nationwide recovery plan (if those plans have jelled by press time).
- "Social Science Studies at Great Basin NP: What Do They Tell Us?" by Perry Brown and Marty Lee.
- "Reconstructing Climate Data in Parallel Watersheds" by Robyn Myers.

Working with Williams in WASO

By Sarah Allen

In July 1993, I began working in the Western Regional Office with two primary duties: coordinating both the biological inventory and monitoring program and the threatened and endangered species program. I am not only new to the Western Region, but also to the Park Service. I have studied in and around parks for the past 18 years, but this hardly prepared me for the labyrinth of places, people, forms and procedures.

The trip to WASO was by invitation from Dr. Gary Williams, Manager for the Inventory & Monitoring (I&M) Program. Gary had a check list, at least up to my elbow, of various tasks from which I could select. I chose defining and fleshing out the duties of the I&M regional coordinator. My primary reason for being in WASO, though, was to meet the staff with whom I have, and will have, working relations.

I arrived at Dulles airport with many preconceptions. The first was that temperatures are arctic in mid-November on the east coast. When I departed from home near San Francisco early Sunday morning, I had had to scrape ice off the car window, but when I arrived in Dulles that evening, temperatures were warm and due to be still warmer the next day. A second fallacy was that Washington was a swollen and sluggish bureaucracy. Instead I was greeted by a devoted, bustling staff with little time for small talk. I have seen this motivation throughout the Park Service—the ability to do a lot with very little. People work long hours with short breaks and come in on weekends. One down side, though, is that I found little opportunity to socialize with staff; I would have delighted in relaxed conversations outside of the office where we could escape interruptions from phones and people. Rather than leave the overtures to WASO staff, I would encourage any new visitor to take the initiative and corner a hapless victim for lunch or a walk to the Smithsonian.

The Washington Office actually is two offices; the main offices of Interior are on C Street; the Vegetation and Wildlife group is a few miles away near the Capital building. A shuttle service cycles between the two offices several times each day. This convenience was particularly appreciated because I had been warned that walking around the Capital can be a dangerous exercise. Everyone, from hotel clerks to taxis drivers, exhorted me not to venture out after dark. One evening, though, I found a bevy of labor union protesters marching to a rally on the Hill, so I joined them for protection and a bit of sightseeing.

I had never before been in Washington, so I spent some time orienting to the city and locating offices and personnel. This pastime proved very rewarding. All whom I approached were more than willing to interrupt their tasks to help orient a newcomer. This was particularly true at the NPS Vegetation and Wildlife office, where I spoke with all who were not out of town.

I also made an effort to get out for lunch and stroll around the Capital to visit monuments such as the Lincoln and Vietnam War Memorials. The grounds around the monuments were very clean, with little trash or graffiti, and I reflected with some pride that NPS personnel were responsible for the pristine appearance of the grounds—a condition that added significantly to the overall visual and aesthetic impression.

Several points may be helpful to the new arrival to WASO. Foremost, find out in advance what sort of office accommodations will be available to you including space, phone and computer access. Gary Williams provided a small, neat desk from which to work, and I was fortunate when a staff member who was going to be absent for a week kindly offered use of her office. Being fairly picky about computer programs, I brought my own lap-top machine. An additional benefit was few phone interruptions since I was away from home duties. Having all the tools of my home office and privacy too increased my productivity and signficantly shortened the "settling in" process. Rose, the secretary, was especially attentive. She made sure I was comfortable, knew where to find things (such as the FAX) and had all needed supplies.

Finally, a week is the minimum time for a Washington stint, and a longer stay is better. I was just becoming comfortable with the ways of WASO when my visit was over.

Gary Williams has just issued a call to all Regions offering an opportunity to visit WASO on detail to work in the I&M Program. He proffers several tasks to attract participants. Now is your chance!

Sarah Allen is a Natural Resource Specialist in NPS Western Region

Ash Yellows and Defoliating Insects Related to Decline of Velvet Ash in Zion National Park

By Wayne A. Sinclair, Helen M. Griffiths, Michael Treshow, and Robert E. Davis

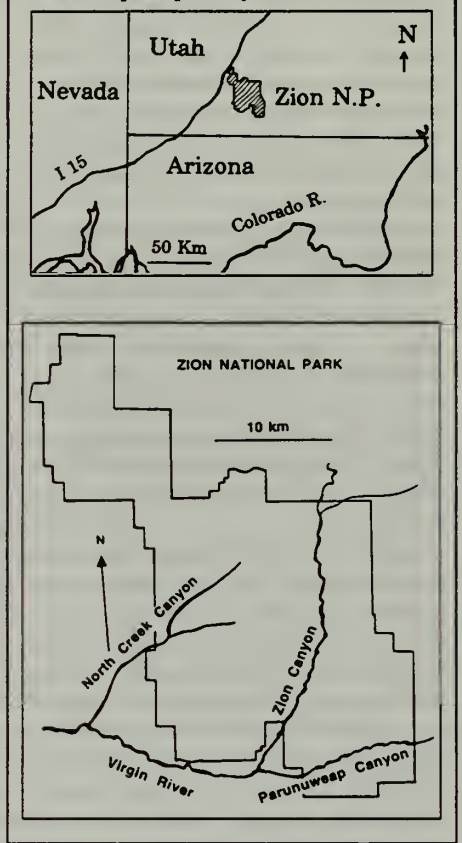
Zion National Park, on the southwestern flank of the Markagunt Plateau in southwestern Utah (Fig. 1), encompasses habitats ranging from arid to wet (Hamilton 1984). Velvet ash (*Fraxinus velutina*) colonizes moist sites in canyons there. In the late 1980s, a syndrome of slow growth and branch dieback was noticed affecting many velvet ash in Zion Canyon. The symptoms resembled those of a disease, ash yellows, that affects ash species in eastern and midwestern states (Matteoni and Sinclair 1985). Ash yellows is caused by noncultivable mycoplasmalike organisms, or MLOs.

MLOs are prokaryotic obligate parasites of plants and of the insects that serve as their vectors. MLOs belong to the class Mollicutes and cause several hundred plant diseases (Lee and Davis 1992). Within plants, MLOs colonize plants systemically by way of phloem sieve tubes and are confined to this cell type. Because MLOs can not yet be isolated and cultured apart from plant or insect hosts, they have not been named or classified at generic and species levels. The term *mycoplasmalike organism* connotes resemblance to mycoplasmas, a number of which are significant pathogens of birds and mammals (Maniloff et al 1992).

In northeastern states, ash yellows causes rootlet necrosis, growth loss, and dieback of white ash (*F. americana*) (Dyer and Sinclair 1991; Matteoni and Sinclair 1985; Sinclair et al 1990, 1993b; Smallidge et al 1991). Growth suppression also occurs in MLO-infected green ash (*F. pennsylvanica*) (Sinclair et al 1993b), but dieback in this species is not closely linked to yellows disease (Luley et al 1992). Witches'-brooms (Fig. 2a) are diagnostic for ash yellows, but only a minority of trees with the disease produce them.

MLOs were detected in velvet ash in Zion NP in 1988 (Sinclair et al 1990). Slow growth, dieback, and occasional witches'-brooms were noted. It seemed likely that velvet ash was displaying an MLO-induced syndrome similar to that described for white ash. The research summarized here (Sinclair et al 1993a, 1993b; 1994) began in 1990 to learn the distribution and incidence of declining velvet ash and of ash yellows within Zion NP, to evaluate the relationship between MLO infection and health of this species, and to learn whether or not singleleaf ash (*F. anomala*) in Zion NP is also affected by MLOs.

Figure 1. Location of Zion National Park and its principal canyons.



Methods

Velvet ash in the three largest canyons of the park (Fig. 1) were surveyed for health status and incidence of MLO infection. In Zion Canyon, ash on 17 plots were scored for degree of vigor and severity of dieback. The trees were also examined for evidence of injury by insects and for symptoms associated with ash yellows: witches'-brooms, sprouts on the butt or bole, simple leaves on sprouts, deliquescent branching, and chlorosis (Matteoni and Sinclair 1985). The condition of tree species associated with velvet ash was noted. Soil and other site conditions were recorded. Root samples for diagnostic testing by means of the DAPI (4',6-diamidino-2-phenylindole.2HCl) fluorescence method (Sinclair et al 1989) were taken from 382 velvet ash trees and saplings and from 53 singleleaf ash. This method permits detection of microorganisms in phloem sieve tubes based on fluorescence of their DNA when sections treated with DAPI are examined microscopically with UV illumination.

Relationships between vigor scores and diagnostic data were evaluated by means of contingency analyses that tested whether frequencies of symptoms observed in MLO-infected trees could differ from the corresponding frequencies in noninfected trees due to chance. These tests were performed

Figure. 2. **A.** Witches'-broom on an MLO-infected stump of a velvet ash felled by a beaver. **B.** Velvet ash shoot from a cluster growing at the base of a dying, MLO-infected tree, showing simple leaves and precocious axillary shoots. These symptoms were seen only on MLO-infected trees.

parately for trees 6 cm dbh and for saplings 6 cm dbh. Growth of velvet ash as related MLO infection was assessed by measuring idths of growth rings on increment cores d comparing average annual growth rates MLO-infected and noninfected trees. The sceptibility of velvet ash to MLOs from hite ash, and of white ash to MLOs from lvet ash was assessed by grafting potted es of each species with bark patches or oots from diseased trees of the other spe-es. Grafted trees were then tested for infec-n and observed for symptoms.

MLOs in velvet ash in Zion Canyon were entified as ash yellows MLOs by three ocedures: DNA hybridization tests utiliz-g cloned ash-yellows-specific probes de-ved from a New York strain of ash yellows LO (Davis et al 1992), amplification of LO DNA by a polymerase chain reaction CR) utilizing ash-yellows-specific prim-s derived from one of the DNA probes, and munofluorescence microscopy utilizing an h-yellows-specific monoclonal antibody riffiths et al 1994).

Results and Discussion

Slow growth, branch dieback, and deli-escent branching were the most prominent mptoms of distress in velvet ash. Trees of sizes greater than approximately 6 cm dbh re affected, and they occurred on diverse es. Foliar color was generally normal. Ex-pt for an occasional irrigated specimen, gorous trees were confined to the sapling tegory. Water shortage associated with anged site conditions but not with precip-tion deficiency apparently contributed to cline of some trees, because declining or ad specimens were found in a number of locations that were formerly irrigated or came isolated from the river. Records from Zion NP meteorological station revealed unusual precipitation deficiency during 1980s, when much of the dieback appar-ly developed.

Symptoms diagnostic for ash yellows were common. These symptoms included witch--brooms near or at ground level (Fig. 2a) d shoots with simple leaves and precocious condary shoots in leaf axils (Fig. 2b) within ooms or growing from the root collar.

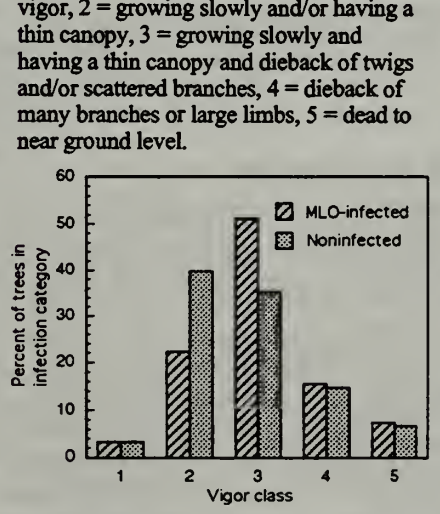
Damage by defoliating insects was prom-nt on velvet ash, box elder (*Acer negundo*) d Fremont cottonwood (*Populus fremontii*). verity of defoliation ranged from none to mplete, even among individuals in the ne stand. The insects responsible were identified loopers (*Lepidoptera: ometridae*). Slow twig growth and die-k of twigs and branches occurred on ash d box elder on which severe defoliation s previously observed. Many velvet ash o sustained severe foliar injury by ash plant bugs (*Tropidosteptes pacificus*) or lace bugs (*Leptophya* sp.). The former insect caused stunting and sometimes death of developing leaves and shoots and stippling on expanded leaves. The latter insect caused stippling and general yellowing of mature foliage in summer.

MLO infection was detected in velvet ash all three canyons surveyed. In Zion Canyon, 50 percent of 243 trees 6 cm dbh and 35 percent of 139 saplings tested were found to be infected. In North Creek and Parunuweap canyons, MLOs were detected in only 5 percent and 7 percent, respectively, of the 70 and 79 velvet ash tested. The high incidence of MLO infection in velvet ash in Zion Canyon was thought to reflect a more suitable habitat for vector insects (presumed to be leafhoppers) than occurs in the other two canyons. MLO infection was not detected in singleleaf ash. DNA hybridization and immunofluorescence tests both indicated close relatedness of MLOs in velvet ash in Zion NP to those in other ash species in eastern states (Griffiths et al 1994).

Velvet ash saplings infected with MLOs were found in all three canyons, indicating that young plants are at risk of infection, that overland spread of the MLOs by airborne vectors has probably occurred, and that incidence of infection may have been increasing in Zion NP in recent years. Possibly ash yellows is widespread in the Southwest, because MLO-infected Modesto ash, a variety of velvet ash, have been found in Las Vegas, NV (Sinclair et al 1990) and Tempe, AZ (Bricker and Stutz 1992).

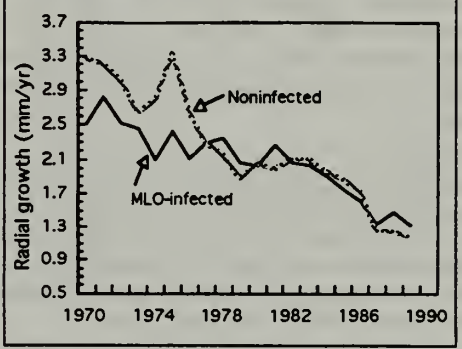
The frequency of MLO infection varied among vigor categories of trees larger than saplings in Zion Canyon (Fig. 3). Dieback was observed in 74 percent of trees in which MLOs were detected, versus 56 percent of trees tallied as not infected. This difference was greater than could be accounted for on the basis of chance. Moreover, the frequencies of various vigor scores of MLO-infected ash did not fit the ratio that would be predicted from the distribution of vigor scores of noninfected trees. These results were in accord with the interpretation that MLOs play a role in the decline of velvet ash in Zion Canyon. In velvet ash saplings, however, no significant association of MLO infection with dieback was detected.

Figure. 3. Distribution of vigor classes among MLO-infected and noninfected velvet ash 6 cm dbh in Zion Canyon. Classes: 1 = normal in appearance and vigor, 2 = growing slowly and/or having a thin canopy, 3 = growing slowly and having a thin canopy and dieback of twigs and/or scattered branches, 4 = dieback of many branches or large limbs, 5 = dead to near ground level.



Annual radial growth of velvet ash in Zion Canyon was found to have declined steadily during the 1980s, but trees in which MLOs were detected in 1990-1992 displayed the same growth trend and grew at nearly the same average rate as those in which MLOs were not detected (Fig. 4). In the northern half of the canyon, where defoliation was most conspicuous in each year of the study, radial growth averaged less than 1 mm per year throughout the 1980s (Sinclair et al 1993b). Previous episodes of defoliation may have caused the observed slow growth and dieback. No differences in growth or form were detected between MLO-infected and noninfected saplings that were observed for 3 years.

Figure 4. Annual mean radial growth of MLO-infected and noninfected velvet ash in 1970-1989. Data represent measurements on two increment cores from each of 38 infected and 19 noninfected trees in Zion Canyon.



A New York strain of ash yellows MLO was transmitted by grafts from white ash into velvet ash and white ash seedlings. The latter species provided susceptible standards for comparison with velvet ash. MLO-infected velvet ash continued vigorous growth, while MLO-infected white ash developed rootlet necrosis and grew feebly. MLOs were transmitted from velvet ash growing in Zion Canyon to only one white ash seedling out of 25 grafted. This seedling developed rootlet necrosis and died.

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Ash Yellows continued from page 21

The findings of only a weak association of dieback with MLO infection, no difference in growth rate of MLO-infected and noninfected trees in Zion Canyon, and vigorous growth of young velvet ash inoculated with an eastern strain of ash yellows MLOs all indicated that velvet ash is tolerant of infection by these organisms. Perhaps MLOs affect the health of velvet ash only to the extent that infected trees may be more sensitive to, or may recover from, other stresses (e.g., defoliation, water shortage) less fully or rapidly than noninfected trees, as Han et al (1991) suggested for white ash. Or perhaps AshY MLOs are widespread and innocuous in healthy-appearing as well as debilitated velvet ash but have been detected only where declining trees were studied.

The role of MLOs in decline of velvet ash in Zion Canyon is apparently small. On the other hand, the decline of mature individuals of this species is conspicuous. This decline may have been caused primarily by defoliation by insects, with water shortage playing a role for some trees. The question for resource managers is whether measures to arrest or reverse the decline of velvet ash in Zion Canyon should be attempted. Feasible options for remedial action are limited by the policy of allowing natural processes to proceed.

Sinclair and Griffiths are Professor and Research Associate, respectively, Department of Plant Pathology, Cornell University, Ithaca, NY; Treshow is Professor Emeritus, University of Utah, Salt Lake City; Davis is Research Leader, Molecular Plant Biology Laboratory, Plant Sciences Institute, USDA-ARS, Beltsville, MD.

Acknowledgments

This research was supported in part by NPS through contract CA-1463-5-0001. We thank Larry Hays, Darla Sidles, and Victor Vieira of the Resource Management Unit, Zion NP, for facilitating the work.

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Research Exhibit Available

NPS science, resource management, and interpretive staff should be aware that an exhibit inviting scientists to do research in national parks is available for use at conferences and elsewhere. The exhibit states reasons for choosing parks as research sites, shows examples of research done in parks, describes needed types of research, and has an attached holder with information sheets listing regional office contacts.

The exhibit is 88" high and 80"wide, with 3 roll-up panels that attach to a collapsible network frame. The exhibit packs into a large-golfbag-sized carrying case with wheels and weighs 68 pounds loaded. The existing exhibit is available for loan. Any office desiring to own the exhibit can obtain one for about $4,500. Call Anne Frondorf, Wildlife and Vegetation Division, NPS Washington Office (202)343-8129 for further information.

Partnerships: NBS and the States

The National Biological Survey and the States have similar missions when it comes to distributing biological information.

On Nov. 11, 1993, the NBS was established to gather, analyze, and disseminate the biological information necessary for the sound stewardship of the Nation's natural resources, and to foster understanding of biological systems and the benefits they provide to society.

State governments are major collectors and managers of biological information and are major natural resource decision makers in their own right. Consequently, the NBS is constantly developing working arrangements for biological data sharing. NBS is encouraging positive scientific relationships with each state, to allow for increased access and integration of biological information. NBS will be a facilitator, and will work with states to form partnerships for research projects and data sharing.

To date, NBS staff have begun discussions with several states to determine their interest in initiating such efforts. A nationwide analysis is being prepared that evaluates state capabilities and identifies existing NBS operations that would form a strong initial basis for cooperation with NBS.

Discussions regarding state interest, capabilities, and sensitivities also are ongoing with the International Association of Fish and Wildlife Agencies, the National Association of State Foresters, and the Wildlife Management Institute.

The goal of these efforts is to develop the capability, at the state level, for increased access and integration of biological information. Meeting this objective will require increased cooperation in the identification and delivery of information held by federal agencies and others. A key component of early NBS activity in these state partnerships is working with state and federal agencies to identify available information, and to ensure that users of this information are aware of and have access to the information.

The NBS mission includes performing research in support of biological resource management; inventorying, monitoring, and reporting on the status and trends of the Nation's biotic resources; and developing the ability and resources to transfer the information gained to resource managers and others concerned with the care, use, and conservation of the Nation's natural resources.

Bu Eugene Hester
Deputy Director, National Biological Survey

Study Documents Mountain Goat Impacts at Olympic National Park

By E. Schreiner and A. Woodward

Approximately 12 mountain goats were berately introduced to the Olympic Mountains in the 1920s; the animals subsequently ead throughout the Olympic Range. Olympic National Park was created in 1938. Although mountain goats are native to the rby Cascade Mountain Range, historical, haeological, and anthropological evidence icates they were absent historically from Olympic Peninsula. The estimated Penula-wide mountain goat population was to 800 in 1980, 1,175 plus or minus 171 ndard error) in 1983, and 389 plus or us 106 (SE) in 1990. Several hundred nals were removed from Olympic NP ween 1981 and 1989. The mountain goat is a generalist herbie, strongly associated with cliffs and rock crops (Chadwick 1983). Its food habits y considrably among populations because this association. Diets apparently are ated more by whatever plant species are sent than by a preference for any particuspecies or growth form.

Seasonal Distribution

n the Olympics, mountain goats are seaally migratory and are distributed in des" or subpopulations. Subalpine and ne areas above 5,000 feet generally are sidered to be summer range, but even on summer days animals sometimes are nd as low as 2,000 feet. Goats generally ter on steep south and southeast facing crops and cliffs below 5,000 feet, and may found down to 1,000 feet. Our studies e conducted in mountain goat summer ge, which we defined as the region above 00 feet.

Previous studies of the interactions been mountain goats and their summer range Olympic NP clearly demonstrated that ts changed native ecosystems. Plant comnity effects included reduced moss and en cover, increased exposure of mineral from wallowing and trampling, and reargement of plant species dominance relaships in favor of ruderal species (plants nd mainly in disturbed areas, so-called urbance-oriented species). In addition, e Olympic Peninsula and one Olympic insula/Vancouver Island endemic plant a were consumed by goats (these are "nar-" endemics—they are found on the Olym- Peninsula or the Olympic Peninsula and ncouver Island, but nowhere else in the rld).

Even though the aforementioned studies nonstrated that goats substantially altered ive plant communities, additional investigations were required to extend the evaluation in space and time. Previous studies were conducted chiefly in one area of the park over a four-year period. Consequently, a series of investigations was begun in 1981 to expand our understanding of mountain goat/vegetation and soil interactions. Objectives were to describe plant communities and large herbivore sign in mountain goat summer range (5,000 ft) and to test the following two general null hypotheses:

(1) Reducing mountain goat densities will not result in changes to the relative abundance of plant species (i.e. plant community structure).

(2) Mountain goats pose no threat to the long-term persistence of rare plants.

Methodology Employed

We employed a variety of independent study methods from 1981-1992 to achieve these objectives:

(1) Extensive surveys of vegetation and herbivore use were conducted in high, medium, and low goat density areas within the 107,490 acres of land free of glacial ice above 5,000 feet;

(2) Permanent plots were established in three areas to quantify plant community responses to intentional reductions in goat density. (This is a unique aspect of our study—goat density was reduced intentionally through live capture concurrently with our permanent plot studies in areas with vastly different climates; thus we did not have to rely on exclosures as a means of evaluating the effects of herbivores);

(3) Potential effects of goats on the long-term persistence of rare plants were assessed using data on rare plant geography and abundance;

(4) The demography and autecology of a particularly rare endemic taxon (Olympic Mtn. milkvetch—we estimate the total population as about 4,500 plants) was investigated; and

(5) A series of historical photographs was used to examine qualitatively the vegetation changes over a 70-year period, specifically addressing the relationships among climate, human use, natural disturbance, and mountain goats.

In common with all other studies of ungulate grazing systems, our work demonstrated that introduced mountain goats have indirect and direct effects on the vegetation of the Olympic Mountains. We have no reason to believe that the overall biotic effects of goats on Olympics vegetation differs appreciably from mountain goat grazing systems where the animals are native. Nonetheless, changes in the park's vegetation due to goat activity have been substantial, and the status of rare plant populations in goat habitat is of concern.

Plant Community Changes

Mountain goats modified the structure of subalpine plant communities of the Olympics. Following the reduction in goat density, ruderal species such as yarrow decreased while selected goat forage species such as Idaho fescue increased at Klahhane Ridge (estimated annual precipitation, 40-60"). Yarrow cover exceeded that of fescue when goat density was high; it was less than fescue by the end of the study.

We believe mountain goats changed the nature of the competitive relationship between these two species, particularly since a laboratory study demonstrated that Idaho fescue was the stronger competitor except when clipped (del Moral 1985). Similar changes in plant cover of these two species were observed in comparative photographs in exclosure studies (Pfitsch and Bliss 1985).

Modifications of plant communities also occurred in another area of the park. Mount Dana (estimated annual precipitation 200+ inches) plots exhibited statistically significant changes in the plant cover of selected and non-selected plant species, but no change in dominance. Percent cover of dominant, strongly competitive species such as showy sedge appeared not to respond to lower goat density. This does not necessarily mean that the sedge was unaffected by goats. This highly productive species is consumed by goats and may compensate for loss of grazed plant tissues. Graminoid species are well-known for compensatory response to grazing.

Mountain goats also influenced the Olympic ecosystems by wallowing and trampling. Wallows disturb soils and create mineral substrates for colonization by plants. Studies of Klahhane Ridge goat wallows (and bison wallows elsewhere) have shown that disturbance-oriented plant species dominate wallow edges and that this community differs from surrounding vegetation.

Presence of Wallows

We did not examine vegetation surrounding goat wallows, but did document the presence of wallows. There are fewer in areas of low goat density, but at least one wallow was found in each of the 22 areas examined across

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the park. We suspect that the disturbance-liking species have invaded these wallow edges as they have on Klahhane Ridge. Such a result would not be unexpected because Olympic subalpine and alpine plant communities are particularly sensitive to soil disturbance. Moreover, some scientists believe that physical disturbances associated with herbivory may be even more important than grazing as an ecosystem shaping process.

Incidentally consumed forage species may suffer intensive grazing at either high or low herbivore densities (Futayama and Wasserman 1980 and Houston 1982). These forage species may be eliminated because they exert no feedback control on herbivore population size. In a hypothetical one-herbivore/one-plant species system, the eminent biologist Graeme Caughley noted that the herbivore and plant must reach a dynamic equilibrium or the herbivore goes extinct (Caughley 1982).

Further, in a one-herbivore/two-plant system (assuming the two plant populations have different growth rates), "The extinction of one of the two plants is a direct consequence of its sharing the area with the other...It goes extinct when sharing the area because the herbivore numbers and hence the grazing pressure is maintained at a higher level than would be possible if the slower growing plant were the only food available." (Caughley 1982:311).

Thus, rare plants may be at risk from mountain goats for at least two reasons: (1) Mountain goat population densities likely are not controlled by plant abundance on summer ranges (Houston and Stevens 1988), let alone rare plant abundance, and (2) goats are generalist herbivores with the capacity to consume most plant species, including rare plants.

Long-term Concerns

We remain concerned about the long-term persistence of rare plants in mountain goat habitat. Direct effects were observed as mortality and injuries to individuals of the endemic Olympic Mountain milkvetch. One other endemic, Olympic aster, was a plant "selected" by goats. We also found that rare plant distributions (33 taxa), including 7 of 8 endemic taxa, overlap goat summer range. We note that *the effects of goats on individual plant taxa may be severe* or potentially severe, especially for taxa with very restricted distributions (i.e. those that occur in fewer than 5 subpopulations). Rare endemic plants have been driven to extinction or near extinction elsewhere by introduced herbivores (e.g. goats in Hawaii, Galapagos Islands).

Plant/herbivore grazing systems have been the subject of intense study by ecologists during the last two decades. Herbivores have been shown to affect numerous attributes of vegetation including plant morphology, species composition, abundance, net primary productivity, and the genetic makeup of plant populations. The scale of plant/herbivore interactions ranges from effects on individual plants to whole ecosystems. Effects of herbivores have been documented in long-established natural ecosystems such as Olympic NP (elk), Wind Caves NP (bison and prairie dogs), and the Serengeti plants of Africa (wildebeest and others). Also chronicled are the consequences of recently introduced wild ungulates (Himalayan thar in New Zealand and red deer in the Falkland Islands).

Characteristically, ungulates and vegetation are linked by strong feedback loops between the dynamics of the plants and the dynamics of the animals. Where ungulate populations are limited by available food

(PHOTO BY J. HARTER, OCTOBER 20, 1981)

rces, as their populations increase, avail-
er capita resources (i.e. palatable plants)
ase. Natural mortality increases, and
ty decreases because of insufficient food.
lants' "feedback" to cause a new, lower
of the animal population. Plants and
late populations oscillate with decreas-
nplitude over time as dynamic equilib-
is achieved. Profound vegetation chang-
ually occur.

e believe our studies describe only a
part of the total picture of mountain
vegetation relationships in Olympic
Recent studies demonstrate that ungu-
alter nitrogen cycles and soil formation
sses. Moreover, vegetative changes
ght by one herbivore may influence the
ng behavior of other herbivores (such as the link between bison and prairie dogs). Given the relationship between site productivity and the degree of interspecific plant competition in Olympic subalpine vegetation, mountain goats are likely to have a far greater influence on individual plants, communities, and ecosystem processes than we have demonstrated here.

Status Report

Olympic staff are completing the Draft Environmental Impact Statement on mountain goat management (scheduled for release in early 1994). Once the EIS is released, a period of public comment will take place and a course of action will be selected. This may prove a significant test of NPS natural areas exotic species management policies.

Schreiner is a Research Biologist at Olympic NP Field Station; Woodward is with the U/WA CPSU, National Biological Survey.

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7-year interval between 1981 and 1988, lahhane Ridge goat population was re- by more than 80%. The entire wallow s outwash have more plant cover, pri- y Idaho fescue *(estuca idahoensis)* and w *(Achillea millefolium)*, by 1988. The right wallow margin has grown-in derably, but the steep undercut edges of pper wallow have continued to erode er back despite establishment of Idaho e.

(PHOTO BY J. BURGER, OCTOBER 20, 1988)

Prescribed Fire: Current Status and Future Directions

By David J. Parsons
Research Scientist
Sequoia and Kings Canyon NPs

Sequoia and Kings Canyon NPs have long been recognized as national leaders in fire management and fire related research. Yet as these programs have matured, new questions and challenges have arisen. If these parks are to remain among the leaders in fire management, everything from program objectives to our understanding of fire effects and how such information influences programmatic decisions must be periodically reevaluated. Specifically, we must improve our understanding of the long-term, cumulative effects of varying fire regimes and management activities on park ecosystems. As our understanding of ecosystem processes and interactions improves, program objectives must be revised as appropriate.

In an effort to facilitate such a review, a prescribed fire workshop was held in the parks in January 1993. Thirty individuals representing park and regional office staff, the CPSU at U/CA Davis, Yosemite NP scientists and managers, the Boise Interagency Fire Center, the USFS, and university researchers participated in this 3-day review.

Workshop objectives were to assess the current status of the prescribed fire management and fire effects research programs; review the existing information base, and determine if (and how) this information and subsequent recommendations have been applied by management; identify management and research concerns and needs, and develop strategies for acquiring and applying new information.

Basically, we asked where we are with the program, how we got where we are, where we want to go, and how to get there. Emphasis was given to identifying data needs and applications and overcoming perceived constraints. The format made for informal, open discussion around general agenda items. The timing was particularly appropriate in that the political and advocacy group pressures that often have driven the program have been relatively quiet in recent years. A growing number of questions from park staff regarding program objectives and accomplishments assured a receptive audience and active participation.

Examples of the issues included: (1) the tendency to emphasize fire behavior rather than ecological objectives as the basis for setting prescriptions and evaluating "success"; (2) the need to articulate more clearly the program goals (what do we really mean when we say "reduce fuels" and "restore fire as a natural process"?); (3) identification of the constraints (funding, air quality, state and regional preparedness planning) that keep more acreage from being burned; (4) whether the current rate of burning is sufficient to make a difference, and (5) ways to improve our understanding of historic fire regimes and consequent fire effects and to improve feedback of such information to management.

Major conclusions reached included the following:

• In an effort to define more clearly an overall goal for the prescribed fire program it was agreed that the traditional emphasis on restoring fire as a "process" should be expanded to include recognition of the importance of the effects of that fire on forest structure. The goal of the overall program thus was reworded to read **"To restore and perpetuate the fire regime and the vegetation structure (or range of structural variability) that would have existed today had Europeans not come on the scene."** Improved understanding of the relationships between fire regime and vegetation structure will be required before specific structural objectives can be articulated.

• Burning rates in the mixed conifer forest zone need to be accelerated if anything even approaching natural fire regimes are to be restored. Yet, since it was felt that more damage is generally done by not burning than by burning without fully understanding all of the possible effects, lack of information should not be used as an excuse not to burn.

• If constraints to burning more acreage cannot be overcome, serious consideration must be given to identifying areas where natural fire frequencies can be maintained while managing others under either a fire suppression scenario or through application of other hands-on manipulations.

• Increased emphasis needs to be given to second and third burns in the mixed conifer forest zone. Under current conditions initial burns often create more fuels than existed prior to the fire. Similarly, emphasis needs to be given to getting away from the traditional burning of defined blocks under relatively uniform conditions. Use of larger, variable intensity fires set from point ignitions (rather than strip headfires) needs to be encouraged.

• Preparation time spent clearing fuels from around the base of trees in non-frontcountry sequoia groves presents a major time constraint and greatly limits the acreage that can be burned. It was agreed that additional effort should be given to studying the effects of past fuel manipulation practices in the sequoia groves. In addition, if increased sequoia regeneration and recruitment is desired, consideration must be given to finding ways to encourage occasional "hot spots" that punch holes in the canopy during prescribed burns.

• The current fire effects monitoring program does not provide sufficient levels of understanding on cause and effect relationships to permit statistically valid analysis of program effects (such as what frequencies and intensities of fire result in what types of forest structures?). The monitoring program must be supplemented with research studies to understand fully the relationships between fire behavior and effects.

• Smoke and related air quality issues have the potential to seriously restrict future burning activities (and have done so already in Yosemite). Increased emphasis needs to be given to monitoring smoke during different burning conditions and to understanding the effects of smoke on ecosystem properties and human health. Improved communication with local air quality districts also is essential.

• The lack of a base funded long-term research program on fire effects continues to plague program advancement. Critical questions regarding the historical range of fire frequency, intensity, season, and size for different vegetation types, and the effects of varying fire characteristics on vegetation structure, mortality, seedling recruitment and survival, etc., must be answered before we can make sure that program objectives are both reasonable and attainable. Research will be critical to defining the range of forest characteristics that we are trying to achieve as well as establishing criteria for evaluating success. Long-term studies of the effects of different burning patterns will require a base funded commitment to support rotational plots burned under different frequencies and intensities. Support also is needed to fully develop, validate, and implement fire spread and forest dynamics models that will permit managers to test the consequences of various management decisions.

In retrospect, this workshop provided a critical opportunity to reflect on past accomplishments and discuss future directions and needs for the parks' fire management and research programs. Many of the policies and practices that have been ingrained in our system were found to be lacking in the face of modern realities. Improved understanding of the interdependence of fire, climate, and vegetation, together with appreciation for the importance of the spatial and temporal variability of fire characteristics and ecosystem response, has forced recognition of the importance of trying new ideas and techniques. The lessons we learned from the 1963 Leopold report, while still of value, must be updated to reflect a new understanding of ecosystem dynamics. The need for improved understanding of disturbance processes and their effect on ecosystem properties could not be clearer.

f the spate of new books and articles be- spawned by the budding "sciences of plexity" is any indication, a whole new ld paradigm is a-borning. The National System, and the Service which exercis- ollective stewardship over it, eventually be caught up in any new paradigm that rges, hence the following "review of ews." The take-off point for each of the s is "complexity," and together they much of the human condition—from ogy (with strong overtones of philoso- and religion) to "management" (our at- ts to cope with the powers our tools have n us).

new paradigm is one that affects our le internal picture of reality. It involves eral principles whose understanding and ptance affect the ways we see and deal our world and ourselves. At the same , this particular paradigm—the sciences omplexity—has given rise to writings question the heretofore largely unques- ed applicability of general principles in nstances—across the board.

hree books, all of which can be read as els to the book reviewed in the Summer issue of *Park Science*, (*Complexity: at the Edge of Chaos* by Roger Lewin),

eginning Again: People and Nature in New Millennium, by David Ehrenfeld, ord University Press, NY, 1993. 194 pp. 00 (ISBN 0-19-507812-8 cloth);

eadership and the New Science, by Mar- t J. Wheatley, Berrett-Koehler Publish- Inc., San Francisco 1993. $22.95 (ISBN 1052-01-X);

rigins of Order: Self Organization and ction in Evolution, by Stuart A. ffman, In Press, Oxford University.

ll three are available in forms more ac- ible to the general public in the following ner:

eginning Again as a review by Bryan G. on, School of Public Policy, Georgia tute of Technology, Atlanta 30332, ap- ing in the January 1994 issue of *cience* (pp. 37-9);

eadership and the New Science as a re- by Susan Mokelke in *Timeline*, (pp.4- ublished bi-monthly by the Foundation Global Community, 222 High St. Palo , CA 94301-1097; and

rigins of Order as an article by the author elf, appearing first in *IS Journal #12*, the early publication of International Syner- nstitute, a global network of vanguard ts, scientists and activists, and appearing in *Annals of Earth*, Vol. XI No. 3, 1993, 9-26.

To begin with the toughest, but still accessible to the layperson, Kauffman's article describes the evidence for the complexity scientists' claim that complex adaptive systems "achieve in a law-like way, the edge of chaos." This "edge of chaos" is described by Kauffman as "the phase transition zone" between two broad regimes that are "chaotic and ordered." It is in the narrow third complex regime—poised at the boundary of chaos—that Kauffman detects "order for free."

Kauffman leads the reader painstakingly through the complex pathway of how spontaneously ordered features of computer simulations parallel a host of ordered features seen in the ontogeny of mouse, human, bracken, fern, fly, bird. A "cell type," he explains, becomes a stable recurrent pattern of gene expression, or to use mathematical jargon, an "attractor"—like a whirlpool—a system toward which all the possible patterns of gene activities tend to flow and remain. Eventually he arrives at the following paragraph:

"Bacteria, yeast, ferns, and humans, members of different phyla, have no common ancestor for the past 600 million years or more. Has selection struggled for 600 million years to achieve a square root relation between genomic complexity and number of cell types? Or is this order for free so deeply bound into the roots of biological organization that selection cannot avoid this order? But if the latter, then selection is not the sole source of order in biology. Then Darwinism must be extended to embrace self-organization and selection."

Kauffman's articles (about his book) extrapolate complexity theory to such societal phenomena as economics. He posits the notion that complexity theory accounts for "why economics has had a difficult time building a theory of the evolution of technolgical webs."

Here, Kauffman may be illustrating what Ehrenfeld, in *Beginning Again*, warns against—the wholesale extrapolations of cherished "general principles." According to Norton, Ehrenfeld suggests that while physics emphasizes general laws that facilitate predictions and centralized control, biology is inherently a science of the **particular**. In Ehrenfeld's Part 1, "Taking Bearings," he explores aspects of the idea of **place**, the local and particular wisdom about, and commitment to, a home in the natural world. The word "chaos" again appears, often. "It is possible to steer through the chaos of modern life in a deteriorating environment, Ehrenfeld believes, if we follow the secret of all navigation: "the secret...is in paying attention to the fixed landmarks, both celestial and earthly" (p. viii from the book).

The celestial landmarks are described by Norton as "the gems of religious wisdom, introduced on nearly every page." The earthly landmarks (which are of intense interest to National Park System managers) represent the particular knowledge of particular places—the understanding, gained by ecologists and other sharp observers, of the particularities of life in diverse systems and landscapes. Ehrenfeld calls them "the innumerable examples of how to live and endure in the kaleidoscopic environment of our earthly and only home."

Thus, Ehrenfeld enjoins both ecology and religion as partners in the search for a new beginning.

Norton terms Ehrenfeld's book an embodiment of "religion in the best sense--an attitude of respect for cultural wisdom that emerges over many generations—without dogma—simply a search for wisdom as opposed to information, expertise, and technique.

With direct application to the National Park Service, Ehrenfeld states: "Places can be destroyed, that is, they can have their nature and meaning irrevocably changed and their connection with the past severed." And then he states (on p. 33) what Norton calls "the central insight of this insightful book":

"Conservation has to start at home, where we know, or ought to know, the problems, and where we are most likely to understand the opportunities and limitations of our solutions."

But managers do not escape with only guideposts. Ehrenfeld devotes much of his book (again according to Norton) to "the explosion of the managerial class, which he indicts as "the most destructive force of modern society." Norton quotes Ehrenfeld thusly:

"Overmanagement is a by-product of an exploitative age in which the massive extraction and processing of natural resources have been accompanied by the release of huge amounts of surplus wealth." He uses universities as an example of management run amok. He decries these large new "sources of unregulated cash" where a positive feedback loop emerges: the need to control funds, leading to more administrative tasks, even as more administrators choke the system and reduce the productivity of educators who are more and more frozen out of control of their own fates.

For another view of management, Wheatley's *Leadership and the New Science* offers hope that managers of the future will do their jobs within the new paradigm—one

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Book Review

The Visitor's Guide to the Birds of the Eastern National Parks: United States and Canada (1992; $15.95 U.S., $20.95 Canada) and **The Visitor's Guide to the Birds of the Rocky Mountain National Parks: United States and Canada** (1993; $15.95 U.S., $19.95 Canada), by Roland H. Wauer. John Muir Publications, Santa Fe, NM.

Those who know Ro Wauer will not be surprised to learn that he hasn't slowed down since retiring from the Park Service. Among other projects—such as serving on the National Academy of Sciences committee that produced the report, *Science in the National Parks*—Ro is writing a series of four books on birds in the national parks. Two of these have been published and the third—on the parks of central North America—is in press. This year he is researching and visiting parks along the west coast up to Alaska.

The series is the idea of Robert Cahn, noted conservation writer with a special interest in national parks. With his "trailer slave" (wife Betty), Ro has visited all the parks he writes about, adding this up-to-date acquaintance to knowledge gained and notes taken over his 32-year career with NPS. (Betty, not an avid birder, has enjoyed these trips more since taking up videography.)

The books are introductions to both birding and national parks. For each park, they describe the most common and obvious birds, their behavior, and plant community associations; park environments; and park facilities, services and publications. They also summerize the bird life as presented on the park checklist. With this format, readers can compare parks easily. Ro apparently assumed that readers would turn to selected park accounts and therefore wrote each account to stand alone. This results in descriptions of many species being repeated several times throughout the book. Ro's birding skills and close, precise observation habits are everywhere evident.

Because the books are written for beginning birders, advanced birders will be disappointed by the lack of discussion of the less common species. However, every reader will benefit from the advice on good birding areas and will find many bits of intriguing bird behavior. I was surprised to learn, for instance, that red-tailed hawks sometimes stalk their prey on the ground. Conservation messages, especially on neotropical migrants, are sprinkled throughout. The illustrations include maps of park locations and excellent bird drawings and color photos of park environments. A single summary checklist of all birds in the parks described, a list of plant names, and a bibliography end each book.

The books will be sold in many parks and will be useful additions to park libraries, for both staff and visitors. The central North America book should be out in 1994 and the west coast book in 1995.

Napier Shelton
NPS Washington Office

Spate of New Books continued from page 27

that abandons the world of predicatability that Newton and Descartes envisioned in favor of a world of potentials and probabilities.

Wheatley is a Harvard-educated organizational consultant who, while trying to address the growing problem of organizational dysfunction, became obsessed with the new sciences of complexity and chaos. Haunted by such questions as "Why does change, which we are supposed to be managing, keep drowning us?," she plunged into a journey of discovery and arrived at her premise:

"I believe that we have only just begun the process of discovering and inventing the new organizational forms that will inhabit the 21st century. To be responsible inventors and discoverers, though, we need the courage to let go of the old world, to relinquish most of what we have cherished, to abandon our interpretations about what does and doesn't work. As Einstein is often quoted as saying, 'No problem can be solved from the same consciousness that created it.' We must learn to see the world anew."

It would seem that Wheatley has gone directly from a layperson's description of new sciences to the management implications they present for dealing with self-organizing systems. Change, stability, and renewal are hallmarks of a self-organizing system, and Wheatley defines the key to such systems (self-reference) this way:

"In response to environmental disturbances that signal the need for change, the system changes in such a way that it remains consistent with itself in that environment." She sees this as an optimistic lesson for despairing humans. Freedom and order are partners in the new paradigm...the more freedom in self-organization, the more order.

And further good news is the new insight that "under certain conditions, when the system is far from equilibrium [at the edge of chaos], creative individuals can have an enormous impact." As she notes, "It is not the law of large numbers, of favorable averages, that creates change, but the presence of a lone fluctuation [the butterfly wing effect] that gets amplified by the system." (*See Editorial, page 2 of this issue, for additional thoughts—Ed.*)

Information, Wheatley concludes, is the creative energy of the universe. Certainly this emerging paradigm suggests it. It was back in the '20s and '30s that astronomer Sir James Jeans observed: "The universe begins to look more like a great thought than a great machine."

Mokelke calls *Leadership and the New Science* an inspiring book, with much to offer any individual or organization walking the edge of chaos on the road to a higher order of being," and offers this quote from Wheatley as a concluding example:

"To live in a quantum world, to weave here and there with ease and grace, we will need to change what we do. We will need to stop describing **tasks** and instead facilitiate **process**. We will need to become savvy about how to nurture growing, evolving things. All of us will need better skills in listening, communicating, and facilitating groups, because these are the talents that build strong relationships. It is well knwon that the era of the rugged individual has been replaced by the era of the team player. But this is only the beginning. The quantum world has demolished the concept of the unconnected individual. More and more relationships are in store for us, out there in the vast web of universal connections."

Jean Matthews
Editor, Park Science

Latest Research at El Malpais Reveals Dating Errors

By A. William Laughlin

l Malpais National Monument was creat- preserve some of the youngest and most ctacular volcanic rocks within the conti- al United States. These cinder cones and flows are part of the Zuni-Bandera vol- c field which in turn is just one of several anic fields that form a northeast trending nment that extends across Arizona and Mexico. Geologists refer to this align- t as the Jemez lineament. Although logists have long known that the volca- and lava flows of the Zuni-Bandera anic field are very young, it has only been in the past 20 years that serious attempts been made to determine the age of this anic activity. In the mid 1970s, we ined potassium-argon dates on some of lder lava flows from the Zuni-Bandera anic field. These dates suggested that the r flows are about 1.4 millon years (Ma)

the late 1980s and early 90s, a group of archers from Los Alamos National Lab- ory, the University of Arizona, and New ico Institute of Mining and Technology ined an additional dozen potassium-ar- and argon-argon dates from the volcanic . The results of our second study indicat- at our prior dates of about 1.4 Ma were ror (anomalously old). Our new results ghlin et al., 1993) indicated that there three major pulses of volcanic activity in the Zuni-Bandera volcanic field. The of these, which occurred about 700 sand years ago (700 ka), produced basalt s south and west of the Monument. A nd pulse, which produced flows in the ern part of the Monument, in the Chain raters area, took place between 150 and ka. The third and youngest pulse of anic activity produced the spectacular dera and McCartys flows as well as the s from the Lost Woman, Twin Craters, Paxton Springs volcanoes. In this second y, we were unable to date these youngest s.

late 1992, a third geochronological study e volcanic rocks of the Zuni-Bandera anic field and El Malpais National Mon- nt was begun by researchers from Los nos National Laboratory, New Mexico tute of Mining and Technology, and the Mexico Bureau of Mines and Mineral urces working with NPS staff. The r goal of this third study was to date the gest volcanic rocks of El Malpais NM nly to aid in understanding the volcanic ry of the area but also to provide a test area for calibrating newly developed dating techniques. To accomplish this goal, four different dating methods have been applied to these lava flows and volcanoes: argon-argon, radiocarbon, helium-3 surface dating, and uranium-series dating. At least two different methods have been applied to three different flows: the Bluewater flow (uranium-series and helium-3), the Bandera flow (radiocarbon, helium-3, and argon-argon) and the McCartys flow (radiocarbon and helium-3). Results on each of these flows are discussed below.

The Bluewater flow, which is probably the oldest flow of the third pulse, is exposed in the valley west of the town of Grants and outside the Monument. Prior to our most recent work, we had obtained two potassium-argon dates of 5.69 and 2.23 Ma on this flow. These dates were clearly anomalously old because of "excess" argon incorporated in the flow during crystallization. Two different samples of the surface of the Bluewater flow were collected for helium-3 dating. These samples yielded an average age of 57 +/- 6 ka; a third sample of the flow was dated by the uranium-series method, yielding an age of 79+40/-30 ka. The ages obtained by the two different methods agree within experimental error.

The Bandera flows were erupted from Bandera Crater, which lies within El Malpais NM about 40 km southwest of Grants, New Mexico. With the assistance of the NPS, a backhoe was used to excavate trenches through scoria erupted from the volcano. Two samples of charcoal for radiocarbon dating were collected from the soil immediately below the scoria. This charcoal probably represents roots burned from the heat of the scoria eruption. These samples gave ages of 10,050-10,070 and 10,990 calibrated years before present (B.P.). We believe that the older age is more likely to be correct. Three samples of the Bandera flow were dated using the helium-3 method giving ages of 11,000+/- 1,100, 10,000+/- 1,800, 12,500+/- - 1,400 years. We consider the agreement between these methods to be exceptionally good. Work is now in progress on the argon-argon dating.

The McCartys flow, the youngest flow within the Monument, was also dated by both the radiocarbon and helium-3 methods. A site was found on the eastern edge of McCartys flow where stream erosion had cut beneath the flow. Two charcoal samples, representing burnt plant roots, were collected for radiocarbon dating from beneath the flow.

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The youngest pulse of volcanic activity at El Malpais National Monument about 3,000 years ago produced the McCarty flow, shown here overlying the approximately 80,000 year old Laguna flow.

El Malpais continued from page 29

These two samples gave an average age of 2,987+/- 92 calibrated years B.P. Two samples of the surface of McCartys flow were dated by the helium-3 method. These samples gave ages of 2,500+/- 1,100 and 2,400+/- 600 years. Again we consider the agreement between methods to be excellent.

The results of our third geochronological study were presented at a geochronology field conference held in Grants, New Mexico in April, 1993. This conference was hosted by Los Alamos National Laboratory, New Mexico Bureau of Mines and Mineral Resources, New Mexico Institute of Mining and Technology, and the NPS. In attendance were 55 geochronologists and geomorphologists from the U. S. and Canada. Considerable interest was expressed by the participants in developing El Malpais NM as a test area for new dating techniques. A large number of samples were collected during the conference for cosmogenic carbon, chlorine-36, and thermolumnescence dating and paleomagnetic studies. Results of these studies will be reported to the NPS on an annual basis.

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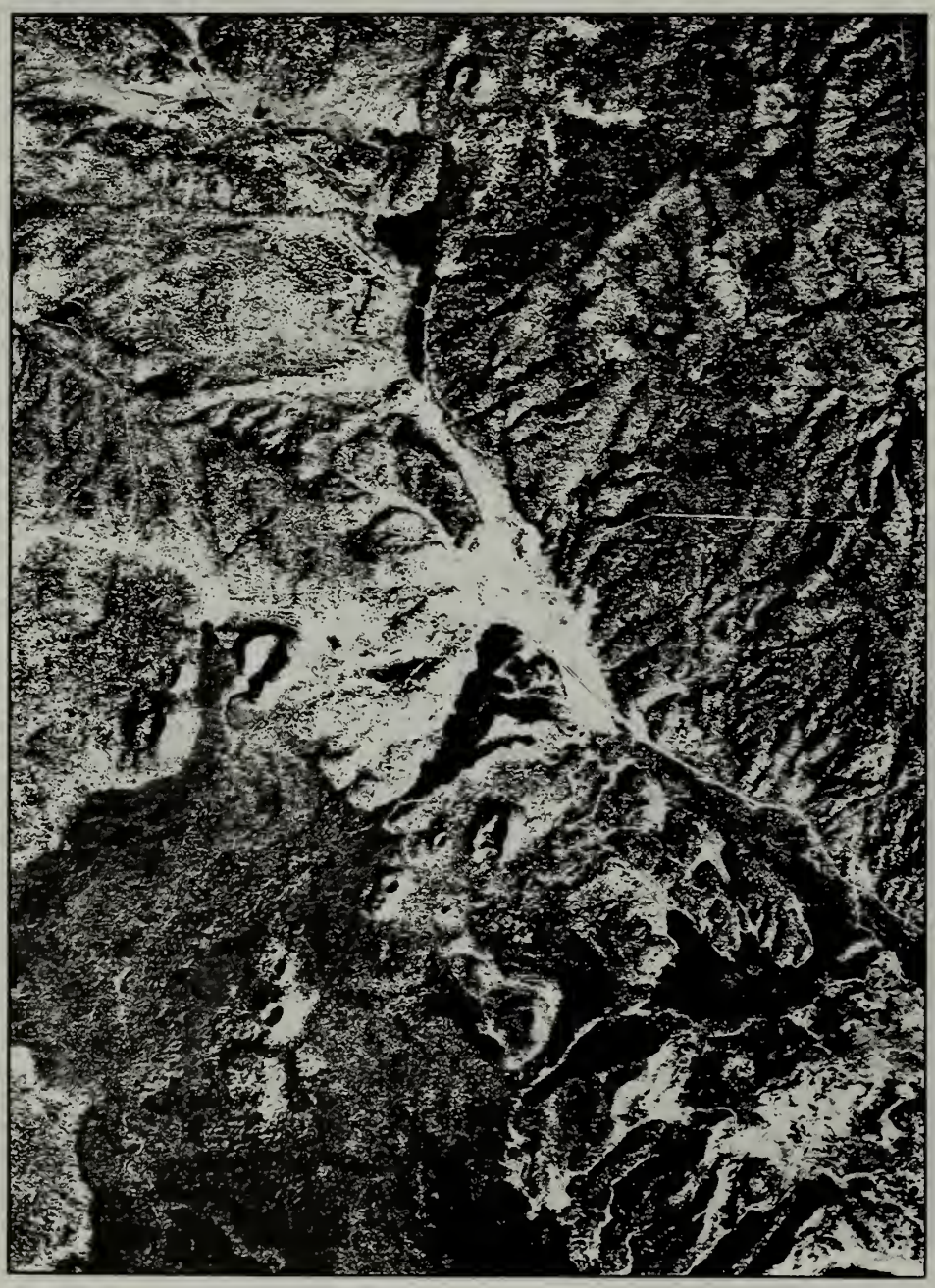
Bandera Crater (left center, by the highway) can be seen here together with several other cinder cones that lie within El Malpais National Monument.



CPSU Hosts 2nd Biennial Conference on Colorado Plateau Research

The Second Biennial Conference on Colorado Plateau Research was hosted by the Cooperative Park Studies Unit at Northern Arizona University (NAU), Flagstaff, Oct. 25-28, 1993. Patsy B. Reed, Interim President of NAU, introduced by Unit Leader Charles van Riper III, expressed pleasure at the university's opportunity to participate with the National Biological Survey (NBS) in gathering and disseminating biological research information.

Bruce Kilgore, NPS Western Region Chief Scientist, presented the NPS Director's Natural Resources Award to Henry O. Hooper, NAU's Vice-president for Academic Affairs, for his support of NPS resource protection issues and CPSU operations on the NAU campus.

Ray Stendell, Director of the National Ecology Research Laboratory (NERC) in Fort Collins, CO, shared information on the organizational structure and function of the new NBS and indicated that the CPSU, serving as a Research Station under NERC supervision, will continue to focus on research for the Colorado Plateau ecosystem.

Formal sessions opened with a workshop on the Endangered Species Act, followed by a session discussing the prototype I&M program developed for Montezuma Castle National Monument. The 167 registrants sampled 68 presentations in 8 paper sessions and two poster sessions. Papers covered topics in the fields of endangered and declining species, physical resources, animal and plant ecology, and cultural resources. A workshop on Global Positioning Systems (GPS) closed the conference. The conference program abstracts and author identification encouraged future information exchange among researchers.

Representatives from 7 agencies, 13 universities and colleges, and half a dozen other organizations took part in this truly interactive conference. Proceedings of the first such conference had just been published and were available to attendees. A proceedings from the second conference is due from the printer shortly.

Connie C. Cole
Publications Editor
NAU Cooperative Park Studies Unit

ooperative Efforts Improve Forest Health at Coulee Dam

By Karen Taylor-Goodrich

ust what is "forest health"?

Recognizing that forest types vary consid-
ly depending on which biogeographic
vince they're in, generally, a healthy for-
is resilient to change, is biologically di-
e, provides sustained habitat for fish and
llife, and meets long-term resource man-
ment objectives.

A forest can become unhealthy when its
ral dynamics are interrupted, challenged,
therwise subjected to natural and/or hu-
-caused agents that affect "normal" for-
volution. Agents such as fire (or lack of
nsects, diseases, site degradation, weath-
xtremes, "catastrophic" events, air and
er pollution, and improper forest man-
ment practices, all can contribute to mak-
a forest unhealthy.

Unhealthy forests tend to be even-aged
overstocked stands with little resistance
silience to pests.

lthough forest pest infestations are con-
red natural processes, forests in devel-
d areas also must be managed with visitor
in mind. At Coulee Dam National Rec-
ion Area (CODA) the forests in our 26
loped visitor use areas pose unique man-
nent challenges. Decades of fire sup-
sion, multiple years of drought, threats
poor forest management practices near-
and other human caused activities have
riorated the quality of the ponderosa pine
us ponderosa) forests in the area.

iven the linear nature of the recreation
(Lake Roosevelt is 150 miles long with
0-mile shoreline), and its proximity to
r federal, state, tribal, and privately man-
l forests, we recognize the importance of
aging forest vegetation in our developed
in a way that enhances surrounding
resources as well. The sustainability of forests in these areas of high recreational value is in question, and we realize that we may face major forest losses in our campgrounds if we do not act soon.

NPS staff are addressing forest health issues on Lake Roosevelt in cooperation with other resource agencies. We have utilized the expertise of Forest Service entomologists and pathologists in identifying the types and causes of insects and diseases taking over our forests. (This may sound melodramatic; forest pests are common and natural in forest ecosystems, however it's the degree of infestation that is of concern here.)

The Forest Service also has provided silviculturists to train NPS resource management and maintenance staff in the evaluation of local forest conditions. We are in our third year of funding for forest insect and disease management projects through the USFS sponsored Forest Pest Management Program. In addition to Forest Service staff, we have contacted resource professionals from other NPS areas, outside agencies, and universities to discuss the latest developments on managing forest insects and diseases in developed areas.

The first step was to recognize and document the extent of our forest health problems. We knew we had lost hundreds of trees to a major outbreak of western pine beetle in one of our popular campgrounds, but we didn't have enough information to determine the condition of all our developed sites. We decided to address the problem systematically, and we have taken measures to determine the extent of active infestations, the potential for continued insect and disease problems, and what management options for treatment are available to us.

NPS resource management staff conducted an extensive Forest Insect and Disease Risk Assessment Survey of the 26 developed campgrounds at CODA in 1992. Based on basal area measurements (tree spacing), diameter at breast height (DBH), and other tree health indicators, preliminary survey results indicate the forests along Lake Roosevelt are extremely overstocked, stressed, even-age stands, with minimal regeneration occurring. This weakened condition has resulted in declining resistance and resilience to pest damage.

The survey has provided us with sufficient data to prioritize areas by level of health, allowing us to make more informed management decisions that may involve suppression and/or prevention activities. In order to keep infestations from spreading, and to address public safety concerns, active infestations receive the highest priority for treatment. Prescribed fire, and the removal of overstocked trees to an optimum level for growth will be used as secondary measures to improve overall forest vigor and resistance to pests.

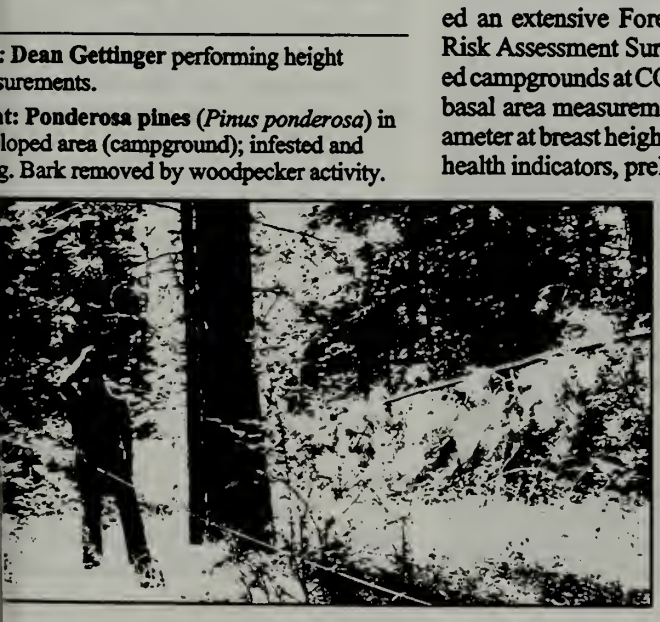
Along with NPS efforts to improve forest health at CODA, most resource managers in the region are working to address the deteriorating condition of forests in the Inland Northwest, including Canada. Major forest insect and disease outbreaks are occurring throughout the area, and managers are working together to educate the public and their agencies on forest health issues. NPS staff at CODA are participating actively in regional forest health education efforts, and serving on task forces and committees to address these issues. Cooperative efforts to develop public information and educational materials involve press releases, posters, a brochure (completed), and a videotape (in the planning stage).

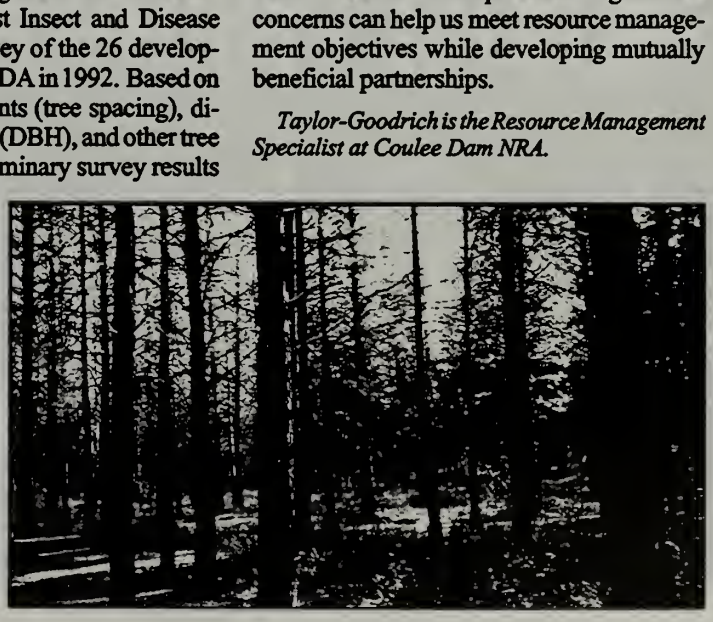
What we have learned will serve as a foundation for the long-term protection and preservation of significant ecological and recreational forest resources. Likewise, recognizing the importance of cooperative efforts to address both park and regionwide concerns can help us meet resource management objectives while developing mutually beneficial partnerships.

Taylor-Goodrich is the Resource Management Specialist at Coulee Dam NRA.

: **Dean Gettinger** performing height
surements.

t: **Ponderosa pines** (*Pinus ponderosa*) in
loped area (campground); infested and
g. Bark removed by woodpecker activity.





Meetings of Interest

1994

April 20-22 **Ecosystem Management of Natural Resources in the Intermountain West,** at Utah State University, Logan, UT; with 16 co-sponsors including NPS. Contact Dr. Gred Wagner, (801) 750-2555.

May 4-6 **1994 GEOLOGIC SOCIETY OF AMERICA, ROCKY MOUNTAIN SECTION MEETING,** Durango, CO; papers from a platform session on NPS Paleontological Research, chaired by Vincent L. Santucci, will be published in a symposium volume. Contact Santucci at (412) 766-6207.

May 16-18 **SECOND INTERNATIONAL CONFERENCE ON SCIENCE AND MANAGEMENT OF PROTECTED AREAS,** at Dalhousie U, Halifax, Nova Scotia; contact: Neil Munro, Parks Canada, Historic Properties, Upper Water St., Halifax, N.S., CANADA B3J 159; FAX (902) 426-7012.

June 7-10 **FIFTH INTERNATIONAL SYMPOSIUM ON SOCIETY AND RESOURCE MANAGEMENT,** CO/State/U, Fort Collins, CO. Michael J. Manfredo, program chair; contact Human Dimensions in Natural Resources Unit, CO/State/U, Fort Collins, CO 80523.

Aug. 28–Sept. 2 **6th ANNUAL INTERAGENCY WILDERNESS CONFERENCE,** tentatively scheduled for Santa Fe or Albuquerque, NM.

Oct. 22-26 **NATIONAL SYMPOSIUM ON URBAN WILDLIFE** at Seattle-Bellevue, WA Embassy Suites Hotel; a 2-day local workshop will precede the national focus on the needs of wildlife, advice for conservation, and measuring progress toward meeting the needs of both people and wildlife in metropolitan environments. Sponsored by the National Institute for Urban Wildlife; contact Dr. Lowell W. Adams, NIUW, 10921 Trotting Ridge Way, Columbia, MD 21044; (301) 596-3311.

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PARK SCIENCE

A Resource Management Bulletin

ume 14 — Number 3 National Park Service U.S. Department of the Interior Summer 1994

Neotropical Migratory Bird Workshop and Research

By Ralph Grundel and Theodore R.Simons

National Workshop on the Status and agement of Neotropical Migratory Birds held in September 1992 at Estes Park,

he Proceedings, recently published and able from the USFS Rocky Mountain st and Range Experiment Station, (Gen. . Report RM-229) covers issues that are al to Neotropical migratory bird conser-n:

hich avian species currently are in de- in North America?

re there commonalities in biogeography ehavior that link, in a unique manner, es that are in decline?

re declines most closely related to prob- originating during the breeding season, nigratory passage, or on the wintering nds?

hich monitoring protocols provide the useful data on the status of avian popu-ns?

hat solutions can researchers and re-ce managers devise for preventing popu-n declines or for augmenting threatened lations?

he workshop was organized under aus- of Partners in Flight, a cooperative ment between governmental and non-rnmental (NGO) organizations intended cilitate the study and management of ropical migratory bird populations. The is one of 14 federal agencies represented e Neotropical Migratory Bird Conser-n Committee, the federal government's onent of the Partners in Flight pro-.

Populations Status: nds and Monitoring Methodology

e methodology for evaluating the status eeding birds is evolving to improve the tical validity of population estimates. studies of breeding bird population mics are striving to gather information nd simple abundance of birds. These dural changes should improve signifi-y the usefulness of such data for conser-n.

Since 1966, the primary source of information on trends in breeding bird populations in the U.S. and Canada has been the North American Breeding Bird Survey (BBS). The BBS now is coordinated by the National Biological Survey (NBS) in the U.S. The BBS relies on roadside counts of breeding birds, conducted throughout the country. Inadequacies of this methodology were noted

Continued on Page 3

Breeding Bird Survey (BBS) data indicate that Ovenbird (below) populations increased nationwide from 1966-1977, but significantly declined therafter. These changes are regional—Ovenbird populations in the Northeast increased during the 1980s perhaps due to forest maturation. This illustrates the complexity of population trends and the importance of multiple types of census stations. Many warbler species, such as the female Black-throated Green Warbler (above), have experienced especially large population declines according to the BBS, over the past decade. (*Photos: NPS, Indiana Dunes NP*)

PARK SCIENCE

NATIONAL PARK SERVICE

SUMMER 1994

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

Contents

Departments

Editorial

It must be true that what you do, you come to love. The wisdom of the ages has it so, and so, I see, it has become with me.

Since the early days of Jack Kennedy and Stewart Udall, when I was a writer of speeches and press releases in the Secretary's Office of Information, I have been drawn ever more deeply to the National Parks...so much so, that after 6 years of writing the Departmental Conservation Yearbooks I was lured away from my comfortable GS-15 position by NPS Director George B. Hartzog, Jr., and have never once looked back.

My initial attraction to the National Park System led to active involvement and eventually to love, with all the anxious concern that inevitably occurs with the full-blowing of that emotion. I have watched the cyclic struggle to define and control the uses and care of that unique set of resources—a natural, cultural, and spiritual asset whose fate today is teetering on the brink between treasure and tragedy.

I have observed and participated in many of the attempts to understand, interpret, and care for this awesome System. These various attempts have both flourished and languished in the short run, but over the long haul they have stubbornly persisted—even through extended periods of what can only be seen in retrospect as massive ignorance and deliberate destruction.

One of the great joys of recent years has been the sturdy growth of park-based research and science-based resource management. It was a development woefully long in coming and desperately needed. The current well-intentioned effort to strengthen science-based decision-making across the board at Interior has launched--not for the first time (see page 21 for Gerry Wright's review) a consolidated science effort. That effort, once again entitled National Biological Survey, has a chance this time of fulfilling its bright promise without undermining th NPS science program.

But this re-formation of Interior's scienc program must not be allowed to focus rigidly o "pure" science as opposed to applied researc that responds in a timely manner to the cryin needs of a System under incredible pressures

The NPS scientific research program grev out of a desire to understand and document th National Park System's priceless resources an to apply the results of research to the needs o enlightened management. The Park Syste can profit from the added light that a consolida ed cadre of scientists can throw on its makeu But the feedback into the System from th results of such research must continue as stron support of System management.

No matter how lofty the aim or how high minded the instigators of the NBS, the Nationa Park System–vulnerable and irreplaceable- must not be allowed to lose its science suppor its access to informed input into managemen decision-making.

As the only editor of this bulletin, which started 14 years ago, I have tried always t maintain a positive attitude, reporting on th hopeful signs and celebrating news of promis ing trends. But as I prepare to depart, I hav asked myself if I want to be remembered (if a all) as Pollyanna, or would I rather sound th warning note that more faithfully reflects anxi eties lying not far below surface bravado. came to the conclusion that I could not g without one word of caution.

Looking back can be as important as lookin to the future. Regrettable events that hav happened in the past should be faced, recog nized, and not allowed to overtake us again Once, we lost our way. It happens. But twice Please, not again!

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eotropical Migratory Bird Workshop and Research continued from page 1

ne conference. For example, the BBS phasizes species readily seen or heard n roadsides and active during early morn- Also, BBS data provide limited clues to ses of documented declines. Still, BBS do inform us of changes in relative ndance of many species over many years. BS data suggest that population trends n 1982-1991 for many species were dif- nt from the overall trends noted for the 6-1991 span of currently analyzed BBS . A statistically significant proportion of tropical migratory species in the U.S. %), exhibited declines in breeding season bers during the 1982-1991 period. Over entire 1966-1991 period however, there not a statistically significant percentage pecies exhibiting declines. Thus, a sig- antly increased rate of decline seems to e occurred in the decade from 1982- 1.

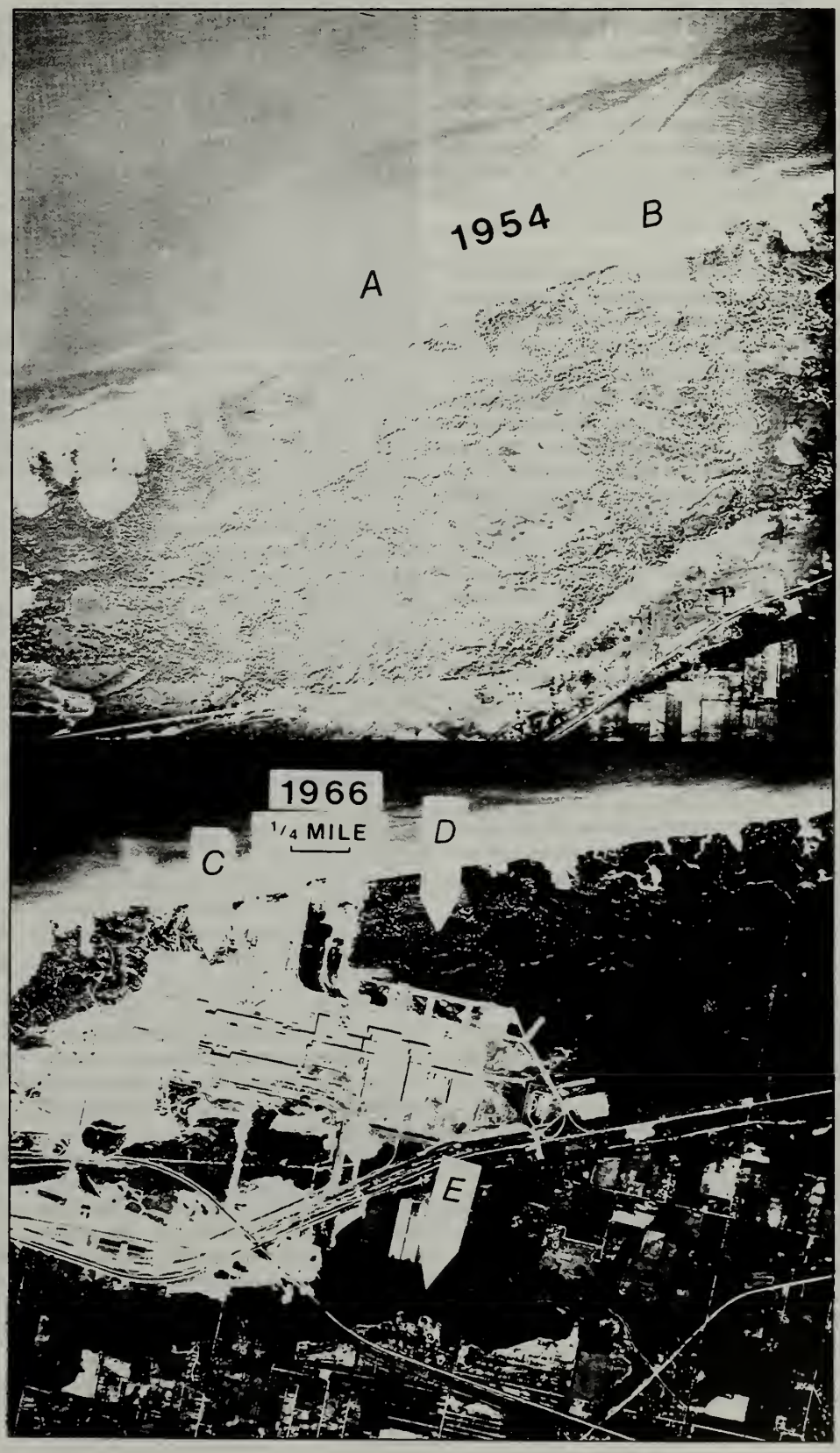
ationwide BBS analyses show that popu- n trends for species often are regionally topographically specific, so that a spe- declining in one biogeographic province nt not be declining elsewhere. Only ugh a large network of monitoring sta- s is it possible to document this type of ability and establish the true current s of a particular species.

reas that are experiencing relatively little an modification to the landscape are cially important stations within a moni- g network. This critical role is one the nal parks are uniquely suited to per- n. In addition, the national parks can m the public of within-park trends in ding bird numbers and how these trends e to global changes in bird populations. ne frequently raised point at the meeting the need for additional monitoring pro- ns to collect data on avian breeding uctivity. David DeSante, of The Insti- for Bird Populations in Point Reyes, CA, an overview of the MAPS (Monitoring n Productivity and Survivorship) pro- n, which is attempting to obtain such ographic data at stations throughout the try. Many of the MAPS stations are on al lands. Programs that count the num- f breeding adult birds in an area but do document productivity, or how many birds are hatched and fledged, can ent a misleading assessment of the hab- ability to support breeding birds.

ne quality of the breeding habitat should ad be assessed by asking whether the per of young birds produced is sufficient mpensate for adult mortality through- ne year; in other words does that habitat

Continued on page 4

The habitat fragmentation that negatively affects many breeding bird populations is strikingly illustrated here. A, from 1954, and C, from 1966, point to the same location just outside the boundary of Indiana Dunes National Lakeshore; B & D are just inside the park's boundary. Intensive commercial development (c) of dune ecosystem, from 1954 to the time of the park's formation in 1966 increased insularity of the park. Insularity often negatively affects animal and plant populations. Riparian corridor section of the park (E) is separated from body of the park by farm and residential land.



produce enough birds annually to sustain population levels? Monitoring nest success directly, by nest inspections or by mist netting birds to count the fledglings produced, improves our understanding of habitat breeding suitability. This is one goal of the MAPS program.

It should be noted here that monitoring nest success is an intensive procedure—one that provides information on many fewer species than does a BBS census. The differences between BBS and MAPS surveys illustrate why it is mandatory that specific goals be delineated before a monitoring protocol is chosen. For a given amount of effort there always will be a tradeoff between the scope of the survey and the detail of the information gathered.

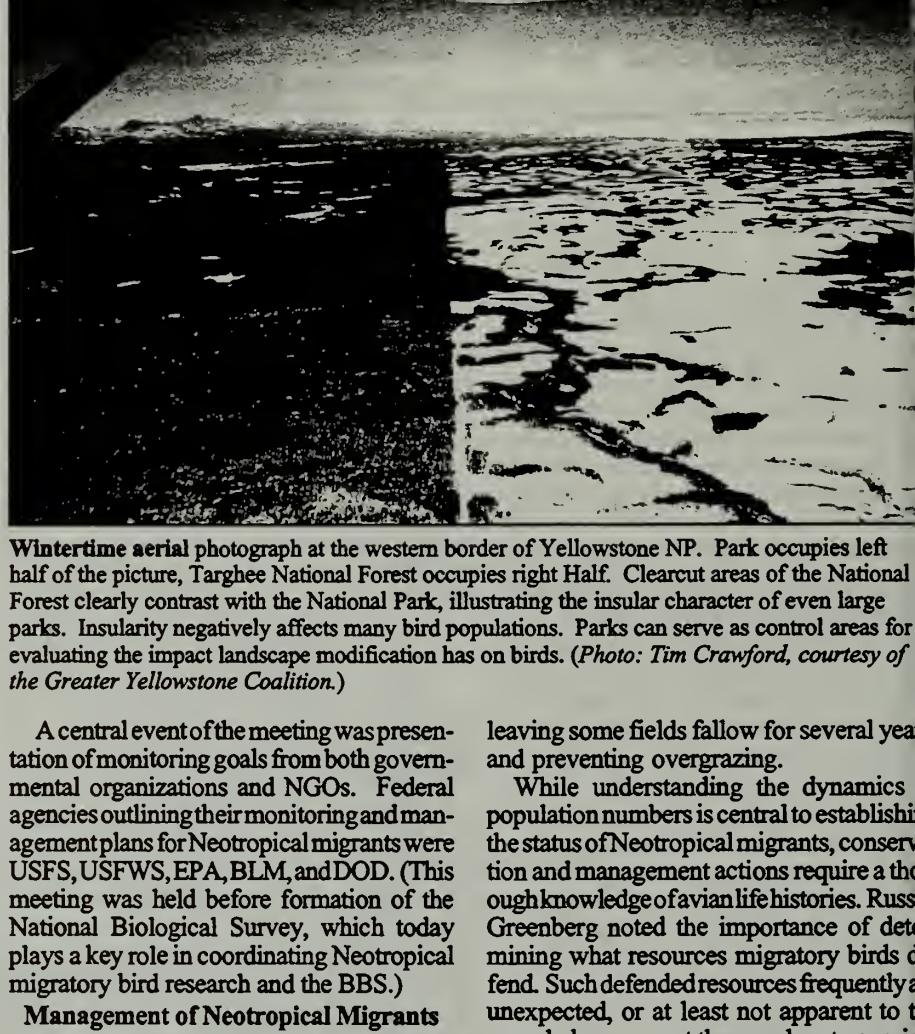
BBS and MAPS type surveys are parts of a comprehensive program. For example, within a park it often will be most useful to proceed from more general to more specific monitoring programs and to be cognizant of the types of conclusions that can be drawn from each program's data. Most parks will want first to produce a checklist of birds so that researchers and resource managers are aware of what species are present. Additional information on relative population trends might be established by a BBS type survey, and those trends might be better understood by undertaking a MAPS type study of several species.

Goals for Management

Sam Droege urged those considering establishment of a monitoring program to ask the specific purpose of the program. Can you define management goals that will use your monitoring data and management actions that will rectify disturbing trends shown by your data? For example, is a park's management goal to ensure that no species experiences more than a 50 percent decline over time, or that a minimum of 100 breeding pairs of a particular species is maintained? These two questions require different monitoring approaches, although both require high intensity monitoring, probably on a yearly basis. On the other hand, less accuracy might be required in evaluating more common species, which might be monitored on a five year cycle.

If no management options are available to influence a declining population, then you cannot expect good population news to follow bad monitoring news, and the usefulness of your monitoring program is undermined.

Make sure your monitoring program fits within your long-term monitoring budget, Droege urged. Try to standardize your monitoring protocols so your data will be comparable to data collected by other studies, and be sure to evaluate periodically the effectiveness of your protocols.



Wintertime aerial photograph at the western border of Yellowstone NP. Park occupies left half of the picture, Targhee National Forest occupies right Half. Clearcut areas of the National Forest clearly contrast with the National Park, illustrating the insular character of even large parks. Insularity negatively affects many bird populations. Parks can serve as control areas for evaluating the impact landscape modification has on birds. (*Photo: Tim Crawford, courtesy of the Greater Yellowstone Coalition.*)

A central event of the meeting was presentation of monitoring goals from both governmental organizations and NGOs. Federal agencies outlining their monitoring and management plans for Neotropical migrants were USFS, USFWS, EPA, BLM, and DOD. (This meeting was held before formation of the National Biological Survey, which today plays a key role in coordinating Neotropical migratory bird research and the BBS.)

Management of Neotropical Migrants

Given the inevitably limited resources available for study and management of Neotropical migrants, many suggestions were made as to how to allocate these resources effectively. Several schemes were given for ranking which species deserve most immediate management attention. William Hunter, David Pashley, and Michael Carter suggested that global abundance, threats on the wintering and summering grounds, size of winter and summer distribution, and population trends are the chief factors, to be considered together, in determining a species' conservation priority rating.

Ways of improving habitat were suggested by Chandler Robbins, John Sauer, and Bruce Peterjohn: For forest birds, maximizing the interior portion of forests and minimizing isolation of forest fragments from one another, encouraging diversity of native plants and the age structure of forests, and controlling exotic vegetation; for field birds, reducing mowing during breeding season, increasing the amount of grasslands that lie more than 100 meters from other habitats, leaving some fields fallow for several yea and preventing overgrazing.

While understanding the dynamics population numbers is central to establishi the status of Neotropical migrants, conserv tion and management actions require a th ough knowledge of avian life histories. Russ Greenberg noted the importance of det mining what resources migratory birds d fend. Such defended resources frequently a unexpected, or at least not apparent to t casual observer, yet they are key to survi of that species. For example, the conserv tion of trees containing essential food--su as honeydew-secreting scale insects or c tain fruits--is a critical concern in the ma agement of wintering grounds for some m grants.

Such biological facts are known in onl small percentage of cases, so basic natu history studies must not be considered esoteric addenda to practical research b rather as critical elements in conservati management.

The workshop also addressed proble inherent in making land use decisions. Pa ners in Flight is a cooperative progra dealing with species that require seve geographically diverse habitats for yearlo survival. There is great potential here promoting cooperative management of ma habitats, benefitting all landbirds and oth biotic resources.

Cooperative land management involv great biological and management comple ity. The conference talk that was voted be

ed on the topic of integrating land man-
ment practices for multiple animal spe-
was Ronald Escano's: "You cannot
nage for every species on every acre."
rcia Patton-Mallory urged review of re-
rch plans by resource managers early in
research planning process. Such early
ew increases likelihood that the informa-
gathered can be used to make land
nagement decisions. Land management
ons are essentially experiments-in-
gress, she noted, but they rarely are docu-
nted, and the information they yield is not
eminated.

The concluding workshop talks noted the
mma land managers face in making land
decisions based on scant data, and the
eoffs that arise in managing for single
ies versus the multiple species that actu-
inhabit any plot of land. The use of
cator species, or a guild management
roach, have not solved these problems.
ge geographic scale approaches to man-
ment were stressed, recognizing for in-
ce that a Neotropical migrant might be
angered in lowland portions of its range
not in upland portions, or recognizing
one forest opening can provide feeding
ortunities for brown-headed cowbirds,
ch can then parasitize passerine nests for
s around.

The 1992 workshop represented the third
e gathering in the past 15 years of re-
chers in the field of Neotropical migrant
servation. Since the late 1970s, our
erstanding of the importance of winter-
grounds in maintaining populations has
vn greatly. The pendulum has swung to
fro in scientific circles as to the relative
s of changes in wintering, migration, and
ding grounds in avian declines. The
icipants of this workshop mainly were
onsible for researching and managing
ies outside of wintering grounds, hence
workshop emphasized breeding season
cts and effects during migration.

Conceptual advances are being made that
rove the data gathered from monitoring.
now recognize that monitoring avian
luctivity is essential to more effective
nagement. Methods for gathering these
in a statistically valid way are improv-
We recognize that more complete natu-
istories of birds are essential conserva-
tools. We know that early and continued
munication between researchers and re-
ce managers increases the likelihood
research will contribute to more in-
ed management decisions. We recog-
too that our ability to understand the
n conflicting requirements of co-occur-
species is extremely limited. Prioritiz-
conservation and land management ef-
, given that limitation, is one of the
ing challenges facing the Partners in
ht coalition.

Table 1. On-going Neotropical migratory bird research and monitoring on NPS lands. This table presents results of an informal survey and of summaries from Investigators Annual Reports. If you know of other such projects being carried out in the national parks, please notify the authors, who are preparing a report on migrant bird research in the parks for the *Partners in Flight* newsletter.

Park	Activity
Acadia	Breeding bird surveys
Apostle Islands	Migration monitoring Breeding bird surveys
Arches	Pinyon/juniper breeding bird research
Bering Land Bridge	Gyrfalcon research
Big Bend	Peregrine Falcon monitoring Black-capped Vireo monitoring Christmas bird counts
Cape Cod	Breeding bird surveys
Channel Islands	Terrestrial bird census
Chiricahua	Resident and migrant bird survey
Craters of the Moon	Breeding bird surveys
Devil's Tower	Breeding bird monitoring
Denali	MAPS station (5)
Everglades	Breeding bird surveys
Fire Island	Pinelands bird community research Migration monitoring
Gateway	Migration monitoring
Glen Canyon	Willow Flycatcher survey
Grand Canyon	Willow Flycatcher survey
Grand Teton	MAPS station (1)
Great Smoky Mountains	Cove hardwood breeding bird community research Wood Thrush population dynamics research Breeding bird surveys
Gulf Islands	Trans-Gulf migrant stopover ecology research Trans-Gulf migrant habitat research
Indiana Dunes	Breeding bird survey, rail survey, nightjar survey, heron survey
Isle Royale	Raptor monitoring
Kubuk Valley	Breeding bird surveys
Lava Beds	Breeding bird surveys
Mount Rainier	Breeding bird surveys
North Cascades	Breeding bird surveys
Ozark Riverways	Swainson's warbler research
Padre Island	Breeding bird surveys Peregrine Falcon monitoring
Point Reyes	MAPS station (1)
Rocky Mountain	Peregrine Falcon monitoring
Santa Monica Mountains	Corridor bird survey Urban/wildland interface bird survey
Sequoia/Kings Canyon	MAPS station (2)
Shenandoah	MAPS station (6)
Wrangell–St. Elian	Breeding bird surveys
Yosemite	MAPS station (5) Peregrine Falcon monitoring
Yukon Charley	Peregrine Falcon monitoring
Zion	Breeding bird monitoring

The Role of National Parks

A variety of activities taking place in National Parks is contributing to the Partners in Flight program (Table 1). These activities can be as simple as Christmas bird counts or as complex as long-term research and monitoring programs. National Parks are ideal control sites for long-term population monitoring. Monitoring trends on protected habitats in parks can help determine whether changes in Neotropical migrant populations result from changes in habitat conditions on the breeding grounds in North America or from changes to tropical wintering habitats.

The newly formed NBS will be initiating regional scale research and monitoring programs to contribute to the Partners in Flight program. Data from control sites on NPS lands will make a valuable contribution to those efforts.

Grundel and Simons are Research Ecologists with the National Biological Survey. Grundel is at 1100 N.Mineral Springs Rd., Porter, IN 46304, (219) 926-8336; Simons is at North Carolina State U, 5112 Jordan Hall, Raleigh, NC 27695, (919) 515-2689.

Minor Violations, Major Damage: A Survey of Noncompliant Visitor Behavior and Managerial Practices

Darryll R. Johnson, June C. Rugh, Mark E. Vande Kamp, Thomas C. Swearingen

A hiker, hot and thirsty, pauses to catch his breath and drink from his canteen. As he looks across the lush subalpine meadow bordering the trail, his eye catches the faint traces of a path cutting through the meadow to the next switchback. Throwing the canteen back in his pack, he starts out across the meadow. "After all," he muses, "I'm not leaving any tracks."

To the typical day hiker, the impact of a few minutes of off-trail hiking in a national park appears negligible, even in a highly sensitive area. Yet it is *minor* rule violations such as these which, according to a system-wide survey conducted by the University of Washington CPSU, cause over 80 million dollars of reparable damage to national park resources every year[1,2]. Minor rule violations are also reported destroying nonreparable resources at about two-thirds of the reporting units, and annual clean-up costs are estimated to be approximately 18 million dollars. In all, *noncompliant visitor behavior* (see **Glossary of Terms**) emerges as a costly, system-wide problem which resource managers cannot afford to ignore.

The fact that the growth rate of national park use in the United States has exceeded the national population growth rate over the past two decades makes the magnitude of the problem even clearer. As host to 273 million recreational visitors in 1993, the National Park Service (NPS) encourages visitors to enjoy park resources. However, high visitation rates pose a challenge for resource managers, who must balance visitor enjoyment with the agency mandate of preserving park resources. In addition to documenting the magnitude and type of resource impacts due to noncompliance and specifying which of 20 explicitly defined types of noncompliant behavior are responsible for the damage, this survey also explored current managerial practices for preventing such damage in national parks, including managers' perceptions of the effectiveness and appropriateness of specific *noncompliance deterrence techniques* (see **Glossary of Terms**).

In describing damage to natural and cultural resources caused by noncompliant behavior, respondents answered in terms of 16 types of sites (10 frontcountry and 6 backcountry sites[3]) and gave both cost estimates for repairs and annual costs for recurring problems such as litter. Eighty-nine percent of the units reported reparable damage at frontcountry sites, with developed visitor sites most frequently reported as damaged, followed by frontcountry historic sites and picnic areas. Repair cost estimates concerning damage to historic sites totaled 32.3 million dollars; for all frontcountry sites reported, the repair cost estimate reached 66.3 million dollars. Of the units having backcountry, 87% reported reparable damage at some type of site, with damage to hiking and stock trails totaling about 4.6 million dollars and repairs for all backcountry sites reaching 13.7 million dollars for estimated repair costs and recurring annual costs of clean-up in frontcountry and backcountry sites). Overall, historical sites were most often reported as the most damaged type of site, followed by developed visitor sites[4], archaeological/paleontological sites, accessible natural attractions, and campgrounds and picnic areas.

The high figures for repair and annual clean-up costs are sobering. However, due to the NPS mandate of resource preservation, the extent to which noncompliant visitor behavior impacts *nonreparable or nonrenewable resources* is an even more serious matter for park managers. Of all reporting units, 72% reported damage to nonreparable resources. Nonreparable damage was reported at frontcountry sites in 68% of reporting units and 71% of units with backcountry reported nonreparable damage in those areas. Archeological, paleontological, and historical sites are most often reported as having nonreparable damage. Managers' comments from the survey offer illustrative examples of the consequences of such damage:

If falcons do not successfully nest—this is irreparable for the year, and they may not return the following year—a potentially nonrenewable resource.

Totem poles are nonrenewable resource in the sense that they are cultural objects an are unique. While new or reproduction pole can be carved, these are not the same.

Cryptobiotic crust and plants are renew able, but so slow-growing that if destroyed o continually disturbed they may not return— or it may take decades.

Constant touching and rubbing of histori cannon wears away the carved/cast features particularly when multiplied by 600,000 800,000 persons a year. Unlike, say, Civi War cannons, these 200+-year-old Spanis cannons are extremely rare.

Respondents were also asked to identif the noncompliant visitor behaviors they con sidered the most destructive at each type o site for which any degree of damage wa reported. For all sites, littering is the highest ranked damaging behavior, followed by dam aging the built environment, damaging o defacing cultural or historical objects, col lecting paleontological or cultural objects a souvenirs, and off-trail hiking. Fo backcountry sites, the highest-ranked dam aging behavior is collecting paleontologica or cultural objects, followed closely by litter ing and off-trail hiking.

Regarding visitor management strategies the responding units reported the use of variety of methods for controllin noncompliant behavior, ranging from bro chures and informal personal contact to bar riers and direct enforcement. However, al though almost all units try to prevent non compliance, managers estimated that thes efforts deter only about 60% of such behavio in the frontcountry and 52% in th backcountry. Clearly, a substantial amoun of damage caused by noncompliant visito behavior—to both reparable and nonreparabl resources—is undeterred by current contro methods. If unchecked, this damage wi reach crisis proportions in some units durin the next century.

Compounding this problem is the appar ent widespread disagreement among resourc managers concerning philosophically accept able and practically effective means of deter rence. Survey results showed a strikin disparity among respondents when they wer

[1] The survey employed an extensive questionnaire addressed to all NPS administrative units. The superintendent of each NPS field unit was contacted by phone and asked to recommen a staff person from the unit most qualified to complete the questionnaire. The questionnaire was sent directly to this person, except in cases where the superintendent asked to examin the questionnaire first, and then passed it on to the staff person. The questionnaires were mailed in March 1992 and garnered a response rate of 82%. The research was supported b the Office of the Associate Director of Natural Resource Management of the National Park Service with the Natural Resource Preservation Program (NRPP) Special Initiative funding.

[2] This survey has several limitations that should be kept in mind. Although we asked that the most knowledgeable person in the park complete the questionnaire, the extent to which respondent had accurate and complete knowledge of damage and the cost to repair or maintain resources is unknown. The costs reported here for repair and maintenance of NPS resources bein damaged by noncompliance were estimated by assuming that the rates of damage in nonresponding units occur at the same level as in responding units. Finally, the attitudes of respondent toward the effectiveness and appropriateness of various deterrent strategies represent the population of people chosen by the unit's superintendent to complete the questionnaire. Th extent to which these attitudes are congruent with other people in park management positions is unknown.

[3] **Frontcountry**: Areas not designated backcountry and wilderness, and areas of backcountry and wilderness easily accessible to day-hikers.

Backcountry: Areas designated as backcountry or wilderness that are not easily accessible to day-hikers.

ed to consider the appropriateness and ctiveness of a variety of deterrence techues in a hypothetical frontcountry subale setting, "Magnificent Meadows." is hypothetical scenario was used to en- that respondents answered questions cerning the use of deterrence techniques er identical conditions and assumptions.) en asked to rate informal personal con- in terms of *effectiveness* (see definition **Glossary of Terms**) as a control strategy, example, similar proportions of respons rated this technique as 80% effective hly effective) and 20% effective (mini- y effective).

When respondents were asked to consider *appropriateness* (see **Glossary of Terms**) pecific deterrence techniques, similar repancies surfaced. Given the context of 's explicit mandate of management for or enjoyment, 43% of responding man- s believed that threats of citations or s were inappropriate. Yet 17% of re- dents chose threats of fines and citations he best deterrence technique for use in gnificent Meadows.

his lack of consensus concerning both ctiveness and appropriateness of visitor agement strategies underscores the fact little scientific knowledge is available to e NPS resource managers in making sions about deterring the noncompli- . Coupled with the magnitude of the lem, this fact indicates that the first step ntly needed for a coordinated approach sitor control strategies is the establish- t of an institutionally distributed data- dealing directly with appropriate and ctive means of deterring such behavior. t, there must be an organizational agree- t on acceptable means and strategies. agreement will be reached only if ac- panied by research in the national parks h examines the relationship between ous deterrent approaches and the quality sitor experiences. Finally, in order to e concrete recommendations for holis- isitor management strategies through- he national park system, in-house re- h and a technology transfer program d be essential.

lthough it would be unrealistic to hope all damage-producing noncompliance d be prevented, related research at Mount ier National Park[5] and the accompany- iterature review suggest that a well- dinated program of research and infor- on dissemination to park staff dealing noncompliant behavior, coupled with the willingness of managers to act, would significantly reduce the incidence of resource damage. In fact, this problem represents an excellent opportunity for leadership on the part of both the NPS and the National Biological Survey (NBS). Specifically, appropriate divisions of these agencies could plan and fund a coordinated research program designed to provide system-wide guidelines for the deterrence of damaging noncompliant visitor behavior and, in turn, establish an information dissemination program to promote the use of this information. Considering the magnitude of repair and clean-up costs necessitated by ongoing noncompliance, such a research program would offer a highly favorable cost-benefit return. And visitors to the national parks would be spared the unfortunate irony of destroying the resources they hope to enjoy.

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loped visitor sites are areas characterized by a centration of visitor services such as restaurants, or centers, lodging facilities, etc.

list of publications at the end of this article.

GLOSSARY OF TERMS:

Noncompliance [Noncompliant Visitor Behavior]—Minor rule-breaking behavior or failures to comply with minimum impact regulations (e.g., off-trail hiking, souvenir collecting, feeding wild animals, littering). This definition excludes major acts of vandalism and acts motivated by obvious criminal intent.

Deterrence: The act of preventing noncompliance. Managers who seek to deter noncompliance are trying to get visitors to follow the rules (and refrain from breaking the rules).

Deterrence technique: A method of deterring noncompliance (e.g., educational programs, regulatory signs, threats of fines).

Effectiveness: Defined here as the percentage of noncompliant behavior that would be deterred if the indicated means of control were adopted.

Appropriateness: Defined here as the extent to which a means of control is acceptable, given the broad philosophical principles concerning park management and the specific NPS mandate of management for visitor enjoyment.

The following publications are available from the NBS CPSU, AR-10, U/WA, Seattle, WA 98195:

Johnson, Darryll R. and Thomas C. Swearingen. 1988. *Minor rule violators: A profile of off-trail hikers, Paradise Meadows, Mount Rainier National Park.* NPS CPSU, College of Forest Resources, University of Washington, Seattle.

Johnson, Darryll R. and Thomas C. Swearingen. 1992. *The effectiveness of selected trailside sign tests in deterring off-trail hiking, Paradise meadows, Mount Rainier National Park.* In: C. Christensen and D. Johnson (eds.), Proceedings of the International Symposium on Vandalism: *April 20-22, 1988.* USFS - PNW Forest and Range Experiment Station, Seattle.

Johnson, Darryll R., Mark E. Vande Kamp, and Thomas C. Swearingen. 1994. *A survey of park managers' perceptions of noncompliant visitor behavior causing resource damage in the national park system.* USDI, National Park Service, Technical Report NPS/PNRUW/NRTR-92/07.

Swearingen, Thomas C. and Darryll R. Johnson. 1988. *An analysis of off-trail hiking in response to selected social control techniques at Paradise Meadows, Mount Rainier National Park.* NPS CPSU, College of Forest Resources, University of Washington, Seattle.

Vande Kamp, Mark E., Darryll R. Johnson, and Thomas C. Swearingen. 1994. *Deterring minor acts of noncompliance: A literature review.* USDI, National Park Service, Technical Report NPS/PNRUW/NRTR-92/08.

Yellowstone Fires Of 1988 Told In New Book

A Bibliography and Directory of the Yellowstone Fires of 1988, by D. Despain, J. Greenlee, J. Parminter, and T. Sholly, is an important new tool available for assisting those engaged in fire research. The International Assn. of Wildland Fire announces the second edition of this volume, complete with 1,051 citations and 344 names and addresses of researchers. The index of this 169-page paperback document guides the user to articles of interest, with names, addresses, phone and FAX and e-mail addresses of authors included.

The directory may be had in paperback for $20.19 and in hardcase for $30.19 from the International Assn. of Wildland Fire, P.O. Box 328, Fairfield, WA 99012-0328.

In the next issue...

New *Park Science* Editor, Jeff Selleck, will share his vision for an expanded pool of writers from among NPS resource managers and his criteria, guidelines, and suggestions for new catagories of articles.

Note on page 16 of this issue Rolodex card with new instructions for contacting the editor.

Preventing Visitor-Caused Damage To National Pa

Mark E. Vande Kamp, Darryll R. Johnson, Thomas C. Swearingen

NPS managers require new information if they are to prevent visitors from breaking park rules and damaging park resources. The preceding article described our survey of NPS managers that showed both extensive damage to park resources due to minor acts of noncompliance and a lack of agreement among resource managers concerning the usefulness of various methods used to deter noncompliance. In conjunction with the survey we also reviewed social science literature relevant to the question, "How can NPS managers get visitors to follow park rules?" (i.e., How can managers *deter noncompliance*?) This article summarizes twelve recommendations to NPS managers suggested by the review, and also proposes a research program to develop a complete strategy for deterring noncompliance. (A full report of the review is available from the University of Washington (U/WA) CPSU -- see references)

The literature we reviewed was gathered from several social sciences including sociology, leisure and recreation science, social psychology, and environmental psychology, and fell into many theoretical traditions ranging from applied behavior analysis to sociological deterrence theory. The research could not be integrated into any existing or new theoretical approach. Instead, we searched for general assertions about deterring noncompliance that were relevant to the NPS and were supported by research results. The assertions we found are presented below as twelve recommendations for NPS managers. Let's consider each of these recommendations and their basis in the research.

What We Know

1) In evaluating a deterrence technique (i.e., a method of getting visitors to follow the rules), NPS managers must consider its deterrent effect, its impact on visitor experiences, and the level of noncompliance that is acceptable in their units. If resource preservation were the only requirement of NPS managers, there would be no noncompliance problems. Managers could fence in visitors, institute prison sentences for noncompliance, or simply exclude visitors entirely. However, the dual mandate of the NPS specifies that the national parks should be managed so as to both maximize visitor enjoyment and preserve park resources for future enjoyment. The delicate balance between these mandated goals is inextricably linked with decisions concerning noncompliance. For example, in an NPS unit where moderate levels of noncompliance produce acceptable levels of resource damage, a deterrence technique that achieved such moderate levels would be preferable to a more effective technique that had greater negative impacts on visitor experiences.

2) Multiple deterrence techniques should be used when attempting to deter noncompliance because no single technique is likely to deter all forms of noncompliance, or even to counteract the many motives for a single form of noncompliance. The diversity of the literature cited in our review suggests that using a single label -- noncompliance -- to describe the huge set of behaviors that are against some rule in a given environment conveys a false sense of simplicity. Noncompliance is even more complex because there can be many motives for any given noncompliant act. A single NPS environment may be affected by many noncompliant behaviors, each of which occurs for a number of reasons. Because of this, no single deterrence technique should be expected to deter a major portion of noncompliance, even in a single environment.

3) Decisions about deterrence techniques should not be based solely on the intuitive assessment of NPS managers using their own reactions to the intervention. In scientific terms, each NPS manager constitutes a sample of one person who is unlikely to represent most visitors to their unit. In addition, research from social psychology suggests that managers, like the rest of us, seldom recognize all the factors that actually affect their behavior. Unfortunately, the current literature is usually insufficient to provide managers with scientific evidence on which to base their decisions about deterring noncompliance. In the absence of scientific evidence, manager decisions could be improved if they were to imagine a variety of visitors reacting to deterrence techniques and then select the method appealing to the broadest range of visitors.

4) NPS managers should consider stationing uniformed employees within sight of areas damaged by visitor noncompliance because the presence of such employees is one of the most promising means of deterring noncompliance. Research suggests that the presence of a uniformed employee strengthens visitor beliefs that noncompliance will lead to negative social or legal consequences, even when that employee is not engaging in enforcement activity. The uniformed employee may also remind visitors of their own attitudes or personal norms that are inconsistent with noncompliance. Research conducted by the U/WA CPSU at Mount Rainier National Park showed that uniformed employees were perceived as a neutral or positive part of the park experience by the vast majority of visitors, while simultaneously reducing noncompliance (off-trail hiking) to very low levels (see references).

5) NPS managers should ask, "Why are visitors breaking this rule?" as a first step in controlling noncompliance. If an incentive can be readily removed, noncompliance may drop to acceptable levels. A large body of psychological theory (e.g., applied behavior analysis and utility theory) specifies that people generally act to gain rewards or avoid punishments. Accordingly, removing the reward or punishment that prompts noncompliance may be easier than overcoming its presence. For example, a social trail that cuts a switchback may see less use if thorny native vegetation is planted at its entrance and exit.

6) To maximize effectiveness, messages designed to limit noncompliance should be presented as close as possible to the place and time in which noncompliance is likely to occur. Substantial research (e.g., studies from applied behavior analysis, attitude theory, and investigations of social norms) suggests that messages designed to deter noncompliance are most effective when presented as closely as possible to the place and time in which noncompliance is likely to occur. Signs are generally an effective means of communicating such messages. A study in Mount Rainier National Park conducted by the U/WA CPSU found that sign texts varied greatly in effectiveness, but that all signs placed near social trails deterred significant amounts of off-trail hiking.

7) The current NPS focus on deterring noncompliance by instilling beliefs consistent with compliance should be altered to focus primarily on activating such beliefs in visitors who already have them rather than on converting the unconvinced. A broad range of research (e.g., research on attitude theory and personal norms) has shown that it is difficult to change visitor beliefs. However, related research has also shown that activating existing beliefs can alter behavior. Accordingly, more noncompliance will probably be deterred by erecting several trail-side signs that say, "Help preserve the meadow. Stay on the trail.", than by adding a single visitor-center display describing the unique nature of the meadow.

8) Showing visitors that noncompliant behavior damages NPS resources will only deter noncompliance for visitors who hold strong values inconsistent with such damage. Basic behavioral principles suggest that short-term rewards generally have more control over behavior than long-term negative consequences. For example, many visitors will pick up small bits of rock or vegetation as souvenirs even if they are aware that, in the long-term, such actions cause substantial damage. Knowledge about long-term consequences will deter noncompliance only for visitors who have strong values inconsistent with harming the environment. Because visitors who do not hold such values may be responsible for most noncompliance at some NPS units, control of noncompliance at those

sources: What Do We Know? What Should Be Done?

ts will require deterrence techniques oth- than education.

9) Noncompliance can be reduced by noving evidence of prior noncompliance, l by providing evidence that most visitors low the rules. Research on social norms l related studies of noncompliance sug- t that decreasing direct and indirect obser- ion of noncompliance can decrease fur- r noncompliance by observers. For ex- ple, several studies have found that litter- increases in already-littered environ- nts, and decreases when the environment cleaned. Also, research by the U/WA SU found that off-trail hiking was most ely to occur when visitors were within ual distance of other off-trail hikers. Re- rch on speeding suggests that park non- npliance can also be reduced by providing dence that most visitors follow the rules. example, speeding was reduced by signs ing, "Percentage of cars not speeding terday: **%", where ** was near 90%.

0) When noncompliance is deterred by eats of punishment, the threats should be ompanied by messages emphasizing visi- benefits from compliance. The U/WA SU found that a sign stating, "Off-trail ers will be fined", was the most effective everal signs used in their study at Mount nier National Park. Evidence from social chology suggests that such a threat of ishment would be most effective and e the least negative impact on visitor eriences when visitors believe that com- nce benefits both themselves and NPS nagers. Educational programs empha- ng the public benefits of preserving park ources may deter little noncompliance on r own, but may increase the effectiveness acceptability of threatened punishments.

1) NPS rules can produce a "boomerang ct" of deliberate noncompliance when tors feel their freedom is threatened. To uce the probability of such effects visitor ons should be emphasized. Reactance ory suggests that when threats of punish- nt are communicated, messages should phasize the visitor's freedom to choose s in which to comply. For example, a ulatory sign might say, "Fine of $100 for trail hiking", and then continue, "Be- se this is a high traffic area, visitors are not wed to walk off official trails. If you are rested in walking through an alpine adow you may take hike #12 to Golden adow."

2) When NPS communication is ad- ssed to a group, the effectiveness of mes- es intended to deter noncompliance will nhanced by special efforts to address the ssage to group leaders or to address all viduals within the group. Social psy- logists have found that persuasive mes- es are more effective when addressed to individuals than when addressed to groups. A message directed at a group leader who is responsible for the group's behavior is likely to be more effective than a message directed at the whole group. Alternately, NPS agents should design messages so that all group members feel they are being individually addressed.

What Should Be Done

Although the above recommendations represent an advance in the information available to NPS managers concerning the control of visitor noncompliance, they are far from complete. Future research can and should focus on the development of a comprehensive strategy that provides managers at all NPS units with guidelines for deterring noncompliance. Highlighted below are the basic characteristics of a future research program that we propose as a means of developing such a complete strategy.

Characteristics of a future research program aimed at developing effective programs to deter noncompliance in the NPS.

1) Program will test multi-pronged interventions that incorporate multiple deterrence techniques and are designed to influence diverse visitors who break rules for diverse reasons.

2) Both effectiveness of deterrence and impact on visitor experiences will be measured and used in designing and evaluating interventions.

3) Program's primary goal will be the development of two to four multi-pronged interventions that vary simultaneously in deterrence effectiveness and negative impact on visitor experiences. NPS managers could select the intervention offering adequate resource protection with minimal negative impact on visitor experience.

4) Program's secondary goal will be the development of a set of guidelines for designing evaluation research that can accurately determine the effectiveness of an intervention in any specific application.

5) Program will be designed and monitored by a multi-disciplinary panel of scientists.

6) Research will be conducted in a variety of NPS settings representing a wide range of visitor populations and park environments.

Characteristic 1. Because noncompliant behavior is very complex and because current theory and research concerning noncompliance are undeveloped, the research program would focus on testing interventions that incorporate multiple deterrence techniques. A range of techniques selected would be selected that appealed to a broad spectrum of motivations for compliance and noncompliance. Although some of the techniques incorporated in such multi-pronged interventions might have only a small deterrent effect, the aggregate effect of the intervention would be more likely to reduce noncompliance to acceptable levels than would any single deterrence technique.

Characteristic 2. Because of the NPS dual mandate it is critical that tests of proposed interventions consider both their deterrent effects and their effects on visitor experiences. Unfortunately, our limited knowledge about the experiences expected by NPS visitors currently provides a poor basis for predicting visitor reactions to deterrence techniques such as threatened punishments. Thus, investigation of visitor expectations and the ways in which deterrence techniques negatively impact visitor experiences would also be high research priorities.

Characteristic 3. Even using multiple deterrence techniques, a single multi-pronged intervention is not expected to perform adequately in all NPS units. NPS units vary greatly in their sensitivity to damage caused by noncompliance, and thus require that noncompliance be reduced to different levels. Where acceptable levels of noncompliance are low, interventions producing some negative impacts on visitor experiences may be justified, but where acceptable levels of noncompliance are relatively high, visitor experiences should be given a higher priority. By developing several multi-pronged interventions that simultaneously vary in deterrence effectiveness and negative impact on visitor experiences, this research program would allow NPS managers to maximize the balance between resource preservation and provisions for visitor enjoyment.

Characteristic 4. The effectiveness of the interventions designed in this research program will vary across applications, and some form of assessment will be necessary to determine if an intervention is performing adequately. However, NPS managers are unlikely to have the knowledge or motivation necessary to perform such assessment. This problem would be minimized by developing simplified procedures for evaluating intervention effectiveness and communicating to NPS managers the importance of using the procedures to conduct evaluation when implementing interventions.

Characteristic 5. A multi-disciplinary advisory panel would be assembled to oversee the research program thus far outlined. The panel would include members representing diverse approaches to the study of noncompliance so that the multi-pronged interventions initially tested would represent a broad spectrum of theories concerning noncompliance and would combine deterrence techniques so as to maximize their effectiveness. The panel would also include biologists and other natural scientists to provide input concerning the limits of acceptable damage for various natural resources.

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Oregon Lecture Series Addresses Global Change

by Ruth Jacobs

The Center for Analysis of Environmental Change at Oregon State University is sponsoring a series of seminars focusing on current research on global biogeochemical cycles. The Center is a cooperative partnership between Oregon State University, the USDA Forest Service, the US Environmental Research Agency, and Battelle Pacific Northwest Laboratories. Topics addressed in the spring series of 11 talks at OR/State/U were the global carbon cycle, methane emissions, chemistry of rain water, responses of vegetation to global change, and biogeochemistry of Crater Lake. This series furthers the Center's objectives of creating new collaborative opportunities for its partners and providing a focus for research and discussion on causes and consequences of environmental change.

Peter Vitousek, Stanford professor of biological sciences, opened the series with a lecture on "Beyond Global Warming: Ecology and Global Change," constituting a pep rally for the scientific community. He argued that crucial decisions are being postponed by those who would argue that the scientific uncertainty is too great for effective decision-making . Undeniably a major amount of uncertainty exists about many facets of global change, but conversely, a sufficient core of knowledge exists to define some aspects of change, predict some of the consequences, and take action in treating some problems.

There are three major classes of change that are all global, well known and well-related to human activity -- levels of atmospheric carbon dioxide are increasing, the global nitrogen cycle is changing, and monumental land-use changes are occurring. Causes of increasing levels of carbon dioxide are combustion of fossil fuels and changes in land use, both of which remove carbon from natural storage systems. Changes in climate, amounts of nutrients used by plants, composition and dynamics of biological communities, and even nutrient concentrations of some plants have been documented. These are profound changes, effective worldwide.

In terms of the nitrogen cycle, human activity has recently and rapidly doubled nitrogen fixation worldwide. Because many systems are naturally limited by nitrogen, rapid increases in nitrogen can alter the number of species in an ecosystem, change the diversity of landscapes, and alter grazing and decomposing food chains. These changes are generally viewed as negative, not positive. Increasing nitrogen levels in some communities, for example, have been shown to decrease species diversity.

The major global change in land use is the most important of the classes of change discussed by Dr. Vitousek. These land-use changes, deforestation for example, are occurring subtly, acre by acre. Remote sensing is the ideal tool for documenting the change, but the time span of the records that we can view with this tool is brief. We are left with indirect measures of the effects of the land conversions, such as the fact that between 30 and 50 percent of the net primary productio of Earth is dominated, used, or foregon because of humans. That does not leave a lo for the millions of other species that exist o the planet.

These three major changes are couple with other changes propagated by humans such as over-harvesting of species, biologica invasions of exotic species, and introductio of ozone-depleting chemicals. All togethe these and other changes are leading to tw major events -- global climate change, whic we cannot clearly demonstrate yet and can not predict locally with much certainty, an a loss of biological diversity, which is becom ing increasing evident and is truly an irre versible loss. Leading all of this change is th ever-growing human population.

Simple reversals of the changes we fac are nonexistent. We can limit the amount o change we cause, but the crucial first step t setting some limits is for scientists to ge active in communicating what they kno rather than focussing on uncertainty. D Vitousek insisted that we know a lot, and thi knowledge can be used by society today t make decisions that will determine ho much global change occurs. His messag was that we all should actively seek ou colleagues who have confidence in thei knowledge and ability to effect a change form partnerships with these people, an work actively to make a difference in th future of the world.

Ruth Jacobs is a Research Assistant at Orego State University, CPSU

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Such information is critical for maximizing the balance between resource preservation and visitor experiences.

Characteristic 6. In order to maximize the effectiveness of the intervention strategy developed by the research program, testing would be done in NPS units that represent the diversity of environments and visitor populations regulated by the NPS.

Summary

Several recommendations that are useful to NPS managers can be made based on the existing noncompliance research. However, increased knowledge about the control of noncompliance is critical for the preservation of NPS resources. The creation of the National Biological Survey creates even greater opportunities to apply such knowledge to a resources on a variety of other public lands. Funding allowing, we at the U/WA CPSU hope to continue a leadership role in the investigation of visitor noncompliance and the techniques used to deter it.

Research concerning methods to control noncompliance should prove to be extremely cost-effective. Based on the survey results presented in the preceding article, research that developed means of deterring just 10% of current noncompliance in the NPS—a modest goal—could save over $5,000,000 in repairs. Distribution of such knowledge to other public land managers would entail minimal costs and dramatically increase savings. Even more important, any reduction in irreparable damage to natural and cultural resources yields benefits that are priceless.

Vande Kamp is a research consultant and Johnson is the Program Leader, Social Science, at the U/WA CPSU, Seattle. Swearingen is an Assistant Professor in the Department of Health, Physical Education and Leisure Studies at the University of South Alabama, Mobile, AL.

The following publications are avail able from the NBS CPSU, AR-10, U/WA Seattle, WA 98195:

Vande Kamp, Mark E., Darryll R. Johnson, and Thomas C Swearingen. 1994. *Deterring minor acts of noncompl ance: A literature review.* USDI, National Park Servic Technical Report NPS/PNRUW/NRTR-92/08.

Johnson, Darryll R., Mark E. Vande Kamp, and Thomas C Swearingen. 1994. *A survey of park managers' percep tions of noncompliant visitor behavior causing resourc damage in the national park system.* USDI, National Par Service, Technical Report NPS/PNRUW/NRTR-92/08.

Swearingen, Thomas C. and Darryll R. Johnson. 1988. *A analysis of off-trail hiking in response to selected soci control techniques at Paradise Meadows, Mount Rainie National Park.* NPS CPSU, College of Forest Resources University of Washington, Seattle.

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Swearingen, Thomas C. and Darryll R. Johnson. 1988. *Da hiker attitudes toward the presence of a uniformed par employee in a front-country area of Mount Rainier Nationa Park.* NPS CPSU, College of Forest Resources, Unive sity of Washington, Seattle.

Winter Mass Balance Measurements on Teton Glacier
Begin to Build Basis for Predicting Seasonal Melt and Runoff

By Kelly Elder, Sue Fullerton, and Kathy Tonnessen

Water resources in the western United tes are gaining attention as both our per- tion and reality point toward ure shortages. Persons and or- izations interested in agricul- l, hydropower, municipal, and reational water use now are wing keen interest in every drop wing down western rivers. In ny cases the rivers are over- cated and demand exceeds the ply.

The greater Yellowstone region ompasses headwater basins crit- to some of the most important er sources in our nation, in- ding the Columbia, Colorado, Missouri River basins. Grand on National Park (NP) con- s one reservoir dedicated to icultural water storage and the ply to this reservoir is primarily n snowmelt. The reservoir, ch predates the park's estab- ment, is the first in a long list of tainments on the Snake River. n order to manage water re- rces efficiently and realistical- we need to improve our meth- of prediction for supply and off. Uncertainty about climate nge makes our predictive capa- ies subject to considerable er-

In mid-latitude alpine regions ch of the annual precipitation is stored as w during the winter. Slight changes in nate may make large differences in the unt of precipitation and storage in the n of snow. Glaciers offer a long-term rd of climate by storing information lost he seasonal snowpack which melts annu- on nonglacier surfaces.

Mass balance, the gains and losses of ice s over time from a glacier, is the primary meter with which we can couple glaciers limate changes (Meir, 1992). There is dence that the Earth's ice sheets are not reasing in volume (Bentley and vinetto, 1992), and that the observed rise lobal sea level may be attributed partly to ative mass balance in mountain glacial ems (Meier, 1984; Jacobs and Hellmer, 2). Small alpine glaciers such as Teton cier in Grand Teton NP are more sensi- to climate change than larger glaciers ice sheets, providing relatively accessi- information about subtle changes in dern climate. However, detailed mass nce measurements rarely are made and surement data spanning more than a ade are scarcer still.

Figure 1. Teton Glacier surrounded by the Grand Teton on the left, Mount Owen in the center, and Mount Teewinot to the right. Teton Glacier occupies the shaded cirque in the center of the photograph below Gunsight Notch. The glacier's large terminal moraine extends from the East Ridge of the Grand Teton. This photo was taken from the east after the first significant snowfall in October 1993.

The National Park Service has acknowledged the importance of glacier studies in Global Change research and, in particular, detection of climate change through mass balance changes (National Park Service, no date). Glaciers of Grand Teton NP offer unique opportunities for climate change studies relating to the entire Greater Yellowstone Ecosystem.

When winter snow accumulation is measured at, or close to, the date of its peak, an estimate of winter mass balance can be made. A similar survey at the date of minimum snow cover, at the end of the ablation season, gives a value of summer mass balance. A multi-year record of summer and winter mass balance provides clues to changes in overall glacier mass balance resulting from climate perturbations. Seasonal snowpack mass is measured in terms of snow water equivalence (SWE). SWE is simply the amount of water that would be produced if the snow were melted simultaneously at a point, or if the depth of snow were multiplied by the snow density where density is expressed as the percent of the density of water.

Results reported are the first of a series of surveys designed to measure winter and summer mass balance of Teton Glacier. These measurements will be a valuable baseline for future climate change studies carried out in the region. This research project also demonstrates the value in using GIS techniques to extrapolate from point measurements to spatial estimates of snow water equivalence.

Study Site

Teton Glacier is located in the Teton Range of Wyoming. The glacier lies within Grand Teton NP at about 43 44'30"N and 110 47'31"W (4,842,985 N and 516,755 E UTM) and ranges between 3,095m and 3,500m above sea level. Teton Glacier occupies a deep cirque surrounded by steep walls of the Grand Teton (4,196m) to the south and Mount Owen (3,937m) to the north (Fig. 1).

Methods

To calculate SWE, systematic field measurements of snow depth and density were gathered from May 17 through 20, 1993, the time of peak snow accumulation for the year.

To measure density, snow pits were dug at two sites, with dual snow density profiles. Snow temperature and stratigraphy also were observed and recorded. From these values an estimate of density as a function of snow depth was derived.

Aluminum probes were used to measure snow depths at intervals of approximately 10 meters along 5 major transects (Figs. 2 through 4). One vertical transect extended the length of the glacier from the terminal moraine to the head of the accumulation area, while four horizontal transects were positioned across the first. Five additional point measurements were made at locations where probing was too difficult for an entire transect to be completed. In all, 201 depth measurements were made. From these depth values, combined with density values from the snow pits, SWE (depth x density) at points along the transects were calculated.

Further analysis required addressing a classic geographic question: How do we distribute point values over a surface? Many attempts have been made to do this in glacio-

Continued on page 12

logical contexts (e.g. Young, 1974 and 1975; Paterson, 1981; Elder et al., 1992; Elder and Yang, 1992). Four interpolation techniques for modeling such a distribution of SWE over the glacial surface were selected for comparison. Each required elevation as an input for calculation. While elevation does not itself affect snow distribution, it works well in many cases as an index for physical processes that do (i.e. temperature, precipitation).

Estimates of elevation for each probe site might be obtained by relating field collection locations to an established topographic surface, such as a USGS 1:24,000 contour map. However, geographic information systems (GIS) can create and use computerized equivalents of such maps. Comprised of cell grids covering the area of interest, these digital elevation models (DEM) have elevation values assigned to each cell throughout the coverage. Thus, any mapped site is automatically assigned the elevation for the cell upon which it falls.

Constructing a Digital Elevation Model

The standard USGS 30m DEM did not offer sufficient resolution or accuracy to be used in the data analysis. As an alternative, maps were located from USGS field studies (Reed, 1964), which presented 1954 and 1963 margins and contour lines for the glacier. When processed into a digital elevation model, these maps provided the necessary DEM. From the digitized version of this map, a DEM was generated at 5m resolution using GRASS (GIS) software. The choice of cell size ensured that field data, collected at 10 m intervals, would occupy separate cells when referenced back to the map.

Registering field locations to such a DEM was the next step to make the map functional. Probe sites originally were marked off in sequence along each transect from an established point in the field. Distances between successive sites were measured while traveling up the glacier surface from each previous point. Sequential points measured along an ascending slope will, necessarily, lie closer together when placed upon a flat map. Slope and azimuth determined at each field location were used to calculate the corresponding horizontal distance traveled. The resultant UTM coordinate pair represented the proper location on the Reed map for each field site. All field points now took their correct locations within the digitized map margins and the elevations value for each on the DEM could be applied to its respective field position. The 5m DEM and locations of the field measurements are shown in Figure 5.

SWE at all points now could be estimated as a function of elevation. Models programmed across the entire surface resulted in estimates of SWE volume for the entire snowpack. In addition, the average SWE

Figure 2. Field hand Martin Hagen with portable depth probe in the ice fall portion of the glacier. Note the crevasses in the background common in this section. The photograph was taken during field work in September 1993.

was calculated as the total volume divided by the area of the glacier. A second feature of DEMs is the capability of deriving distributed slope and aspect cell values from their corresponding elevations. Using these values to locate areas of steep slope, an index of avalanche probability was defined upon the surface. These areas accounted for additional snow depth due to local redistribution of snow by avalanching.

Modeling Snow Water Equivalence

Four methods of interpolating the depth and density measurements were used. These included: (1) dividing the glacier into evenly spaced elevation zones and assigning the mean of all the measurements within each zone to that zone; (2) linear regression of measurements against elevation; (3) binary regression tree using elevation as the independent variable, and (4) binary regression tree using elevation and an index of avalanche activity as independent variables.

The first two methods are conventional techniques often applied in glaciological and hydrological studies; the binary tree classifier was experimental in the glaciological context and was used here in an attempt to better refine the model and to introduce one element of snow redistribution.

Results

The binary regression tree method using elevation and the avalanche index as independent variables provided the most accurate distribution of snow based on statistical analyses of the field data. Figure 6 shows the results of the binary regression tree method using elevation and the avalanche index. Based on the models, the best estimate of mean snow depth on the glacier was about 6.85m. The best estimate of mean snow water equivalence was 3.22m with a total volume of about 970,000m^3. The other modeling methods produced similar estimates of total snow storage on the glacier, but they differed significantly in the distribution of the snow over the glacier surface.

The 1993 water year was just below normal for snow accumulation based on long-term measurement stations in the region (Wyoming Basin Outlook Reports, 1993). "Normal" in this context is defined as the 30-year mean, taken from 1961 to 1990. Martner (1986, p. 79) shows an isohyetal map of annual precipitation that places the Teton Range within the 1.5m (60") isohyet. This estimate is based on a complex relationship between topographical information and long-term precipitation and snowpack measurements, both of which are sparse in mountain areas. Martner (1986, p. 84) shows the Teton Range receiving less than 20 percent of annual accumulation during the months of June through August. Subtracting out 20 percent for summer precipitation, the winter accumulation based on the isohyetal map would be about 1.20m water equivalent. Although the values in Martner's map must be applied with caution, we can compare

Figure 3. Rod Newcomb and Robbie Fuller take a depth measurement in an avalanche debris cone on the southeast margin of the glacier. Gunsight Notch is in the background between the flanks of the Grand Teton on the left and Mount Owen on the right.

ure 4. Martin Hagen in the accumulation e above the ice fall. Snow depths in the a averaged greater than 10m. Mount ewinot is in the background.

m to our modeled results for accumulation Teton Glacier. The expected aerial aver- from Martner of 1.20m compared to our deled accumulation of 3.22m shows 2.7 es the expected value.

t is believed that the high value of accu- lation is attributable to high rates of oro- phic precipitation, leeward deposition of pended snow load, and redistribution of al accumulation by avalanching on to the cier from surrounding slopes. Teton Gla- r occupies a deep cirque flanked by the two hest peaks in the range. These peaks, and arete between them, lie to the west or ndward side of the glacier, effectively ating the largest eddy or potential lee-side osition area in the range. This fact, nbined with avalanching and the souther- blockage of solar irradiance, gives the que a high accumulation potential. Note t most of the other east-facing cirques in Tetons do not contain glaciers.

The accumulation gradient observed on glacier is remarkable. The gradient was culated for the cirque area covered by field asurements using linear regression of SWE ed on elevation. Using only the field data, alue of 0.84m SWE per 100 m elevation n was found. The large gradient is appli- le to this portion of the cirque only; it dicts no snow cover below an elevation of out 2,900 m elevation which is contradic- y to the existence of substantial snow cover he valley floor at 2,080m. Other localized ques in the range with similar morphom- y may have such accumulation gradients.

Summary

This study has produced two relevant conclusions. The first is that seasonal snow inputs to Teton Glacier may be a great deal larger than expected for the region. The second is that although a neophyte statistical modeling technique, the binary regression methods may prove to be a useful tool in mass balance estimation on glaciers with variable accumulation patterns (Chambers, 1992), complex topography (Kuhn et al., 1985) and where a glacier exists over a variety of climate conditions (e.g. accumulation area in the alpine with the toe at sea level).

The conclusions and analytical methods applied in this study are valid for the 1993 water year only. Accumulation in the region was close to normal, and it is believed that the distribution of snow on the glacier was typical of normal years. More years of field work and analysis are needed on Teton Glacier before any of the results can be taken as normal. Additional years of field data collection and analysis will allow us to establish "average" accumulation and melt patterns, so that we can then attempt to predict changes in seasonal melt and runoff that may accompany changes in regional precipitation and temperature.

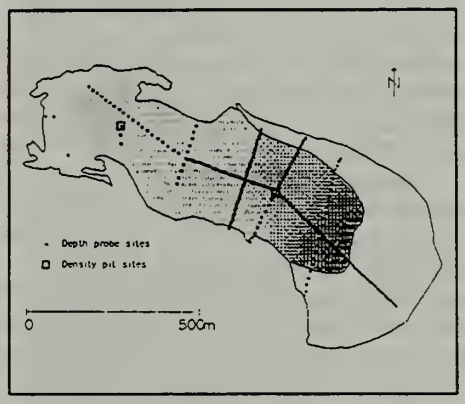

Figure 5. Digital map of 5m DEM constructed from contour map (see Fig. 3). Lighter shades represent higher elevations; darker shades, lower elevations. The line dissecting the area from top to bottom is the approximate terminus of the glacier. The line to the east of the present glacier area represents the terminal extent and moraine of the glacier at its maximum during the "Little Ice Age."

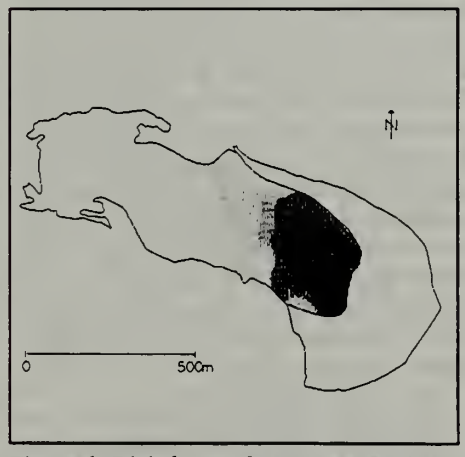

Figure 6. Digital map of snow water equivalence on the glacier surface. Snow was mapped using a binary regression tree with elevation and an avalanche index as independent variables. Lighter shades represent areas of greater snow accumulations; darker shades, shallower snowpack areas.

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This research was funded by the Grand Teton Natural History Assn.; support for the first author was provided by NASA's EOS program.

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Animal Disease Issues In The National Park System Clarified By Nationwide Survey

By Alonso Aguirre, Edward Starkey, and Donald Hansen

Animal diseases are potentially significant management concerns in a number of units of the National Park System. Some of these diseases are a threat to human health; others are of primary concern because of potential impacts to domestic livestock on adjacent park lands; and still others may threaten native wildlife populations.

Therefore, to identify key animal disease issues, we conducted a nationwide mail survey of national parks, federal and state agencies, and universities. In addition to wildlife diseases in national parks, participants were questioned about the implementation of wildlife and domestic animal health programs including treatment, control, and management of wildlife diseases (e.g. vaccination, medication, herd management, quarantine, and habitat management). Information was also compiled on the use of pack animals and pets, livestock grazing in park ecosystems, and policies and regulations on domestic animal management within the park. In all, 503 questionnaires were mailed to 179 units of the NPS and 324 universities, state, and federal agencies. Overall we obtained a response rate of 70 percent.

Sixty-eight percent (94/138) of the national parks surveyed indicated that at least one animal disease related issue had been of concern in the last 10 years. In general, other agencies' responses indicated that 29 percent (57/196) have reported wildlife disease issues in or adjacent to NPS units in their state. Fish & game agencies were most commonly involved in wildlife disease research and management (54%). State departments of health (42%) reported zoonotic diseases involving wild carnivores and rodents. Sixteen percent (9/55) of Animal & Plant Health Inspection Service (APHIS) respondents reported bovine brucellosis as the greatest concern regarding animal disease issues in the National Park System.

Domestic Livestock Diseases

Serologic studies (13%) demonstrating the presence and prevalence of domestic livestock diseases including bluetongue, bovine respiratory syncytial virus, bovine virus diarrhea, infectious bovine rhinotracheitis, parainfluenza-3, and vesicular stomatitis were reported in wapiti, deer, bighorn sheep, moose, and caribou. Lungworm-pneumonia complex in bighorn sheep and epizootic hemorrhagic disease in white-tailed deer were the most important disease issues affecting wild ungulates in national parks. Several cases of hemorrhagic disease in deer and bighorn sheep were reported based on clinical signs and lesions; however, no laboratory confirmation was made to differentiate these diseases. Parelaphostrongylosis in elk and deer, psoroptic scabies in bighorn sheep, leptospirosis in deer, and pseudorabies in feral pigs apparently represent an increasing threat to native ungulate populations.

Rabies (22%), sylvatic plague (14%), canine distemper (11%), Lyme disease (9%), and endoparasites (i.e. heartworm and raccoon worm) (9%), were the most common diseases reported affecting carnivores and rodents in national parks. Diseases which may be increasing in zoonotic importance include trichinosis in wild carnivores; tularemia in rabbits and beavers, and leptospirosis, giardiasis, and Rocky Mountain spotted fever in rodents.

We requested information on animal health programs including treatment, control, and management of diseases (e.g. vaccination, medication, herd management, quarantine, and habitat management). The implementation of wildlife health programs was reported by 19/138 (14%) national parks. Treatment and control of sylvatic plague in small rodents, by dusting burrows and closing visitor areas, were the most common practices implemented by park personnel. Treatments were also reported for lungworm-pneumonia complex and psoroptic scabies in bighorn sheep.

We compiled information on the use of pack animals and pets, livestock grazing in park ecosystems, and policies and regulations on domestic animal management within the park. Thirty-two percent of the parks surveyed did not allow or report the presence of pack animals inside their boundaries. Horses (38%), followed by mules/burros (10%), llamas (5%), and sled dogs (3%) were the most common species reported in parks allowing their use as pack animals. Grazing occurred adjacent (36%), inside (11%), and both in and near (13%) national parks. The species grazing inside or adjacent to NPS lands were cattle (60%), horses (21%), sheep (14%), and other species (5%) including llamas, bison, and goats.

Park Policies For Pets

Dogs, cats, and birds were the most common pet species allowed to be kept by park personnel and visitors inside national parks. Seventy-one percent of parks responding allowed pets on a leash with different degrees of restriction. For example, pets could enter the park if confined in a vehicle, kennel, or restricted to concession areas. Other national parks allowed pets on a five to 6-foot leash within 100 feet of the road or shoreline; in developed areas, pavement, campgrounds or overlooks; or within one-fourth of a mile of developed roads, on trails but not in backcountry, and only during the day. Unrestrained pets were allowed in 3 percent of parks (4/138). No pets were allowed to be kept by visitors or park personnel in 33/138 (24%) NPS units.

Although only 16/138 parks (12%) provided a copy of guidelines, permit requirements, and pet policies; NPS Units generally apply the Title 36 Code of Federal Regulations and Management Policies. Eleven parks (8%) expressed their concerns about free-ranging feral dogs and cats, sled dogs, and unleashed pets. Contact between feral animals, pack animals, or pets and wildlife was reported as frequent, representing an increasing threat or health risk to native species. Carnivore species including wolves, coyotes, foxes, puma, lynx, and bobcat are vulnerable to infectious diseases such as canine distemper, parvovirus enteritis, and feline panleukopenia.

Human health issues were reported by 61 percent of parks surveyed (84/138). Several confirmed cases of Lyme disease in humans were reported in the following parks: Point Reyes NS, California from 1987-1990 (3/9 cases); St. Croix and Lower St. Croix NSR, Minnesota (high prevalence among human and animal populations; 50 percent of park staff has been diagnosed and treated since 1987); Cuyahoga Valley NRA, Ohio (three cases); Crater Lake NP (one case); Delaware Water Gap NRA (one case) and Valley Forge NHP, Pennsylvania (two cases); Big South Fork NRRA and Obed WSR, Tennessee (confirmed in several park employees and visitors); Colonial NHP (one case) and George Washington Memorial Pkwy, Virginia (one case). Giardiasis was reported only in Rocky Mountain National Park, Colorado, and North Cascades NP, Washington, but the disease is undoubtedly present in other parks. Human leptospirosis, possibly acquired from wild pigs, dogs, or cats, was reported in Hawaii Volcanoes NP (three cases). LaCrosse encephalitis was reported in St. Croix and Lower St. Croix NSR, Minnesota and Cuyahoga NRA, Ohio (one case in 1981). Relapsing fever was reported in Grand Canyon NP, Arizona (six cases since 1990). Rocky mountain spotted fever was confirmed in a human fatal case in Cape Cod NS, Massachusetts in 1990.

Avoidance Techniques

n nine percent of national parks surveyed, tor use and access was restricted to avoid nan contact with wildlife and reduce the of disease transmission. Management niques included bearproof garbage cans, ure of visitor use areas (caves, trails, ic areas, and campgrounds), and restric- of use to developed trails. Interpretive or cational programs designed to inform tors about risks and/or prevention of wild- borne diseases were reported by 43 per- of parks (59/138). These interpretive grams were focused primarily on the vention of sylvatic plague and rabies. ters received information and were asked eport contagious ecthyma in mountain s and Dall sheep in national parks in ska (contagious ecthyma can readily be ad to humans by direct contact). Inter- ive and educational programs commonly included direct contact on an individual s, warning signs in visitor centers and use s, slide shows and lectures, posters, pam- ts, brochures, leaflets, and posted infor- ion in bulletin boards.

hirty eight percent (53/138) of NPS ondents considered that the occurrence iseases and parasites in wildlife in park ystems is part of a naturally functioning ystem. The general consensus in the ey was that native diseases should be ected even if they are detrimental to life populations. Parasites and diseases ld be allowed to perform their natural tions in the ecosystem within the full e of what might be considered natural. ve diseases should only be managed to ect adjacent areas or to preserve ecosys- that have been altered or threatened in by human influences, for protection of ngered species and species of special ern, for public health reasons, and for play" populations (those very impor- for visitor enjoyment), to the extent that ment does not detract from the appear- of naturalness (NPS 1988).

A number of respondents listed several s to be considered in making decisions erning control of diseases in national s. These include status of the infected al population, classification of disease otic or native, pathogenicity and infec- ness of the etiologic agent, and capacity fect other hosts (domestic animals and ans). Most parks surveyed concluded diseases introduced by humans and do- ic livestock or pet animals should be icated from national parks.

Immediate Disease Issues

ational parks, state, and federal agencies asked to identify the most immediate se issues that should be addressed in the onal Park System, if funding became available. Highest ranked priorities of NPS respondents were Lyme disease, sylvatic plague, BHS disease, rabies and giardia while brucellosis, lyme disease, BHS disease, rabies and tuberculosis reflected the relative priorities of other agencies. Differences in priorities between NPS and other agencies undoubtedly result from differing objectives and legal mandates of agencies reponding to the survey. For example, NPS respondents were most concerned with diseases related to public health, such as sylvatic plague and Lyme disease. On the other hand, APHIS considered brucellosis the most important issue facing national parks. Although brucellosis can infect humans (undulant fever), pasteurization of milk has reduced its public health threat. However, in some areas, it remains a serious disease in domestic livestock and APHIS is responsible for issues affecting the health of domestic animals.

Because pack animals and domestic livestock are common in and near national parks, disease monitoring programs should be established which could detect transmission of diseases among native wildlife and livestock. Such a program would be of value to managers of parks, as well as those managing adjacent grazing lands.

Pet diseases represent a potentially serious threat to park wildlife populations. Although most parks allow pets only on a leash or in restricted areas, several respondents were concerned that leash requirements often are overlooked by visitors. Pets from different geographic regions represent a health risk to national park wildlife populations, and enforcement of regulations is critical to reduce the likelihood of exotic diseases and parasites entering national parks. With increasing numbers of visitors and pets, and with increased mobility, the potential for introduction of new diseases also is increasing.

This work was supported by Special Initiative funding from the NPS Wildlife and Vegetation Division, Washington, D.C. We wish to thank Drs. John Dennis, and Sharon Taylor for advice, encouragment and review of the final report (Aguirre, A.A., D.E. Hansen and E.E. Starkey. 1993. Special Initiative Project: Animal Disease Issues in the National Park System. USDI, National Park Service, Pacific Northwest Region, Cooperative Park Studies Unit Technical Report NPS/PNROSU/NRTR-93/16. 126 pp.)

Aguirre was, and Hansen is currently with the College of Veterinary Medicine; Starkey is with the National Biological Survey, Coop. Park Studies Unit, OR State Univ., Corvallis. Aguirre is presently with Wildlife Laboratories Inc, P.O. Box 1522, Fort Collins, CO 80522.

Assateague Island Mares 'Shot' With Contraceptives

In January 1994, Assateague Island NS staff met with Dr. Brian Underwood, NBS, to discuss the application of a draft population dynamics computer model for the feral horses. Population projections are based on known historic genealogy, fecundity, mortality, and density-dependent birth and survival correlations. Preliminary model simulations which factored in modest natural mortality indicated a continued rise in the population over the next decade. An environmental assessment was prepared to assess feral horse management alternatives for 1994.

The approved alternative was to treat all mares with a single dose of immuno-contraception for one year in order to suppress population growth in 1995. Thanks to a combination of good luck and good shooting, the goal of 76 adult mares was achieved in 15 actual field days of darting. For 28 of these mares which have been a part of the ongoing immuno-contraception research, this shot should provide near 100 percent effectiveness. Past research indicates that the initial dose could provide contraceptive effectiveness of up to 70 percent for the remaining mares. Park staff expects 27 births in 1994 and 10 births in 1995. According to the population model, the 1994 treatment appears to at least stabilize the present population. The treatment also conditions all reproductive age mares for the future use of immuno-contraceptives.

The Delaware Water Gap NRA, Upper Delaware Scenic and Recreational River, and Delaware River Basin Commission recently sponsored an Upper Delaware Water Quality and Biological Monitoring Conference that included participation by 51 individuals from 23 agencies and citizen volunteer groups. A similar workshop was held in 1987. Seventeen agencies and organizations are actively involved in monitoring water quality in the region; a representative from each described their monitoring activities. Discussions focussed on macroinvertebrate monitoring methods and experiences. As a first step towards interagency standardization of methods, technical representatives of the agencies agreed to meet later in a field session.

Jeff Selleck Succeeds Jean Matthews as *Park Science* Editor

The Natural Resources Publication Office of the NPS Associate Director for Natural Resources has selected Big Bend NP Interpretive Supervisory Park Ranger Jeff Selleck to succeed Jean Matthews as editor of *Park Science*. Matthews, the publication's founder and editor throughout its 14 year history, plans to retire later this year in Washington state and will turn over editorial responsibility to Selleck this summer when the fall issue goes into production in Denver. The specter of Matthews' departure, a matter of concern to all associated with the publication, led to Selleck's appointment to the post last December.

Selleck is shifting careers in coming to *Park Science*. As an interpreter and supervisor at Yellowstone, Everglades, and Big Bend NPs during the past 10 years, Selleck specialized in guiding walks and giving evening programs that primarily interpreted birds, volcanic geology, and ecosystem threats. In 1989, he won the Freeman Tilden Award for the Southwest Region in recognition of his abilities as an outstanding interpreter. In recent years, his skills and experience expanded to include writing exhibits and site bulletins, and editing and laying out the award-winning *Big Bend Paisano* newspaper.

He brings to *Park Science* communication skills, experience in layout and design, a link with the field, and a commitment to the mission of the National Park Service. "Every time I visit a national park, I become more interested and excited about the diversity of wonderful resources that we protect and present to the public," Selleck commented. "I also become concerned about the many complex resource management issues that face us. I love our parks and I want my association with this bulletin to help further science-based resource management programs, decisions, and solutions."

Park Science currently is undergoing a nine-month transition from Matthews to Selleck. During this time, the publication will be moved from the Pacific Northwest Region to Denver, where Selleck has an office in the Denver Service Center building. The editor-in-training presently is working out details of the changeover; collecting articles and developing contacts at conferences and meetings; preparing for desktop publishing production of the quarterly; generating ideas for future articles; visiting with resource managers and scientists in the field; tracking progress with natural resource programs, such as R-MAP and NRPP; and redesigning the distribution list database. He will begin editing articles and doing the layout for the fall issue, in which he will new procedures for submitting material to *Park Science*.

Selleck inherits a publication that has grown both in distribution and importance. When it began in 1980, *Pacific Park Science* was circulated only within the Pacific Northwest Region, but it soon included the entire National Park System. Acting on feedback from the field, Matthews refined the publication's niche in the overall NPS mission effort into a way of communicating findings and science-based resource management, with emphasis on their implications for park managers. The approach has appealed to an ever broader audience in the natural resource field—inside and outside of government at all levels, and especially in the academic community, where it is widely used as course material.

Selleck plans to build on the established foundation of publishing good field science and resource management. However, sweeping changes with the science program during the past year will require careful attention from the new editor. "*Park Science* will certainly become an important link between the evolving National Biological Survey and the NPS as we begin to understand how to make use of the new agency's services," Selleck said recently. "While I hope to publish park-relevant research from the NBS, more importantly I hope to encourage and develop additional authors within our own ranks as we continue to professionalize the resource management field."

Also of interest will be exploring the idea of ecosystem management for the National Park System and looking beyond park boundaries for solutions to resource management problems.

Donna O'Leary
NPS Publications Coordinator

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Park Science

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Long-term Monitoring on a Shoestring at Apostle Islands

By Julie Van Stappen

At Apostle Islands National akeshore (APIS), an effective, w-cost, long-term monitoring ogram has been developed over e past few years. This article escribes how resource managers small to medium sized parks can ndertake long-term monitoring espite very limited resources.

APIS is a 42,000 acre park with islands and a small mainland it lying along the Lake Superior ast in Wisconsin. The islands nge in size from 3 to 10,000 res; the mainland unit is approx-ately 12 miles long and less than mile wide. The lakeshore is near e northwestern edge of the hem-ck hardwood forest and the south-n fringe of the boreal forest. The most ominant forest type is northern hardwood, ost of which is >50 year old second growth. he lakeshore also has aspen/birch, oak, land conifer, and pine forest. Special bitats include a wide variety of dunal atures, bogs, sandstone cliffs, clay banks, d-growth forest, colonial bird nesting sites, igratory bird concentration areas, and bald gle nesting sites.

When I transferred to the park in 1988, a rk goal was to establish a long-term mon-oring program. Some such projects already ere occurring in the park, but they were earheaded by University researchers and rsonnel from other agencies without NPS nding so there was no guarantee they ould continue. At the time, only part-time sistance from a seasonal biological techni-an was available. I started by looking at isting projects for their appropriateness d identified important gaps.

Following the lead of Channel Islands ational Seashore, we wrote monitoring idelines for each existing or proposed oject. The guidelines included an intro-ction describing what needed to be moni-red and why, and a history of past research d monitoring; objectives; methods; equip-ent needed; areas to be monitored and equency of monitoring; number of person-l required/hours or days/FTE; and refer-ces. Some of the first guidelines written cluded bald eagles, colonial birds, ruffed ouse, woodcock, merlins, piping plovers, ndscapes (dunal features), bluff erosion, d campsites.

The primary objective of most monitoring ojects is to determine the status and trends a resource and/or to monitor visitor im-pact. Projects that monitor visitor impact are specifically designed to gather data for making management decisions; however, both types of monitoring provide important information for management decision-making.

Karin Kozie and Mark Mackey collect a bald eagle blood sample for toxic analysis (*Photo by J. Van Stappen*)

The 1989 field season was the first year for the fledgling monitoring program. Many new and on-going projects were formalized. It was an important year to test methods and to determine the time needed per project, the appropriate frequency of monitoring, and the general feasibility of each project. Following the 1989 field season, all monitoring guidelines were reviewed and revised to reflect lessons learned.

Prior to the 1990 field season, the biological technician position was extended to six months and its description re-written to include, as a primary job element, assistance with monitoring. Projects added in 1990 included breeding birds, migratory birds, frogs and toads, and purple loosestrife. In 1991, mollusc monitoring was added and repeat monitoring had begun. By the end of the 1992 field season, many of the projects had been repeated and data from previous years could be compared, beaver monitoring was started, and a fairly large loosestrife control program was begun. Need for loosestrife control was based on monitoring results. Rare plant and forest vegetation monitoring are planned.

Guidelines are an important tool; they force you to evaluate each monitoring project. If you can't justify a given project, it should be reconsidered. Guidelines provide important institutional memory. They should be written so that someone unfamiliar with the project can repeat it and obtain data comparable to past results. They also should contain information on time and personnel needs, facilitating scheduling. Having all the information in one place that is needed to conduct a monitoring project provides critically needed organization during the hectic field season.

Quality control and assurance should be part of each monitoring project, and data management is an important consideration. Ideally, data should be entered into a park database immediately following completion of each monitoring project, but no later than the end of the field season. Monitoring reports should be written annually. Some of our reports are simply memos stating the results of general surveys, such as ruffed grouse or woodcock. Other reports require considerable data analysis and are many pages longer. Finally, monitoring guidelines should be considered dynamic documents and be reviewed and revised on a regular basis.

Long-term monitoring programs need to be institutionalized. Staff come and go, so the success of such programs depends on their being set up in such a way as to continue over the long run. Steps we have taken to institutionalize APIS's program include monitoring guidelines, incorporation of monitoring projects into the park's Resource Management Plan, and incorporation of monitoring duties into position descriptions and performance elements.

APIS's monitoring program covers a wide variety of projects that are skill rather than funding intensive. Without additional funding, the program focus has been on high priority projects that can be done by well-trained biologists, and that do not require outside expertise or expensive equipment. Although there are high priority inventory and monitoring projects that do require additional funding and personnel, much has been done using our own limited resources and assistance from highly qualified volunteers.

If you are a Resource Manager in a small or medium sized park, don't wait for additional funding or personnel. Start with what you have, check around with others as to how to put it to best use, and then build on it as you can.

Van Stappen is Resource Management Specialist at Apostle Islands National Lakeshore.

Public Education Pays Off At Great Smokies In Smooth Sailing For Red Wolf Release

By Napier Shelton, Robert Miller, Karen Ballentine and V.Gary Henry

Public support can spell the difference between success and failure of a resource management project, especially one that could be controversial. It is instructive, therefore, to look at public education programs that engendered support. One such success story has to do with the information effort preceding and accompanying the release of red wolves in Great Smoky Mountains National Park (GRSM).

The goal of the U.S. Fish and Wildlife Service (USFWS) recovery plan for the endangered red wolf is 220 individuals established in the wild in three areas of the Southeast (and 330 in captivity). An earlier plan to restore red wolves at the Tennessee Valley Authority's (TVA) Land Between the Lakes in Kentucky and Tennessee was suspended because of public opposition, primarily from agricultural, hunting, and animal rights groups. Learning of this experience, the USFWS and conservation groups conducted an intensive public education program around the Alligator River National Wildlife Refuge in coastal north Carolina, and subsequently carried out successful red wolf restoration there.

A similar approach was taken at GRSM. For nearly two years before the first red wolf release, in November 1991, the National Park Service (NPS) and the USFWS jointly carried out a broad public education effort to explain the reasons for and goals of the project, aimed at allaying any fears and gaining support.

The primary audience was park neighbors, most of whom live on small acreages, in small towns near the park, or in the cities of Knoxville, TN and Asheville, NC. Because of the rough foothill topography, most farms are small and most farm owners have jobs elsewhere. Tourism is a major and increasing component of the economy, and there is a growing population of retirees. Hunting remains an important part of life for many people here.

Extensive planning went into the public information program. Representatives from USFWS, park management, resource management, public affairs, and interpretation brainstormed to identify interest groups, sensitive points, appropriate media for conveying messages, and timing of efforts. Lists of groups to be contacted were developed, but the persons who were to contact specific groups were decided upon only as the effort developed.

Kim Delozier, Great Smoky Mountains National Park wildlife biologist holding up a 6 week old pup of the first litter to be born in Great Smoky Mountains National Park in 100 years. *May 1991 photo.*

The Communication Effort

The public information program began with briefings of the Tennessee and North Carolina congressional representatives and governors' offices by the USFWS Red Wolf Coordinator and regional director. The superintendent, UWFWS coordinator, and NPS resource management and science personnel, in various combinations, also talked to NPS and USFWS officials in Washington, DC and the region, local officials, farm bureau heads, and heads of state and federal land management agencies. Contacts with these key officials were followed by presentations to civic, school, conservation, and other groups by NPS public affairs and interpretation personnel, with input and assistance from the superintendent, USFWS project personnel, and others.

The park public affairs officer and resource management/environmental education interpreter, with assistance in some cases from the Southern Appalachian Man and the Biosphere Cooperative (SAMAB) and NPS staff developed various tools for communicating information about the red wolf project. Among these were a slide program, brochures, poster, periodic updates, video (in cooperation with station WBIR-TV in Knoxville, TN), traveling exhibit, a wayside exhibit, and teacher's guide (including lesson plans) to the video and poster.

The video/poster/teacher's guide package was sent to 800 schools, libraries, nature centers, and other requesters. In addition, 7,000 posters were distributed. The 30-minute video, "Front Runner," and an earlier short video piece presented the background, plans, and early activities of the red wolf project, including the temporary release of a red wolf family, reasons for the project, and viewpoints of various people. These latter included local farmers who feared the presence of red wolves would result in livestock depredation. An update of the video incorporating developments after permanent release of a second red wolf family later was produced. Because of the demand for the video/poster/teacher guide package, an additional 1,000 videos and 3,000 posters have been produced.

Program Progress Updates

Media representatives have been kept informed through press releases, press conferences, a red wolf newsletter, and media briefing packages. Park visitors learn about the project through campfire programs and other personal services, park newspaper articles, the wayside exhibit, the brochure that is available at visitor centers, and the traveling exhibit, which is on display at a visitor center when not traveling.

Continuing communication with park neighbors occurs through newspaper articles

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ed Wolves continued from page 18

television programs, through the schools civic club meetings, and at special events he community, where the traveling ex- it often is displayed and talks given. For mple, a booth exhibit is manned and talks sented throughout the annual 5-day Wil- ness Wildlife Week in Pigeon Forge, TN. also include wolf information at teacher kshops, elderhostels, and other sessions he Great Smoky Mountains Institute at mont. The red wolf newsletter now goes mailing list of some 350 individuals and anizations.

n addition to all the talks and use of media ls, a communication committee meets iodically. Representatives from the park, USFWS, conservation groups, the Ten- see and North Carolina wildlife agencies, adjacent USFS national forests and dis- ts, the state and local Farm Bureaus, and ers are invited to attend these meetings react to planned red wolf activities.

Superintendent's Role Important

A very important element in the commu- ation effort from the project's start was the sonal interest and involvement of the WM superintendent. He made this a top rity, participated in early planning and -level meetings, chaired communication mittee meetings, and was active in major isions. Many other GRSM staff mem- s, besides the two principals mentioned ier, have contributed to the communica- effort. The NPS regional office has been portive but not actively involved, leaving to the park and the USFWS.

SAMAB also has helped, primarily through ncial assistance by a member--the TVA- developing and disseminating the video/ ter/teacher's guide package. Station IR-TV has been interested and support- throughout, producing and airing the eo and pre-project and ongoing news ates. The NBS affiliate in Asheville, NC aired "Front Runner." The Great oky Mountains Natural History Associa- (GSMNHA) contracted for production provided some of the funding for the first wolf brochure, using money from the Pt. iance Zoo in Tacoma, WA. The associa- also sells art prints and administers a stock indemnity fund.

We estimate the time spent on the commu- ation effort between 1990 and early 1993 the NPS was 1.25 work years divided stly between two people at a total cost of ,200. Considerable additional time was tributed by three USFWS employees. of pocket purchases by the NPS, USFWS, TVA in the Great Smokies area are mated at $50,850. Additional contribu- s include the $24,500 cost to WBIR-TV

One of the red wolves released permanently into the Cades Cove area of Great Smoky Mountains NP in the Fall of 1992.

to produce the Front Runner program; sales from a red wolf print by artist Steve Jackson, and a $25,000 indemnity fund consisting of contributions from the National Fish and Wildlife Foundation, the National Parks and Conservation Association, and the Jackson print sales.

Results and Evaluation

We have been pleased and somewhat surprised at the nearly unanimous public support for the red wolf project. The only groups voicing opposition have been local and state Farm Bureaus on the Tennessee side of the park, and their opposition has been low key. They follow the policy of the National Farm Bureau, which is to oppose any restoration of predators. The wolves have taken some domestic animals in the Cades Cove area at the park, but this has aroused little expressed concern, other than that of the owner of the livestock taken. The owner was compensated from the fund operated by the GSMNHA.

We attribute the success of the education effort to the following:

- Thorough advance planning
- Close targeting of audiences
- Commitment of the park superintendent
- A team approach
- Cooperation and coordination among the participants
- Objective, honest, consistent presentation of scientific information
- Initiation of the program well in advance of the first wolf releases
- Numerous personal contacts with individuals and groups
- Use of a variety of effective media
- Involvement of partners, such as the press, WBIR-TV, SAMAB, and the GRSM Natural History Association

In addition, certain pre-existing conditions probably contributed to the program's success:

(1) the biology of the red wolf, which is smaller than the gray wolf and usually takes smaller prey; (2) the absence of wolves from the southern Appalachians since the turn of the century; (3) the relatively small economic importance of livestock in the area; (4) earlier press coverage of peregrine falcon and otter restoration in the park; and (5) generally good relations of the park with its neighbors.

The success of red wolf restoration in the Smokies now depends on the animals themselves--whether they can live and reproduce in the park environments over the long term. Public interest and support seem assured.

Shelton recently retired as a writer-editor with the Wildlife and Vegetation Division, Washington Office, NPS; Miller is Public Affairs Officer at Great Smoky Mountains NP; Ballentine is an interpreter who works as a liaison with the Resource Management Division, Great Smoky Mountains NP; Henry is the Red Wolf Coordinator, UWFWS, Asheville, NC.

Bill Brown-Denali NP Make A Prize Package

Denali, Symbol of the Alaskan Wild: An Illustrated History of the Denali-Mount McKinley Region, Alaska, by William E. Brown, took first prize in the 1994 NPS publications competition at the Conference of National Park Cooperating Assns. Conference in Williamsburg, VA.

Brown's engaging prose captures the multi-threaded history of Denali NP, from the pioneering spirits that first imagined such a park around majestic Mount McKinley to the government agencies and scientists who prepared the park for the visitors to come. Judges comments included "a beautiful and inviting book," "wonderful historic photos," "an impressive volume of information presented effectively,"

This handsome 224-page soft cover volume is available from the Alaska Natural History Assn., P.O. Box 230, Denali NP, AK 99755 for $19.95, plus postage. The book also is available in hard cover for $29.95.

NPS Paleontologists Present Papers at GSA Conference

By Jeff Selleck

Paleontologists from the NPS and affiliated universities recently shared 35 papers on paleontological research in the national parks as part of the 46th annual Rocky Mountain Section meeting of the Geological Society of America. The meeting was held on May 4 at the Tamarron Resort north of Durango, CO, where some 60 individuals listened in on diverse research presentations that spanned 300 million years in 11 national park system areas. Twenty of the papers, not reviewed here, focused just on Florissant Fossil Beds NM and the surrounding area, and were presented the following day.

Paleontologist and former Petrified Forest NP Chief of Resource Management Vince Santucci coordinated the NPS effort and introduced the sessions. Santucci is deeply proud of his association with the paleontology work going on in the national parks. He speaks enthusiastically of the vast fossil treasures we protect. "The history of life on earth," he says, "is well represented within the units of the national park system. Around 100 of the 370 plus park areas have significant paleontological resources that need our attention and care." Pre-cambrian stromatolites in Glacier NP, early sea organisms in Grand Canyon, dinosaurs in the Colorado Plateau parks, early mammals at John Day and Hagerman Fossil Beds NMs, among others, combine, he asserts, to tell a story of the evolution of life.

Now on staff at the department of parks and recreation at Slippery Rock State University, Pennsylvania, and a part-time professor of paleontology at the University of Pittsburgh, Santucci maintains a strong link with the NPS, currently as a resource management advisor to Grand Canyon NP.

Before introducing the speakers, Santucci recounted the contributions made by Ted Fremd of John Day Fossil Beds and Dan Chure of Dinosaur NM in the gradual evolution of the NPS paleontology program. He explained that just 10 years ago there were few paleontologists within the Service, and archeologists often were the only staff with field excavation experience. When a fossil issue arose, archeologists were the natural choice to deal with it, even though their expertise was cultural sites.

The association between archeologists and fossils in the NP system may have led to the incorrect categorization of fossils as cultural rather than natural resources--an error that Chure and Fremd managed to correct. Also a problem then, managers often viewed the discovery goal of paleontology and the resource protection goal of the parks as incongruent, and denied research projects.

Since those troublesome early days, NPS paleontologists have organized their human resources, as demonstrated by this symposium, and developed a respectable fledgling fossil research and protection program. Critical to this transformation has been educating park managers and staff, as they turn over, about the role and value of paleontology.

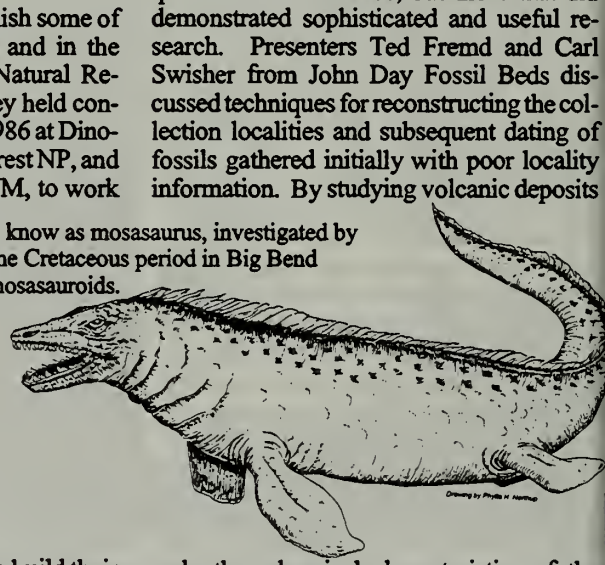
Paleontologists began to publish some of their findings in *Park Science* and in the technical report series of the Natural Resource Publications Office. They held conferences on fossil resources in 1986 at Dinosaur NM, in 1988 at Petrified Forest NP, and two years ago at Fossil Butte NM, to work through the growing pains and to build their track record. In these open exchanges, superintendents, researchers, resource managers, and interpreters, all contributed their perceptions of the value of research and the need for fossil protection.

The culmination of this endeavor and a triumph in Santucci's mind was the adoption of NPS-77, the Natural Resource Management Guidelines, that includes a brief chapter defining how we manage paleontological resources and promoting paleontological research.

Santucci also credits Fossil Butte Supt. David McGinnis for helping legitimize paleontology in the parks by demonstrating the benefits that can be derived from an integrated program of paleontological resource management and research. While the NPS conducts some fossil research, most is done by outside cooperators in the academic world. These partners often fund their projects independently of the NPS and help us understand in their published works the significance of our resources. They and experienced volunteers also can help us set up cyclic prospecting and inventorying and monitoring programs that identify the variety of fossils in an area, determine the relative importance of the fossils, and list the threats they face. Resource managers can then plan excavation priorities. Increased presence in the field also helps us protect the resources, and the information shared aids in interpretation.

Dr. Santucci is pleased with the progress toward building a foundation for paleontology and fossil resource protection in the parks in the past decade, but he sees this as only a beginning. He went to Durango with colleagues from around the park system to continue building the program, to share research findings, and to generate further support.

Many fossil resource parks did not participate in the conference, but those that did demonstrated sophisticated and useful research. Presenters Ted Fremd and Carl Swisher from John Day Fossil Beds discussed techniques for reconstructing the collection localities and subsequent dating of fossils gathered initially with poor locality information. By studying volcanic deposits and other chemical characteristics of the soils and correlating date findings with the distribution of fossil species, they hope to improve their understanding of the time period when some of the early mammals unique to the John Day area lived.



The 30-foot long marine reptile know as mosasaurus, investigated by Gordon Bell, diversified during the Cretaceous period in Big Bend NP evolving into two groups of mosasauroids.

Other studies centered on Petrified Forest NP. Spencer Lucas discussed his bio-stratigraphy work on one of the world's most significant upper Triassic Camian-Norian transition-preserving strata. He inventoried a wealth of fossils including vertebrates, molluscs, fossil pollens, ostracods, coprolites, tetrapods, logs, and other plants. Also interested in the upper Triassic, Tim Demko used a road cut to examine closely associated soil deposits and flora of the Chinle Formation in order to reconstruct the paleogeography of the time. He found that different fossils, while deposited concurrently, may indicate differences in landscape features.

William Davis concentrated on plants, anatomically detailing the preserved reproductive structures seen in plants from the Late Triassic. Finally, Adrian Hunt looked at early to late Triassic dinosaur tracks and fossils in both Petrified Forest NP and Dinosaur NM to learn of their beginnings and why they became so successful. He found that the dinosaurs appear to have evolved in the late Carnian; therapods in Dinosaur NM became more common with time, and the prosauropods began to diversify then.

Reporting on other parks of the Rocky Mountains, Stephen Hasiotis discussed the earliest known fossil evidence of burrowing crayfish at Canyonlands NP, while Jeffrey Eaton described the complexities of verte-

e paleontology of the Cretaceous rocks in ce Canyon NP. James Kirkland detailed igh resolution stratigraphy of the Mancos le in Mesa Verde NP, a Cretaceous ma- strata rich in fossils. The study was cessful as much for its yield of 90 taxa (yet e described) as for cooperation with the in working through the necessary ar- ological clearances along the half-mile ch.

at Jablonski, an active caver at Carlsbad erns NP, described an easy-to-manage nique for excavating deep cave fossils; ol Manganaro detailed her study of fossil nals found in Graveyard Cave at Wind e NP. Both presenters highlighted the ntial of caves to reveal relationships ng species trapped within them.

adlands NP researcher William Wall of a bio-mechanical change in the jaw cture of oreodonts in response to a late ene to Oligocene climate shift that fa- d grazers over browsers. Robert Hunt rted on his research at Agate Fossil Beds , where he excavated the earliest known ocene) carnivore den communities on rd. Discovered in association with fos- of the bear dog animal group, these nbers measure 10m in length by 2m in h. To close the full day of sessions, don Bell reported on his work in Big d NP in dating a fork in the evolutionary of the marine reptiles known as asaurs.

he symposium demonstrated that good gs can come to parks that integrate pale- logy into their programs. Most of the entations detailed significant advances ur understanding of life on earth from arch conducted just within NP units. But antucci commented later, this kind of ering is just one component needed to er paleontology in the parks. Also rtant is to develop partnerships with ersities, use volunteers to carry out ects, train resource protection rangers to tify fossils at risk, encourage interpreters are the stories in the rocks, and motivate s to participate in paleontology informa- exchanges.

hose who missed this discussion of pale- logy within the parks have another op- unity to participate when the fourth con- nce on fossil resources is held in Colo- Springs this October 31 to November 4. conference has broadened its scope to ude fossil resources on all public lands the list of cooperators is now made up of BLM, USFS, USGS, and the Colorado e Lands Board, along with the sponsor- Florissant Fossil Beds NM. Contact gie Johnston for further information at Box 185, Florissant, CO 80816; 719/ 3253.

lleck is the incoming editor of Park Science

The National Biological Survey– A Perspective From the Past

By R. Gerald Wright

The administration of Franklin Roosevelt was a heady time for those individuals who believed that the federal government should play a major role in the socio-economic affairs of the country. Conservation of the nation's natural and cultural resources was one of those roles. Harold Ickes, the Secretary of the Interior under this administration, firmly believed that this goal could best be accomplished through the creation of a Department of Conservation--an agency that would include the Forest Service, National Park Service, Biological Survey, Bureau of Fisheries, and the Grazing Division.

This concept had at least the tacit approval if not the strong endorsement of the President. However, because of intense Congressional opposition against moving the Forest Service out of the Department of Agriculture, the creation of this new department was not realized -- although over the years, the concept has retained its allure and has surfaced time and again under subsequent administrations.

In lieu of achieving this larger goal, Ickes was offered the more modest prize of taking over the administration of the Bureau of Biological Survey, which was transferred from Agriculture to Interior in 1940. The Biological Survey was an agency with a long and illustrious history. Originally established as the division of Economic Ornithology and Mammalogy in 1885 and headed by the famous biologist C. Hart Merriam, its name was changed to the Bureau of Biological Survey in 1905 to better reflect Merriam's interests . . . that was as the natural history agency of the government, with much of its early work being devoted to defining the geographical distribution of animals and plants in various regions of the country. In subsequent years, however, economic and utilitarian factors exerted an ever greater influence on the agency and its primary roles became predator control and the management of wildlife refuges and migratory waterfowl.

With the transfer of the Biological Survey to Interior, Ickes sought to carry out his goal for a Department of Conservation on a smaller scale by consolidating all federal research personnel in the department (primarily wildlife researchers) in the Biological Survey. This involved the transfer of the wildlife biologists from the National Park Service and the Grazing Division, and the biologists in the Bureau of Fisheries to the Biological Survey.

This expanded Biological Survey had many similarities to the present National Biological Survey. Among them were debates over how well NPS research needs would be served by biologists that now worked for another agency. Although an "Office of National Park Wildlife" was established within the Biological Survey which housed the transferred NPS biologists, it was, as Lowell Sumner (one of the transferred biologists) told me in an interview: "...difficult to know how to address national park concerns in a bureau whose goals were set by ... predator control and sport hunting [interests]." Also, as today, the number of NPS biologists transferred to the expanded agency was small in comparison with the number of biologists who already were a part of the existing Biological Survey.

The expanded Biological Survey proved to be short-lived because, after only a few months, Ickes decided to merge the Biological Survey with the Bureau of Fisheries to create the Fish and Wildlife Service. So in 1947, seven years after it was established, the Office of National Park Wildlife, then in the Fish and Wildlife Service, was abolished and the scientists in that office were transferred back to the NPS, where it took many years to build a credible natural science program.

Wright is a wildlife research scientist and Unit Leaders of the NPS CPSU at U/ID, Moscow, ID.

Suggested Readings

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Reconstructing Climate Data in Parallel Watersheds Provides Useful Data on Muir Woods

By Robyn Myers

While I was a graduate student and also a former ranger at Muir Woods National Monument (NM), a class assignment provided me the opportunity to reconstruct the Muir Woods precipitation history as part of a dendroclimatic study. The tree ring analysis itself was not significant, but the precipitation reconstruction provided some interesting and useful data.

Muir Woods NM has kept precipitation data only since 1948. However, a nearby, and parallel, watershed in Kentfield has instrumental precipitation data going back to 1888. Because the two watersheds exhibit similar precipitation patterns, I was able to reconstruct the precipitation record for Muir Woods for the years prior to 1948 based on the instrumental record for Kentfield.

Climatic data series generally are based on instrumental climatic measurements, but also may be based on historical documents and paleo-climatic reconstructions from tree rings, ice cores, and sediment cores. These data all vary in quality, geographic coverage and time resolution, as well as the total length of the record (Fritts 1991). According to Fritts, instrumental data have the highest quality and resolution, but in North America they seldom span the last 200 years. The primary goal in collecting tree rings for dendroclimatic analysis is "to obtain the longest and clearest record of past climatic variations," Fritts notes. However, he adds that ring width measurements do not always contain information on climate. It is for this reason that other methods of obtaining climate history often are used.

For a Muir Woods dendroclimatic study (Myers 1993), climatological data for the Muir Woods area were obtained from several sources. Muir Woods itself has kept climatic records and reported them for inclusion in the California State Climatological Data books since 1948. On request, Muir Woods sent me the seasonal rainfall from 1948 to the present. I obtained the annual rainfall totals from the State Climatological data books. Redwood Creek in Muir Woods is one of several watersheds originating on Mt. Tamalpais. Muir Woods' rainfall is consistently greater and has a different pattern from that of the County weather station at the Marin County Civic Center in San Rafael. Therefore, due to the differing weather patterns, the County weather data were not appropriate for comparison and were not considered.

However, a watershed near Redwood Creek has a weather recording station that has

Figure 1.

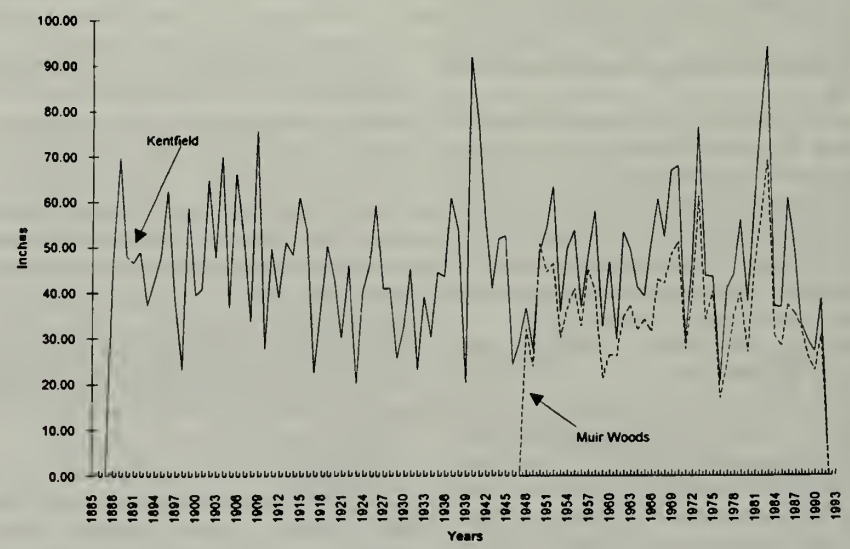
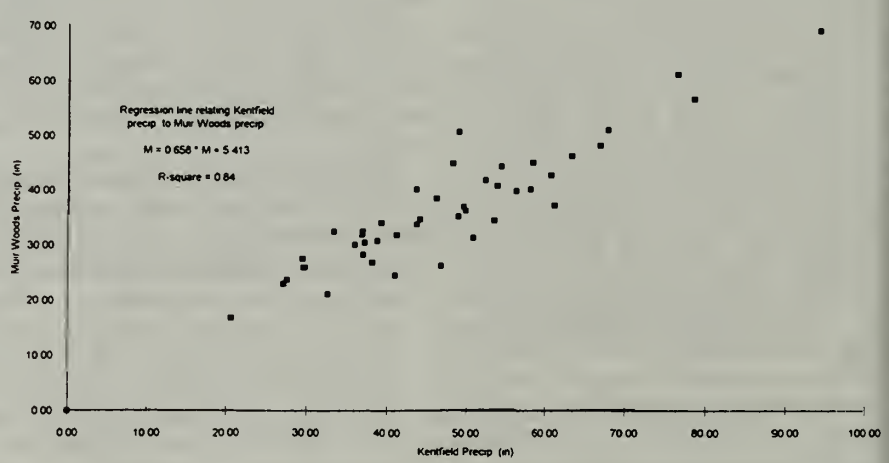


Figure 2.

lag	CCF	lag	CCF	lag	CCF	lag	CCF
-43	.0088	-42	.0372	-41	.0535	-40	.0278
-39	-.0153	-38	-.0303	-37	.0028	-36	.0303
-35	-.0367	-34	-.1204	-33	-.0878	-32	.0226
-31	.1409	-30	.0125	-29	.0565	-28	.0933
-27	.0297	-26	-.0311	-25	-.0094	-24	-.0952
-23	-.0133	-22	-.1711	-21	-.0613	-20	-.1003
-19	-.0432	-18	-.0250	-17	-.0330	-16	.0436
-15	.1750	-14	.0649	-13	.2275	-12	.0353
-11	-.0176	-10	.0989	-9	-.0767	-8	-.2329
-7	-.3854	-6	-.1269	-5	.0235	-4	.0081
-3	-.0479	-2	-.0802	-1	.2360	0	.9168
1	.2158	2	-.0973	3	-.1065	4	.0783
5	-.0498	6	-.3102	7	-.3897	8	-.1196
9	-.0915	10	.1144	11	-.0208	12	.1578
13	.2427	14	.0832	15	.0725	16	.0703
17	-.0126	18	-.0079	19	-.0512	20	-.1396
21	-.1904	22	-.1318	23	-.0496	24	-.1087
25	.0359	26	-.0043	27	.0278	28	.0877
29	.1103	30	.0420	31	.1829	32	.0935
33	-.0361	34	-.1318	35	-.0102	36	.0473
37	-.0371	38	-.0811	39	-.0465	40	-.0091
41	.0314	42	.0294	43	.0058		

95% significance is .2955

Figure 3.



econstructing Climate Data continued from page 22

intained precipitation records dating far r back. The Kentfield weather station ose historical and current location re- ins a mystery, even after telephone inquir- throughout the county!) has maintained cipitation data back to 1888. The U/CA- vis had California State Climatological a books with Kentfield data back to 1907. a from 1888-1906 were obtained from State Climatologist at the State Depart- nt of Water Resources, Division of Flood nagement, in Sacramento.

The Kentfield area in Marin county is ther of the primary watersheds of Mt. nalpais. Kentfield has the not undeserved utation of being the "wettest" place in the unty in terms of annual rainfall. Despite ferences in the rainfall amounts between ntfield and Muir Woods, there was a ng corresponsdence between the patterns he two precipitation records. When a ng correspondence is present it is pos- e to reconstruct reasonable estimates for missing data in the parallel watershed. Muir Woods precipitation from 1888 to 8 was reconstructed based on the Kentfield fall data.

The following hypotheses were tested us- climatological data from Muir Woods Kentfield weather reporting stations:

H1: Muir Woods rainfall is directly correlated to Kentfield rainfall.

H1a: There will be a strong positive cross-correlation function.

Kentfield (1988-1991) and Muir Woods (1948-1991) annual precipitation (instrumental) records were plotted for years and inches of precipitation (Fig. 1). The instrumental precipitation records for Kentfield (1948-1991) and for Muir Woods (1948-1991) show a reasonably close correspondence, with Kentfield generally having the greater rainfall.

The cross correlation function between the Kentfield and Muir Woods instrumental precipitation was calculated (Fig. 2) using ASTSA for Windows (Shumway 1992). The data show a strong positive cross correlation at lag 0 of .9168, where 95 percent significance is .2955. The statistical correlation for Kentfield vs. Muir Woods precipitation was plotted in Excel for Windows (Fig. 3). As expected, the Kentfield instrumental precipitation data (1948-1991) and the Muir Woods data (1948-1991) show a very close correlation, with an R2=0.84. Considering they are watersheds on the same side of Mt. Tamalapais, experiencing the same weather patterns, this high correlation is not surprising.

The Kentfield vs. Muir Woods precipitation regression statistics were calculated in Excel for Windows (Fig. 4). As discussed above, the regression statistics for the instrumental precipitation data of Kentfield and Muir Woods show a very high correlation. These statistics were used in the graph shown as Figure 5. Data for the missing Muir Woods years (1888-1947) were reconstructed, using the formula $M = 0.658 * M + 5.413$ and the Kentfield instrumental data for those years. Muir Woods precipitation was reconstructed for the years 1888-1947. Both the reconstructed and instrumental precipitation data using the data from the regression statistics above were plotted (Fig. 5). While these are only estimates, they are a best guess based on the high R2.

Conclusions

It is clear that Muir Woods rainfall is directly correlated to Kentfield rainfall, supporting hypothesis H1. The time series analysis confirmed this with a strong positive cross-correlation function, supporting hypothesis H1a. The reconstructed precipitation data for Muir Woods from 1888 to 1947 could be useful in future dendrochronological analyses.

This technique may prove useful in other locations when weather station instrumental data is available from parallel watersheds. Like tree ring analysis itself, climate data patterns can be linked by matching the patterns. Where instrumental data from the parallel watersheds show a strong correlation, extrapolation of missing data from one watershed to the other appears to be a reliable analog.

Myers is a PhD candidate in the Graduate Group in Ecology at U/CA-Davis. She is cooperative education research scientist trainee in the Ecosystem Science and Technology Branch of the NASA Ames Research Center, Moffett Field, CA.

gure 4.

Regression Statistics

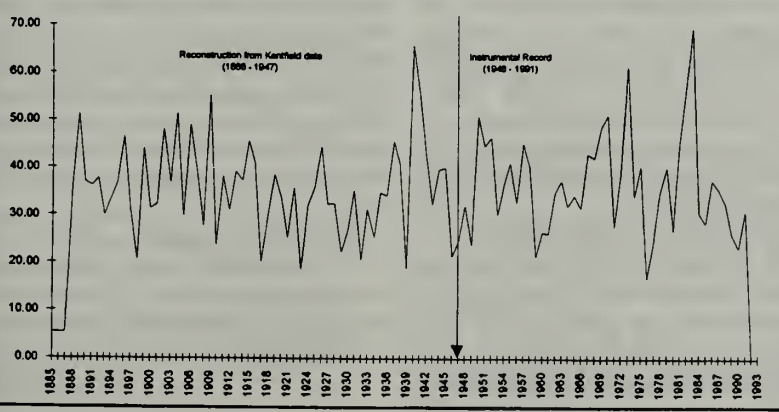
Multiple R	0.916839119
R Square	0.84059397
Adjusted R Square	0.836798588
Standard Error	4.367636119
Observations	44

Analysis of Variance

	df	Sum of Squares	Mean Square	F	Significance F
Regression	1	4224.970796	4224.970796	221.48	2.3778E-18
Residual	42	801.2023013	19.07624527		
Total	43	5026.173098			

	Coefficients	Standard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	5.413155216	2.200779753	2.459653316	0.018	0.97180046	9.85450997
x1	0.65835101	0.044237655	14.88214072	1E-18	0.56907578	0.74762624

gure 5.



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Gap Analysis: Another Look

By Kathy Jope

The winter 1994 issue of *Park Science* carried a thought-provoking article by Machlis et al., which extends the concept of gap analysis described by Scott et al. (1991, 1993) to its social dimension.

Gap analysis has been advanced as a means of identifying "unprotected yet critical areas of biodiversity." Through gap analysis, it is posited, we will be able to protect areas that are crucial to the conservation of biodiversity.

Such an approach is attractive, since it presents an objective means of identifying areas to be protected. However, it is based on two fundamental assumptions, which need to be critically examined. In discussing them, my intent is not to undermine the concept of gap analysis, but to encourage critical thought about it.

The first assumption of gap analysis is that a viable population of each rare species can be contained within the delineated reserve. This may be possible for resident species, but it is more problematic for species that require widely separate summer and winter range, not to mention highly migratory species such as many shorebirds and songbirds. For species to persist over the long run, provision must also be made for changing landscapes and recolonization following disturbance.

Ecosystem Linkages

This leads to the important point that gap analysis focuses not on ecosystems but on aggregations of individual species. An ecosystem is far more than simply an aggregation of species. The essence of an ecosystem is the flows and processes, and the *interrelationships* among the myriad species. It is critical to recognize that gap analysis is not a method that will necessarily conserve ecosystems. There is no guarantee that a reserve designed through gap analysis will conserve the vital linkages and interrelationships of the intact ecosystem.

The second assumption in gap analysis is that species and, presumably, the ecosystems of which they are part, can be effectively protected in a reserve. One has only to look at the results of our efforts to conserve the integrity of park ecosystems to see that the validity of this assumption is debatable. Reserves designed through gap analysis are a valuable part of the conservation agenda, serving valid roles as biological insurance policies and in their contribution to diversity of management. However, reserves alone are not sufficient to conserve biodiversity if they are surrounded by a landscape that is hostile to life.

In delineating reserves to conserve biodiversity, gap analysis accepts a paradigm of dualism, a paradigm that considers people as separate from the natural world, and human-use areas as separate from reserves. Human use of resources and land are seen as incompatible with nature and the conservation of biodiversity. At its extreme, such a dualistic approach does not recognize any substantive link between the well-being of people and the well-being of the environment. In its more moderate version, it focuses conservation efforts on delineating preserves that will be protected from human activities that will continue unabated beyond the preserve boundaries.

Impact or Interaction?

We have too easily accepted the premise that human activities are inherently destructive. This is even reflected in our "Environmental *Impact* Statements." In striving to minimize the impact of human activities, we imply there will inevitably be some level of impact. Need this be so?

As Scott et al. (1993) noted briefly, there is an alternative paradigm, one that rejects the dualistic approach and instead views people as inextricably linked with the earth. According to this paradigm, wherever we go we are part of an ecosystem. In the air we breathe, in the water we drink, in our interactions with plants, animals, insects, even soil microorganisms, we are linked with the ecosystem around us. We take responsibility for the direct and indirect effects of our activities, not just in a few reserves, but everywhere, in everything we do.

This alternative to dualism might be considered an "ecocsystem" approach. Its focus is on interrelationships, flows, and processes. Consider how our approach would be different if we consciously recognized our connectedness--the interrelationships between ourselves and the ecosystem in which we live and work.

In discussing the social dimensions of gap analysis, Machlis et al. (1994) cited "demographic change" and "monetary wealth and capital" as two factors that contribute to impacts on biodiversity. However, these two factors do not inherently lead to impacts. Rather, the impacts stem from the level of resource consumption that we have considered acceptable in our society and which varies with demography and wealth. Similarly, industrial activities and land use do not inherently lead to ecosytstem impacts. It is the way of living and doing business that needs to be redesigned.

What Goes Around Comes Around

Viewing people as connected with the ecosystem, we would look differently at the effects of our activities on the ecosystem. We would not be so accepting of their destructiveness. **It is true that life and death are fundamental ecosystem processes. But what other species in an ecosystem destroys not only life, but the very life-giving potential of the system?** Humans do, through release of toxic materials, extinction of species, destruction of fertile soil, and many other actions. Seeing ourselves as members of the community of life, we would be more likely to recognize that when we harm the ecosystem, we harm ourselves. We need to become more responsible members of our community.

One way we can do this is to work with rather than against, ecosystem processes--to strive to nurture the ecosystem around us, its diversity of life, and its life-giving capability. In business there is a growing field known as industrial ecology. Industrial ecology explores ways in which industrial processes can be designed using ecosystems as a model. Processes in ecosystems tend to occur as loops and cycles rather than the linear path from the source to the dump that characterizes so many of our industrial processes. In an ecosystem, the by-products of one process are the raw materials for another, and there is no such thing as effluent.

How would our operations in national parks differ if we were to adopt an approach such as this--if we use ecosystems as our model, worked with, rather than against, ecosystem processes, and fostered a sense of connection between people and the earth? Consider how we would design visitor centers, roads, and housing areas if we viewed people and our infrastructure as a nurturing component of the ecosystem. Consider how we would design a facility if, for example, we saw ourselves not as using water, but only borrowing it. Consider how we would design the visitor experience if a common thread running through it was to foster our sense of connection with the world around us.

A Society in Transition?

Adopting such a paradigm is not as unrealistic as it may seem. Things change. Society's values and behavior change. Our old way of doing business and the way we relate to the environment simply is not working anymore, and the results are becoming less and less acceptable. More and more people, and more and more communities, are recognizing that there is a different way. There is a perception that society is entering a transition, with increased recognition of the difference between needs and wants, and greater willingness to forego immediate gratification in the interest of long-term well-being.

The NPS has a choice: We can either follow along behind society in these changes or we can move to the forefront as leaders in environmental stewardship. We can support a dualistic paradigm that has not been re

Continued on page 2.

m Larson Retires As PNR Chief Scientist

n Larson, who retired May 3, 1994 as ic Northwest Regional Chief Scientist, ving down the capably held reins of nsibility for a life of reading, biking, mplating, and generally enjoying the things he has had to squeeze into the s of life up till now.

rson began his Park Service career in as a ranger in Mount McKinley (now li) NP. He served as park naturalist at y Mountain and Haleakala NPs. In Larson joined the Office of Natural ce Studies under NPS Chief Scientist rt Linn in Washington, DC. Since then, s served as Regional Chief Scientist in outheast, Midwest, Alaska, and Pacific west Regions. He began his PNR tour y in 1983.

s the hope of this editor, who also is g, that Jim will continue to read exten- in the science and resource manage- field, and will share his readings with *Park Science* editor Jeff Sellick, as he one so generously over so many years to enefit of this editor and Information file readers.

rson has been a mainstay of the *Park ce* editorial board, holding the post of nan continuously since the board was d in 1983. He will be missed.

* * *

Jope Appointed Acting

thy Jope, PNR Chief of Natural Re- e Management, has been named Acting Scientist in an interim action and will on the job of developing a working rship with the National Biological Sur- it staffs its new eco-regional office in e. Shirley Clark will continue as Assis- egional Chief Scientist.

Meetings of Interest

1994	
Oct. 22-26	NATIONAL SYMPOSIUM ON URBAN WILDLIFE at Seattle-Bellevue, WA Embassy Suites Hotel; a 2-day local workshop will precede the national focus on the needs of wildlife, advice for conservation, and measuring progress toward meeting the needs of both people and wildlife in metropolitan environments. Sponsored by the National Institute for Urban Wildlife; contact Dr. Lowell W. Adams, NIUW, 10921 Trotting Ridge Way, Columbia, MD 21044; (301)596-3311.
Oct. 24-27	GEOLOGIC SOCIETY OF AMERICA, Seattle, WA; for program, registration, and lodging information, call (303)447-2020 or 1-800-472-1988.
Oct 26-29	NATIONAL WATCHABLE WILDLIFE CONFERENCE, Burlington VT; Theme: "Take a Closer Look" — The public and private sectors will join experts to find effective ways to make watchable wildlife work to conserve biodiversity. Contact National Watchable Wildlife Conference, 607 Lincolnway West, Mishawaka, IN 46544.
Oct. 31-Nov. 4	FOURTH CONFERENCE ON FOSSIL RESOURCES, Colorado Springs, CO; contact Maggie Johnston, PO Box 185, Florissant, CO 80816: (719)748-3252.
NOV. 14-18	SIXTH NATIONAL INTERAGENCY WILDERNESS CONFERENCE—"The Spirit Lives: Reflections and Visions on the 30th Anniversary of the Wilderness Act," at the Sweeney Convention Center, Santa Fe, NM; contact Peter Keller, Rm. 3230, NPS—Park Planning; 1849 C St. NW, Washington, D.C. 20240.
1995	
Apr. 17-21	EIGHTH CONFERENCE ON RESEARCH AND RESOURCE MANAGEMENT IN PARKS AND ON PUBLIC LANDS, sponsored by The George Wright Society; Portland, OR. Theme: "Sustainable Society and Protected Areas—Challenges and Issues for the Perpetuation of Cultural and Natural Resources." Registration information will not be available till September 1994, but those interested in attending should notify at once The George Wright Society, PO Box 65, Hancock, MI 49930-0065

Parsons Named Director of Wilderness Institute

The Aldo Leopold Wilderness Institute (see *Park Science* 13:3, p 12) has a new director: David J. Parsons, formerly NPS Research Scientist at Sequoia/Kings Canyon NPs. The Institute is located in the Research branch of the USFS but physically situated on the campus of U/MT at Missoula.

The new venture is designed to bridge the gap between science and management as applied to the broad concept of wilderness management. It will focus on ecological as well as visitor impact and social phenomena. "I hope," Parsons said, "to use the Institute as a forum to continue my efforts to improve the quality of science available to managers and policy makers in furthering the long-term understanding and protection of wilderness, parks, and other natural areas."

The Institute is an interagency effort, with memoranda of understanding among the USFS, NPS, USFWS, BLM, and NBS.

Analysis continued from page 24

lingly successful in the past and whose osis for long-term success is dim, or we mbrace our role as responsible and ctful members of our diverse ecosys-

ere is no difference between you and the . When you learn to read the Earth, you to read yourself. When you heal the , you heal yourself.

Doreen Mahoney
Skagit Systems Cooperative
Native American Tribal Organization)

Jope is Chief, Natural Resources, NPS Pacific Northwest Region, Seattle, WA 98104

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Mihalic, Johnson and Loope Win 1993 Natural Resources Awards

The Director's Natural Resource Awards for 1993 were presented at the March 22 Regional Directors' Meeting to Dave Mihalic, Mammoth Cave NP Superintendent; Beth Johnson, Chief of Research and Resource Planning at Delaware Water Gap NRA (and a new member of the **Park Science** editorial board), and Lloyd Loope, Conservation Biologist at Haleakala NP, (now with the National Biological Survey).

Fire Ecology of Pacific Northwest Forests by James K. Agee. Island Press. 1993, Box 7, Covelo, CA 95428.

"As long as plant biomass had been present on the earth," Jim Agee writes in his opening chapter, "lightning has ignited fires, and the myriad ecological effects have been repeated time and again." This comprehensive and well written book could not come at a better time.

Among the lessons learned over the past few years about how to and how not to manage forest ecosystems, one of the more important has been the critical need to understand and account for fire when developing strategies for protecting species and restoring and maintaining ecosystem health. Like the fierce Hindu goddess, Kali, who carries a bloody dagger in one hand while blessing and protecting with another, fire both destroys and renews, and in this complex process plays a central role in maintaining ecosystem health.

The importance of fire in shaping forests of western North America is evidenced by the wide array of adaptations evolved by trees and other plants to either survive or quickly recover from fire: thick bark, the ability to sprout from roots, serotinous cones, seeds that lie buried for hundreds of years to germinate only when sufficiently heated. My colleagues and I have hypothesized that the ubiquity yet uncertainty of wildfire has catalyzed the evolution of cooperative relationships among plant species. In the west, we have learned to our chagrin that eliminating the frequent, gentle fires that historically burned through dry forests has led to unforeseen and unwanted consequences; native insects and pathogens have become more aggressive and forests more susceptible to drought, and rather than eliminating fire the stage has been set for fires that are significantly more widespread and destructive than those that occurred in the past.

The book is divided into 13 chapters. The first six chapters deal with individual forest zones, including Sitka spruce, redwood and hemlock; Pacific silver fir and red fir forests; subalpine forests; mixed conifer and mixed evergreen associations; ponderosa and lodgepole pines; and oak and juniper woodlands. For each forest type, Agee discusses fire regimes, stand development patterns following fire, and management implications. The final chapter addresses the future role of fire in ecosystem management, park and wilderness management, species conservation, and forest health, and briefly touches on how fire regimes might be altered by global climate change.

The Ecology of Coexistence

The Feb. 18, 1994 issue of Science contains a book review by James H. Brown at the U/NM biology department of Species Diversity in Ecological Communities: Historical and Geographical Perspectives, Robert E. Ricklefs and Dolph Schluter, editors; University of Chicago Press, 1994 ($32.50). The review, which appears on pp 995-6, applauds the work as evidence that "contemporary ecology is built upon a strong empirical and theoretical foundation."

Brown's review opens with a reference to G.E. Hutchinson's 1959 essay, "Homage to Santa Rosalia, or why are there so many kinds of animals?" and observes that "not only did Hutchinson focus attention on the ecological processes that enable species to coexist in the same environment, he was remarkably prescient: most of the processes he hypothesized to be important in regulating diversity are still the subjects of major research programs today."

And now, 35 years after Hutchinson's 14-page essay, "we have a wonderful 414-page volume summarizing the extent to which modern ecology has succeeded in explaining biological diversity." Editors Ricklefs and Schluter have put together 30 chapters by 50 authors from 10 countries and provided "an exceptionally broad and deep representation of the current state of the science. There is such a wealth of ideas and information that in my department we plan to spend the entire coming semester of our journal club on the volume."

Two important things the book does, says Brown. "First, it shows how much we have learned about the organization and diversity of ecological communities in the last 35 years ... (and second) it makes clear that modern ecology still has no general, satisfying answer to Hutchinson's question." No consensus yet exists for explaining the most pervasive patterns of biological diversity, but the book illustrates this well by two chapters (Rosenzweig and Abramsky; Wright *et al*) that discuss the relationship between diversity and productivity and reach quite different conclusions.

In recognition that traditional ecological studies of local patterns and processes are inadequate to understanding diversity, the editors include chapters by biogeographers, paleobiologists, and systematists, giving the book "an exceptional breadth of data, theory, and viewpoint."

Brown's enthusiasm comes through strongly in his concluding paragraph: "Many scientists in other disciplines still think of ecology as old-fashioned natural history or as comparable in rigor to a social science. Some ecologists, both young and old, are hypercritical and discouraged, rather than optimistic and excited, about the status and prospects of their discipline. I wish that all these skeptics would read this book. It is a testament to how far ecology has come in the last 35 years and to the great challenges that still lie ahead."

The word that comes most often to mind as I think about this book is "scholarly"– however, I hasten to add that does not translate into boring or unreadable. Quite the contrary, the book is readable and packed with good information. It is thoroughly researched and documented (close to 1,000 references), and includes numerous graphs and photos (including some interesting historical shots showing changes in stand structure following fire exclusion).

Though the book deals with the Pacific Northwest, Agee does not hesitate to pull relevant information from other regions, thereby avoiding a feel of provincialism. There are a few issues I would like to have seen receive more space (e.g. the importan of sprouting plants in stabilizing soils, t protective role of some hardwood species conifer forests). However, that should considered minor criticism; I know of other work on the ecology of fire, from a region, that comes close to being as compr hensive and far-ranging in the topics it co ers.

I recommend it highly for profession land managers, academics, environmenta ists, and anyone with interest in forest ecosy tems.

David A. Per

Perry is a professor of forest science at O gon State University, Corvallis.

ific Northwest

ne Rivers, Trails and Conservation Asnce (RTCA) program in the Region is ting the Department of Agriculture to lop USFWS/NPS cooperative partnerprojects with outside groups in four pilot s--Seattle, Atlanta, Chicago, and New . RTCA held its first workshop on uary 17--discussion among 50 Seattle county (King, Pierce, and Snohomish) ials, and conservation leaders from all the region. Since then, RTCA has ed with organizing groups to develop dentify partnership goals and potential ct areas; to define the organizing frame- of the Partnership; to select a full-time nership coordinator, and to set a schedf implementation for the rest of the fiscal

irector Kennedy has made a formal comnent of NPS staff through RTCA to the lopment of this concept, and the RTCA will continue to participate in its develent and implementation.

* * *

TCA and the Soil Conservation Service orking with the Kalispel Reservation in neastern Washington for the use and ction of the Reservation. The Kalispels small tribe interested in habitat restoraand resource management, and in the lopment of recreation/interpretive opnities that could generate revenue. The vation, which possesses significant wildnabitat and a rich abundance of water , mammals, and rare riparian forests, is ed in a scenic but poor part of the state nas untapped resources for tourism. The will provide proposals for resource contion and restoration, interpretation, recon, and appropriate economic enters.

* * *

TCA is helping the Trust for Public ls and the Evergreen Alliance write and uce the "Conservation Toolbox," a ual for communities to use in developing egies for acquiring and/or protecting space and other significant local, natucultural, or recreational resources. They nvestigating development of electronic ucts to accompany the manual, which be available for distribution by Septem-

* * *

uth Anderson attended the annual long nce trail managers meeting in Tallahas-FL in February. Strategic planning for distance trail management had been ated at the last annual meeting in Tucson, AZ, and the improved focus has become particularly important in light of various reorganization plans. Other initiatives discussed included multi-objective resource management, GIS, cultural landscape identification, and urban initiatives.

The Pacific Northwest Region's proposal to conduct a cultural landscape inventory and study along the Oregon National Historic Trail may become a demonstration project for other Regions.

* * *

Bill Walters and Kathy Jope are working with the Regional Interagency Executive Committee toward implementation of the President's Forest Plan. Supporting the Executive Committee are 18 working groups addressing such topics as watershed analysis, watershed restoration, endangered species consultation, coordination with other intergovernmental efforts, adaptive management, strategic research planning and coordination, monitoring, and public information.

NPS personnel from Crater Lake, Mount Rainier, North Cascades, Olympic, Redwood, and the PNR Office, are participating on 14 of the working groups. The Committee has approved delineation of 12 multi-watershed "provinces" in the area extending from the Canadian border to Muir Woods in California.

* * *

Marsha Davis, geologist in the Regional Office, met in Menlo Park, CA with researchers from the USGS, Washington DNR, and Oregon State University to discuss the Cascadia 2000 research program, the results of which will have significant implications for all the parks in western Oregon and Washington.

Beginning in 1994, the USGS, through its Deep Continental Studies Program, will conduct geophysical experiments in southwestern Washington to study the geometry of plate boundaries, their interactions, and the deformation and mobility in the continental rocks. Tectonic research can yield information about deeper parts of the earth that cannot be gained by surface geologic mapping.

Purpose of the Menlo Park meeting was to discuss possible locations for an east-west seismic survey line from offshore to the eastern margin of the Cascade Range. Part of the research involves seismic refraction and wide-angle reflection surveys. The proposed seismic survey will fall between Mount Rainier and Mount St. Helens. Exact location will be based upon proximity to geological anomalies that would interfere with the data, accessibility by road, and permitting approval by WA/DNR.

* * *

In recognition of his contributions to the university community, Dr. H. Gregory McDonald, NPS paleontologist at Hagerman Fossil Beds National Monument, has been appointed an affiliate faculty member in the ID/State University department of geology. Dr. McDonald is developing the monument's research programs and fossil resource inventory criteria.

* * *

PNR Chief of Natural Resources (and Acting Chief Scientist) Kathy Jope has accepted an invitation to serve on the Advisory Board for the Division of Ecosystem Science and Conservation in the U/WA College of Forestry. The advisory board will help devise the curriculum for the "Wildlife" and the "Conservation of Wildland Resources" majors, as well as address other needs such as continuing education and potential opportunities for students to work on natural resource surveys and other park projects.

* * *

Michael Tollefson, Associate Regional Director, represented the PNR at the dedication of the Sterling Munro Trail at North Cascades NPS Complex on May 28, as part of the celebration of National Parks Week. Supt. William F. Paleck, speaking at the Henry M. Jackson Visitor Center, reminded guests of the tremendous contributions to natural resource protection by Senator Jackson and his administrative assistant, Munro. The results of their work, Tollefson told the assemblage, "benefited the NPS and all Americans." Among those significant accomplishments are the Wilderness Act, the Redwoods NP Act, the North Cascades NP Act, and the National Environmental Policy Act.

Tollefson cited the Service's primary responsibility--protection of park resources, and credited Jackson and Munro for breaking important ground in this direction. "Ecosystem management must be our proactive style," he said. "We must be committed to increasing our understanding of how entire ecosystems interrelate and how other agencies and organizations manage their lands so we can better protect park resources."

Western Region

David M. Graber, Research Scientist at Sequoia and Kings Canyon NPs, (now with the National Biological Survey at the Sequoia/Kings Canyon NPs Field Station), is the author of a chapter in **Nature and Reality: Critiques of Postmodernism**

Regional Highlights

Deconstruction, edited by Michael E. Soule and Gary Lease and published early this year by Island Press, Washington, DC.

Graber's chapter is entitled "Resolute Biocentrism: Managing for Wildness in National Parks." In seven packed pages, he examines the concept of "wildness," the attempts to perpetuate of native ecosystem elements and processes, the largely unacknowledged landscape alterations that occurred as a result of former aborigine activities, the on-going alterations that are taking place in the no-man's land of it's-not-my-job, man, and the biodiversity problems thereunto pertaining.

In a provocative wind-up, Graber asks "What are parks for?" He doesn't so much answer as suggest answers, but he does suggest that "Whatever the 'rightness' or 'wrongness' of the civilization we continue to invent, wild nature and national parks represent--however imperfectly and however dependent upon our continued care--ecological anchors to our own and the planet's past."

Alaska Region

The National Park Stewardship Association (NPSA) was organized recently to represent the concerns of NPS resource management professionals. Membership is open to persons interested in the application of scientific principles in the monitoring and management of national park natural resources.

The group provides a forum (meetings and newsletter--first edition has been printed) for the discussion and information exchange of NPS policies and practices related to the science of resource management. The newsletter includes a viewpoint section that offers pros and cons of controversial issues. Overall, the aim is to support leadership and fellowship among members.

New of the organization comes from Gary Vequist, who gives the following address for copies of the newsletter and membership information: NPSA; 1902 N. Salem Dr.; Anchorage, AK 99508.

Southeast Region

The regional office has begun a water resources monitoring program to provide small parks with a cost-effective, self-sustaining mechanism to acquire and interpret sound aquatic resources data. The program, designed and directed by the SER Water Resources Coordinator, aids in developing baseline aquatic biological and water quality information. It also addresses threats to water resources.

The monitoring program at Kennesaw Mountain National Battlefield Park in Georgia is the prototype. King's Mountain National Military Park in South Carolina and Shiloh National Military Park in Tennessee have instituted similar programs. More parks will follow as funding becomes available. A detailed account of this program will be submitted this year to the *Highlights of Natural Resource Management* publication. For information, contact Brendhan Zubricki at 404/331-4916.

* * *

A regional resource management workshop was held in April in Chattanooga, TN and attended by representatives of 22 parks. Two days of the workshop focused on exotic vegetation management. Highlights included presentations by NBS Research Center Directors Milton Friend and Robert E. Stewart, and Asst. Center Director Nick Fufmicelli, and presentations by U.S. Congress Office of Technology Assessment Project Director Phyllis Windle and by Randy Westbrooks of APHIS. Updates were provided by WASO Wildlife and Vegetation staff and a field exercise was conducted at Chickamauga Battlefield, where Bob Warren of U/GA provided interim results of his deer research.

Christine Johnson and Lillian McElrath conducted an overview of the region's exotic vegetation. Rob Sutter of The Nature Conservancy covered I&M techniques, and David Jones, Doug DeVries, and Tony Pernas discussed exotic pest plant councils and a case study. Also covered were various IPM topics, including fire ants, Africanized bees, and hantavirus. A computer lab was devoted to the new WASO resource management plan software and GIS applications.

* * *

Trish Patterson, Program Analyst for the region's Natural Resource Management and Science Office, has been selected for the Women's Executive Leadership Program. This program, for non-supervisory employees at GS levels 11 and 12, is designed to prepare participants for future leadership positions.

* * *

Recently published reports include:

Hammitt, W.E., M.E. Patterson, R.M. Chubb, F.M. Noe, and N. Guse. 1994. Starting a Geographic Information System (GIS) Database for Blue Ridge Parkway. NPS/SERBLRI/NRTR-94-01

Publications of interest:

Davis, S.M., and J.C. Ogden (eds). 1994. "Everglades: The Ecosystem and Its Restoration." St. Lucie Press, Delray Beach, FL.

Mid-Atlantic Region

Under the coordination of Elaine Furbish Assateague Island National Seashore (NS successfully conducted two prescribed burn in March 1994, over a total of 200 acres. Th burn plan and fire management plan wer prepared by Dr. Bill Patterson, U/MA. Th purpose was to evaluate the use of fire t maintain native dune grass communities The protective nature of the dunes has al lowed the development of an unnatural shrul community, which is a desirable habitat fo the exotic sika deer.

* * *

Colonial National Historical Park is com pleting work on a Water Resources Manage ment Plan and associated GIS map portfolio Work is continuing on a groundwater study of adjacent urban impacts. Three-fourths o the sampling has been conducted by th Virginia Institute of Marine Sciences, also a cooperator on the Plan. Locations of all th sampling wells are being entered into th park's GIS. The park also is cooperating with the Virginia Department of Natura Heritage in the preparation of a detailed monitoring and management plan for RTE species; and the Virginia State Geologist i working on a 1:24,000 geological map tha will include the park and be GIS-based.

* * *

Results from a 1991 time of travel study o the Delaware River have been published "Determination of traveltime in the Dela ware River, Hancock, New York, to th Delaware Water Gap by use of a conservative dye tracer." 1994 USGS Water-Resources Investigations Report 93-4203.

* * *

An organizational meeting of cooperative researchers involved in the Hemlock Woolly Adelgid project was held March 8 at Dela ware Water Gap NRA. Preliminary results from the 1993 season were presented for th hemlock monitoring program, the small mammal and amphibian survey, and the fish population study. Plans for the understory vegetation study were presented and strategies developed to prevent conflict and overlap of simultaneous studies.

* * *

Delaware Water Gap NRA staff attended a Neotropical Migratory Bird Workshop sponsored by New Jersey. The objective o the conference was to inform people of national, regional and state efforts to protect Neotropical birds and their habitat; and to develop a state (NJ) plan to guide protection, monitoring, research, management, and information and education programs.

Conservation Biologists Conduct Study Of Alien Species in Hawaiian Rainforests

obinMyers and Christine Schonewald-Cox

e are currently conducting a multi-scale of the spread of alien species into the e rainforests of windward East Maui. study involves the National Park Ser- (NPS), National Biological Survey), NASA, the Nature Conservancy, and Hawaiian agencies. Our primary analy- ol will be ARCINFO geographic infor- n system (GIS) software.

e are trying to coordinate our efforts ther local, state, and federal agencies to nize duplicate efforts and maximize the results. Because our work involves ing standards for aerial photography ation classification, inventory and moni- , GIS data analysis, and meta-data on, we want to be sure that others ved in similar work are aware of our ng study. If you have information on olving standards, protocols, and tech- s we describe, or if you would like more nation on our research, please contact

ndscape Transformation Factor

e conservation of biological diversity is portant topic in both resource manage- and research. Recently ecologists have to recognize issues in biological con- ion as high priority research topics, ling habitat diversity, the conservation e and declining species, natural and opogenic changes in patterns of spe- and the effect of global and regional e on biological diversity. The loss of s, communities, or entire ecosystems ntly is the result of human landscape ormation.

e spread of alien species into native s is a concern in most island and conti- l systems. However, most attempts to and map the spread of alien species been conducted at the two extremes of scale: (1) local transect analysis, which ensive and geographically limited; and tellite imagery analysis, which is diffi- o interpret and frequently too coarse- ed to compensate for geographically ted transects. This study, for the first provides an integrative approach for fying, detecting, and predicting changes d to alien species spread into native s at both scales, integrated and con- d by a meso-scale analysis.

nservation generally takes place at the cape or regional level, while ecological ch occurs at the species or community level. Our challenge is to integrate the two, while focusing on a middle ground. Integrative multi-disciplinary research is the key to finding practical and biologically defensible solutions to conservation problems. This study provides an integrative approach for identifying, detecting, and predicting changes related to alien species spread into native montane forests--for the first time at both the micro and macro scales, and integrated and connected by a meso-scale analysis.

A Crisis Management Tool

Our primary motivation in this effort is drawn from the crises related to ecosystem changes caused by the introduction of alien species. Our long-term goal is to determine the patterns of alien species spread in such a way that our methods of interpretation can be used throughout Oceania and the Pacific Rim. These islands (Polynesia, Micronesia, Melanesia) are experiencing alien species invasions with concomitant losses of native fauna and flora.

This multi-scale interdisciplinary study is designed with three primary components (Fig. 1). The Macro-scale Component is a coarse-grained landscape analysis of geographic features for the entire watershed; the Meso-scale Component is a medium-grained landscape analysis examining current and historic aerial photographs over time in identified focus areas; and the Micro-scale Component is a fine-grained field verification of landscape features conducted in permanent plots and transects to identify corresponding native and alien species assemblages and indicators of disturbance. Previous research has suggested that the presence and extent of alien species are related to disturbance, whether the result of human land use or natural events.

Our first goal will be to identify the key factors in this relationship. A gap analysis (Scott et al. 1993) of the macro-scale data will be analyzed in the ARCINFO Geographic Information System, comparing agency land use policies with changes in the percent of alien vegetation cover to identify gaps in protection of native forest.

Our second goal is to identify what landscape features and species assemblage information can be detected at each scale. Using a multi-scale approach, we will analyze the abilities and limitations of the three component scales of observation to detect landscape features and patterns.

Our third and final goal is to determine if the presence of alien species assemblages can be detected by specific dominant canopy classes and landscape features using aerial photography and/or remote sensing.

Myers is a PhD candidate in the Graduate Group in Ecology at U/CA Davis, and a cooperative education research scientist trainee in the Ecosystem Science and Technology Branch of the NASA Ames Research Center, Moffett Field, CA. Her dissertation research in East Maui is being conducted with interagency cooperation at the NBS/CSU at Davis. Schonewald-Cox is a research scientist with the NBS/CSU and adjunct professor at U/CA Davis.

Reference

Scott, J.M., B. Cauti, R. Noss, et al. 1993. Gap Analysis - A Geographic Approach to Protection of Biological Diversity. Wildlife Monographs, N123:1-41.

H. Ronald Pulliam Named To Direct NBS

H. Ronald Pulliam, whose research specialities are conservation ecology, ecosystem management, and avian population dynamics, will take over the reins of the newly emerging National Biological Survey--creature of Secretary Babbitt's effort to sharpen and focus scientific research across the board at the Department of the Interior. The NBS mission is to gather, analyze, and disseminate biological information helpful for good stewardship of natural resources.

A native of Miami Beach, FL, Pulliam received his formal training at U/GA (B.S., 1968), Duke University (Ph.D., 1970), and postdoctoral studies at the University of Chicago (1070-71).

Most recently, he was director and professor at the U/GA Institute of Ecology (1987-1994). Under his leadership, the Institute expanded from its research mission to a school at the University, offering a full graduate and undergraduate curriculum. His recent research focus has been on predicting the impact of land use changes on animal population trends.

Pulliam was highly recommended for the appointment to the NBS post by the National Academy of Sciences, which at the request of Secretary Babbitt conducted a nationwide search for qualified candidates. The Academy recently recommended the nomination of the current director for the U.S. Geological Survey, Dr. Gordon Eaton.

Babbitt noted that "We want Americans everywhere to understand and learn more about the health of our nation's resources. The NBS is a tool that will make science more accessible to the public."

Eugene Hester, who guided the NBS through its formation period, will continue at NBS as deputy director.

Information Crossfile

A productive and easy method to discover what animal species are present in a particular parcel of managed land is the conduct of regular road kill surveys. This method is described in ***Resource Management Notes***, Vol. 6 No. 2 p. 4, the Newsletter published by the FL DNR in Tallahassee. As a result of this practice, six "new" species have been added to the Guana River Stte Park's vertebrate list.

Systematic collection of these data can be made during routine patrols of park staff in performance of their regular duties. An impressive vertebrate list can be accumulated in this way in a cost effective manner. Bert Charest, the state park's biologist, points out that rare and highly secretive species can often be added to park lists via road kill surveys.

* * *

On April 21, 1994, Director Kennedy's Bulletin Board contained a memorandum to all NPS employees regarding strategic planning for the Service. Sections on "Creating Our Future," "Our Changing Circumstances," and "Our Symbiotic Roles," were followed by "The Ten Most Important Things We Can Do." Separate sections on these 10 were headed: (1) Lead through exemplary park resource management; (2) Achieve sustainability in park operations and development; (3) Ensure that the NP System reflects our shared national heritage and use the System to help people forge emotional, intellectual, and recreational ties with that heritage; (4) Develop and support heritage education; (5) Move toward ecosystem management; (6) Reorient assistance programs to focus on conservation of entire landscapes and critical open space; (7) Develop NPS leadership; (8) Invest in employees; (9) Create management structure and systems that place organizational resources as close as possible to the sources of value and enhance accountability for results; and (10) Pursue maximum public benefit through partnerships and other forms of entrepreneurial management.

* * *

Craig Shafer, author of ***Nature Reserves: Island Theory and Conservation Practice***, has written an invited chapter entitled "Beyond Park Boundaries" for a forthcoming book, ***Landscape Planning and Ecological Networks***, to be published in 1994 by Elsevier. Focus of the book is on reversing the negative effects of habitat fragmentation.

* * *

R. Gerald Wright, NPS Research Biologist, is one of three authors of an article, "An Ecological Evaluation of Proposed New Conservation Areas in Idaho: Evaluating Proposed Idaho National Parks," appearing in ***Conservation Biology***, Vol. 8, No. 1, pp 207-216. The article deals with four areas that have been proposed by various interest groups as national parks. The four average 220,000 ha and contain important biological, scenic, recreational, and geological resources, but the biological resources that would be protected have received little consideration. Using the USFWS Gap analysis project databases, the authors evaluated the vegetation types contained in each proposal and found the proposals wanting in this regard.

"However," their abstract states, "the protection provided by each proposal could be enhanced...with the addition of relatively few hectares...Although national parks throughout the world play an important role in the conservation of biodiversity, this attribute is often accidental, and as our analysis showed, more attention needs to be devoted to biological data in the selection and design of new parks."

* * *

An ecological thriller in the making is the once-abandoned and now about-to-be-revived effort to combat *Solenopsis invicta*, the Argentine fire ant accidentally introduced into the U.S. in the early '40s, and seriously threatening insect biodiversity in its seemingly inexorable spread.

The unfinished story is outlined by Charles C. Mann in the March 18, 1994 issue of ***Science*** (pp 1560-61). The ants, which began as territorial "monogynes," have developed a "polygyne" form that creates interconnected "super-colonies" with scores of egg-laying queens. Today they dominate in Texas and may be ready to spread throughout the South...their polygyne form represents "a kind of sheet of fire ants through the earth," according to David F. Williams of the Medical and Veterinary Entomology Research Lab at the USDA Agricultural Research Service in Gainesville, FL. In one research area studied, the number of other ant species fell by 70 percent after the fire ant invasion; the number of arthropod species—insects, spiders, ticks, etc., dropped by 40 percent.

A late 1950s attempt to eliminate the pests, using World War II bombers and the poison mirex, only helped spread the fire ants rather than controlling them, and the effort was abandoned after 1960. However, recent reports that they are actually damaging the environment has given rise to plans for a "rejuvenated" program...one that will not resemble the mirex orgies of the past, but instead will be "a three-legged stool:" occasional use of mirex, educational efforts, and biological control.

Three organisms are being studied—for efficacy and for their effects on non-targeted species. The three most likely candidates for "hero" in this epic are a protozoan parasite, *Thelohania solenopsae*, known in Argentina to kill as many as 2/3 of the *S. invicta* in a colony; a phorid fly in the genus *Pseudateon*, that preys exclusively on fire ants; and *Solenopsis daugerri*, a parasitic ant. Because of its ability to mimic the queen's pheromones, the parasitic ant hornswoggles worker ants into feeding it, rather than the queen they are supposed to be guarding—thus allowing the parasites to "yoke" the queen, who starves to death in full view of the workers who serve her.

Williams says controlling fire ants my be necessary to avert a small-scale catastrophe for insect biodiversity in the South.

* * *

The Desert's Past: A Natural Prehistory of the Great Basin, by Donald K. Grayson (Smithsonian Institution Press, Washington, DC, 1993, 356 pp, $44.95) is reviewed in the March 18, 1994 issue of ***Science*** by David P. Adam of the USGS, Menlo Park, CA. He notes that the book provides a useful overview of the insights gained through analysis of packrat middens and accelerator-mass-spectrometer radiocarbon dating over the past two decades. The remarkably late appearance of single-leaf pinon pine during the Holocene, for example, now is understood far better than it was only a few decades ago. This book brings together the results of a wide variety of investigations in archeology, geology, paleohydrology, climatology, meteorology, biogeography, dendrochronology, and history "to create an engrossing description of the region's changing environment during the past 25,000 years."

* * *

Desperate measures to control the rabbits and foxes introduced to the island of Australia in the mid-1800s are being considered by the Cooperative Research Centre for Biological Control of Verebrate Pest Populations (a government and university consortium), and a chorus of rising concern is greeting the proposal.

Described by Virginia Morell in the August 1993 issue of ***Science*** (pp 683-4), the plan is to release genetically redesigned viruses that will sterilize most foxes and rabbits by tricking the females' immune systems into attacking male sperm.

Mark Bradley, a reproductive immunologist and project leader of the fox program, admits that "No country has ever tried to

ge a pest species on this scale or in this efore. It raises questions across disci-s, from virology to immunology to the als' social behavior and ecology." Yet ld, if successful and safe, provide a l for wiping out pests in other fragile, tened habitats such as Hawaii and New nd.

ring the 110 years of failed control pts, foxes and rabbits have been impli- in the extinction 20 species of local pials.

* * *

n, do not walk, to find the April 1994 of *BioScience* (Vol. 44, No. 4). No are cited, because the entire issue is acked with articles of interest to NPS ists and resource managers. Five Spe-Section articles deal with Hurricane ew and its impact on the Everglades: ricane Andrew" by Stuart L. Pimm, E. Davis, et al, assesses damage and ders long-term consequences to well-d ecosystems; "Hurricane Andrew's s on Marine Resources" by James T. nt, Richard W. Curry, Ronald Jones, et scribes the small underwater impact ontrasts sharply with the destruction in rove and upland-forest communities; ricane Impact on Uplands and Fresh- Swamp Forest" by Lloyd Loope, ael Duever, Alan Herndon, et al, treats trees and epiphytes, which sustained eatest hurricane damage; "Hurricane ew's Impact on Freshwater Resources" arles T. Roman, Nicholas G. Aumen, . Trexler, et al, finds that water quality-nportant to defining the Everglades' e ecological composition–appears to been little affected; "Mangroves, Hur-s, and Lightning Strikes" by Thomas ith III, Michael B. Robblee, Harold R. ess, and Thomas W. Doyle, is an assess-of Hurrican Andrew that suggests an ction across two differing scales of bance.

he same issue, Jeffrey P. Cohn's "Sala-ers slip-sliding away or too surreptiti-o count?" is an overview of the scien-ebate regarding salamander numbers. tes that Interior Secretary Babbitt an-ced last November that the USFWS and ational Paper had agreed to conserve acres of company-owned timberland Alabama for the Red Hills ander...listed as threatened in 1976.

o in this excellent issue is a piece by ond E. Grizzle titled "Thinking of gy: Environmentalism should include n ecological needs." Grizzle's "refer-" amounts to a literature review of the subject, citing 37 sources including former NPS scientist S.P. Bratton. Grizzle posits that lack of explicit inclusion of human needs in the formulation of environmental protection programs has created problems that are insurmountable at the level of what he terms "the basic world view." Striking a now familiar note of "transcendence" above the current level of struggle, he concludes: "Environmentalism must be expanded to explicitly address human needs."

* * *

A dismal record of success in attempts to reintroduce endangered plants (in "mitigation" efforts) as an easy option in the political and legal frameworks of conservation is exposed in an article by William H. Allen in the February 1994 issue of *BioScience* (pp 65-68). Translocation, often in order to allow a development years in the planning "to reconcile the long-term realities of ecology with the short-term imperatives of the economic bottom line") is the most dramatic of the reintroduction techniques "and the one where success is the most uncertain—especially for species that are rare or restricted to rare habitats."

Instead of being treated as something we know how to do with a high degree of confidence, "mitigation" by this means is "surrounded by uncertainty and partial success at best and failure more frequently," according to a quote from Don Falk, executive director of the Society for Ecological Restoration based in Madison, WI. "At its worst," Falk says, "mitigation can be a charade, a fairy tale." He adds: "At its best, it is a healing art of ecology...the art of the possible."

* * *

"A Conceptual Model of Arid Rangeland Degradation" by Suzanne J. Milton, W. Richard J.Dean, et al in the February 1994

Continued on back cover

Dinosaur Blood: Warm or Cold?

The paleontological debate over ectothermy vs. endothermy among the dinosaurs continues to rage within the scientific arena, hotter than the hottest blood proposed by the most ardent endothermy advocates. For an entertaining recap of the battle thus far, see Richard Monastersky's piece in *Science News*, May 14, 1994, pp.312-313.

Monastersky outlines the history of the debate, quotes the scientists whose names recall the various twists and turns in the evidentiary arguments, and brings us up to date with the recent work by Anusuya Chinsamy of U/PA, who compared the bones of young and old animals from a single species. Her reconstruction of how dinosaurs grew has yielded "a confusing array of results," arising from analyses of the cross sections of femurs from the dinosaur type called *Syntarsus*. She found growth rings, usually indicating temporary stops in bone-building and seeming to link the animal with ectotherms (cold-blooded animals that tend to become dormant in difficult seasons such as wintertime).

But Chinsamy also found evidence that this small predatory dinosaur stopped growing when it reached adulthood—typical of endotherms and not of ectotherms. In addition, the *Syntarsus* bone showed rapid growth, another characteristic of endotherms.

Into this muddy picture has leapt John Ruben, Oregon State University professor of zoology. Ruben contends that the focus has been all wrong—that paleontologists, instead of examining slices of femur, should have been looking up a dinosaur's nose. Endothermic animals have a special set of nasal bones directly related to their metabolism, called maxilloturbinals--bones that form thin, folded sheets inside the nasal passages of birds and mammals and prevent warm-blooded, fast-moving animals from losing too much moisture.

The maxilloturbinals work as a humidifier-dehumidifier system. Willem J. Hillenius, a former student of Ruben's, has traced the evolution of endothermy in mammals by searching for maxilloturbinals or the internal ridges to which they attached. His findings support the idea that endothermy evolved because it enhanced an animal's ability to maintain strenuous activity, and he suggests that this is the most promising avenue to pursue in determining whether dinosaurs had a fast metabolism.

Ruben points out that some modern ectotherms can grow and move rapidly, but they lack the endurance of mammals and birds. "I think in the end," Ruben said, "we're going to find that dinosaurs were probably fairly typical ectotherms, metabolically, but that doeat doesn't mean they were sluggish or uninteresting."

cost of declining productivity. A four-step model of degradation is presented and analyzed against data from all levels of the arid ecosystems. Shifts in vegetation compositio have been conceptualized to occur either in predictable sequences or unpredictably in response to stochastic events. As degradation progresses, each step may lead to a number of states, and within each state various cyclic successions may occur. At every descending step of rangeland degradation, restoration becomes more costly in terms of loss of secondary productivity and expenditure of energy.

The authors conclude that "Unless rangelands are maintained at the step-one condition by livestock reduction in dry years, productivity will be irreparably lost because further degradation involving changes in secondary productivity, fauna, and soil become too costly to reverse in an overpopulated, resource-starved world."

* * *

Two more articles in the February 1994 ***BioScience*** that are of interest to certain resource managers are "Forest Gaps and Isolated Savanna Trees" by A. Joy Belsky and Charles D. Canham, and "Coevolution of Agroecosystems and Weed Management" by C.M Ghersa, M.L Roush, S.R. an application of patch dynamics in two ecosystems, concludes that discontinuities alter both the microclimate and the availability of resources crucial to component species. The latter maintains that weed-management practices have become closely linked to social and economic, rather than biological, factors. The key proposed by the authors to finding a way out of the resulting dilemma, lies in minimizing the use of energy and maximizing the use of information.

In both cases, the references cited amount to a virtual survey of the literature.

* * *

To meet the need for a pocket-sized field reference for the wetland plant list, Resource Management Group, Inc., has published the most recent version of the ***National List of Scientific Plant Names*** for Regions 1, 2, 3, 9, and 10. Region 1 is ME, NH, VT, MA, CY, RI, WV, KY, NY, PA, NJ, MD, DE, VA, and OH; Region 2 is NC, SC, GA, FL, TN, AL, MS, LA, and AR; Region 3 (which currently is sold out) is MI, IN, IL, MO, IO, WI, and MN; Region 9 is WA, OR, ID, western MT and western WY; Region 10 is CA.

The books, which are $15 each plus shipping and handling, can be ordered from Resource Management Group, Inc., PO Box 487, Grand Haven, MI 49417-0487.

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PARK SCIENCE

A Resource Management Bulletin

olume 14 - Number 4 National Park Service U.S. Department of the Interior Fall 1994

Sequoia National Park Hosts 'Pulse II'

And the Beat Goes On. . . .

By Jean Matthews; photographs by the editor

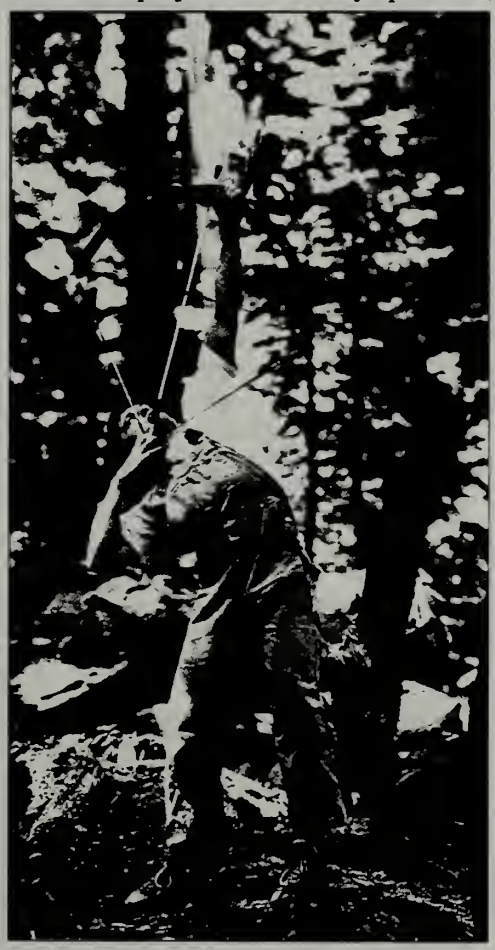
Eleven years after their first "pulse dy" in Sequoia/Kings Canyon National rks (SEKI), Dr. Jerry Franklin, Profes- of Ecosystems Analysis at the Univer- of Washington (UW), and a 65-mem- group of researchers returned to the ginal sites at the 7000-foot level to see at the passage of time afforded in the y of a stereoscopic view. The scientific ciplines represented by the research m covered the broad range of study gles involved in discerning a total pic- e. As team members picked up on the system beat that was first pulsed in 32-83, what struck the observer was the narkable evolution of the pulse itself.

The data gathered between June 20 and must await analysis, but the dynamic, erative nature of the pulsing process s immediately apparent. Like a strong ly, the pulse attracts not only indi- ual researchers (see companion article), whole long-range research programs. veral of the latter either held overlap- g meetings at the SEKI pulse campsite were represented by individuals, who in in and out of the action--making their n inquiries and sharing their findings.

Hear Oregon State University (OSU) logist (and rotten log maestro) Mark rmon, holding forth at the pulse group's sing campfire:

"The original pulse studies were a spark t ignited a paradigm shift in research-- m single species and single problems in ividual parks to an awareness of biotic nmunities and ecosystem functioning r broader areas that extend beyond k boundaries."

Back in 1980, when Franklin orga- ed a pulse at the Hoh River drainage at mpic NP (see *Pacific Park Science* l. 1, No. 1), he was working for the FS out of the Corvallis, Oregon For- y Sciences Lab. A corps of scientists l associates with a tradition of integrated, ecosystem-oriented research had developed around programs centered there. Baseline data to serve managerial and scientific purposes within Olympic National Park (NP), especially the South Fork of the Hoh River drainage, were needed. One objective was to describe the role of vegetation in landform development and the formation of different aquatic habitats. Another was to develop baseline descriptions of the valley bottom forest; another was to analyze the role of dead and down wood and the regeneration of trees in valley bottom forests; another to describe and analyze aquatic habitats and their use by fish; and finally to examine the interactions between Roosevelt elk and vegetation.



Oregon State University Ph.D. candidate and big tree climber Steven Sillett shoots a monofilament line-trailing arrow over a giant sequoia branch 180 feet above ground in preparation for climbing the behemoth. Albeit difficult, canopy research in the sequoias provides an unequalled opportunity for investigating the interactions between the hard-to-reach epiphytes and their hosts. Sillett and his partners collected over 15 different lichens and other epiphytes in four days of intensive research as part of Pulse II.

Seven scientific papers grew out of the Hoh River pulse study. A summary by Franklin stated the major conclusions and described the interrelationships among ecosystem components.

The Pulse I study at SEKI, was described in the Fall 1983 issue of *Park Science*. The study involved plant ecology, geomorphology, hydrology, entomology (aquatic and terrestrial), aquatic biology, forestry, and geography. The focus was largely on collections of basic descriptive data on the stream, riparian, and forest systems at the selected study sites.

In the decade-plus since Pulse I, SEKI's original 6 research plots grew to 23. Nine acid deposition plots were added, as were 8 global change plots (5 in SEKI, 3 in nearby Yosemite NP). Many of the same people were back. Sequoia NP science personnel--Wildlife Ecologist Dave Graber, Ecologists Nate Stephenson and Annie Esperanza, and Larry Bancroft, Chief of Resource Management--were still keeping sweaty fingers crossed as to what the future under the new National Biological Survey (NBS) might hold. Jeff Manley, Natural Resource Specialist; Mary Beth Keifer, park Staff Ecologist; and Dan Driscoe, Forestry Technician,

Continued on page 3

PARK SCIENCE

FALL 1994

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

CONTENTS

DEPARTMENTS

Editorial

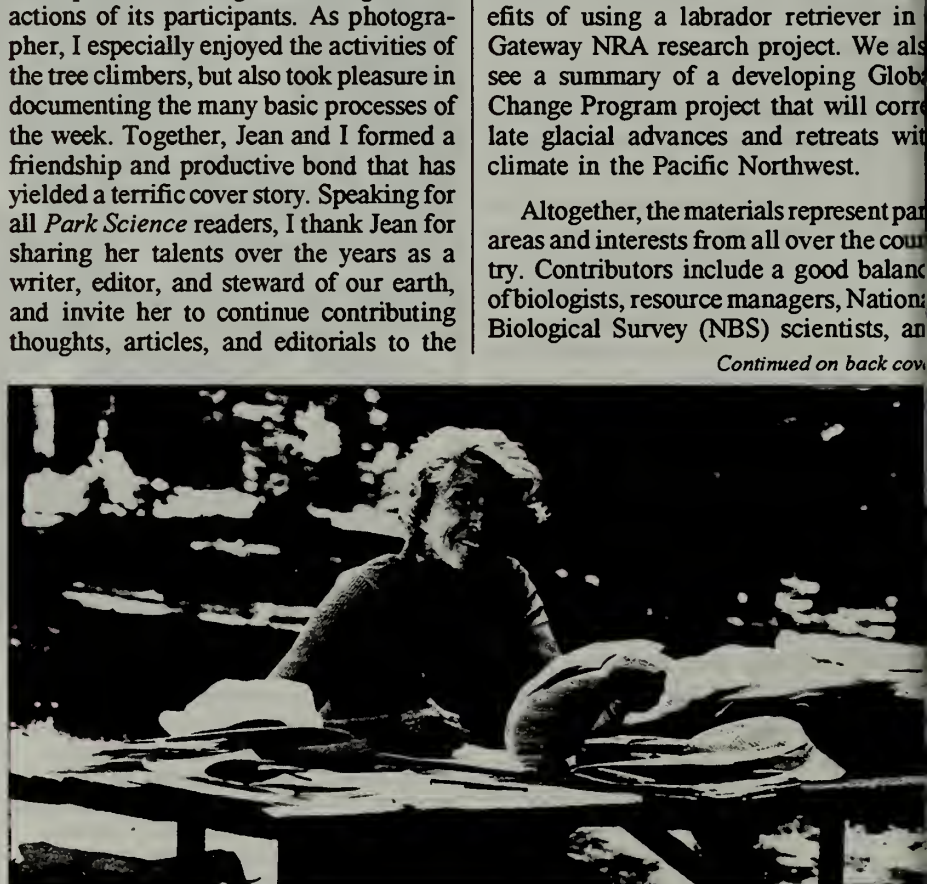
Six months have gone into the transition between editor Jean Matthews (now retired) and myself and this time has made me very appreciative of the strengths of this publication, the interests of its readers, the importance of its supporters, and especially the skills and dedication of Jean.

Last June, the two of us traveled to Sequoia and Kings Canyon NPs to be a part of a specialized kind of holistic ecosystem research, called a pulse study. Working amongst the giant trees and alongside "giants" from the field of forest ecology was a thrill and reemphasized the value of repeating basic monitoring protocols over time. Jean's article (our cover story) explores the pulse study and tells of its importance through the thoughts and actions of its participants. As photographer, I especially enjoyed the activities of the tree climbers, but also took pleasure in documenting the many basic processes of the week. Together, Jean and I formed a friendship and productive bond that has yielded a terrific cover story. Speaking for all *Park Science* readers, I thank Jean for sharing her talents over the years as a writer, editor, and steward of our earth, and invite her to continue contributing thoughts, articles, and editorials to the bulletin from time to time. Best wishes i your retirement, Jean.

The rest of the articles this issue rang from a third installment of social scienc research on off-trail hiking deterrents i Mount Rainier NP to a profile of th people and products of the Natural Re sources Publication Program, which guid *Park Science*. Several items deal wit wildlife; they include pieces on Florid panther radio collar signal calibration an recommendations for managers of park with mountain lion safety issues. On th other end of the spectrum, geologist Wayn Hamilton interprets the geologic histor of Zion NP through the comparison o fossil mollusks with those found ther today, while University of Maine CPS leader Allan O'Connell describes the ben efits of using a labrador retriever in Gateway NRA research project. We als see a summary of a developing Globa Change Program project that will corre late glacial advances and retreats wit climate in the Pacific Northwest.

Altogether, the materials represent par areas and interests from all over the cou try. Contributors include a good balanc of biologists, resource managers, Nationa Biological Survey (NBS) scientists, an

Continued on back cov



Enjoying a week out of the office and away from her computer, retired *Park Science* editor Jean Matthews interviewed scores of scientists and their assistants in preparing this edition's lead article.

Sequoia Pulse . . . and the beat goes on *(cont'd from p. 1)*

ompleted the SEKI staff on hand. Long-me Senior Scientist Dave Parsons at-nded Pulse II as a final farewell. He as leaving not just the park, but the ark Service (See article on page 8).

Stream ecology studies begun in 1983 ere on hold because their personnel ere needed for intensive aquatic sam-ing for the Coastal Oregon Productiv-y Enhancement. But two new strings the pulse bow were the canopy archi-cture and epiphyte ecology study be-un in the permanent reference stands, d respectively by Robert Van Pelt of W and Steven Sillett of OSU, and the rest floor epiphyte study, led by Dave naw.

OSU Research Associate Steve Acker led the team investigating changes in three reference stands (riparian, white fir, and mixed conifer), and found pronounced evidence of mortality. Gregg Riegel, a major organizer of the 1983-84 Pulse I study at SEKI, reported that almost 30 percent of the sugar pines tagged in 1983 had died and a much higher percentage of the remaining trees are infected with white pine blister rust, paving the way for beetles as the proximate cause of death. Acker's team also recorded what was found in the Jeffrey pine and the two giant sequoia reference stands. All these data will be reviewed, verified, and entered by Acker into OSU's Forest Science Data Bank, whose establishment was supported in large part by the National Science Foundation (NSF).

Ruth Kern, Duke University graduate student working with the Global Change Program, reported on her investigations into regeneration in mixed conifer zones at the 5000- to 7000 foot elevational level. In one approach, she enters the permanent reference stands and plots seedling patterns of regeneration in relation to light patterns. Baseline information useful to the parks will come from models that predict seedlings survival and that show whether there is a repeatable pattern for success or whether the reality is too random to make a difference. So far, her results indicate that survival and growth are strongly related to light, but almost not at all to water.

Continued on page 4

the shadows of huge sugar pines (*Pinus lambertiana*), this sapplingstruggles to mpete for limited sunlight. Researcher Gregg Riegel, with the OSU Silviculture Lab in nd, Oregon, documents the tree's vital statistics, noting poor general health and the esence of white pine blister rust (*Cronartium ribicola*), a nonnative fungus and pathogen t has become more prevalent in the ten years since Pulse I.

Pulse pioneer Jerry Franklin chips in with the basic pulse work: remeasuring trees from the six permanent study plots originally laid out and surveyed as part of Pulse I and assessing them for growth, vigor, disease, and causes of death. Researchers hope to learn more about the health of the mixed pine forests and sequoia groves nearby and the factors responsible for any changes of the past decade. Preliminary findings suggested greater mortality in the Jeffrey and sugar pine forests than ten years earlier.

Sequoia Pulse *(cont'd)*

Art McKee, Site Director at the USFS H.J. Andrews Experimental Forest in Oregon, who sampled the original riparian plots for vegetation diversity (along belt transects on three streams), was back to measure changes. In 1994, in addition to resampling streamside vegetation, for comparison his team sampled species richness in surrounding uplands. A somewhat surprising early indication is that vascular plant species, while they are more diverse as expected in riparian zones, are not more than two- to three-fold richer than upland zones. The four- to five-fold greater diversity that had been expected for plants *did* hold true for riparian "critters" compared to critter numbers in upland situations.

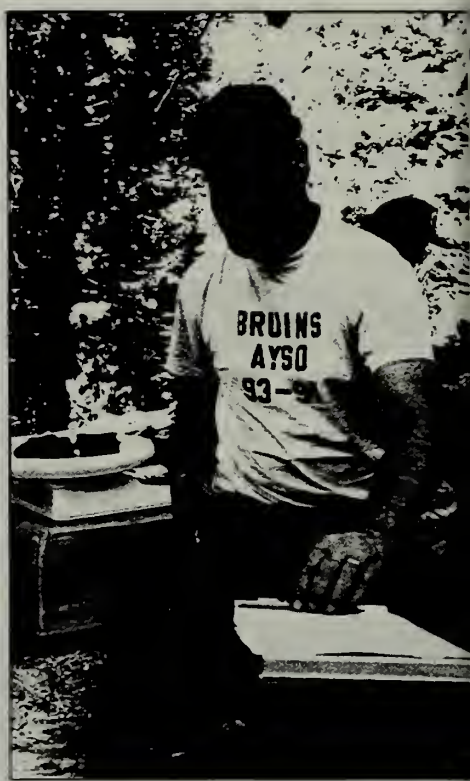
Mark Harmon, author of "Ecology of Coarse Woody Debris in Temperate Ecosystems" (in *Advances in Ecological Research,* Vol. 15, 1986) began investigating SEKI "dead" wood during the 1982-83 pulse. Harmon revels in decomposition. "Sequoia National Park," he said approvingly, "is a very rotten place." He points out that the "so-called 'live' trees consist of no more than five to ten percent living tissue--a biological desert. Now a *dead* tree," he says, his eyes beginning to sparkle, "is about half living matter."

Harmon and his rotten loggers found in 1994 that downed sequoias had remained almost as they were 11 years before, whereas white and red fir logs showed such rapid deterioration that some previously recorded simply no longer existed. Carpenter ants, termites, and white and brown rot fungi can't get a meal out of sequoias, but fir logs decay so fast "they almost vaporize" in Harmon's words.

The Sierra Nevada sequoia stands offer an unparalleled opportunity to study the swings of climate over thousands of years, and such a magnet is drawing top drawer scientists into the pulse. Malcolm Hughes, Director, and Lisa Graumlich and Thomas Swetnam, associate professors, all from the Tree Ring Lab at the University of Arizona, reported findings from dendrochronology and fire scar studies that make possible reconstruction of the spatial and temporal patterns of surface fires in five giant sequoia groves for the past 1,500 years. The extent, the intensity, and the seasons of fire in general correlate with the climate. Multidimensional disturbance (fire) patterns now in hand show fire regimes by elevation. Beginning with the chaparral level, fires occur every four years or so, becoming less and less frequent at higher elevations. The upper tree line also has moved up and down over the years in response to climate changes.

Sequoia regeneration is spotty, according to the findings of the tree ring people. Sometimes decades go by with none at all, followed by a flurry of successes; disturbance, such as fire, would be a key factor in such an event. The pollen record in the meadows suggests that sequoias may have become established only 4,000 years ago, "which means," Swetnam said, "that these groves are only two tree-lifetimes old."

Malcolm Hughes looked around the campfire and beamed: "I love people who actually go out and *measure,* instead of just having wonderful evolutionary thoughts.



"Rotten logging" is the interest of OSU researcher Mark Harmon who reexamines the decay process in logs studied a decade ago at Pulse I. Since then, many specimens have been all but reclaimed by the forest ecosystem. Among the most important factors in their speedy demise is moisture content: too wet or too dry and decay is retarded; just right, as in SEKI, and mechanisms, such as brown and white rot (fungi), termites and ants, and other creatures from bacteria to black bears, efficiently redistribute log nutrients.

My joy is reading the ancient past throug tree ring records. In every giant sequoia, th A.D. 500-year growth ring is either entirel missing or very, very thin. Some particula climatic event is indicated here--probabl drought. We find that in the past 80 years thin rings match a climate of *severe* drough We're now using that relationship to estab lish the dates of such severe droughts i California for the last 2,000 years."

Lisa Graumlich's research looks at long lived trees for what they can tell her abou past climate and atmospheric composition helping her formulate more realistic hy potheses. Data from the ancient past abou subalpine forest dynamics (tree rings an fire scars) have provided the basis for a mor complex model of past climate. She ha found temperatures in the past (A.D. 110 to 1300) exceeding those of the 20th Cen tury, showing that this century's tempera tures, while warmer than average, "ar within the envelope of natural variabil ity."

OSU research assistant and sawyer Jay Sexton prepares "cookies" or crosssections of decaying pine for evaluation by his Pulse Study teammates. After measuring diameter and thickness of the sections and then weighing them, the team evaluates the means and rate of decay by comparing samples from the two studies.

"Our investigators at the upper eline," she continued, "find dead trees; ing these trees shows that the upper e line retreated around A.D. 1,000--a ie of regional drought." She described e ring evidence for century-long drought the past. "A drought-stressed tree nkers down," she said, "so that its bole nsists of a mere strip of live cambium, opposed to a cambial sheath that nor-lly surrounds the entire bole." Then she ndered aloud: "Do they sort of hiber-e?"

At the opposite end of the research le lies the microsite work of Pat Halpin. lpin's studies overlap with the pulse at g Creek near the Giant Forest. They lress the theoretical question of where dividing line lies between the large g., climate) actions and the tree-to-tree eractions in a particular plot. How long established local interactions outweigh effects of major global climate change?

Halpin and his wife spent six weeks in summer of 1993 in the Log Creek site, rting water flow paths and flow accu-lations "at a ridiculously small scale" three 2-ha sites. They report that they nd tree-to-tree interactions more im-tant at the microscale level, but that larger physical controls are beginning make themselves felt, even there. Hid-n water storage in many giant sequoia ves seems to be acting as a drought vival agent, mainly to downstream es. Halpin also has found roots much per than the 200 cm depths thought to usual for sequoias--some as far down 500 cm.

Depressions that once may have been bases of mature sequoias, now long ie, are holding water up to three weeks ger than the surrounding ground, "and uoia seedlings are popping out in the v routes and on the catchments downsite m the mature trees," Halpin reported.

On Friday, the last full day of Pulse II, mbers of the Global Change Research gram arrived. This formerly NPS pro-m was transferred in its entirety in vember 1993 to the National Biologi-Survey. Global change in the Sierra vadas poses such potential problems as s of biotic diversity, increase in fre-ncy and severity of wildfire, increased e and shrub mortality from drought and lution, shifts of treeline and other veg-tion to higher elevations, changes in cies distribution, increased stress on e plant and animal species, and de-ased snowpack with earlier runoff.

Objectives of the Global Change Re-rch Program are to understand and

Professor Jerry Franklin hosted traditional evening information exchange campfires where pulse takers compared their preliminary findings from the day's hard work with data logged ten years earlier. Carried over from Pulse I, the nightly gathering was also a venue for discussions on the next stage in SEKI's prescribed burning program and reports on Global Change projects.

predict changes in the structure and function of the Sierra Nevada ecosystems, with emphasis on the effects of climate on forest ecosystems (including disturbance regimes), species-habitat relationships, and hydrology. The program provided support for a number of individual research projects and for long-term study plots, data management activities, and cooperative outreach activities. Members of the Global Change project attended the Thursday and Friday night campfires, and several pulse study people sat in on the Saturday meetings of the Global Change group.

Early Recognition

The importance of the earlier pulse study was first sounded when then-Superintendent Boyd Evison wrote in the Spring 1983 issue of *Park Science:*

"A remarkable team of 30 scientists, students, and technicians from Oregon State University [arrived at the park in September 1982 and worked for 10 days] from dawn to dusk, carrying out intensive field studies of stream, riparian, and forest systems in a mixed-conifer forest, a giant sequoia forest, and a meadow." Evison described the nightly campfire sessions held by the group and led by Jerry Franklin as "structured, but very lively discussions of project objectives, progress, and applications to Park needs . . . open to Park staff, who were able frequently to provide valuable insights."

Evison applauded the pulse for its attention to "assuring maximum applicability of the findings to on-going Park programs such as basic resources inventory, acid rain research, and long-term monitoring of vegetation changes, the effects of fire, and water quality." He credited the pulse with "providing interdisciplinary information of the kind that most parks unfortunately seem to have little hope of obtaining."

In 1994, the scene of the repeat pulse was a park with no superintendent. Tom Ritter, its latest leader and once head of the NPS Western Region's Science Advisory Task Force, had retired to a cabin in the Puget Sound area. The future of park management was a hazy question mark, but the pulse beat went on. The ecosystem continued to adapt to its own inner and outer conditions; the park research team continued to gather information about how the ecosystems work--struggling to refine their research methodologies, sharpen their focus, and deepen their understanding of both the work they must do on behalf of the systems, and the work they must do to assure their own continued support.

The results of SEKI Pulse I largely dominated the 1984 conference at the University of California/Davis on Research in California's parks, but the papers given there were mostly descriptive and only a very few were published in journals. A dozen years ago, in order to get one's results into the mainstream of science literature, it was necessary to publish in the journals--a process whose timeliness has been aptly described as "proceeding with glacial dignity." Today, the flood of data coming out of pulse and pulse-related research is being fed into data banks--there to await bright hypothesizers who can devise models to test alternative futures.

Continued on page 6

Sequoia Pulse Study . . . *(cont'd from page 5)*

The emerging genius of the pulse lies in this new approach to resource management. No longer will we have to rely on what Nate Stephenson calls "the lumbering, limping, ancient equations of 1988" that give one or two recommendations for park management to accept or reject. Today's scientists are looking confidently toward the day when they can run off a host of "what if" scenarios, using the numbers laboriously collected in the field. From these models they anticipate being able to give management a score of "outcomes" to choose from. However, Sarah Greene, USFS ecologist at the Forestry Sciences Lab in Corvallis, Oregon, cautions that much more data remain to be collected before we can confidently predict ecosystem futures. "A model is still only a weak attempt at best to second guess nature," she warned.

"Models are tools for thinkers, not crutches for the thoughtless."
M.E. Soule`

Given the enormous array of variables inherent in, and affecting, ecosystems, just where the SEKI study plots are heading in the long term is still guesswork. But the pulse crews carrying on the "work" are chipping away at the "guess" in guesswork. Meanwhile, social science research is becoming an increasing necessity, as management is faced with such additional questions as, What do people conceive of as "natural wilderness?" What do they come to parks to experience (and thus what are they willing to support)? How much personal freedom are people willing to forego and how much money are they willing to spend to shape nature to the preferences of *human* nature? (And once we have *that* answer, do we really want to let it guide resource management?)

Franklin's answer, voiced during an evening campfire: "I suspect that the next century will find the 'naturalness' issue to have pretty much gone by the boards. You'll be choosing how you want your parks to look, and managing them to look like that. At Sequoia/Kings Canyon, air pollution from the valley and a couple of degrees of climate warming will make the whole question of 'naturalness' irrelevant."

Or, as a University of Montana philosophy professor fondly remembered by Dave Graber observed some years ago: "We're about to enter an era in which we will treat nature--once lively, vigorous, and stronger than any of us--as a doddering, beloved old aunty, requiring our thoughtful, loving care."

Vital to any research project, data recording was accomplished at Pulse II through the skillful use of electronic data recorders. Sarah Greene tirelessly translated the shouts of distant and near forest pulse takers into keystrokes that accurately portrayed the trees' vital signs, i.e., identification numbers, species, diameter, general health, and prominence in the forest canopy. The data were then downloaded to computers for deferred analysis in Corvallis.

Even as the ecosystem is showing signs of stress and change, so too is the stewardship system. At precisely the time that land managers (e.g., the National Park Service) need the most careful and continuing research, the rug is being rearranged under their science capability. "The transfer of the NPS's Global Change Research Program to the new National Biological Survey," says the 1993 SEKI Annual Report, "leaves many questions regarding the funding and direction of the Sierra Nevada Global Change Research Program." From resource managers across the entire National Park System can be heard a shaky "Amen."

As the latest chapter in the Hairbreadth Harry story of science and the parks is written, two quotations come to mind. The first is from Shakespeare: "... tongues in trees, books in the running brooks, sermons in stones, and good in everything. I would not change it." The other is from John Muir, one of the most eloquent tongues the trees ever had: "We all travel the milky way together--trees and men."

And when we have mulled all this, we can pick up the next issue of the George Wright Society's *Forum* and read William E. Brown's latest "Letter from Gustavus," in which he writes:

"No discussion of wildlife, habitat, or ecosystem preservation has any long-term meaning unless the human condition of overpopulation and its amelioration and eventual solution is the overarching context of discourse. All else is fiddling while Rome burns--playing games with research plots, taking record photos before assured destruction. Assuredly all these things must go on, but if they go on in other than the context of human population control, they will have no bearing on coming realities."

Sequoia Ecologist Annie Esperanza may not be as eloquent as the immortal bard, but her words at a Pulse II campfire are as appropriate an epilogue as can be said at this uncertain moment in park history:

"The pulse payoff for the park is the short-term labor force it affords us, the collection of a mountain of data, the stimulation and excitement of the participants who work in this important place and who know they are doing important work here. The long-term payoff is the way it helps us keep long-term research alive here. The tone of acceptance from management is so much better than it was when the pulsing began. We still get resistance, but it's *friendly* resistance.

"Research has become more institutionalized than ever it was before. We've proved our worth to management. And we did it by 'swarming' them. We dug ourselves deep into the fabric of the park until our work has become as much a part of park management as cleaning the toilets."

Matthews recently retired as editor of Park Science. She now makes her home in Vancouver, WA., where her address is 6010 Riverside Dr., Vancouver, WA 98661, (206) 690-8568.

Project Diversification a Positive Sign for Pulse Future

By the editor

The week of Pulse II was busy with the eractions of researchers from the first KI study 10 years ago and leaders of w satellite studies that were added more cently. The Pulse projects had diversi- d from the bread-and-butter originals remeasuring the permanent reference nds and reexamining their decay pro- sses to include forest mapping, ephiphyte dies, and others.

Ph.D. candidate Robert Van Pelt of V brought his expertise in three-dimen- nal mapping to the Pulse as the ground- rk for developing a detailed computer del of a sequoia grove that could be ed to answer What if . . . ? questions.

Studying canopy lichens and other epi- ytes that live hundreds of feet off the ound in giant sequoias challenged epi- yte niche expert and aerialist Steven lett (OSU) and his partners. The expe- nced tree climbers spent three days ling four sequoias and examining the ationship between tree height, growth face availability, and lichen species. eir goal was to produce a detailed map the distribution of the epiphytes in the canopies.

David Shaw's (UW) team used a thod for surveying the tree canopies for nens that allowed them to operate from ground. The tedious job involved col- ting all of the lichens that had fallen m the trees overhead and were lying hin a series of 2m-radius plots ran- domly located throughout the six study plots. Shaw's hope was to determine the diversity of the lichens found in the mixed pine/fir stands, to estimate their abundance in the forest, to associate them species by species with tree species, and to categorize them by function. Both Sillett's and Shaw's work provide an inventory of species diversity, density, and health that will serve as baseline data for future pulses.

The Pulse approach to research has generated tremendous interest as exemplified by the number, and kind, of participants. The large undertaking appealed to graduate students who wanted to contribute their skills to proven research experiments. The experiments also enticed researchers wanting to learn about the pulse process and imitate it in similar studies elsewhere on the continent. Now recognized as a foundation for long-term research, the Pulse study plots lured scientists to the park to add a layer of new studies to augment the originals.

The Sierra Nevada Global Change Program (initiated by NPS, now run by NBS), while independent of Pulse, coordinated eight projects, many of which used the same Pulse study plots to add to the collective data. Pat Halpin, Global Change research assistant from the University of Virginia, summed up the success and synergism of Pulse in saying, "the beauty of the Pulse Study lies in the permanent plots that have been established and that can be used by subsequent researchers. New projects can be started that build on a foundation of data that will improve with time. Scientists hear about the Pulse and are more likely to sign on because they trust that their own work will contribute to a greater whole. It creates a research situation that compounds."

The growth in participation at Pulse II suggests that the study may operate under its own power in the future while getting to the bottom of the tough questions about the forest ecosystem's health, its dynamism, and its threats. Pulse founder and dynamic leader Jerry Franklin always wanted it this way.

se investigator Robert Van Pelt surveys a study plot in the Lower Crescent Meadow nage at Sequoia with the help of a state-of-the-art laser theodolite. Van Pelt plans to generate tailed 3-d computer model or "map" of the giant sequoia plot with enough detail to predict effects of global warming and other natural disturbance regimes on the forest.

Tree climber Sillett ascends a 280 foot tall giant sequoia (*Sequoia gigantea)* in search of lichens and other epiphytes living high up on the huge trees.

Dave Parsons' Farewell

Editor's note: Parsons is a past research scientist at Sequioa and Kings Canyon NPs. He left the park and the NPS in June to become the director of the Leopold Wilderness Institute in Missoula, Montana. The following are excerpts from an interview he had with past editor Jean Matthews around the Pulse Study campfire.

I came to Sequoia/Kings Canyon in 1973--21 years ago--when there was very little science in the parks. We built the program from a one-person operation to a fairly effective program, with outside scientists, with other agencies, and with academics. It was a cooperative effort that brought science to bear on day-to-day park management.

The pulse studies of 1982-83 were the strategic event that really swung science here into a new, exciting mode. NPS science has struggled over the years. There have been flashes of hope, signs of excellence, and managers who have backed our efforts and who saw our usefulness to management.

But the new direction--the National Biological Survey--is draining the NPS science ranks and threatening to redirect research. It is critical that the NPS and NBS establish effective communication links if the parks are to avoid a return to the days of management by whim. Today's world requires quality scientific data upon which to make management decisions.

We had come such a long way. We had convinced managers of the value of good data to managers. For instance, we were just beginning to get a handle on the data we need in order to manage fire properly. Nate Stephenson's research shows we aren't getting the hot spots we need for sequoia regeneration. David Graber recently showed that under modern fire management we have achieved a fire cycle in mixed conifer stands of no more than 70 to 80 years, whereas the presettlement fire cycle was closer to 15-20 years.

We're not getting anywhere with our current fire practices. We're a long way from the end of the tunnel. Our fire program is still far from perfected. We're facing the need to burn more, burn hotter, and educate the public to the need for this . . . plus figure out how to do it without violating air pollution standards. We need better functional understanding so we can posit various valid scenarios. There are the management frustrations here, and we've had to play whatever funding game is currently hot in order to get money for what needs to be done.

SEKI is a premier study site for long-term environmental research, but it has never been successful in securing a long-term funding base. The lack of an overall commitment to science on the part of the NPS will become even more of a problem now that their researchers have been moved to the NBS.

In addition, many in the scientific community are convinced that there's no point in doing research in the national park system, since the Service on the whole has been negative about accommodating the intrusions necessary for long-term ecological research site work.

It is easy to feel discouraged with the current situation. But it will not do any good to feel sorry for ourselves. We are faced with a new set of rules and we need to make them work. We must work together--NPS, NBS, and other agency and academic scientists and managers--to assure that the NPS is able to meet those needs, and then that the parks are prepared to apply the new scientific findings. It is time to make the system work!

NBS Director Pulliam to Address Problems Faced by Former NPS Scientists

NBS Director Ron Pulliam has appointed Dr. Charles Van Riper III of the agency's Colorado Plateau Research Station in Flagstaff, Arizona, to serve for three months as an ombudsman, or complaint investigator, for the new agency. Acting on reports that the NBS already has too many layers of bureaucracy between field scientists and headquarters, Pulliam felt it necessary to appoint a trusted former NPS researcher, such as Van Riper, to investigate problems and offer realistic solutions. Pulliam has directed the scientist to begin his investigation with former NPS employees now transferred to the NBS because he believes their problems are especially acute and need to be addressed promptly.

During the next three months, Van Riper will be calling on former NPS scientists and present managers to discuss several issues. Van Riper considers his most important area of investigation to be the relationships between the NBS scientists and their parent bureaus. He plans to find out how NBS field stations relate to NPS managers that once supervised them as well as to help the agencies form an ideal relationship. Also on his list of inquiries are questions about overhead costs affecting field researchers negatively, lacking support services (technical, clerical, etc.) that were available in former agencies, and inefficiencies resulting from bureaucratic layering. Van Riper sees this as a very positive move and encourages scientists and managers to use the opportunity to be candid and solution-oriented in the upcoming effort. This midcourse correction exercise may be very helpful. *Van Riper can be reached at (602)556-746*

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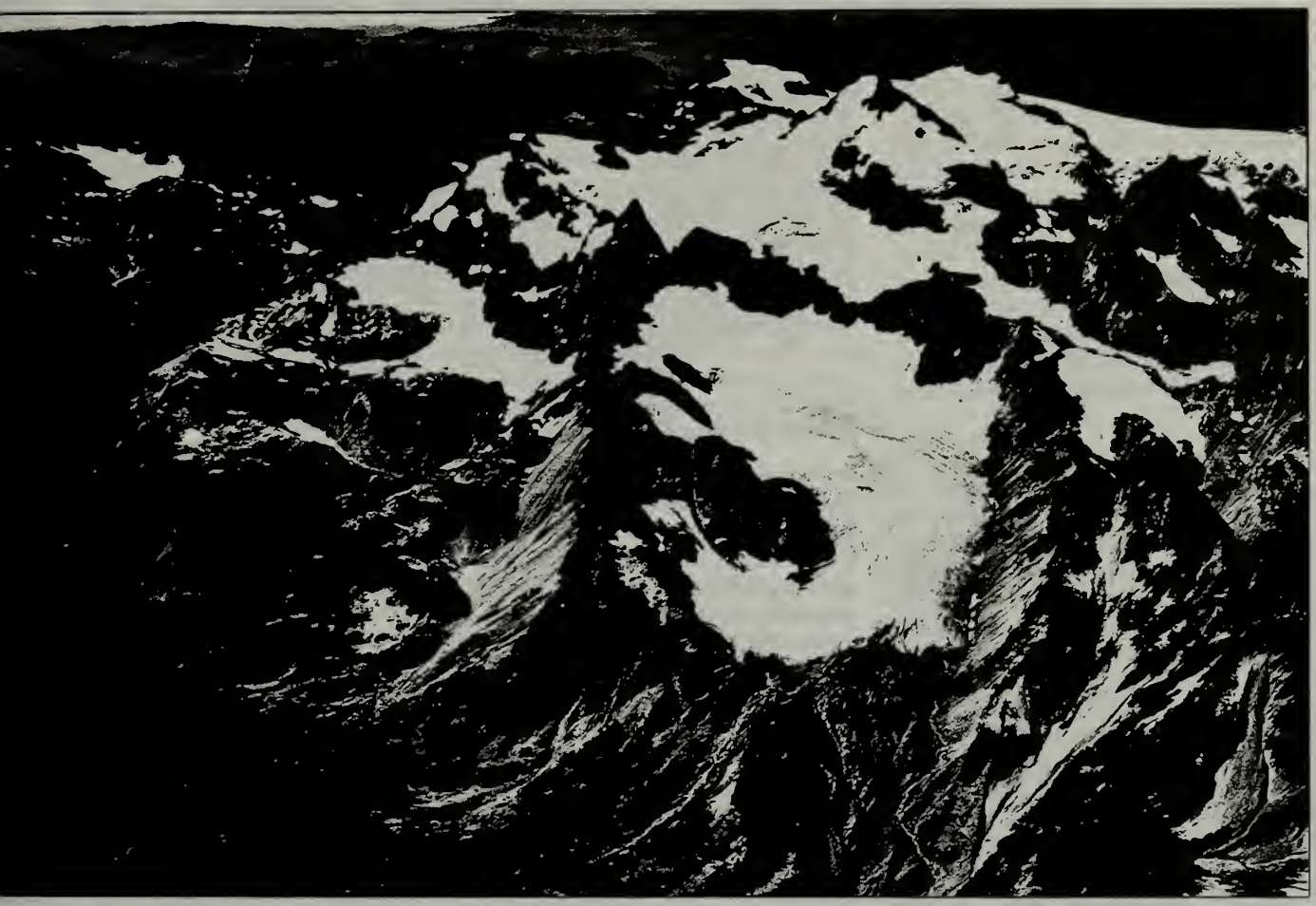
Cooperative Research on Glacier-Climate Relationships Begins in the Pacific Northwest



nes Glacier on the heavily glaciated Mt. Olympus, Olympic NP, Washington

At least 800 glaciers occur in the greater ific Northwest, extending from the ific Ocean to the Rocky Mountains, ween the Columbia River and the Ca- ian border. This concentration of ice ne largest in the conterminous United tes, and crosses a gradient from mari- e to continental climate.

Glaciers exist in the Pacific Northwest ause winter precipitation often exceeds mer melt, even at relatively low el- tions. They are sensitive indicators of nate change due to their size which ects winter snow accumulation and mer temperature. Melting of glaciers esponse to changing climate will have stantial consequences for river hydrol- , particularly increasing flow-rate in short-term and altering seasonality of v in the long-term. Glacial melt could result in greater incidence of geo- ic hazards. These changes will affect etation and animal habitat, as well as e economic consequences.

Although the size of glaciers is dependent on climate, defining the precise relationship is difficult. Describing the climate experienced by the glacier is complicated by the lack of local weather records. Detection of changes due to short-term weather trends may be difficult because effects may be obscured by the flow dynamics of glaciers. Finally, there are few long-term records of annual changes in glaciers to compare with climate records. However, these difficulties are not insurmountable, especially if the expertise of researchers from many fields is combined.

Personnel from NPS (some now with NBS) and USGS have been cooperating informally to obtain histories of the glaciers of the Pacific Northwest. Supported by the NBS Global Change Program, the agencies held a workshop entitled Glacier-Climate Relationships on May 17-18, to develop a coordinated glacier-climate research project. Numerous federal agencies, including the NPS, NBS, USGS, and National Weather Service sent representatives. Glacial resource national parks from the Pacific Northwest, including Olympic, Mount Rainier, North Cascades, and Glacier, as well as Denali, Alaska, also sent staff.

Presentations by participants showed that glaciers throughout the region are currently in retreat, although some glaciers in maritime climates had a period of advance in the 1970s and 1980s. Glaciers now experiencing a continental climate are merely remnants. Climatologists and glaciologists described the available climate models and several approaches to linking glaciers with climate. These participants identified the most valuable variables to collect from historic glacier size records. Finally, the group designed a four-stage research project to study glacier response to climate in the Pacific Northwest. They are currently seeking funding for this project.

For more information, contact Andrea Woodward, College of Forest Resources/CPSU AR-10, University of Washington, Seattle, WA 98195, (206) 685-4448, fax (206) 543-3245.

Natural Resource Publications: A Resource of Products and People

By Donna O'Leary

Interested in the complexities of reintroducing an extirpated wildlife species? Considering alternatives for dealing with a difficult wildlife issue? Need to prioritize threats from exotic plant species before targeting funds and personnel? The answers to these and many other typical resource management concerns can be found in publications of the NPS Natural Resources Publication Program, available through the NPS Natural Resources Publication Office (NRPO) in Denver, Colorado.

Since 1989, this publication program has provided guidance for managing the publication of natural resource information, specifically information disseminated through the national *Park Science* bulletins, the Scientific Monographs and Proceedings series, the Technical and Natural Resources Report series, the annual Science Report series, and the regional report series. The national publications address natural resource topics that are of interest and applicability to a broad readership that includes the NPS, others charged with managing natural resources, the scientific community, the public, and the conservation and environmental constituencies; the regional series address issues of regional interest. Each has its niche--purpose, readership, content, review--and is associated with a variety of NPS professionals who have roles and responsibilities in managing the publication of natural resource information.

The Natural Resources Publication Advisory Board advises the Associate Director, Natural Resources, the regional chief scientists, and chiefs of resource management on policy, procedures, and standards for managing the publication of natural resource information through the national and regional series. This board meets yearly to discuss publication issues and make recommendations relevant to the national and regional series (see sidebar).

Park Science, under the editorship of Jean Matthews for 14 years, grew from a regional bulletin of the Pacific Northwest Region (PNR) to a national and international bulletin that includes the widest readership of any natural resource publication. The *Park Science* Editorial Board reviews proposed articles and editorials for technical credibility and management applicability and gives appropriate consideration to NPS policy and sensitive topics. The board consists of NPS professionals with technical credentials that represent a wide range of scientific and resource management expertise and knowledge of NPS issues. Jim Larson, Chief Scientist, PNR, retired in May and has handed over the chairmanship of this board to Ron Hiebert, Chief Scientist, Midwest Region (MWR).

The prestigious Scientific Monographs (formerly the Fauna of the National Parks Series of the 1930s) and the Scientific Proceedings, the only NPS peer-reviewed series for natural resource research, offer scientists an alternative to publish longer and more comprehensive research of scholarly quality in-house. Under an NPS-Fish and Wildlife Service (USFWS) interagency agreement since 1992, and a continuing partnership with the NBS, wildlife biologist Dr. Paul Vohs edits, reviews and manages both series. Formerly with the FWS, but "adopted" by the NPS, Vohs serves as the senior editor, with the support of the technical publication editor and editorial assistant. This fine editorial team has produced nine publications(see sidebar for a list of titles) and will con-

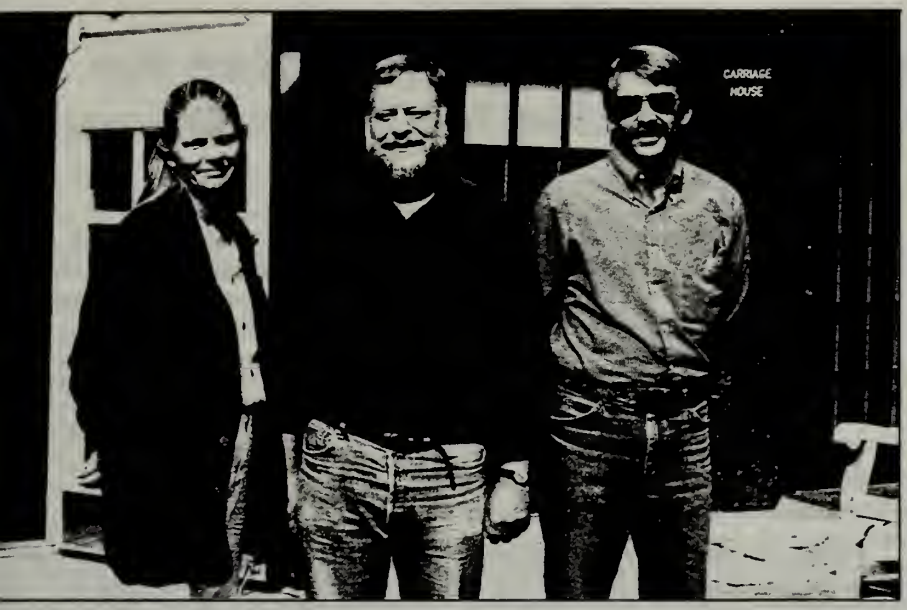
Recommendations of the Board

Meeting on May 10-11 in Albuquerque, NM, the advisory board focused on forming policy in regards to extending services to former NPS scientists that are now with the NBS. They also began developing strategies to encourage resource managers to publish more in the natural resource series.

Recommendations included retaining the Scientific Monographs and Proceedings series at this time in the NPS; allowing former NPS scientists to continue submitting manuscripts to the natural resource series; continuing to fund reprint charges for former NPS scientists; continuing regional funding of a portion of *Park Science* to ensure that "ownership" of the bulletin remains in the field; and continuing the NPS regional natural resource series--some are now managed by former NPS scientists.

Natural Resources Publication Advisory Board

(front row left to right) Gary Sullivan, MWR; Jean Matthews, PNR; Donna O'Leary, NRPO; Jeff Selleck, NRPO; (back row) Dr. Charles van Riper, III, Northern Arizona University, NBS; Dr. R. Gerald Wright, University of ID, NBS; Dr. Milford Fletcher, University of NM, NPS; and Robert Cook, Gateway NRA.



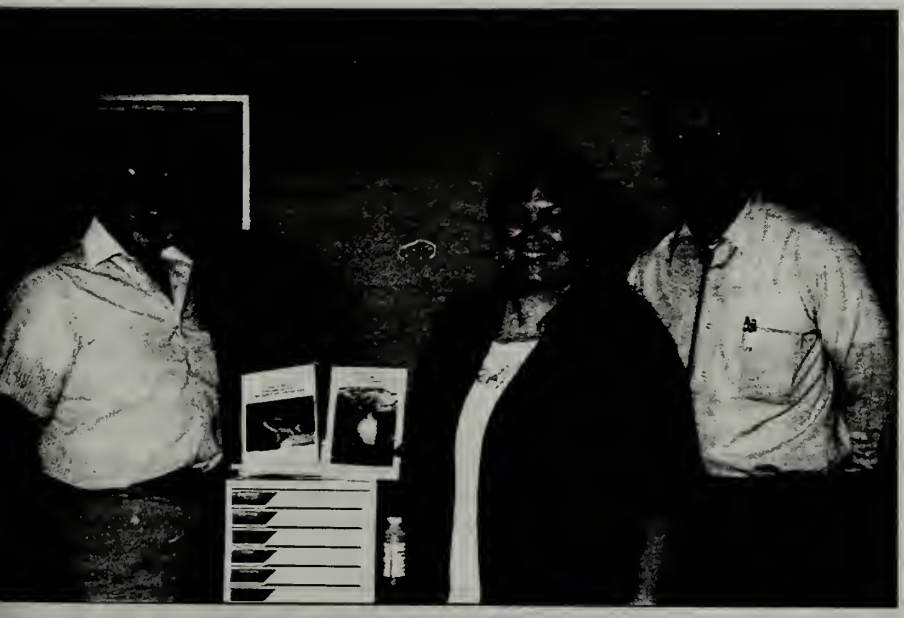
rk Science editorial board
t to right) Elizabeth Johnson, Delaware Water Gap NRA; Ron Hiebert (Chairman), dwest Regional Office; and Jon Jarvis, Craters of the Moon, NM. Absent are Gary vis, Channel Islands NP and John Dennis, Washington office.

ue to produce the Monographs and Proedings and manuscripts submitted by mer NPS scientists to NBS series.

The Technical Reports disseminate chnical information that addresses manement issues, such as research results, ventories and monitoring activities, litture reviews, bibliographies, and proedings of technical conferences that are t peer-reviewed. Natural Resources ports contain information on technoloes and resource management techniques, ow to" resource management papers, nference proceedings, and prototypes programs and resource actions plans.

The yearly *Highlights of Natural Resources Management* report, edited by Lissa Fox, is produced through this series. I serve as the managing editor of both series (a new listing of titles along will be published in the winter issue of *Park Science*).

Finally, the annual Science Report lists the research projects and related studies ongoing or completed in a calendar year. The managing editor of these reports for the past seven years, Anne Frondorf, is now with the NBS. That editorship has been turned over to Tim Goddard, Wildlife and Vegetation Division.



onographs and Proceedings editorial team
t to right) Jerry Cox and Martha Nichols, NPS, and Dr. Paul Vohs, NBS.

O'Leary serves as publications coordinator for the Natural Resources Publication Office. As program manager, she coordinates all aspects of publishing the national series, consults with series authors, administers the planning, review, and compliance processes, facilitates the activities of the editorial and advisory boards, and oversees the partnership with the NBS. She also maintains a complete listing of available natural resource publications and can be reached at P.O. Box 25287, Denver, CO 80225-0287.

Available Monographs and Proceedings

1. **Ecological effects of the Lawn Lake flood of 1982, Rocky Mountain National Park. H.E. McCutchen, R. Herrmann, and D.R. Stevens, editors.**
2. **Ecological issues on reintroducing wolves Into Yellowstone National Park. R.S. Cook, editor.**
3. **Demography of grizzly bears in relation to hunting and mining development in northwestern Alaska. W.B. Ballard, L.A. Ayres, D.J. Reed, S.G. Fancy, and K. Faulkner.**
4. **Proceedings of fourth conference on research in California's national parks. S.D. Veirs, Jr., T.J. Stohlgren, C. Schonewald-Cox, editors.**
5. **Proceedings of first biennial conference on research in Colorado Plateau national parks. P. Rowlands, C. van Riper, III, and M. Sogge, editors.**
6. **Ecology and management of ticks and Lyme disease at Fire Island National Seashore and selected eastern national parks. H.S. Ginsberg.**
7. **Mammals of Indiana Dunes National Lakeshore. J. Whitaker, Jr., J. Gibble, and E. Kjellmark. ***
8. **Mountain goats in Olympic National Park: biology and management of an introduced ungulate. D.B. Houston, E.G. Schreiner, and B.B. Moorhead. ***
9. **Proceedings of the second biennial conference on research in Colorado Plateau national parks. C. van Riper, III, editor. ***

*** Available first quarter of FY95.**

Changes Bring Greater Opportunities for Resource Managers to Write for *Park Science*

By the editor

At a time of great change for the resource management and science programs of the National Park Service, I foresee a need to develop a cadre of *Park Science* contributors primarily from among the resource management ranks. The establishment of the NBS, the proposed combination of natural and cultural resources under one associate director for resource stewardship, streamlining, and the continuing professionalization of resource management challenge us to improve our skills, work more effectively, develop ourselves as leaders, and refine the role of resource management and science in the parks. In order for *Park Science* to continue its relevance and usefulness, we must look to our resource managers to become principal writers for this publication to keep apace with these developments.

The transfer of our scientists to the National Biological Survey has had great ramifications for the role of resource management and will probably begin to affect the numbers and kinds of articles that are submitted to *Park Science*. Staff scientists will no longer be the central source of material for this publication. Cooperative Park Studies Units scientists, contract researchers, and affiliated university investigators studying local questions will, of course, continue to be excellent sources for articles and assistance. To be sure, I encourage article contributions to continue from these sources and from the NBS, but also want to extend an invitation to resource managers to submit items for publication.

While we expect to be well served by the NBS, USGS, and other research organizations in meeting our research needs, resource managers may now recognize opportunities to begin filling some of the niche formerly held by our scientists. Resource managers will have to carry out monitoring protocols that, in the past, often fell to researchers. As long as good scientific design is employed and results are repeatable, resource managers may also be able to forge ahead into new areas, discovering new ways to make progress with research needs through reduction and analyses of monitoring results.

Resource managers are also beginning to coordinate the larger activity of defining the role of science for the parks. This important responsibility gives resource managers the opportunity to work with scientists to identify the most critical research questions; they must also deal effectively with regional offices and WASO to generate research initiatives through the park planning process.

This role as research broker, prioritizing local research needs and figuring out how best to accomplish them, is likely to become more important without staff scientists. Opportunities to write about these maturing roles in *Park Science* may prove both valuable and relevant as innovative approaches to research are tried, projects are completed, and professionalization of the resource management division continues.

While on a recent trip to several parks, I discovered another argument for encouraging article submissions from a broader corps of writers. Many readers perceive that contributions to *Park Science* must comprise hard research to be eligible for publication. While research is welcome, the *application* of research in implementing a local resource management project (along with its results), for example, is of equal interest and importance. Similarly, an article need not concentrate on an especially popular or timely issue, such as wolf reintroduction, but might simply do a good job detailing an approach to solving a routine problem. The recent studies at Mount Rainier on visitor responses to signs requesting that they stay on trail are a good example of this. New data or followup information about existing resource management projects might also make good articles.

In general, submissions to the publication may include natural and social science research and associated recommendations, resource management project implementation summaries and results, inventorying and monitoring updates, public affairs strategies for handling controversial resource management issues, even the use of interpretation as a management tool to involve the public in a resource management program. I suspect that we also will publish more articles (or cross reference them with the CRM) having to do with cultural resources as we move toward integrating natural and cultural resource management into a single division. As long as articles discuss the management implications of research and resource management activities they are suitable for submission to *Park Science*.

With all their variety, parks challenge us with complex and diverse resource management problems. Our response to these problems, through resource management as detailed in *Park Science*, distinguishes this publication. As we meet the challenges ahead, *Park Science* will continue to be the vehicle that tracks our successes, gives us feedback on our failures, demonstrates our effectiveness, and measures our progress toward sound science-based resource management. Let's continue to use this publication to celebrate our development and distinguish ourselves as we adapt to the big changes that are upon us.

National Park Service, U.S. Department of the Interior
Roger G. Kennedy, Director
Dennis B. Fenn, Acting Associate Director, Natural Resources

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ISSN-0735-9462

Contributing to *Park Science:*
Case Study and Feature Article Submission Criteria

Park Science is a quarterly, 32-page, National Park Service resource management bulletin. It explores natural and social science-based solutions to natural and cultural resource management problems in the national park system. Wide circulation facilitates the broad application of research results systemwide.

Content--The publication features articles of general interest on field-oriented research, resource management problem case studies, trends in resource management and research, professional growth opportunities, regional highlights and calendar activities, article and book reviews, and other resource stewardship information.

Focus and Tone—Material should emphasize the implications of natural or social science research for the management of natural and cultural resources. A broad readership calls for clear communication--highlight main concepts, explain methods and project significance, and detail applicability to management. Write primarily in the active voice and explain technical terms.

Target Audience and Primary Authors--Principal readers and contributors comprise national park system area superintendents, resource managers, natural and social science researchers, interpreters, maintenance staff, visitor and resource protection rangers, and other technical and nontechnical personnel. Circulation also includes other federal agencies; state departments of fish and game, parks and recreation, and natural resources; international parks; private conservation organizations; the academic community; and interested public.

Criteria--Feature articles and case studies may include (1) a description of the resource management problem(s) that prompted the research; (2) an explanation of the significance of the resource management project; (3) discussion of management considerations related to the problem(s), such as relevant legislation enabling, NEPA, ARPA, FACA, Endangered Species Act, etc.), pertinent park planning documents (GMP, SFM, FMP, RMP, etc.), planning procedures, and political considerations; (4) a summary of the methodology of the experiment; (5) the results and recommendations of the research; (6) a description of how the findings were applied in the field; and (7) an appraisal of the scope of applicability of the findings to other park areas. As additional information about a project accrues, follow-up reports (one or more years later) may be very useful in fine tuning conclusions.

Length—Less than 1,500 words.

Deadlines—Fall issue--August 1; Winter--November 1; Spring--February 1; Summer--May 1.

Review Procedures--Prior to submission, pieces must be reviewed by the area manager (superintendent) for policy considerations, and by the regional chief scientist. The editor and editorial board ensure that submissions are technically credible, relevant, of general interest, broadly understandable, solution-oriented, applicable in the field, and in agreement with the submission criteria.

Author Information—In addition to a byline, include position title, park area or affiliation, a brief biography, work address, phone and fax numbers, and electronic mail addresses (e.g., cc:Mail or Internet).

Measurements--Report measurements in metric (using abbreviations for units) followed by English in parentheses. Time is to be reported using A.M. and P.M.

Illustrations—Submit a minimum of three illustrations in support of feature articles and case studies. Show personnel at work, project equipment, techniques used, etc., to illustrate the focus of the article. Original line art, photostats, high quality xeroxes, black and white photographic prints (glossies preferred), color prints, and either color or black and white slides are acceptable. Computer-generated illustrations (i. e. scanned art, and drawing software originals saved as .EPS, .BMP, .PCX or .TIF files) can be forwarded through cc:Mail (attach as DOS file), on floppy disc, or on laser-printer originals (600 dpi if possible). Include the name of the artist or photographer and documentation of approved use if the illustration is copyright-protected. Label each illustration with park name, article title, and any placement information (e.g., fig. 1).

Captions--Describe the relationship of the illustration to the theme of the article.

Delivery—Submit approved contributions to the editor using these methods in priority order:

(1) by cc:Mail with the word-processed document and any illustration files attached as DOS files. Indicate the word-processing software and version in the cover message (e.g., WordPerfect 5.1). Files can be compressed using PKZip if especially large.

(2) by mailing the hard copy (double-spaced) and a floppy disc containing the word-processed document (indicate the software and version) and any illustrations;

(3) by mailing the double-spaced hard copy (laser-printed originals if possible) and any illustrations alone;

(4) by fax. Use double-spaced, laser-printed originals if possible. Illustrations may not be faxed.

Questions--If you have an idea for an article, but are not sure about its usefulness, relevance, or desirability, call the editor before writing to discuss appropriateness and ideas for development. Other questions or comments are also welcome.

Contacting the Editor

Cut out this card and place it in your Rolodex . . .

Park Science

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Delineation of Old-Growth Oak and Eastern Hemlock in Great Smoky Mountains National Park

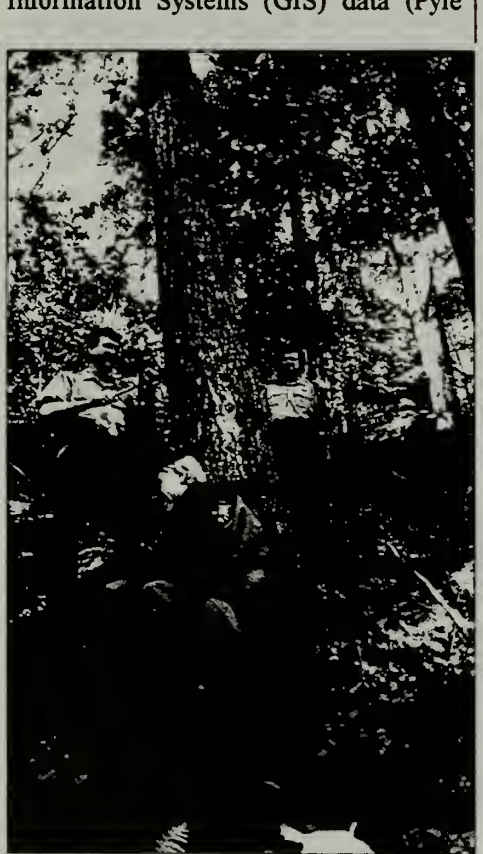
By Edward C. Yost, Katherine S. Johnson, and William F. Blozan

Editor's Note: The Great Smokies old-growth baseline data study was funded through NRPP (Natural Resources Preservation Program) monies as an inventory and monitoring project and was the first of its kind within the park.

In response to the southerly spread of two exotic forest pests, the gypsy moth (*Lymantria dispar* (L.)) and the hemlock woolly adelgid (*Adelges tsugae* Annand), Great Smoky Mountains NP, Resource Management and Science Division, initiated the Old-Growth Project to identify and map the park's old-growth oak (*Quercus* spp.) and eastern hemlock (*Tsuga canadensis* (L.) Carr.) forests and to establish long-term vegetation monitoring plots within these areas. Identification and mapping of representative stands is now complete and establishment of long-term monitoring plots is beginning.

Stand Location and Delineation

We located the old-growth hemlock and oak forests using current Geographic Information Systems (GIS) data (Pyle 1985, MacKenzie 1991) and recent aerial photography (1:12,000 scale) in conjunction with historical information, old photographs, previous vegetation studies, reports of anthropogenic disturbance, and interviews with persons knowledgeable in early pre-park history. We selected a minimum stand size of 5 hectares (ha) for hemlock; a minimum stand size was not used for oak forests due to their small size and patchy distribution (smallest delineated area equaled 2 ha). Each potential site was ground truthed and mapped. We conducted a minimum of two arbitrarily placed canopy tree tallies in each stand using approximately 1/10-ha circular areas to tally species, relative frequency, crown class, and regeneration. The tally information was used to estimate canopy dominance, species composition, and to verify forest types (see table 1 for forest type descriptions). We determined the old-growth forest type by the species or species association with the highest (minimum 50% frequency) representation in the dominant and codominant canopy classes. We took increment cores and



Researchers using increment coring tools examined 700 trees throughout the study area in order to confirm the presence of old-growth. Increment coring is a common technique for aging trees by counting growth rings.

Table 1. Description of Forest Types Used for Delineation

Mesic Oak

Within the park, these forests occur at middle to upper elevations from 1,585-1,067 m (3,500-5,200 ft) on gently sloping ridge crests with south, east, or west aspects, and at lower elevations from 763-1,372 m (2,500-1,800 ft) on nearly flat south aspects. At the higher elevations northern red oak is dominant, with canopy associates of white oak (*Quercus alba* L.), chestnut oak (*Quercus prinus* L.), red maple, eastern hemlock, and Carolina silverbell. Mesic oak forest at lower elevations is dominated by chestnut oak associated with red maple, black gum (*Nyssa sylvatica* Marsh.), pignut hickory (*Carya glabra* (P. Mill.) Sweet), and black birch (*Betula lenta* L.). In both cases, oak species comprise 50% or more of the upper canopy (per canopy tree tally). The understory community includes sweetshrub (*Calycanthus floridus* L.), maple-leaf viburnum (*Viburnum acerifolium* L.), azaleas (*Rhododendron* spp. L.), and witch-hazel (*Hamamelis virginiana* L.).

Submesic Oak

These forests occur on moderate middle elevation 763-1,372 m (2,500-4,500 ft) slopes, with southerly aspects or on nearly flat north-facing ridge tops in the western end of the park. These ecosystems are dominated by chestnut oak, northern red oak, and red maple, and oak species comprise 50% or more of the upper canopy layers (per tree tally). The understory is dominated by deciduous ericads—primarily huckleberries (*Gaylussacia* spp. Kunth), blueberries (*Vaccinium* L.), and azaleas.

Subxeric Oak

These forests are dominated by chestnut oak, scarlet oak (*Quercus coccinea* Muenchh.), and black oak (*Quercus velutina* Lam.), which comprise 50% or more of the upper canopy (per tree tally). Pines (*Pinus* spp. L.) often mix with the hardwoods. The understory component is primarily mountain laurel (*Kalmia* spp. L.), with other ericads such as blueberries, huckleberries, and rhododendron (*Rhododendron* spp. L.).

Xeric Oak

Blackjack (*Quercus marilandica* Muenchh.), scarlet, and chestnut oaks are common on these dry, often south-facing areas. Oak species represent 50% or more of the upper canopy. Virginia pine (*Pinus virginiana* P. Mill), pitch pine (*Pinus rigida* P. Mill), and Table Mountain pine (*Pinus echinata* P. Mill) often share the canopy, along with sourwood (*Oxydendrum arboreum* (L.) DC.), black gum, and red maple. Blueberries and mountain laurel generally occupy the shrub layers.

Hemlock/Cove Hardwoods

These forests generally occur on moist, north-facing slopes to about 1,219 m (4,000 ft) in elevation. Hemlock dominates the upper canopy, and hardwood associates include tulip-poplar, black birch, yellow birch, and Fraser magnolia. The understory is typically dense rosebay rhododendron (*Rhododendron maximum* L.) and dog-hobble (*Leucothoe* spp. D. Don).

iameters at breast height from a mini-
ıum of two trees per tally site, and noted
ld-growth characteristics and anthropo-
enic disturbance (see tables 2 and 3 for
riteria). Additional increment core data—
ıken on the location of potential old-
rowth stands and in areas of suspected
isturbance—were essential for verifying
ee ages and releases in annual growth.
Ve considered a minimum age of 150
ears a coarse filter for old-growth candi-
acy, as the lower valleys were cleared for
griculture and timber as early as 1840
Trout 1987).

Results and Discussion

We located and mapped 86 stands,
talling 926 ha, as summarized by forest
pe in table 4. The stands were distrib-
ed throughout the park, although oak
pes tended to be concentrated in the
estern portion and hemlock types in the
ıstern portion. In general, the hemlock stands represented relatively undisturbed areas; oak areas exhibited a higher level of disturbance, especially due to the loss of the American chestnut (*Castanea dentata* (Marsh) Borkh.). With the exception of xeric oak, we located representative stands in all of the oak and hemlock forest types considered in this project, although we delineated only one small (2 ha) stand in subxeric oak. In the remaining forest types—mesic oak, submesic oak, hemlock/northern hardwoods, and hemlock/cove hardwoods—stands with both high and moderate virgin forest attribute ratings were delineated and are available for permanent plot location.

Technique

Hardwood forest types of the eastern and southern United States are highly variable (Avery 1978), and infrared aerial photo interpretation of old-growth forests proved difficult within our study area. We did not determine a reliable, consistent photo identification pattern of forest types, due in part to the seasonal differences in photo sets and the wide range of color variation between prints on the same flight line. Images at the edges of stereo pairs were inherently distorted and hemlock canopy dominance was visually exaggerated within these areas. In contrast with hemlock, old-growth oak in our project areas could not be reliably determined by photo characteristics. For example, areas with old-growth characteristics such as large flat-topped crowns were generally younger (60-120 years), than vigorous northern red oaks (*Quercus rubra* L.) or second-growth forest. Areas on the photos that appeared as canopy gaps were often rocky areas, cliffs, or steep changes in elevation, and could not be considered indicators of old-growth based solely on the photo image.

Initially, we used a composite GIS map of areas lacking known human disturbance (Pyle 1985) overlaid with predicted forest cover types (MacKenzie 1991) to locate old-growth oak. Ground truthing revealed that oak forest type predictions were fairly accurate but that human disturbance records were not consistently reliable. Old-growth mesic oak was particularly over-predicted, and submesic oak was often of old-growth character inside and outside the predicted areas.

Experience in each forest type has led us to realize that one old-growth characteristics rating system is not applicable to all forests in the park, and forest type-specific rating methods need to be developed. As an example, attributes that were rated higher in our mesic oak forests, such as pit-and-mound microtopography, were rated lower in submesic stands where the trees typically rot and decay without uprooting. The lower rating was not due to a lack of old-growth integrity but perhaps to a difference in soils and windthrow characteristics. Modifications might include quantifying each old-growth attribute or "weighing" human disturbance more heavily than other attributes.

The 150-year-minimum age for old-growth—intended to "filter out" most European influence in the park—tended to exclude old-growth ecosystems with a severe or regular disturbance regime because they lacked the project's old-growth characteristics, such as consistent "old" ages and uneven-aged structure. In addition, "virgin" forests recovering from extensive disturbances, including wind and ice storms, chestnut blight, or forest fires could have been excluded if the disturbance occurred after the 1840s.

Continued on page 16

Table 2

Old-growth Characteristics

Listed attributes rated in all forest types except oak specific (++) and hemlock specific (*).

- Logs in all stages of decomposition
- Standing snags
- Majority of canopy tree ages 150 years or greater
- Canpoy gaps (log present in some stage of decay)
- Little evidence of human disturbance
- Pit and mound microtopography
- High amount of woody debris on ground and in associated streams
- Old bark characteristics of canopy trees
- Bole and root decay
- Canopy structure multilayered (uneven-aged or in a series of age classes ++)
- Flat-topped tree crowns ++
- Undisturbed soil *
- Uneven-aged structure *
- Large trees (relative to site) *
- Large commercially important tree species of high quality *
- Rounded tree crowns in profile *

Table 3

Disturbance Rating Classes

High in virgin forest attributes (A): the stand retained natural structure with little or no record or evidence of human disturbance.

Moderate in virgin forest attributes (B): the stand generally retained natural structure with record of evidence of selective logging or chestnut blight.

Low in virgin forest attributes (C): the stand retained scattered old-growth trees with record or evidence of extensive disturbance due to logging or chestnut blight.

Adapted from Pyle 1985.

Table 4

Delineated Area Totals by Forest Type

Total survey area: 959 ha*

	Oak Types (665 ha)			Hemlock Types (294 ha)	
	Mesic	Submesic	Subxeric	Hem/Cove	Hem/North
Total ha per type	212	451	2	247	47
# stands surveyed	21	39	1	19	6
Avg. stand size	10	12	2	14	8
% Total	22	47	0.2	26	5

*Areas displayed in this table are not adjusted to scale for slope.

Table 5

Forest Type Comparisons Based on Canopy Tree Tallies

Hemlock Type:	Hemlock/Cove		Hemlock/North	
Species	Comp%	Canopy%	Comp%	Canopy%
Betula alleghaniensis	6.4	4.9	8.6	3.6
Acer rubrum	3.7	3.9	3.9	3.6
Magnolia fraseri	2.8	2.3	8.9	1.5

Oak Type:	mesic	submesic	subxeric	mesic	submesic	subxeric
Species	% Composition			% Upper Canopy		
Quercus rubra	30.0	14.6	0.9	50.6	20.0	2.0
Quercus prinus	4.0	22.6	23.4	7.7	34.9	31.4
Quercus velutina	0.1	3.1	8.1	0.2	3.9	5.9
Quercus coccinea	0.4	2.0	14.4	1.1	3.1	27.5
Quercus spp. total	40.8	49.1	54.0	67.7	72.8	82.4

Through the collection of 748 complete (readable, to center, and lacking rot) core samples, we determined that bark characteristics did not always indicate relative age. For both hemlock and oak, old (exceeding 150 years) suppressed trees had "young" bark characteristics, and young vigorous trees had the very rough and furrowed bark usually associated with old trees. In addition, we found some species with atypical bark characteristics, and some species such as American beech (*Faqus qrandifolia* Ehrh.), Fraser magnolia (*Maqnolia fraseri* Walt.), and American holly (*Ilex opaca* Ait.) may never develop rough bark.

Tree Tally Information Summary

The following information is based on arbitrarily placed canopy tree tally areas and should be considered preliminary; data from the permanent monitoring plots will be necessary to substantiate or refine these observations.

Two types of eastern hemlock forests were surveyed in this project: Hemlock-Cove hardwoods and Hemlock-Northern hardwoods. Within our study area, preliminary information suggests considerable compositional differences between the two types (table 5). Some patterns, however, appeared common to both forest types. Species such as Fraser magnolia, yellow birch (*Betula alleghaniensis* Britt.), and silverbell (*Halesia tetraptera* var. monticola Ellis) had a low recruitment to the upper canopy, based on their total compositional value. In contrast, red maple (*Acer rubrum* L.) was relatively even in distribution throughout the canopy. Hemlock was more frequent in the suppressed canopy class, which may indicate that suppressed hemlock saplings were distributed evenly throughout the lower canopy (therefore, well represented in the tally data), whereas suppressed hardwoods were only well represented in scattered canopy gaps. In both types, hardwoods dominated the intermediate canopy class.

We differentiated three types of oak forests based on overall canopy composition related to exposure and elevation (Whittaker 1956). Oak dominated all types and varied considerably in composition as well as in the canopy distribution of species in each. Oak increased in compositional value as a component of the forest as a whole and within upper canopy layers as aspects became more exposed and better drained. Overall, oaks (aside from northern red) increased in composition from mesic to subxeric sites.

Summary

Currently, 959 ha of old-growth oak and hemlock stands are delineated in the Smokies, and permanent monitoring plots will continue to be established through the 1994 field season. The baseline data will provide information for the definition and understanding of these ecosystems, and are valuable as a preinfestation reference for future pest management decisions.

Yost, Johnson, and Blozan are NPS forestry technicians at Great Smoky Mountains National Park, 107 Park Headquarters Road, Gatlinburg, TN 37738, (615) 436-1707

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Keeping Visitors On The Right Track:
Sign and Barrier Research at Mount Rainier

By Thomas C. Swearingen and Darryll R. Johnson

Editor's Note: This is the third report the authors on noncompliant visitor havior at Mount Rainier.

Paradise Meadows is one of the most opular and accessible areas in Mount ainier NP (MORA). Thousands of park sitors stop at Paradise Meadows each y during peak season to hike, eat, view e mountain, and tour the visitor center. ff-trail hiking is a major source of hu- an impact that creates social trails and lated erosion throughout the several thou- nd acres of subalpine meadows. With to 5,000 visits a day, even a small oportion of visitors leaving established ils and deviating onto the meadows has significant adverse impact. Managers at radise Meadows need data on the effect various control strategies to protect the vironment from inappropriate and de- uctive behavior.

Since off-trail hiking can cause severe mage to fragile natural environments, ilside signs, barriers, and other visitor ntrol techniques represent the last op- rtunity for resource managers to deter appropriate activities in such locations. test the effectiveness of such strate- es, the University of Washington Coop- ative Park Studies Unit administered veral experiments at Paradise Mead- vs. These experiments are presented as case study in the applications of social ience methods to natural resource man- gement.

METHODS

The research at MORA assessed the ficacy of alternative trailside sign texts, rrier types, and uniformed personnel in terring off-trail hiking. Altogether, we idied the behavior of 17,416 visitors at ree sites in the meadow in an experi- ent designed to compare the effective- ss of six different types of signs. roughout each observation day, re- archers systematically rotated all ex- rimental signs at each site to control for as due to lack of randomization. Con- ucted of a standard engraved brushed tal and bolted onto brown steel posts, signs were positioned about knee high ng the trail. The topography of the adows and the position of the signs de it difficult to pass the experimental es and fail to see the signs (see sidebar a description of the experimental sign ntents).

Experimental Signs

The experiment design used one stake, six sign treatments, and a control (no sign). The signs read: (1) "No Hiking - Meadow Repairs" (the standard NPS meadow sign), (2) "Stay On The Paved Trails And Preserve The Meadow" (new preservation appeal sign), (3) international red circle/crosshatch sign with a hiker's profile (symbolic sign), (4) "No Off-Trail Hiking"--combination of a prohibitory message with the same hiker symbol--(hybrid), (5) "Off-Trail Hikers May Be Fined" (threatened sanction), (6) short stake (approximately ½m or 1½ ft high) with a small version of the symbolic sign (stake), (7) "DO NOT TREAD, MOSEY, HOP, TRAMPLE, STEP, PLOD, TIPTOE, TROT, TRAIPSE, MEANDER, CREEP, PRANCE, AMBLE, JOG, TRUDGE, MARCH, STOMP, TODDLE, JUMP, STUMBLE, TROD, SPRINT, OR WALK ON THE PLANTS" (humorous sign), and (8) control (no sign).

At one site, each experimental sign was alternately displayed either once at the behavior observation site or several times along the trail leading up to the observation site. Researchers collected data on the behavior of subjects exposed to the experimental signs (preservation appeal, symbolic, hybrid, sanction, and humorous signs). We designed this procedure to determine if the initial effect of a novel sign would be different from repeated exposure to that sign as the novelty diminished.

At a different experiment site, a uniformed NPS employee was alternately present and absent through entire sign treatment rotations on random days. The female employee wore a class A field uniform with green jeans or shorts, a NPS short sleeve shirt, and a forest green NPS baseball cap. She did not wear the class A dress uniform with a more military or authoritarian appearance. The employee did not approach visitors to enforce rules, but was clearly visible along the trail at the experimental sign site during the appropriate data collection periods.

In another component of the study, a barrier experiment included behavioral data on 6,006 subjects at three sites. At these sites, we studied the effect of two types of trailside barriers. The experiment consisted of systematic rotation of (1) a split rail fence, (2) a yellow polypropylene rope supported by lathe posts placed at knee height (approximately), and (3) a control (no barrier). Due to the more permanent nature of barriers, each was erected on each site for several days.

Trained personnel observed visitors from unobtrusive sites, and visitors could not infer that they were under observation. Data were recorded on standardized observation sheets, and additional qualitative comments and observations were logged into daily journals. Data described each participant, group, and compliant or noncompliant behavior in the presence of the signs or barriers, and the behavior of other parties in close visual proximity. We defined noncompliance as off-trail hiking where the subjects deviated off the trail in the immediate proximity of the signs or barriers.

RESULTS

The Sign Experiment

The sign experiment results indicate that trailside signs significantly reduce off-trail hiking in comparison to no sign (a control). In comparisons between signs, each sign was statistically compared to the next most effective sign in a step-wise procedure to determine how the effective signs might be grouped.

Different signs varied significantly in observed rates of noncompliance (table 1). The threatened sanction sign was more effective than the next best treatment, the new preservation appeal (chi square = 10.0, p= .0016), and reduced off-trail hiking by 75% in comparison to the control. The next four most effective signs (new preservation appeal, humorous, hybrid, symbolic) were not significantly different. However, the symbolic sign was not significantly more effective than the old standard sign. Thus, the new preservation appeal, humorous, and hybrid signs represent middle-range effectiveness. The old standard and the symbolic signs are a third range of effectiveness, and the old standard "Meadow Repairs" sign is the least effective. Off-trail hiking rates did not

Continued on page 18

differ significantly from the control (chi square = 3.3, p = .0684) when visitors were exposed to the stake.

The research also addressed the potential for a novelty effect on hiker behavior of the presence of unusual signs placed singularly or repeatedly on the trailside. We investigated whether repeated exposure to an unusual, novel sign causes a change in the effectiveness of the unusual sign type. Data analysis revealed that there was not a significant difference in compliance rates when the repeated preservation appeal, symbolic, or sanction signs were present or absent. There was, however, a significant difference in compliance rates between single and repeated exposures to the hybrid sign; off-trail hiking increased [this is surprising] when the sign was present several times along the trail corridor.

Characteristics of Off-trail Hikers

At experimental sites, the majority (58%) of all off-trail hikers were white adults. However, a disproportionate number were non-white (a large percentage of whom were foreign) Some Asian tour groups were even observed being led off-trai by their tour leaders. Although adults accounted for 58% of al noncompliant behavior, analysis of the data indicated that teen and children were more likely to deviate off-trail.

The majority of off-trail travel (78%) occurred when othe parties in the vicinity of the party under observation stayed o the trails. However, the probability of off-trail hiking increase when the offending hikers could view noncompliance by other in their general vicinity. Finally, when the observed noncompli ance occurred among a group of visitors, a large proportion o all of the group was likely to walk off-trail.

The Barrier Experiment

The data from the barrier experiment sites are presented i table 2. The yellow polypropylene rope barrier was significantl more effective in deterring off-trail hiking than the split ra fence. On average, ropes were over twice as effective as spli rail fences in reducing noncompliance. Both barriers signifi cantly reduced off-trail hiking in comparison to no barrier (th control).

Uniformed Personnel

Noncompliance almost disappeared in the presence of th uniformed employee (table 3). Interestingly, additional analyse revealed that the positive effect of signs remained evident; tha is, signs still had a significant, although slight, deterrent effec on off-trail hiking in the presence of the uniformed person.

Management Implications

The statistical analyses indicate that the threatened sanctio sign is the most effective. Indeed, the next most effective sig (preservation appeal) had a noncompliance rate nearly twice a

Table 1

Sign Text by Visitor Compliance
Mount Rainier Sign Study

Sign Text	Compliance Status[1] C	NC	Row Totals
Sanction (Row)	98.3%	1.7%	100%
(Column)	13.8%	5.5%	13.5%
(Count)	1957	33	1990
Preservation Appeal	96.7%	3.3%	100.0%
	11.3%	9.2%	11.2%
	1596	55	1651
Humorous	96.6%	3.4%	100.0%
	11.3%	9.5%	11.3%
	1607	57	1664
Hybrid	96.4%	3.6%	100.0%
	14.8%	13.0%	14.7%
	2095	78	2173
Symbolic	95.9%	4.1%	100.0%
	15.2%	15.3%	15.2%
	2155	92	2247
Old NPS Standard	95.1%	4.9%	100.0%
	13.0%	15.7%	13.1%
	1837	94	1931
Stake	94.7%	5.3%	100.0%
	9.8%	12.8%	9.9%
	1386	77	1463
Control (no sign)	93.1%	6.9%	100.0%
	10.9%	19.0%	11.2%
	1539	114	1653
Column Totals	95.9%	4.1%	100.0%
	100.0%	100.0%	100.0%
	14172	600	14772

Missing Cases = 0
Chi-Square = 77.5, p = .0000
Cramer's V = .07

[1]C = Complier NC = Noncomplier

Table 2

Barrier Type by Visitor Compliance
Mount Rainier Barrier Study

Barrier Type	Compliance Status[1] C	NC	Row Totals
Rope (Row)	97.9%	2.1%	100%
(Column)	22.3%	8.0%	21.5%
(Count)	759	16	775
Split Rail	95.1%	4.9%	100.0%
	49.5%	43.7%	49.1%
	1682	87	1769
Control	90.9%	9.1%	100.0%
	28.2%	48.2%	29.3%
	960	96	1056
Column Totals	94.5%	5.5%	100.0%
	100.0%	100.0%	100.0%
	3401	199	3600

Missing Cases = 0
Chi-Square = 44.7, p = .0000
Cramer's V = .11

[1]C = Complier NC = Noncomplier

ign and Barrier Research at Mount Rainier, Cont'd

h as the sanction sign. A cluster of signs of nearly equal effect, luding the preservation appeal, humorous, and hybrid signs, ow the sanction sign. All remaining signs were either signifi-tly less effective (symbolic and old standard signs) or essen-ly ineffective (stake).

We did not assess the effect of the sanction sign on the visitor erience. Thus, this sign should be used with caution and only en adverse environmental impacts dictate stringent measures. ier less intrusive signs may suffice to reduce visitor impacts many circumstances.

There does not appear to be a novelty effect related to the amiliar, experimental signs; they worked equally well as a errent to off-trail hiking in multiple or single exposures. wever, there was some indication of a novelty effect specific he hybrid sign.

The effect of the presence of a uniformed employee suggests t off-trail hikers are not ignorant of agency expectations arding appropriate behavior. Evidently, a uniformed park loyee in the immediate vicinity of a sensitive area will atly reduce noncompliant behavior. Without further research, do not understand the psychological basis for the effective-s of the uniformed employee. It appears, however, to be one he most effective deterrents.

The use of both barrier types improved visitor cooperation. n the least effective barrier (split rail) proved advantageous, 46% less noncompliance was observed in its presence in parison to the control (no barrier). At a third site (data not sented), the rope barrier also reduced off-trail hiking at a ular snow play area, but noncompliance remained very high. hough not directly compared to the signs in this study, rope riers may not be more effective than threatened sanction signs leterring off-trail hiking.

Table 3

Uniform Presence by Visitor Compliance
Mount Rainier Barrier Study

eatment	Compliance Status[1] C	NC	Row Totals
iform Present			
(Row)	99.4%	0.6%	100.0%
(Column)	33.0%	10.8%	32.6%
(Count)	2522	16	2538
iform Absent	97.5%	2.5%	100.0%
	66.1%	88.6%	67.4%
	5123	132	5255
lumn Totals	98.1%	1.9%	100.0%
	100.0%	100.0%	100.0%
	7645	148	7899
ssing Cases = 32			
i-Square = 32.2	p = .0000		
mer's V = .065			

= Complier NC = Noncomplier

Vandalism and littering literature consistently suggests that "vandalism [littering] begets more vandalism [littering]." A similar pattern of behavior was also observed in relation to off-trail hiking. Furthermore, when noncompliance occurred within a party, it often involved a large proportion of the group, indicating a likely peer effect relating to noncompliant behavior.

Both youths and foreign visitors disproportionately engaged in off-trail hiking. Perhaps specific communications could be directed toward these visitor subpopulations. However, the primary visitor management strategies must concentrate on the majority of the off-trail hikers--white adults.

CONCLUSIONS

The Mount Rainier study tested the effectiveness of selected social control techniques designed to deter off-trail hiking. Such behavior can cause immense damage, both environmentally and aesthetically, and this problem has been noted in most outdoor recreation areas. Furthermore, the park efforts at rehabilitation of the resources (e.g., high standard trails and meadow restoration) can only be effective if the continuing problem of human impact is also contained.

The park has attempted to influence visitor behavior with naturalist programs and passive communications which emphasize the importance of low impact use of the area and appreciation of nature. An implicit assumption of this strategy is that noncompliant visitor behavior (e.g., off-trail hiking) is caused by a lack of knowledge about, or appreciation for, proper use of the resource. The objective of this communication approach is to motivate behavior by creating a pro-social psychological state in which recreationists view behavior desired by park managers as satisfying personally desired goals.

Exposure to a message does not ensure that it will be accepted or understood by all people, and many other visitors may never see or hear the messages. Some proportion of park visitors will always be unaffected by even the best communication strategies. In these circumstances, the last chance to influence undesirable behavior of day hikers on a park trail occurs with their exposure to behavioral cues located at or near areas where such behavior occurs.

Barriers and signs represent an opportunity to affect the behavior of those visitors who were not influenced by or exposed to other park communication efforts. Similarly, the presence of a uniformed employee may also create a salient reminder of appropriate behavior.

The study established that onsite behavioral cues do influence behavior. To accomplish their purpose, onsite cues must provide motivational incentives that are understood and effective among diverse populations. The observed variable effects of signs, barriers, and the presence of uniformed employees on noncompliant visitor behavior suggest that decisions on the use of on site cues must include more consideration of the type of intervention and the impact of such visitor controls on the behavior and recreation experience of the visitors. The studies represent an important first step in the necessary behavioral research to assist resource managers in controlling undesirable visitor behavior.

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Western Park Personnel Meet on Mountain Lion-Human Encounters

By Bruce Moorhead and Terry Hofstra

Close-encounters and attacks on humans by mountain lions (*felis concolor*) have increased in the past 20 years in western North America and in a number of parks. In April, a lone female runner was killed by a lion in the Sierra Nevada foothills east of Sacramento; this was the second runner fatality in three years (a Colorado runner was killed in 1991) and the fifth lion attack in California since 1985. In Olympic NP, 33 lion-human encounters (i.e., sudden unexpected meetings at close range) and five near-attacks have been reported since 1991 with at least 12 occurring in 1994. Several other western national parks (Sequoia, Redwood, Big Bend, and Yosemite NPs) report similar patterns with two attacks occurring in Glacier NP in the past five years. This trend presents a visitor safety problem, has legal ramifications, and requires timely preparation by park resource managers.

On July 12-13, we participated in a workshop at the University of California, Davis (UCD) on managing lion-human conflicts in western parks. The workshop was sponsored jointly by Redwood NP and the CPSU/UCD. About 30 persons participated, including lion and legal experts, houndsmen, rangers, biologists, administrators, and interpretive specialists from various national parks (Glacier, Olympic, Sequoia and Kings Canyon, Yosemite, Lassen Volcanic NPs, Redwood National and State Parks), Whiskeytown and Golden Gate NRAs, the Western Regional Office, and the California Park Service.

Dr. Howard Quigley of the Hornocker Wildlife Research Institute summarized lion ecology and behavior based on long term research in Idaho, Yellowstone and Glacier NPs, and New Mexico. In unhunted populations, adult lions (>two years old) occur in rather stable social territories that tend to limit population density, with one male territory typically overlapping several (three to five) female territories. Relations between lions in territories (outside of breeding) vary from tolerance to serious fighting and frequent deaths. Female territories are more responsive to prey changes locally. Young animals dispersing from natal territories can move 300 miles in search of home ranges; lingering in an adult territory can amount to a death sentence. These transient animals often interact with humans. Research is still needed, however, on the habituation of lions to people and encounter/attack rates as the human population increases and people move closer to lions.

Dr. Paul Beier, University of Northern Arizona, summarized and expanded on his published research on lion attacks (Beier. 1991. Cougar attacks on humans in the U.S. and Canada. *Wildl. Soc. Bull.* 19:403-412). Overall, the risk of a lion attack is very small although it is increasing and is causing concern in some areas. In the 100 years from 1890-1989, about 50 humans were injured, while 10 people were killed due to lion attacks. The majority of victims (66%) were unsupervised children or lone adults; 60% of the attacks occurred in British Columbia. In the 20 years from 1970-90 (since the end of bounty hunting), the risk of an attack increased five times (from 0.4 human deaths/100 yrs to 2.5/100 yrs).

Avoiding Attack

While children are most vulnerable to attack, risk is much lower when accompanied by an adult. Similarly, people traveling in groups are more difficult targets for lions. At close range, lions may interpret deference in people as increased (prey) vulnerability. Therefore, when encountering a lion, people should stand their ground, not run, be assertive, keep their eyes on the animal, not play dead, and fight back, if necessary.

Bill Clark of California Wildlife Investigations Lab discussed the protocol for investigating incidents, such as the April 1994 fatality where a lone female runner was killed and partially consumed in a state park east of Sacramento. Assume that you'll be sued, and act immediately to protect the scene of an injury or fatality and to permit identification of the lion involved (by tracks, etc.). For forensic work, time is also critical since tissue and other evidence either decomposes rapidly at a scene or is digested by the animal. In the April fatality, human autopsy data, lion tracks, and reference skulls were used to develop a profile of the lion being sought based on its cranial characteristics inferred from bite wounds and other clues. Chase dogs captured the right lion soon thereafter, underscoring the value of tracker availability. The cat's identity was confirmed by DNA analysis of human tissue residues found at the base of its claws. The animal was a lactating female with cubs.

The field solicitor of the Department of the Interior and the deputy attorney general for California addressed park liability issues. While liability is evaluated case by case, it depends largely on whether or not a park is aware of a safety threat (not reasonably to be expected by the average visitor) and whether or not due warning is given. Everyone entering a park where lions are being observed or frequently encountered should be informed of the natural presence of and potential hazard posed by lions (e.g., by entry brochure and posted signs). Reports of lion sighting and interactions with people should be taken seriously, documented, and investigated. More specific warnings should be posted (and areas closed temporarily if warranted) where multiple lion observations and encounters occur. Warning should be neither too soft nor unduly alarming, but must communicate the presence of lions in an area, the potential hazards, how to reduce the likelihood of encounter, and what to do if you meet an animal.

On the second day of the workshop, the group developed uniform mountain lion management guidelines for federal and state parks. Terry Hofstra of Redwood NP is editing the guidelines to include sections on policy and purpose, management alternatives and tactics, documentation and data management, and education and communication.

Some of the management recommendations include encouraging parks with increasing lion-human interactions to (1) complete local response plans; (2) standardize lion sighting/incident report forms and management response procedures-lion behaviors (movements, postures, characteristics of eyes, ears, mouth, tail, etc.) observed during encounters (as summarized by Dr. Lee Fitzhugh/UCD) can aid personnel in placing a particular behavior on an ascending scale of attack risks; (3)control/minimize lion attractants, such as pets, raccoons, carrion, and improperly

Photos by Jan Brill

mpic NP visitor and photographer Jan Brill and a partner ountered a mountain lion suddenly when hiking the popular rdwalk trail between Ozette and Sand Point. What began as itement for the wildlife viewing opportunity turned to concern as lion neared the hikers.

Noting the lion's ear position, Brill decided to wave his arms (see sidebar). The lion sauntered off into the brush ending a typical and potentially hazardous lion-human encounter.

red human food and garbage in oldings and recreation facilities; (4) ognize that a close encounter is poten-ly very dangerous and complex--a n's behavior can rapidly escalate or ft back and forth between secretive, ious, defensive, or offensive depend-in good part upon what people do; (5) ise the public to become assertive and nter-aggressive when a lion behaves gressively or is reluctant to leave an a; (6) promptly haze lions away from se public use areas; (7) realize that nslocation of problem mountain lions complicated by considerations of park e and neighboring land use, and may se fatal territorial competition between ns; (8) develop interagency arrange-nts to ensure that qualified personnel available to capture and remove prob-lem animals as needed; and (9) train rang-ers and interpreters to educate visitors about the hazards of mountain lions and appropriate human responses during an encounter. The group also identified as priority needs establishment of a lion tech-nical coordinating group, to improve com-munication among parks and lion experts, and creation of a central database.

In conclusion, mountain lion-human interactions are increasing in a number of western national and state parks. Reports of lions should be documented, acted on, and taken as seriously as grizzly or black bear reports. Managing these incidents is more complicated than for black bears, however, due to the predatory behavior potential in lions. Serious incidents often develop through a rather unpredictable pattern of "cold" to "warm" reports from visitors which can either foretell some-thing "hot" soon to follow, or nothing at all. Adequate public warning in parks is the first priority, followed by prompt ef-forts to remove or control pets or other food attractants. This trend indicates a timely need for improving management planning, bettering lion behavior and ha-bituation information, and upgrading edu-cation in parks.

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Changing Diversity of Mollusks in Zion Canyon

Is This Fauna Recovering From a Prehistoric Flood?

By Wayne L. Hamilton

Sometimes valuable ecosystem data are just waiting to be found in some file folder in an out-of-the-way cabinet. Deciding what deserves closer scrutiny requires "pure" thoughts, because the significance of small components is often overshadowed by the "popular" fauna of the day. When I saw the file containing data on snails in the library at Zion in 1974, I didn't immediately know that I was interested, or that mollusks could help me interpret ancient sediments of ponds and lakes preserved in the canyons of the park. Not long after, I remembered a course I'd taken and recalled that the different species of mollusks have different habitat preferences. I quickly decided to become better acquainted with these tiny creatures and see how their shells could be used as fossil indicators of past environments in the canyons of the park. Later, it came as no surprise that their living descendants could also tell a story about very recent changes in Zion Canyon.

"The Snails of Zion National Park" is an undated manuscript by Angus Woodbury, a park naturalist at Zion, probably written as a draft of his report later published in *The Nautilus* (Woodbury 1929). This report represents the earliest molluskan inventory of which I am aware, for Zion Canyon. He listed 15 species collected in Zion Canyon, discussed numbers, and described collecting localities (8) and habitats. That study collection is kept in the park museum.

Following closely on Woodbury's inventory, Chamberlin and Jones (1929) collected in the canyon and confirmed all but one of the earlier finds and added a new terrestrial species. Shortly thereafter, Chamberlin and Berry (1930) added another terrestrial snail. The collections of the 1920s constitute, in my opinion, a relatively complete inventory.

In 1935, Wendell O. Gregg collected and identified mollusks at all of Woodbury's locations, plus three others, in Zion Canyon, adding five new species to the earlier list (Gregg 1940). By collecting in May, June, and July, he was assured that most species were active. Gregg's work was the basis for the handout given to visitors in the 1970s. His list qualifies as an inventory.

The next data were provided in a letter from C. L. Richardson (1965) who collected in the park in late May 1965, concentrating on aquatics. Richardson mentioned only three collecting localities.

My collection dates from 1974 to 1977, and it includes both species presently living in the canyon (at most of the locations surveyed earlier) and fossils collected from 4,000-year-old sediments of a slide-dammed lake there (Hamilton 1979, 1992 and forthcoming). My first tutor in identifying mollusks was Alice Lindahl (then at Utah State University), discoverer of an unnamed, probably *Amnicola* sp., at Grapevine Spring. These first identifications were checked, and in several cases corrected, by Jerry Landye (Flagstaff). Thereafter, I worked on my own, but the identifications listed here were further checked (and corrected) by R. Hanley (University of Michigan). All specimens have been deposited in the park museum.

In this update I present in graphical form (fig. 1--page 23) these earlier lists, indicating nomenclature changes conforming to Burch (1962 and 1989), with more emphasis on aquatic species collected in Zion Canyon. Table 1 shows all species and the localities of aquatics. Underlining indicates that a species was collected by the investigator. Very few of these mollusks have common names.

Figure 1 illustrates the changing number of aquatic mollusk species (including one seed clam) and terrestrial snails found in Zion Canyon over time. Aquatic species require pond, stream, or spring habitat while terrestrials live on moist surfaces near flowing water, under logs and in leaf litter, depending partly on precipitation for moisture. The total number of aquatic species appears to have increased since the time of the earliest inventory. The number of terrestrial species observed has declined slightly. Are these changes in diversity, or simply a result of observational bias?

One probable new arrival is *Physella virgata*. Woodbury (1930) identified it at a locality west of the park in 1926, yet he did not report this species in Zion Canyon. Similarly, Chamberlin and Jones (1929) and Gregg (1940) failed to report any Physid other than *Physa zionis* (discovered by Pilsbry in 1925) in the canyon. The first record of another Physid was from Richardson (1965), who reported *Physa ancillaria* Say ". . . in the stream near Weeping Rock, at the Amphitheater and in springs along the Narrows Trail." In the mid-1970s, I identified the Physid common at this and other locations where clear, spring-fed tributaries descend to the valley floor, as *Physella virgata* Gould. Bequaert and Miller (1973) do not list *P. ancillaria*, and I believe that Richardson may have actually seen *P. virgata*, which resembles and which is now common at exactly those locations. I suggest that earlier collectors would simply not have missed seeing *P. virgata* if it had been as abundant then as it was in the 1970s. It probably moved into the canyon between 1935 and 1965.

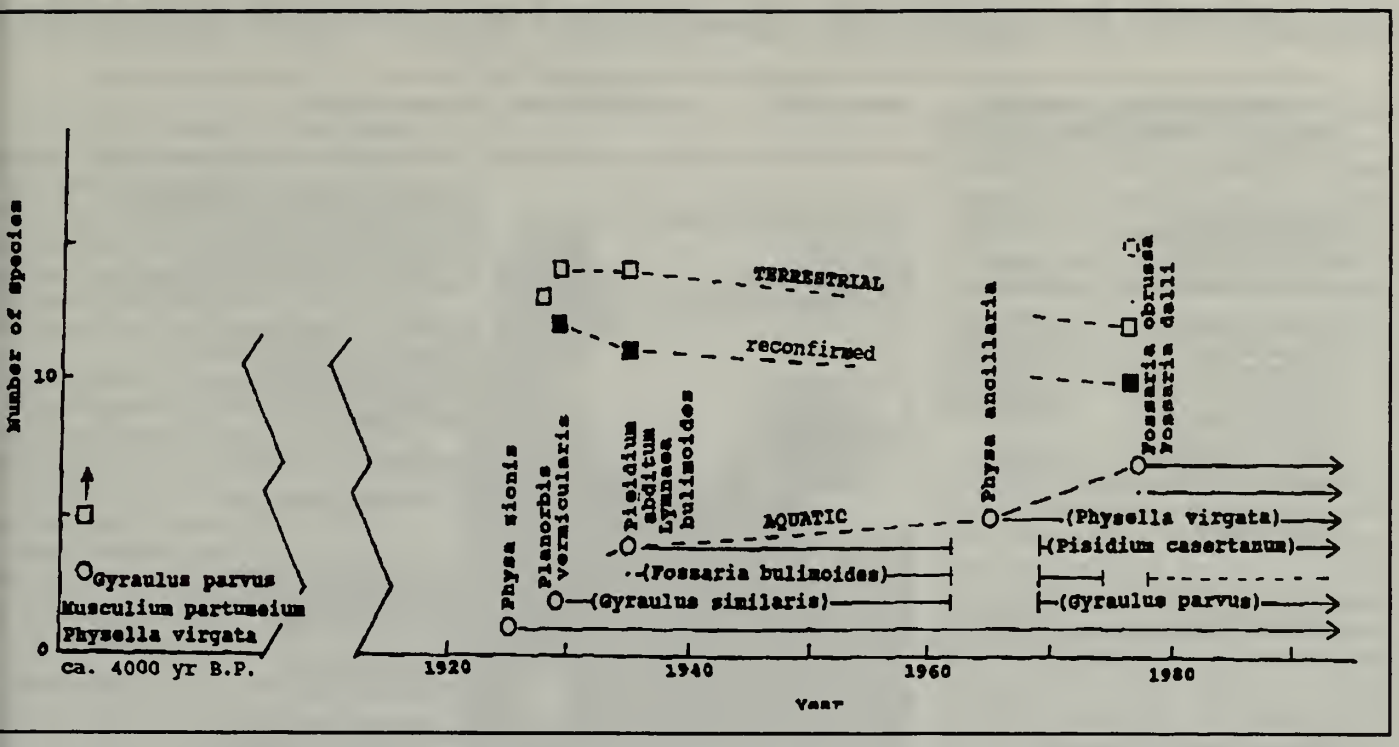
P. virgata was found as a fossil in 4,000-year-old shoreline sediments of Sentinel Lake in Zion Canyon (Hamilton 1979). If suitable habitat existed then why was this snail later extirpated?

Gregg (1940) reported *Lymnaea bulimoides* in a stream at Saddle Nook in 1935, but when Woodbury visited that stream before 1929 he failed to find it. This too suggests immigration. I did not attempt to verify this *Fossaria* colony.

Fossaria obrussa Say (Golden Fossaria) was identified west of the park as *Lymnaea obrussa* by Woodbury (1929), but it was not known in Zion Canyon until I found numerous shells in a spoil bank along a drainage ditch at Temple of Sinawava. This suggests either that the species occupied that site in the recent past and has been extirpated, or that it is a recent immigrant. If living specimens were to be found, this question would be resolved.

The *Fossaria dalli* in Table 1 (see page 24) was collected along with other Lymnaeids and identified long after being collected, therefore its locality is given as Temple of Sinawava (?), the query indicating uncertain locality.

The number of terrestrial snail species has remained relatively constant over time or decreased slightly (fig. 1). Yet, because of their small size, obscure habitat, much greater diversity, and wider distribution in relation to aquatics, it is difficult to exclude observational factors as the cause of apparent changes in species diversity. Terrestrials are capable of surviving dry periods, but prolonged drought can have



gure 1. Number of terrestrial and aquatic mollusk species in Zion Canyon versus time. Species name changes are noted in parentheses. wer half of diagram shows aquatic species. with totals represented by open circles. Terrestrial species are shown by squares. Solid squares resent number of species reconfirmed from earliest survey. Hollow squares show totals including new discoveries. Open, dashed square ludes species in earlier surveys represented only by fossils in the 1970s.

ious consequences when springs stop wing. The trend is interesting enough warrant further investigation.

In the case of the apparent influx of *ysella virgata* and the possible recent migration of *Fossaria obrussa* and *F. limoides,* what agencies might be con-ered? The Zion localities are all con-cted to the North Fork of the Virgin ver, in which brown trout (and other h) are common. Introduction of eggs or enile forms by fish seems a reasonable planation for the arrival of new species. ater birds have also been suggested as ector for snail introduction at isolated nds at Badlands (Beetle-Pillmore 1994).

And what may have removed *P. virgata* d extirpated other species that are now ablished in the canyon? Most of the bitat lies within the 100-year floodplain the North Fork of the Virgin River. reover, most spring-fed tributaries are uated at the base of hanging canyons cut the Navajo Sandstone, having sizeable tersheds (Hamilton 1992). This puts h habitat in range of torrential flooding en waterfalls scour drainages that are ually placid. We may be seeing a recov-, supported by natural dispersal, from h a disturbance early in the century. haps such episodes are a normal part of dynamic canyon ecosystem.

Physella zionis, an endemic species, is ter adapted to survive floods in Zion nyon because its habitat is on near-vertical surfaces where springs issue from the Navajo Sandstone above the canyon floor. Seed clams might similarly survive if the sediments where they burrow were not excised or deeply buried by flooding. A small population of *Gyraulus parvus* persisted in the 1970s only at a spring-fed bog well above the floodplain at Birch Creek. This may have been the only surviving population from ancient Sentinel Lake. The bog (once a pond) at Birch Creek is vulnerable to drying because it has been tapped as a water supply source.

These small invertebrates are an important constituent of the canyon ecosystem. They are a valuable food source for birds and other small vertebrates and insects. In contrast, and in spite of their seeming insignificance, they also play a role in limiting other inhabitants of the canyon. When accidently ingested with forage, *Z. arboreus* can infect sheep with lungworm. *C. lubrica* similarly acts as a vector for the lancet liver fluke that infects deer and wild sheep (Burch 1962). Some aquatic species carry schistosomes that are transmitted to humans who wade in infested waters.

Further inventory is recommended as a means of testing the hypothesis of immigration of aquatic snails proposed here. Habitat is also subject to encroachment by exotic competitors, and a lookout should be maintained for them. In the late 1980s, the exotic species *Helix aspersa* was poised for immigration in irrigation ditches near the park boundary at Rockville.

Some terrestrial snail habitat is vulnerable to acid precipitation, which can hypothetically reduce soil alkalinity to the point where the organism can no longer maintain its protective calcium carbonate shell. More generally, the niches occupied by mollusks are subject to loss through drought, flood, and fire. The mollusks discussed here depend on a variety of habitats, and their presence or absence implies something of the health of the ecosystem. Future inventorying may shed light on the significance of the small reduction of terrestrial species over time.

Hamilton worked in Zion NP beginning in 1974 as a ranger and, on contract with the Zion Natural History Association, as a naturalist producing a geologic map, a book on the park's geology, and several other publications. He moved to Yellowstone NP in 1980 where he now works as a geologist with NBS. He is at the Greater Yellowstone Field Station, National Biological Survey, Yellowstone National Park, WY 82190, (307) 344-7381.

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Continued on page 24

Table 1

Woodbury 1, Pilsbry 2, Chamberlin & Jones 3, Chamberlin & Berry 4 (1925-30)		Gregg (1935)	Richardson (1965)	This Work (1974-77)
				Oreohelix cf. subrudis ("Pfeiffer"Reeve?)
Oreohelix cooperi 1,3	[common]	*Oreohelix strigosa depressa*		*Oreohelix strigosa depressa* (Cockerell)
Microphysula ingersolli 2				*Microphysula ingersolli* (Bland) F
Econulus fulvus 1,3	[v. rare]			*Econulus fulvus alaskensis* (Muller) F
Glyphyalina indentata 1,3	[uncom.]	*Retenilla indentata* (Say)		*Glyphyalinia indentata paucilirata* Morelet
		Hawaii minuscula neomexicana		
Zonatoides arborea 1,3	[common]			*Zonatoides arboreus* (Say) F
Vitrina alaskana 1,3	[widespread]			*Vitrina pellucida alaskana* Dall a,g
Agriolimax campestris 1,3	[common]			*Deroceras laeve* (Muller)
Gonyodiscus cronkhitei 1,3	[widespread]			*Discus cronkhitei* (Newcomb) F,d
Succinea avara 1,3	[common]			*Catinella avara* (Say) F,a
Gastrocopta ashmuni 4				
Pupoides marginatus 1,3	[v. rare]			*Pupoides albilabris* (Adams) ?
Pupilla syngenes dextroversa 1,3			*Pupilla blandi*	
				Pupilla muscorum (Linne) f
Pupilla syngenes 1,3				
		Vallonia pulchella [introd?]		
		Vallonia perspectiva		*Vallonia perspectiva* Sterki F
Vallonia gracilicosta 1,3	[rare]	[v. common]		*Vallonia excentrica* (Sterki 1893) f
Cochlicopa lubrica 1,3	[widespread]	[v. common]		*Cionella lubrica* (Muller) f
				Fossaria dalli (Baker) ?
				Fossaria obrussa (Say) d
		Fossaria bulimoides b		
			Physa ancillaria c,d,e	*Physella virgata* (Gould) c,d,e F
Physa (Petrophysa) zionis 2,3,d				*Physella (Petrophysa) zionis* d
Gyraulus vermicularis 1,3,a		*Gyraulus similaris* a		*Gyraulus parvus* (Say) a F
		Pisidium abditum a		*Pisidium (cyclocalyx) casertanum* (Poli) d

a. Birch Creek pond, b. Saddle Nook, c. Amphitheater, d. Temple of Sinawava, e. Weeping Rock stream, f. Oak Creek, g. Lava Pt., F. fossil, ?, location uncertain (see text)

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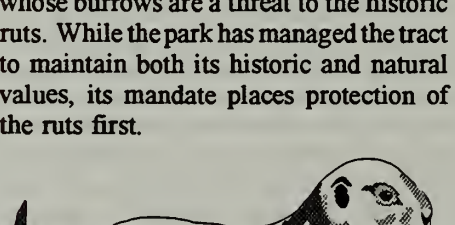
Prairie Dog Control at Fort Larned, Kansas

By Felix Revello, George Elmore, and James David

Fort Larned National Historic Site preserves original Santa Fe Trail ruts as a part of its cultural landscape. This 40-acre detached area where the ruts are located is also home to a colony of prairie dogs whose burrows are a threat to the historic ruts. While the park has managed the tract to maintain both its historic and natural values, its mandate places protection of the ruts first.



Despite control measures in the past that included both poisoning and shooting, the prairie dogs continually reestablish themselves in the historic ruts. In April 1992 (after viewing a news story on a clever new method of control), and again this past May, the park used the innovative, but more expensive, treatment. The method involves using a modified sewer vacuum truck to suck the animals out of their burrows.

The contractor begins by first filling in most of the burrow openings with soil in order to identify the holes in use by the "dogs." Holes also used by the burrowing owl are left open and are not vacuumed so as to minimize disturbance of the symbiotic birds. The following day the vacuum truck circulates to the burrows that had been reopened during the night by the prairie dogs. The contractor inserts a large hose into each burrow to suction up everything close to the surface, including any prairie dogs. The truck is modified to protect the animals as they pass from the

abrador Retriever Assists in Ecological Research

By Allan F. O'Connell, Jr.

As part of an ongoing research project, eway NRA biologist Bob Cook re- tly purchased a labrador retriever to in collecting box turtles. Known as s, the retriever locates and retrieves ntroduced box turtles *(Terrapene olina)* in an attempt to determine their vements and survival rates.

Long Island, NY, was once a strong- d for the box turtle, but the population declined due to habitat loss and urban elopment. As part of a larger effort to ntroduce and maintain viable popula- s of locally native reptiles and am- bians, Gateway staff have experimen- y reintroduced over 300 box turtles Floyd Bennet Field, a grassland sec- of the park.

Staff outfitted turtles with radio trans- ters to determine home range and move- nts, but soon encountered problems cating the animals due to limited trans- ter range, dense vegetation, and the ll size of the turtles. For help, Bob k contacted a colleague in Maine who s and trains retrievers for field trials and who, in turn, contacted Dave Mosher of Sugarfoot Kennel, a professional retriever trainer. Cook purchased Gus from Mosher who owned a litter of puppies sired by a former national amateur field champion retriever. Cook then shipped to Maine turtle shells, as well as a live specimen, and training began. (Gus is trained as a "non-slip" retriever, a term used to indicate that the dog retrieves only on command).

Trainer Dave Mosher of Sugarfoot Kennel, Burnham, Maine with Gus who is holding a box turtle shell.

Gus has now completed two summers collecting turtles and has located and retrieved individuals with and without radios. Although Gus will never compete in field trials and does not hunt waterfowl, he has contributed his share to natural resource management and conservation; he has helped staff to understand better the ecology of this fragile population by increasing sample size. The moral of this story: a dog is truly a man's best friend!

Allan O'Connell is a research wildlife biologist with the NBS and leader of the NPS CPSU at the University of Maine in Orono; he also runs retrievers in nationally sanctioned field trials.

airie Dog Control *(Continued)*

ge-diameter hose into the hopper where dded deflection screen catches them.

n 1992, the weather was not helpful. d temperatures and high winds drove prairie dogs deep into their burrows, ucing the effectiveness of the experi- nt. That year, only five prairie dogs appearing healthy) were captured. In 4, 40 animals were trapped (three died). ource managers compared pre- and t-treatment counts of prairie dog rela- abundance and concluded that the rt had mixed results.

The treatment area had been divided eastern and western plots of which the tern section yielded better results. This because most of the burrows there had or more entrances and unclogged sageways, whereas the eastern plot made up of burrows with either single nings or constricted subterranean pas- es. The contractor explained that vacu- ng is ineffective on burrows with only opening or blockages as only a static uum is created; this effect is similar to gging the hose on your household uum. Each burrow must have at least two entrances and clear passageways to obtain the air exchange necessary to generate the high speed air flow required to pull prairie dogs out of their burrows.

Before starting this project, we had no idea how many prairie dogs could be removed using this vacuuming technique. In the hopes of finding someone to adopt the animals, we had contacted numerous organizations before beginning the project. Fortunately, the Kansas Department of Natural Resources was able to take all the dogs provided and translocated them to Cheyenne Bottoms Wildlife Area.

This method of capture lacks the dangers associated with poisoning and is less objectionable than either poisoning or hunting. Public support and interest even ran high as judged from the newspaper and television coverage of the initial event. However, our take included other nontarget species (in 1994) including one burrowing owl (the first ever for this contractor), salamanders, mice, and numerous beetles (all released unharmed). One unexpected offshoot from this project was interest from the NBS (Dr. Jerry Godbey of the Mid-continent Ecological Center in Fort Collins, 303/226-9460) who would like to survey invertebrates taken from prairie dog holes during the vacuuming process. Godbey feels that this technique may produce new species discoveries.

Following two experiments with this method, we conclude that this procedure is presently expensive, averaging $30-$40 per prairie dog, and is only moderately effective (the contractor has had much better results with other clients, however). It can be justified only for very small prairie dog towns or limited removals in high visibility locations. Then, it will be most effective if used on burrows free of blockages. The technique might also be useful where other control methods might be injurious to threatened and endangered species.

Revello is Chief Ranger at Fort Larned; Elmore is Resource Management Specialist, 316/285-6911; David now is at Horseshoe Bend National Military Park, Alabama, 205/234-7111.

Captive Cougars May Aid Florida Panther Project

By Craig S. Johnson and Joseph D. Clark

The Florida panther (*Felis concolor coryi*) is one of the rarest mammals in the world. Less than 50 animals inhabit 1.5 million ha of land in south Florida, the bulk of which includes the Big Cypress National Preserve (Maehr 1990). More than 45,000 ha of additional land will soon become part of the preserve and most of the Florida panthers at Big Cypress live on those additional lands. An environmental assessment for recreation access to the addition lands calls for monitoring and studies of the Florida panther, its prey, and human visitors. Most public use of the area is associated with hunting for deer (*Odocoileous virginianus*) and hog (*Sus scrofa*) since 1980. Although direct panther mortality as a result of those hunts has not been documented, potential impacts to panthers could result from excessive disturbance by hunters and activities associated with hunting, such as off-road vehicle use. Therefore, we initiated a study in 1993 to test the hypothesis that panther habitat preferences, activity patterns, energy expenditure, and prey are impacted by public use.

A number of panthers are currently being radiotracked by the Florida Game and Fresh Water Fish Commission to monitor the status of the cats (e.g., mortality, home range, reproductive status), but the schedule and timing is not adequate to address the objectives of our research. Those efforts probably are not of sufficient scale or intensity to detect more than gross shifts in home range. However, more subtle changes in panther behavior may occur due to human disturbance and could have a significant impact on their fitness. We wanted to be able to detect these less dramatic, yet potentially important changes in panther behavior, if they were actually occurring, and we wanted to look into some new techniques for doing so.

We began concentrating on how we might obtain more detailed information using the telemetry collars currently worn by the panthers. Equipped with mercury tip-switches, the collars being worn by the panthers indicate whether the head is up or down by transmitting either a fast or slow pulse rate. However, no one has determined whether the tip-switches are accurate in characterizing cougar activity, although analyses have been conducted for other species such as Dall sheep (*Ovis dalli*) (Hansen et al. 1992), elk (*Cervus elaphus*) (Green and Bear 1990), black-tailed deer (*O. h. columbianus*) (Gillingham and Bunnell 1985), and white-tailed deer (Beier and McCullough 1988).

We learned of a local Knoxville man with a number of captive cougars and facilities to enable them to move about in a seminatural environment. We contacted him and were able to obtain permission to fit the cats with collars identical to those at BICY to evaluate the tip-switches for characterizing activity.

To conduct the experiment, we fitted a radiocollar on one of two captive western cougars (named Marcos and Moses) and simultaneously recorded activity and the radio pulse rate. We had planned to use both cougars equally, but, on the first day, Marcos (being fully equipped with claws and teeth) politely informed us that he did not like to be collared. Therefore, in order to keep him happy (and Craig in possession of all his body parts), we decided to use only Moses in our study. Moses and Craig got along great and it did not take long for the cougar to associate the appearance of Craig and the radiocollar with "play time."

The collar was placed on Moses so that, when his head was up, the collar emitted a signal with a fast pulse rate, and when his head was down, the collar emitted a slow signal. Movements by the cougar were categorized as walking, standing, running, sitting, or lying.

On the first day, we noticed that certain movements caused a specific pulse to be generated most of the time. For example, walking caused a slow pulse signal, while standing, sitting, and lying generally created a fast signal. We recorded the pulse signal and direct observations on microcassette tape and later entered the data into a computer spreadsheet.

Preliminary analysis of the activity data is encouraging. We combined all observations (9+ hours) and broke them into 5-minute intervals. Activities with similar energy costs were classed into two groups: active (walking, standing, running) and inactive (sitting and lying). We included standing in the active category, because time spent standing was usually an intermediate behavior between walking bouts. The animal spent minimal time running. Based on the percentage of time that the collar pulse indicated a head up position, we found that we could correctly classify the cougar as active (>60% walking, standing, or running in a 5-minute time interval) 69% of the time (24 out of 35 instances). Likewise, we could classify in activity (>60% lying or sitting) 79% of th time (41 of 52). Based on these result and after further refinements from addi tional forthcoming captive cougar data we can classify gross activity level of th Florida panthers with a good chance o being correct.

With this model, we are now makin arrangements to collect similar data o the wild panthers at Big Cypress to asses human disturbance. We have obtained number of portable, telescoping radio tow ers and a chart recorder to monitor th cats. With that equipment, we should b able to obtain continuous data on activit for selected panthers, and the data will b compatible with the above model for analy sis. In so doing, we can obtain activit data (day and night) without actually hav ing to know the exact location of th panthers. We can also compare data fro areas that are being hunted (treatmen with areas that are not (control). Then, w can develop a statistic to apply to ou study objective using the mercury tip switch technology. There may even b many ways to extrapolate this statisti into a crude measure of energy expendi ture (Gessaman 1973, Ackerman 1982 Corts and Lindzey 1984), a question w will investigate as our research progresses

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d-Atlantic

Assisted by the NPS Mining and Min-ls Branch, the U.S. Bureau of Mines OM), and regional Chief Scientist John rish, Friendship Hill NHS is identify-; and developing mitigation projects for treatment of acid drainage from mines hin the park. Although the interagency reement between the two agencies has led, BOM has continued to investigate chemical and biological processes in wetlands constructed at Friendship l for the purpose of acid mine drainage atment.

BOM recently developed and evalu-d a method for comparing the abilities different organic additives (brewer's st, molasses, polylactic acid, and dairy ey) to stimulate sulfate reduction when led to wetland sediments. Bacterial fate reduction not only removes metals l sulfate from acid mine drainage, but o adds alkalinity. They tested both fer-nted and unfermented organic addi-es in the experiment.

Using an underground pipe system hin the Friendship Hill wetlands, BOM mped whey into the compost of one land lane and within two weeks, most he whey had passed through the lane. ff sampled the wetland water each week four months monitoring changes in er quality. They found slightly lower fate concentrations in the treated lane owing the whey addition and indicat-that the single whey dose may have htly affected bacterial activity. Future eriments will be based on a continual l system.

* * *

Two visitors to Shenandoah NP re-ted seeing peregrine falcons on Stony n Mountain in late July. Park staff estigated and discovered an eyrie with ale and female chick in excellent con-on. USFWS staff banded the chicks secured the area from human distur-ce. The chicks fledged in mid-August.

* * *

Shenandoah's Fish In Sensitive Habi-(FISH), a three year research project, erwent its second year peer review in gust. FISH will enable modeling of the cts of stream acidification on fish in-duals and populations.

* * *

Recently signed by the regional direc-Colonial NHP's Water Resources Management Plan will soon be ready for distribution. It contains an electrostatically-plotted map portfolio produced by the park's GIS (with the assistance of the North Carolina State University FTSC). Colonial is also continuing a fisheries inventory of park waters under an agreement with the USFWS Fisheries Assistance Office in White Marsh, Virginia.

North Atlantic

The Natural Resource Protection Program (NRPP)-funded study of storm breach threats to northern U.S. national seashores has begun. Jim Allen (former NPS coastal geomorphologist and now with NBS) is leading a group of investigators from the University of Rhode Island, SUNY/Stony Brook, and Rutgers who are studying the physical impacts of storm breaching on barrier islands dynamics and multiple inlet estuarine circulation at Fire Island NS, Cape Cod NS, and Sandy Hook/Gateway NRA.

The methodology uses numerical modeling calibrated by intensive field surveys which employ the latest technological developments (electronic total stations, kinematic GPS, remote pressure-temperature-salinity data loggers, etc.). The research will quantify the expected physical changes to barrier-estuarine systems in order to provide a basis for ecosystem impact assessments and breach management planning in this highly developed coastal environment.

* * *

Janice Minushkin of the regional office visited six national natural landmarks (NNLs) this year in preparation of the annual section 8 report. She focused on threatened and endangered NNLs and reports that one site, Acushnet Cedar Swamp in New Bedford, Massachusetts, included in last year's report, will be removed this year because threats to the site have been mitigated by the state park that manages the property.

Southeast

Blue Ridge Parkway and North Carolina Wildlife Resources Commission conducted a stream restoration project on Little Glade Creek on the parkway in Allegheny County, North Carolina during 1993 and early 1994. They improved water quality and trout habitat by excluding livestock from the riparian zone through installation of a fence. The project also aimed to increase vegetative cover and restore eroded stream banks.

Stream bank restoration consisted of installing an erosion-resistant foundation of root wads, rip-rap, or logs at the base of eroded stream banks at water level. Banks were sloped to this foundation at a 2:1 to 3:1 grade, smoothed, seeded, fertilized, and mulched. Crews repaired 23 sites totalling 292 m (950 ft.) and established 2 gravel livestock crossings. Project leader Bob Cherry estimated that more than 450 work-hours and $17,000, including materials and salaries, were expended on this project.

* * *

Twelve Blue Ridge Parkway employees spent four days in the hot sun in June planting more than 800 Heller's blazing stars *(Liatris helleri)* along the Grandfather Mountain Corridor. Heller's blazing star is a federally listed plant that occurs on the Parkway and in only six other locations in the world. The plants were reared in a greenhouse at the University of Georgia at Athens from seeds collected on the Parkway. They were moved to the North Carolina Arboretum in Asheville, North Carolina where the plants were maintained by horticulturalists and greenhouse personnel. Staff will watch this endangered plant population closely for several years to determine the effectiveness of the restoration effort. If successful, the population will have been augmented from around 150 naturally growing plants to more than 1,000.

* * *

Four parks in the southeast have begun long-term monitoring projects of amphibians. Blue Ridge Parkway, Cumberland Gap NHP, and Great Smoky Mountains and Mammoth Cave NPs have conducted field surveys and selected study sites for pond, stream, and terrestrial-breeding frogs and salamanders. The parks will focus on two species of temporary pond breeders (wood frogs and spotted salamanders) and six species of stream breeders. The plan is to collect temporary pond habitat data on water PH, conductivity, temperature, pond depth, total number of egg masses laid, and developmental stages of eggs and their survival in egg masses. Sampling stream and terrestrial breeding salamanders in 30 x 40m subplots, the researchers also hope to learn reproductive status (larva, juvenile, adult), body length, and distance of animals from streams.

* * *

Soil erosion is a major concern at Virgin Islands NP and is being studied by Dr. Lee MacDonald of Colorado State University. Soil erosion damages the coral reefs and other marine ecosystems, major features of the park, by increasing turbidity and redepositing the fine sediment. Along with his master's student Don Anderson, MacDonald is working to understand the erosion sources and sediment delivery mechanisms caused by development on the island of St. John in order to minimize the impacts on the marine resources.

The two researchers originally hypothesized that the majority of steep hillsides erosion is caused by overland flow and shallow landslides triggered by large tropical storms such as Hurricane Hugo. A site visit together with Dr. Bill Dietrich from the University of California at Berkeley revealed that neither overland flow nor landslides presently contribute much sediment to the process. While historic agriculture may have substantially increased erosion rates in the 18th and 19th centuries, vegetation regrowth early this century (following a population decline) may have reduced it to only slightly higher than presettlement conditions. Instead, they found soil erosion from unpaved roads to be the overwhelming cause of the problem. The researchers developed a GIS-based road erosion model to help predict the amount of sediment being generated and delivered for each catchment on St. John.

Dr. MacDonald hopes to follow this initial study with more intensive work on road erosion processes and the relative amounts of sediment generated from unpaved road surfaces, cut banks, roadside ditches, sidecast material, and culvert incision. This work should provide more detailed guidance for planning and mitigation purposes on St. John and other areas. A detailed article on the results of this initial study is planned for a future issue of *Park Science.*

* * *

Jim Renfro, air quality program manager at Great Smoky Mountains, is currently managing one of the NPS's most extensive and sophisticated air quality research and monitoring programs in any national park. Projects include monitoring ozone and assessing its effects on vegetation, studying visibility impairment from sulfate aerosols, and recording acidic deposition.

The NPS, Tennessee Valley Authority, Environmental Protection Agency, and State of Tennessee are currently funding several ambient ozone monitoring stations there. The benefits of this work will include a greatly improved understanding of the ozone exposures and precursors to ozone formation. The work will also provide an enhanced database on ozone exposure that will be helpful in assessing impacts to sensitive plants.

The park is also using a low cost means of monitoring ground-level ozone. The WASO air quality division funded a summer passive ozone sampler study to improve understanding of spatial variability away from continuous monitoring sites and to improve the exposure-response connection of foliar injury. The measurements were made near Cove Mountain and in the canopy of the northern hardwoods.

The EPA and TVA began a three-year study this summer at Cove Mountain and Twin Creeks at the park to study the ambient ozone effects on mature trees species. This work is extremely important in determining the physiological effects of ozone on sensitive hardwood species growing in the park. The last two years have shown that nearly 80 percent of the tall milkweed plants were injured and nearly 80% of the leaves on each injured plant was damaged from ozone.

The University of California at Davis recently reported that concentrations of sulfate particles worsened by 39% over the last 10 years in the park, more than in any other national park in the country. The park conducted an intensive visibility research study at Look Rock this summer to document the ammonium sulfate aerosols and to determine why current models, able to reconstruct measured light scattering at sites in the western U.S., are unable to do so in the east with the same accuracy. This study will improve the understanding of atmospheric sulfates and their impact upon visibility.

The Smokies have also recorded some of the highest sulfur and nitrogen deposition in the country. The EPA has selected Clingmans Dome (elevation 6,643 ft) in the park as one of four acid deposition monitoring sites as part of their CASTNet (Clean Air Status and Trends Network) Mountain Acid Deposition Program (MADMP). Data collected at the dome will be used to determine the effectiveness of emissions reductions mandated by the 1990 Clean Air Act amendments whi require a 50% reduction in sulfur dioxi emissions by the year 2000.

* * *

Researchers from the NBS-CPSU the University of Tennessee were ve busy in August presenting papers and lea ing field trips at the joint Southern App lachian meeting of the Ecological Socie of America and American Institute Biological Sciences. Held in Knoxvil the symposium was attended by 3,0 participants from the United State Canada, Europe, South America, Afric Asia, and Australia. Field trips and pr sentations focused on Southern Appal chian plant ecology, ecology a hydrogeology of the Mammoth Cave Ka aquifer, stream acidification, and ma others.

Dr. Stephen Nodvin, Research Ecol gist with the CPSU, and Dr. Niki Nichol of the Tennessee Valley Authority led symposium on multiple stressors to t high elevation spruce-fir ecosystem. part of the symposium, Dr. Ted Simons the NBS-CPSU at North Carolina Sta University presented a talk entitled, "Avi Diversity in Managed and Unmanag Landscapes in the Southern Appal chians." The CPSU contributed many oth papers and poster sessions..

* * *

Mammoth Cave NP and the Cave R search Foundation co-sponsored the Thi Mammoth Cave Science Conference July. Attended by more than 60 individ als, the research forum enabled in-dep discussion across specialty areas. The a nual event benefits researchers and ma agers alike.

Pacific Northwest

The general management planning pr cess for Mount Rainier will include a dressing geologic hazards associated wi the volcano. Members of the planni team from the Denver Service Cent park staff, and WASO, North Cascad and regional geologists met with USG and Washington Department of Natu Resources geologists at the Cascade V cano Observatory to share information the present state of geologic knowled and ongoing research of Mount Raini They also identified research and mo toring needs.

The group devoted three days to exa ining facilities in the park located adj

t to major rivers that drain the volcano. ry little hydraulic, geomorphic, and nnel profile information exists on these ers within the park. As a result, the file and rate of change of channel rphology and discharge capacity is rly known. River channels will be veyed to address geologic hazards as- iated with floods and debris flows which a threat to life and property. Other ential hazards include rock falls, earth- kes, and processes associated with canic eruptions.

Mount Rainier is listed as a decade cano by the United Nations. This des- ation applies to a select group of active potentially active volcanoes around world that are located near large popu- on regions which could be severely cted during an eruptive event. The . identified these volcanoes during early 1990s as needing to be studied their geologic hazards in the hope of viding forewarning and protection to people living near them. Although no ding support is provided by the U.N. geologic research on decade volca- s in the United States (there is also one Hawaii), designating Mount Rainier increased concern over the variety and ential effects of geologic hazards. The oming Geological Society of America A) Annual Meeting, to be held in tle in October, will give further atten- to this on a field trip to Mt. Rainier.

* * *

cting regional chief scientist Kathy participated in the first two biweekly tings of the Northwest forest ecosys- research and monitoring committee. ctions of the committee, which are ed for in the record of decision on the st Plan, include research, monitoring, scientific oversight of various aspects nplementation of the plan. This com- ee will provide a forum for coordinat- agencies' research and monitoring ughout the range of the northern spot- wl, and will also help ensure that the ncies are addressing the research and itoring needs called for in the record ecision.

* * *

ope also gave a presentation to a group achers, consisting of two from every as well as Washington, D.C., and to Rico, participating in a two-week erness workshop sponsored by the . While the presentation addressed wilderness, it also emphasized the need to build a sense of connection between people and the environment, and a sense of personal responsibility for conserving healthy ecosystems everywhere if the natural systems in wilderness are to survive for long.

* * *

Craig Dalby coordinated the region's response to a request from the eastside ecosystem management project (EEMP) for data on visitation statistics, including spatial data for each of the eastside parks. As part of the EIS development for the Columbia Basin, the EEMP is looking at recreational opportunities, among other factors, using the Forest Service's recreational opportunity spectrum (ROS) classification system. Where possible, Dalby "crosswalked" NPS management zones into the ROS system for each of the affected parks, creating a corresponding spatial data set. These data, along with visitation figures from the parks, were sent to the EEMP.

Dalby and Marsha Davis coordinated the response to a second call from the EEMP, requesting grazing allotment data. The requested information included spatial data for grazing allotments at City of Rocks, John Day Fossil Beds, and Nez Perce, and attributes concerning the nature of the grazing activity for each allotment.

* * *

The Comprehensive Management Plan for City of Rocks is nearing completion. Marsha has been working with the planning team in reviewing and editing final revisions to the document. This included participation in a meeting, held in Boise, with representatives of Idaho State Parks, City of Rocks (NPS and Idaho State), and the regional office to review and discuss the final draft version of the comprehensive management plan.

* * *

The Pacific Northwest Region is tentatively planning the following natural resource training opportunities for FY95: GIS and GPS for Cultural Resource Management, Hazard Tree Management, Landscape Restoration Workshop, Planning for Resource Stewardship, Professional Development in Natural Resources, Regional Natural Resource Refresher Workshop, Orientation to the Management of NPS Resources (Natural and Cultural), Vegetation Monitoring Workshop, and numerous wilderness management correspondence courses.

Rocky Mountain

The wolves are coming! The way has been cleared for reintroduction of the gray wolf to the Yellowstone ecosystem and the USFWS has asked Canadian officials to provide 30 wolves this fall for relocation to the park and central Idaho. No lawsuits challenging wolf reintroduction are expected and wildlife managers are proceeding with recovery plans.

* * *

The black-footed ferret is coming, too! The last major hurdle to restoration of black-footed ferrets into Badlands NP and the Conata Basin in South Dakota has been cleared through publication of the special rule in the August 18 *Federal Register* establishing them as a nonessential experimental population. The NPS, USFWS, and USFS have worked for six years to bring the ferrets to the site. This will be the second reintroduction for the ferret and the first attempted in black-tailed prairie dog habitat. The first ferrets (from captive breeding facilities) should arrive soon after Labor Day, with release expected in mid-September.

* * *

The first of its kind in the region, a cooperative weed management agreement based on the requirements of the 1990 amendment to the Federal Noxious Weed Act was developed for Devil's Tower NM by park and regional staff. The agreement facilitates a partnership between the monument, Crook County, Wyoming, and local landowners for controlling noxious weeds on the monument and adjacent private lands. Under the agreement, a cooperative venture was initiated this year using goats to control leafy spurge as one part of an integrated program. The agreement will serve as a model for weed management partnerships at other parks.

* * *

The NPS, the State of Montana, and the Department of Justice executed a reserved water rights compact in late January describing the water rights of the U.S. for Big Hole Battlefield NHP and Glacier and Yellowstone NPs. The compact established a process for protecting water resources at the three parks. The hydrothermal systems and features of Yellowstone will be the most protected of their kind in

Regional Highlights

the world. The objective is to allow no impact to the geysers, mudpots, steam vents, and hot springs within the park.

* * *

Late last December, Colorado's water division #1 district court granted summary judgment to the U.S.' reserved water rights claims for national parks at Rocky Mountain NP. In granting these rights, the court said, "It appears that Congress in setting aside Rocky Mountain NP intended to reserve all of the unappropriated water in the park for park purposes. Only by doing so can the underlying purposes of the creation of the park be achieved."

* * *

Great Sand Dunes NM recently completed a prototype strategy that focuses resource management activities on achieving the park's purposes a little differently than in most resource management planning processes. The experimental effort differs in that it views park resources as part of a larger ecosystem and involves the public in learning about the park's purposes. Together, the groups defined the components and boundaries of the ecosystem, described the processes needed to understand, monitor, and manage it, and developed a feedback loop to evaluate the success of resource management actions on the system. The strategy also accepts human culture as part of the ecosystem and can be integrated into present resource management planning processes. Recently signed by the regional director, the Great Sand Dunes resource management strategy is available to parks to act as a model in developing their own similar products.

In the Next Issue. . .

NBS researchers will share results from both natural and social science projects in different areas of the country. Dick Hammerschlag will present a case study in marsh restoration for Kenilworth Marsh near Washington, D.C. Natalie Sexton plans to describe an innovative visitor study in Rocky Mountain NP that used visitor-produced photographs to determine the most important park attributes for the visiting public.

Meetings of Interest

1994

Nov. 14-18 **30TH ANNIVERSARY OF THE WILDERNESS ACT** at t Sweeney Conference Center in Santa Fe, NM; a five day conferen sponsored by the NPS, NBS, BLM, USFS, USFWS, and Society American Foresters Wilderness Group examining the intent of t act, recounting accomplishments, and strategizing for the 21st ce tury. Research and operational issues are emphasized with partn ships potential and interagency management and research cons tency to be explored. Contact Peter Keller, NPS Park Planning a Protection, Rm. 3230, 1849 C. St., N.W., Washington, D.C., 202 or contact Alan Schmierer of the Western Regional Office at (41 744-3959.

Oct. 19-22 **ECOSYSTEM MANAGEMENT AND RESTORATION FO THE 21ST CENTURY** in Palm Beach Gardens, Florida; contact E Helfferich, South Florida Water Management District, P.O. B 24680, West Palm Beach, FL, 33416-4680.

Oct. 24-27 **GEOLOGICAL SOCIETY OF AMERICA 1994 ANNUA MEETING** in Seattle, Washington; *At the Leading Edge* is the the for this popular conference. Sessions and symposia will be offe not only on aspects of Pacific Rim and convergent margin geolo but also on a variety of contemporary environmental a hydrogeological topics. Call (303) 447-2020 or (800) 472-1988 program, registration, and lodging information.

Oct. 31- Nov. 4 **PARTNERS IN PALEONTOLOGY--FOURTH CONFEREN ON FOSSIL RESOURCES** in Colorado Springs, Colorado; sp sored by Florissant Fossil Beds NM, the conference has broade its scope to include fossil resources on all public lands and n integrates the BLM, USFS, USGS, and the Colorado State La Board as cooperators. Contact Maggie Johnston for further inform tion at P.O. Box 185, Florissant, CO, 80816; or call (719) 748-32

Nov. 9-13 **FOREST CANOPIES: ECOLOGY, BIODIVERSITY, A CONSERVATION** in Sarasota, Florida. The symposium will dress canopy structure, organisms, processes, and aspects of for conservation. Contact Dr. M. Lowman, Director of Research, Ma Selby Botanical Gardens, 811 S. Palm Ave., Sarasota, FL 342 (813) 366-5731.

1995

Mar. 15-17 **ENVIRONMENTAL REGULATION AND PRESCRIBED FI** in Tampa, Florida at the Hilton Metro Center. The conference v provide a forum for prescribed fire practitioners and environme regulators to discuss roles in maintaining ecosystem health, end gered species preservation, hazard fuels reduction, and air and wa quality protection. Contact Diane Ots, Environmental Regulat and Prescribed Fire Conference, Center for Professional Devel ment and Public Service, Florida State University, Tallahassee, 32306-2027, (904) 644-7453, fax 644-2589.

April 17-21 **EIGHTH CONFERENCE ON RESEARCH AND RESOUR MANAGEMENT IN PARKS AND ON PUBLIC LANDS**, sp sored by The George Wright Society; Portland, Or. Theme: "S tainable Society and Protected Areas--Challenges and Issues for Perpetuation of Cultural and Natural Resources." Registrat information available from the George Wright Society, PO Box Hancock, MI 49930-0065

he USFWS and National Marine Fish- s Service published several new poli- concerning endangered and threat- l species in the **July 1 edition of the *eral Register* on pages 34270-34275.**

SFWS also proposed downlisting the eagle from endangered to threatened, pt in certain areas of the Southwest. he five states where it is currently d as threatened (Oregon, Washing- Minnesota, Wisconsin, Michigan), it ld continue to be listed as threatened. ments are being received until Octo- 11 **(Federal Register July 12, pages 34-35585).**

he USFWS ruled on a petition to list ollusc species, finding that, for some ies, substantial information indicat- hat listing is warranted was not pre- ed, or, for other species, that listing is presently warranted. The species con- red are found primarily in the states of hington, Oregon, California, and o, and some are known or are be- d to occur on NPS lands **(Federal ister July 11, pages 35305-35307).**

he Soil Conservation Service pub- d a revised listing of the soils defined ydric soils," which are used in delin- g wetlands **(Federal Register July pages 35680-35695).**

he USFWS determined the water ellia (*Howellia aquatilis*), a wetlands t, to be a threatened species. Although pated from California, Oregon, and e sites in Washington and Idaho, this ies continues to exist in Montana, o, and Washington, primarily in con- lated clay and organic sediments that r in wetlands associated with ephem- glacial pothole ponds and former river ws. Primary threats to the species are of wetlands and habitat changes due mber harvesting, livestock grazing, lential development, and competition troduced plant species such as reed ry grass **(Federal Register July 14, s 35860-35864).**

* * *

arlier this year, IUCN, the World servation Union, relaunched ***PARKS*, International Journal for Protected a Managers.** Published in February, , and October each year, *PARKS* aims rengthen international collaboration ng protected area professionals and to nce their role, status, and activities. issue is devoted to a theme. For nple, volume 4, no. 1 explored build- community support in protected areas gave practical advice and instructive histories on working with indigenous les. The reinvigorated publication £18 per year (approximately $30) with additional charges for postage. Contact *PARKS*, 36 Kingfisher Court, Hambridge Road, Newbury, RG14 5SJ, U.K., for subscription information.

* * *

A bacterium found in the digestive system of the bowhead whale has been found to be profoundly effective in breaking down key components of oil spills, PCBs, and other carcinogenic compounds. The **June 9 edition of Oregon State University's *OSU This Week*** describes the discovery by A. Morrie Craig, a professor of veterinary medicine. Craig said that despite eating a ton of polluted krill per day, and ingesting PCBs, oil and fuel residues, and acids, the whales don't get sick. Instead, the anaerobic microbes in the whale's forestomach break down anthracene and naphtalene, components of oil spills, into harmless compounds.

Researchers at OSU are also working on isolating bacteria from the stomachs of goats that allow them to digest tansy ragwort, a plant containing toxic alkaloids. While the research has a long way to go before yielding a toxic spill engineered-treatment, it suggests that anaerobic bacteria may one day be employed in along with today's surface aerobic bacteria to aid in toxic spill cleanups.

* * *

The **August 4 edition of the Rocky Mountain News** summarized a shift in Clinton administration science policy that upgrades non-military research that benefits health, prosperity, and the environment. The policy report named an 18-member committee to guide the federal science and technology expenditures.

* * *

A British research team reported in both the **January, 1994 issue of *BioScience* and the September 23, 1993 edition of Nature** that a method presently used by conservationists in selecting lands for the preservation of species diversity are flawed. Conservationists often decide which lands to preserve by evaluating species diversity and the presence of rare or endangered species within them. In using this strategy they frequently make the assumption that species richness for one group of plants or animals will be equally rich for another group, and that an area beneficial to a rare species will be a magnet to others.

J.R. Prendergast of Imperial College in Ascot, U.K. led a research team to look into the question and found no evidence that either assumption was true. They mapped nearly 2,700 ten-kilometer squares and then examined their data for overlapping areas rich in birds, butterflies, dragonflies, liverworts, and aquatic flowering plants. They found that only 12% of the dense bird and butterfly areas overlapped while no single square was rich in all five of the kinds of lifeforms. Only 26 of the squares were especially diverse in any three kinds of the taxa and 25% or more of the uncommon species from four of the groups were not found in any hot spot. While the authors/scientists admit that severe habitat fragmentation in Great Britain may indicate that the data would not also apply elsewhere, they were confident in their conclusions.

***

A comprehensive study of the complex wanderings of Greater Yellowstone Ecosystem (GYE) bald eagles is described in the spring 1994 edition of **Yellowstone Science.** Researcher Al Harmata's account of the near 15-year project discusses project growth from the initial leg-banding scheme to the more effective, but more expensive, radio-tracking methods used in the mid- to late-1980s. Yellowstone was once thought to be a "black hole" for bald eagles (a location where their population was declining and even "sucking in" recruits from outside the Yellowstone area), but Harmata's research demonstrated just the opposite.

Both the leg-banding and radio-tracking experiments indicated that juvenile and immature GYE-born eagles wander westward (rather than the common north or south movements in most areas) early in the fall and often winter from southern California to Washington. The young birds returned to their birth nest areas in and around the park usually in April or May before they dispersed throughout the ecosystem, and beyond, to live their lives and breed. Harmata shows that the GYE eagle population (while perhaps low in productivity by some comparisons) has a very high survival rate for young eagles and that this is significant in supplying recruits to expanding eagle populations outside the GYE.

The researchers also noticed that the summer wanderings of the Yellowstone eagles nicely delineate the boundaries of the GYE. As an indicator of ecosystem health, eagles in the GYE now appear to be successful and the knowledge gained about the biological "boundaries" of this ecosystem as discovered in this research project give an even stronger basis for the ecosystem's protection.

Harmata and his colleagues conclude with resounding confidence that the GYE eagles are not disappearing in Yellowstone, but are rather bolstering the comeback of our national symbol in surrounding areas.

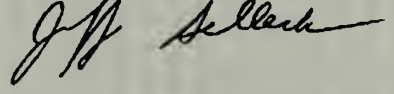
EDITORIAL

(*continued from page 2*)

numerous CPSU researchers. As editor, I want to strive for geographic balance in the articles published in *Park Science* just as I want to encourage participation by diverse authors as detailed in my article about writing for the bulletin. Have a look at the submission criteria and contact me if you have an idea for an article, a suggestion, or a concern.

In moving *Park Science* to Denver, most of the production that once fell to Jean and staff in the Pacific Northwest Regional Office now takes place here. I want to thank Shirley Clark, Pat Geegan, Hildred Vann, and Lynne and Dave McPhaden of that office for their help over the years. Shirley tracked the *Park Science* budget and gave general support; Pat coordinated Jean's travel; Lynne executed the printing and distribution contracts; and Hildred and Dave handled the regional office and international copies distribution. Richard Aroksaar and VIP Edith Miller of the PNRO library, will continue to generate the annual article indexes that we usually publish in the winter issue. Regional Chief Scientist Jim Larson (recently retired) is also to be thanked for serving as the *Park Science* Editorial Board Chairman since 1983. A big thanks to all for past and continued support!

I'm thankful for a smooth transition and a strong foundation to build on. I look forward to continuing the excellence of this publication.



Editor

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PERMIT NO. G-83

PARK SCIENCE
Integrating Research and Resource Management

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

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

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

By Stephen W. Syphax and Richard S. Hammerschlag

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

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

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

Recognizing Potential

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

Continued on Page 16

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

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

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

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

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

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

Printed on recycled paper

CONTENTS

DEPARTMENTS

FEATURES

IN THE NEXT ISSUE. . .

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

New Year, New Look

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

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

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

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

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

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

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

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

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

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

Regional Highlights

Midwest

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

• • •

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

• • •

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

• • •

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

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

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

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

• • •

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

Southeast

Resource managers are developing an integrated pest management (IPM) plan to control a black rat population on three islands at Dry Tortugas National Park in the Gulf of Mexico, 7 miles from Key West, Florida. The rats prey on sooty tern nest on Bush Key and are a threat t this avian colony that is regarde as a wildlife resource of outstand ing international significance. Pre dation of loggerhead and gree turtle nests by the rats on Log gerhead Key is another concern Recent monitoring by snap trap indicates a high rat populatio Furthermore, the rats appear t be able to migrate across th channel following tern nestin season to Garden Key wher food and harborage are ampl Doug DeVries, IPM coordinato at Everglades National Park, i seeking input from rodent exper and assistance (volunteers) wit control implementation.

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One of numerous issues bein addressed by resource manage ment personnel at Biscayne Na tional Park in South Florida i resource damage resulting fro boats that anchor in live coral. U to 1,000 boats per day utilize th park on weekends during pea season, and many of these eithe visit the outer reef tract or the ex tensive system of patch reefs.

The park schedules ancho surveys during peak visitor us periods and conducts them wit a two-person crew. While on crew member explains to a boa captain the damage that occur when boats are anchored to co als, a snorkeler checks the actua location of the anchor. Th snorkeler then relays the positio of the anchor to the partner o board the boat–in sand, seagras hardbottom, or live coral. If th anchor is found to be in coral, th anchor is moved to an alternat location, and any significant im pact to the resource is docu mented on camera.

Staff have checked anchor locations of over 400 boats and have found that 26% rested in live coral. With boater use of park waters on the rise, resource managers expect the number of anchors to be placed in live coral to increase accordingly. The cumulative impacts of this practice over time will result in severe degradation of the park coral reef resource.

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

WESTERN

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

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

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

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

SOUTHWEST

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

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

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

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

NORTH ATLANTIC

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

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

Rocky Mountain

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

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

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

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

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

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

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

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

Alaska

After 18 years of concentrating on its cultural resources, the Klondike Gold Rush National Historical Park Resource Management Division expanded this year to include a natural resource program. First-year efforts included conducting a native and exotic plant inventory, develop ing a herbarium collection, asses ing a campground for limits o acceptable change in preparatio for upcoming state centennial ce ebrations, achieving a trail surve and assessment, creating a wild life observation database, and de veloping both short-term an long-term program goals.

Initial surveys reveal a par that, although small in size b Alaskan standards (approx mately 13,000 acres), is rich i biodiversity and special in geo graphic character. The park lie in the driest and northernmo section of southeastern Alask stretches from sea level to th summit of a coastal mountai and links the moist marine cl mate of the southeast to the dr interior climate of the Yuko With so much landscape an species diversity within such compact area, we anticipate an other exciting season of disco ery.

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The Alaska Region has com pleted a draft natural resourc strategic action plan that wi serve as a regional resource man agement plan and more! It shoul help to improve our science man agement capabilities by identify ing region-based needs i resource management.

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We are planning a resourc management workshop for th end of February in or near An chorage. The gathering will com bine a work group session wit an informational meeting forma for discussing changes. The high lights of technical workshops wi be summarized in the next *Par Science.*

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Gary Vequist attended an interagency Alaska ecosystem management team meeting that might have been termed more appropriately a *design* team. This is because the team designs public involvement approaches to ecosystem management. Ecosystems are complex and require more interdisciplinary expertise, or as we say in Alaska, "more brains per acre." This approach to ecosystem management combines not only the interdisciplinary expertise of the agencies, but also that of the public and other organizations. Past planning and decision-making processes often created adversarial relationships, because resource management decisions were made *for* the public. Using the new ecosystem management design, decisions are made along *with* the public.

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

Pacific Northwest

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

By John G. Dennis

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

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

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

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

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

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

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

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

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

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

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

Continued on page 31

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

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

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

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

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

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

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

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

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

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

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

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

Results

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

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

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

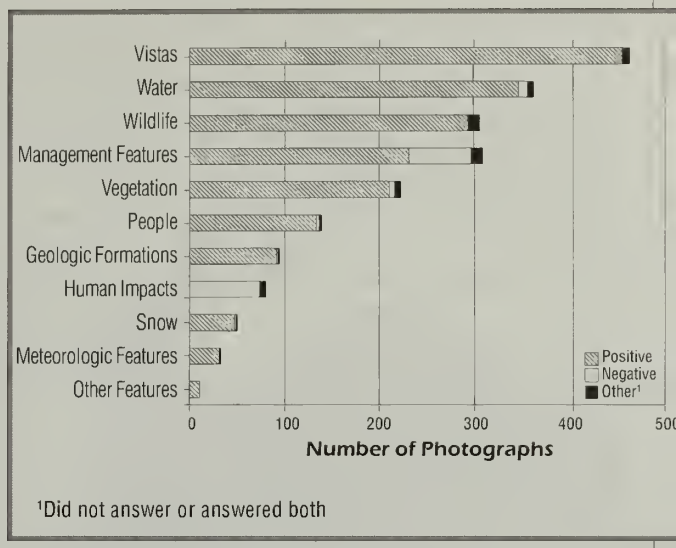

Figure 3. Number of photographs taken by survey respondents of park features by category; participants indicated whether feature effect was positive or negative.

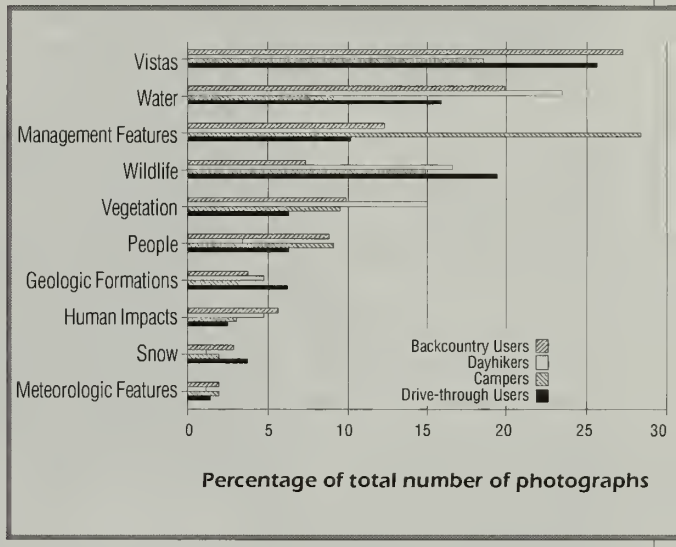

Figure 4. Percentage of total number of photographs comprised of categorized park features photographed by the four user group subsamples in the study.

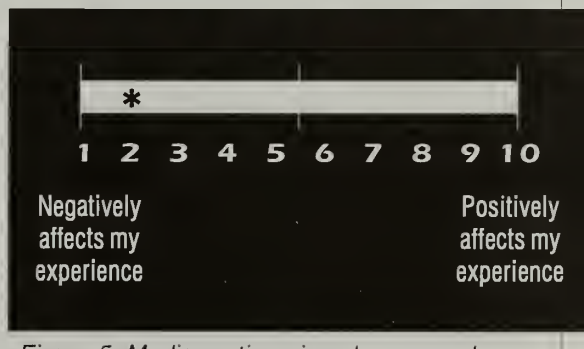

Figure 5. Median rating given by respondents of the effects of reducing park water or water-dependent resources by one-third.

Continued on page 12

pay to preserve the park water resources (figure 6). Nearly two-thirds (63%) stated that they would pay an additional $2 or more in entrance fees to preserve the Rocky Mountain National Park water resources .

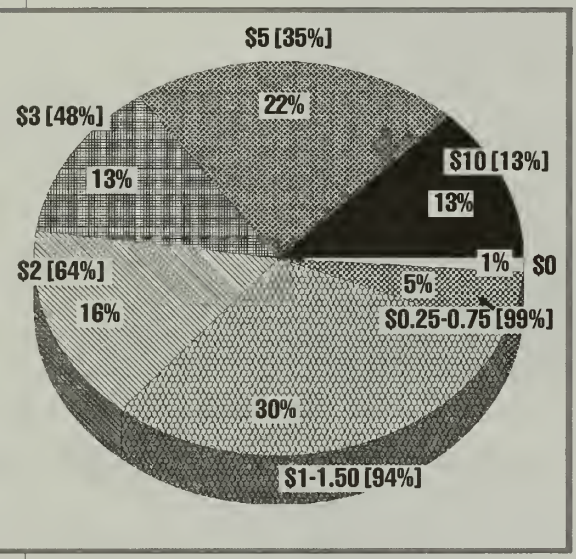

Figure 6. Visitor willingness (by percentage) to pay to protect Rocky Mountain National Park water resources. Numbers in brackets are cumulative percentages: willing to pay $X or more.

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

Management Implications

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

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

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

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

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

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

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An Isle Royale Story

by Jack Oelfke

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

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

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

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

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

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

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

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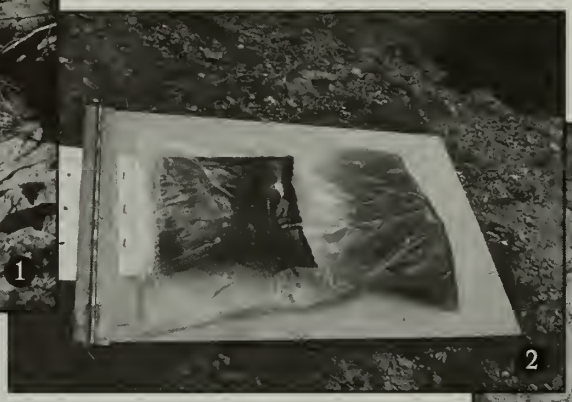

Figure 1. Volunteers backpack PUF kits into remote installation site; Figure 2. The PUF kit before breaking inner bag to mix with contents of outer sack; Figure 3. Installer builds support for PUF plug.

Polyurethane Foam Applications in the Closure of Abandoned Mine Openings

By John Burghardt

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

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

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

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

Basic Application

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

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

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

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

PUF, therefore, offers a good, low-impact closure alternative for AML sites in sensitive, historically significant, or wilderness areas typical to many units of the national park system.

Physical Properties of PUF

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

Environmental and Safety Concerns

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

Case Study: Hand Mixed Application from Plastic Bag Kits

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

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

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

Investigations Begin

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

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

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

Figure Octobe recons marsh mud fl

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

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

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

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

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

Return of the U.S. Army Corps of Engineers

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

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

The Plan

This new larger scale restoration effort required that we modify the methods described in the Biohabitats, Inc., plan. We

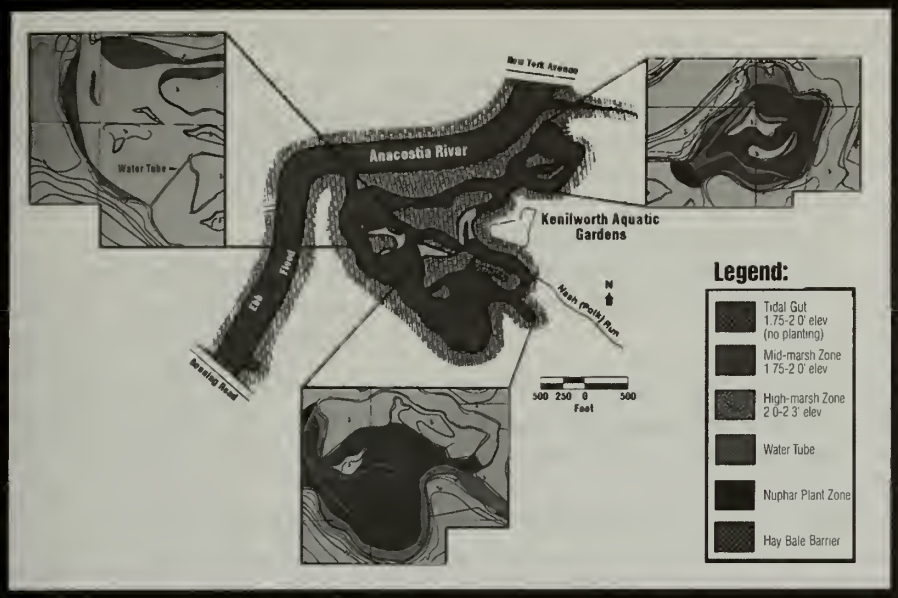

Figure 4. Kenilworth Marsh Restoration Plan.

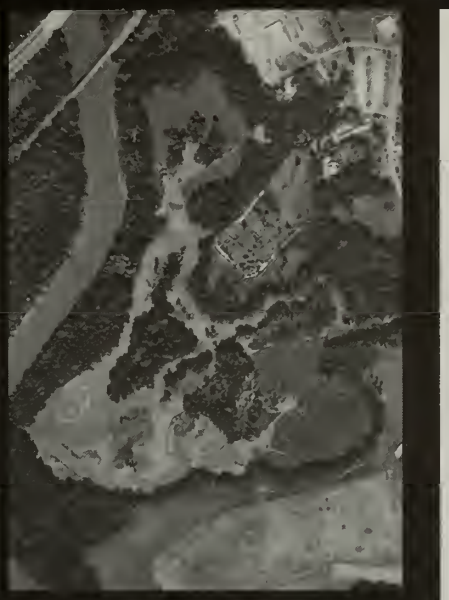

Figure 5. The reconstructed marsh—Sept. 1993. Note greening of mass fill areas #1 and #2 where the newly established marsh can be seen.

cided to reconstruct 32 acres of emer-nt wetland through the establishment of o mass fill areas (#1 and #2), 10 and 15 es respectively, and smaller fringe areas 3) totaling some 7 acres (figure 4).

Our plan was to temporarily separate ass fill areas #1 and #2 from the tidal arsh (and river) using large water tube vices. Once positioned, the water tubes ere pumped full with marsh water. When l, the tubes proved effective at damming placement areas and containing sedi-ents released during the filling operations. nilarly, we established fringe marsh ar-s using the straw bale containment pe-neter approach. Straw bales were also talled to protect the few remnant emer-nt wetland areas that were adjacent to e mass fill sites. We had learned from the monstration phase that building the ush bundles was too labor-intensive, and e energy regime of the marsh did not quire them.

In October 1992, we installed a floating om with an attached sediment curtain the marsh inlet-outlet, and the hydrau-dredge barge Blue Ridge (owned and erated by Cottrell Engineering Corpo-ion) began removing sediment from the per Anacostia riverbed. Through a sys-n of 12-inch diameter pipes, the dredge aterial was pumped to selected areas of e Kenilworth Marsh. Areas of coarse ndy material in the river, which had been identified during preliminary sampling, were dredged first and used as a foundation for the water tubes.

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

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

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

Planting Begins

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

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

We performed planting by creating patches of plant species on 2-foot centers; the number of plants in a flat (about 40) controlled

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the patch size. Placement of plant species was often arbitrary, although we directed high-marsh species to the higher elevation areas.

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

Mass fill #1

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

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

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

Mass fill #2

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

Table 1. Species Planted in the Kenilworth Marsh Reconstruction

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

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

Fringe Areas

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

Summary

Overall, Kenilworth Marsh revegetated e tensively and vigorously. During the first ye at least 90% of mass fill areas #1 and #2 w covered with dense pla growth averaging several fe in height (bottom phot graph, front page and figu 5, page 17). This may be a tributable to several facto the surrounding berms a islands protected the veget tion from fetch, volunte plants established themselv prevalently, the newly depo ited sediments provided d solved oxygen and nutrien sediment levels were ne and just above the high ti elevation, wildlife feeding w limited, we planted nati species, and we timed plan ing to coincide with optim growing conditions.

Follow-up Monitoring

As a prototype, t Kenilworth Marsh resto tion project pioneere methods that may be us ful in restoring other fres water tidal wetlan (including others within the Anacos watershed such as Kingman Lake). T project also raised numerous questio concerning the quality and impacts of t wetlands being produced. Consequent the agencies involved in restoring t marsh (National Park Service, U.S. Arm Corps of Engineers, Metropolitan Was ington Council of Governments, Distr of Columbia Department of Consumer a Regulatory Affairs, Environmental Prote tion Agency, U.S. Fish and Wildlife S vice, the University of the District Columbia, and the Interstate Commissi on the Potomac River Basin) felt strong that the project be monitored for seve years to determine its degree of succe Together, we formed the Kenilwo Marsh monitoring committee for the p

LE 2. Volunteer Plants

ntific Name	Common Name
rubrum	red maple
s sp.	beggar-ticks
sp.	sedges
haris sp.	spike rush *
ia oryzoides	rice cutgrass
m salicaria	purple loosestrife*
mites australus	phragmites*
onum sp.	smartweeds
us deltoides	cottonwood
aria latifolia	duck potato
sp.	willow
angustifolia	narrow-leaved cattail
latifolia	broad-leaved cattail
a aquatica	wild rice
ntial pest species	

se of identifying, promoting, sponsor-g, and conducting monitoring studies to cument the results of the project.

The studies have examined the project m its first year, 1993, and will continue r many years to come. They will assess vels of toxicants, such as chlordane, in diments, pore water, and the biotic food ain of the marsh. They will also moni-r the effectiveness of wetland vegetation establishment; the productivity of wild-e habitat and habitat use (including graz-g) by wildlife; the stability of sediment d development of soil, and hydrologic tterns; and water quality. Finally, they ll inventory plankton, aquatic macro-vertebrates, mammals, birds, and fish. We ve assembled a report for 1993 consist-g of several data sets and anticipate writ-g annual reports and preparing a synoptic port after five years.

ephen W. Syphax is the Resource anagement Specialist for National Capital rks–East. His address is 1900 Anacostia rive, S.E., Washington, D.C. 20020, and can be reached by telephone at (202) 0-5185.

Richard S. Hammerschlag is the Chief of e Center for Urban Ecology, National ological Survey. His address is 4598 lacArthur Blvd., N.W., Washington, D.C. 007, and he can reached by telephone at 02) 432-1443.

Regional Highlights continued

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

• • •

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

• • •

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

• • •

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

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

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

ERRATUM

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

Isle Royale Loons

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

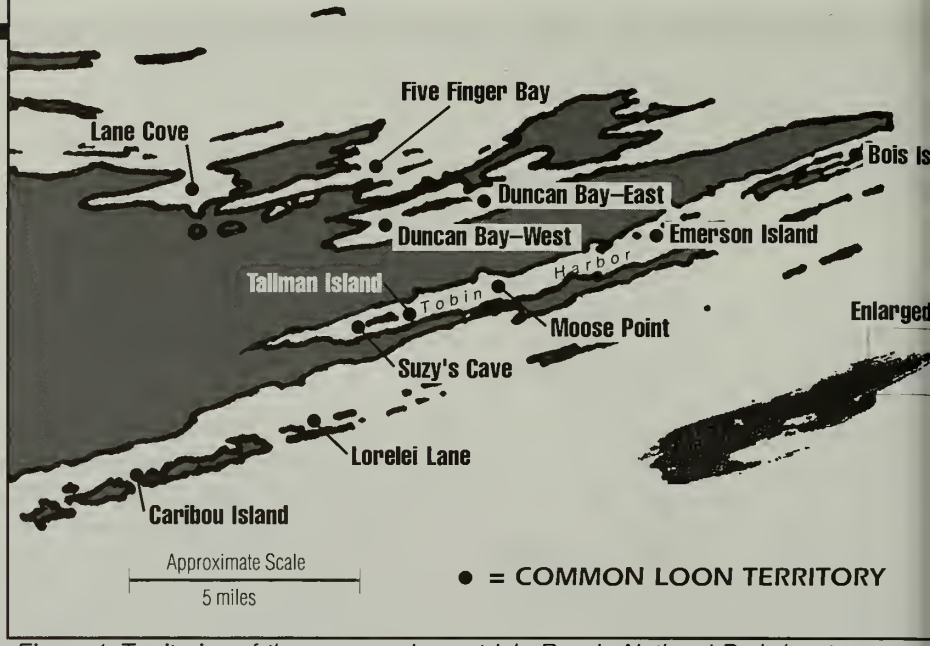


Figure 1. Territories of the common loon at Isle Royale National Park (eastern one-third of island).

By David C. Evers

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

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

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

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

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

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

Results and Discussion

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

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

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

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

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

THE RECRUITMENT DYNAMICS OF LOONS banded as chicks remains unclear. A small sample at the Seney National Wildlife Refuge, Michigan, and the Turtle-Flambeau Flowage, Wisconsin, shows some natal site fidelity. In 1994, however, we did not observe on the island any of the loons banded as juveniles in 1991 (n=8). Since young loons acquire their breeding plumage after their third winter and only return at that time to the breeding grounds (the first 2 years are spent on the ocean for over 90% of this cohort), following their movements is difficult. Add to this their late probable first-breeding age of six to seven years and the need to study loons over the long-term becomes clear.

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

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

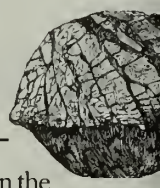
Other recoveries indicate a west-to-east migration of upper Great Lakes loons through the Finger Lakes region of New York to the Chesapeake Bay by mid-November. By early December, most of the adult loons will have probably arrived on their wintering grounds in North Carolina continuing south, along the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

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

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

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

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



Geologic Features Monitoring Begins at Craters of the Moon National Monument

By Kathryn A. Diestler

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

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

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

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

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

We had hoped to compare these phot graphs with similar ones taken early in mon ment history so that we could assess impac over time. Unfortunately, only a few early p tures exist depicting significant features th we can use as a baseline. In the future, wh time and money allow, we will attempt track down other early photographs fro other collections that could pertain to th project. Until then, the baseline for many fe tures will have to be current conditions.

Resources cannot be protected unle threats to them can be recognized. We b lieve this program will help us recogni threats and enable us to take action to pr tect these resources. Without such an ea warning system, the opportunity to proactive does not exist. Additionally, we c use the monitoring program to assess the fectiveness of our mitigation measures, pr viding us with a tool to evaluate our succe in protecting our geologic resources. We r alize this program will not prevent dama to these resources, but recognize that it is step in the right direction.

Geologist Kathryn A. Diestler developed the monitoring program for the park over a 14-we period last summer. Diestler is a graduate of Washington State University and had learned about the opportunity through the Environmental Careers Organization, a firm that places entry level professionals in environmentally oriented positions with federa state, and local governments. Craters of the Moon hired her specifically to develop the monitoring project, because they do not have a staff geologist. Chief of Resource Management Vicki Snitzler-Neek has further details of the project and can be reached at (208) 527-325

Preparing for Dune Swale Wetland Restoration at Indiana Dunes National Lakeshore

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

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

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

During the late 1800s, the Great Marsh was ained, filled, dredged, and then dissected railways, highways, and industrial and muipal development. Originally stretching 34 les (55 kilometers) with a total area of 1,336 es (3,300 hectares), the wetland has been luced to 607 acres (1,500 hectares). Neverless, it is an outstanding natural area and ovides an opportunity for NPS and NBS ff to test a landscape-based restoration .

The Great Marsh is made up of several tinct watersheds that drain into Lake chigan: one containing the natural Dunes eek, and two containing constructed ches (Derby Ditch, and Kintzele Ditch) that through sand dunes. High fecal coliform els in all three drainages have caused the rk to close intermittently several popular imming beaches. Research on wetlands s shown that increased water retention in tland areas decreases bacteria levels that w out of the system. Restoration of a more tural hydrologic regime would increase the e it takes for bacteria-laden waters to flow ough the Great Marsh into Lake Michin, theoretically allowing the bacteria to deompose before reaching swimming beaches. ditionally, changes in the hydrologic reme, fire frequency, and water quality in disbed areas of the Great Marsh have caused placement of native sedges and bluejoint ss by cattails and woody shrubs.

Dunes Creek is the least impacted of the eat Marsh watersheds, although minor ching has occurred in some sections of its ainage. Still, it contains a state nature preve with an extremely diverse array of plant mmunities and is the best available model restoration of the marsh within the Derby d Kintzele Ditch watersheds.

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

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

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

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

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

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

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

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

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

Craig Johnson

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

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

Scott Shull (holding black bear)

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

I first met Scott Shull in 1989. We had hired him as a tech cian on a bear project in the Ozark Mounta of western Arkansas. Scott was from Pop Bluff, Missouri, and had received a B.S. deg from Southwest Missouri State. Scott was able field technician and demonstrated c siderable talent and dedication while trappi immobilizing, and radio-tracking bears. His forts paid off and he was offered a M.S. as tantship at the University of Arkansas to l at the effects of mark and release on nuisa bears. During that project, Scott developed excellent rapport with state game officials, public, and the academic community al thanks to his calm demeanor and amiable p sonality. Scott completed his thesis in 199 had hired him for the panther project in gust because he was a capable field technician and had ac mulated considerable experience with aerial radioteleme Scott was a great person to be with in the field. He was tremely capable, had good *woods sense*, and his wit and hun made the time spent there a real j Scott was a close friend of min will take with me many fond men ries of him crawling into bear d staying up all night radio-track bears, and our many lighthearted cussions.

I take great comfort in know that Craig and Scott loved what t were doing and were extremely co mitted to the work in South Flori They had made many friends th and, both being mountain boys, w beginning to appreciate the bea and vulnerability of the South Flor ecosystem. My plans are to conti our research there; I think that is how Scott and Craig wo have wanted it.

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

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

By Laura J. Sefchik

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

Carl may be remembered as oldest and longest serving ional park ranger, as an expert ine botanist, as professor eritus of botany at San Jose te University, as discoverer of viously unclassified wildflow-, or for establishing the herium at the university, which w bears his name, but he will best remembered as olomne Meadows' best-loved uralist. Carl was an inspiration all and has influenced thouds of children and adult visis to Yosemite. I am one of se, having first met Carl on his adow walk in June 1987. He s magical and delightful while encouraging all of us to deop a greater appreciation for wilderness. Carl's love for the wers and the mountains defined his life, which he joyfully red with all park visitors and friends.

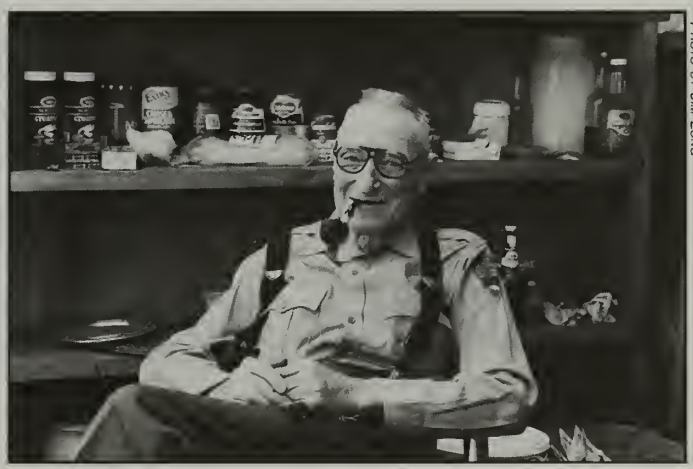


Photo by Jim Long

Ranger Carl Sharsmith, 1903–1994

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

Tuolomne Meadows in Yosemite National Park had been rl's summer home since 1931. He was its first ranger-naturst and its best friend since John Muir. Carl was greatly influced by Muir having first discovered his writings as a boy. rl noted, "I always knew about Yosemite because I knew the itings of John Muir by heart; and I was all prepared to see at I saw. Studying at the Yosemite Field School in 1930 was t the most wonderful thing I could do; and it led to an invition to become a ranger-naturalist."

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

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

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

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

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

Reviewed by Timmothy J. Kaminski

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

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

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

Rick McIntyre

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

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

The organization of the book is weakness, however, and is at tim choppy enough to be annoying, pa ticularly for a reader perusing the cha ters from beginning to end. An add shortcoming is that sections on the st tus of recovery efforts in the natio parks (for example, Great Smo Mountains, Yellowstone, Glacier) a areas where wolves are returning

ir own are overly condensed. In fairss, the book contains inserts or ebars that concisely summarize reery efforts and may be entirely apopriate for the coffee table reviewer; wever, they could still have been imoved upon by adding detail and aling their placement in the text.

McIntyre has carefully watched and perienced wolves in their natural enonments, a complement to his writ- style that adds greatly to the appeal his book. Among the st appealing portions his own experiences d his recounting of them. nile interpretations in a instances are anthromorphic and subject to estion (for example, ndication" by the wolf gs the Digger), his introction, the account of Bill ywood versus the wolf gs the Digger, his poryal of the East Fork klat River) alpha male Alaska (a return to rie's time observing the t Fork den about which rie also wrote in his 4 account of the Wolves Mt. McKinley–now nali), his epilogue to the rit of the wolf, and fily his revisit to Colo- o bring these experies to life for the reader.

McIntyre's time spent as a naturalparticularly his years in Alaska and other parks, serves as the basis for s account, more personal than a rough documentary of the longnding efforts dedicated to returning y wolves to North America, espelly select national parks of the ited States. His insights and photos d to an accurate and positive image the wolf and its rightful place in se remaining vestiges of available bitat.

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

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

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

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

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

New Publications

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

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

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

• • •

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

Morristown to Assess Water Quality and Threats Through National Partnership

By Bob Masson

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

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

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

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

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

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

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

Polyurethane foam continued

different chemical composition enab
the installer to use this product at mu
lower temperatures than other PU
products, which is helpful in northe
latitudes or at high altitudes whe
temperatures fluctuate greatly throug
out the day and warm seasons a
short.

This kit produces rigid foam tha
more granular and less resilient th
the other PUF products we tested, b
is thoroughly capable of supporting
loads anticipated over a mine openi
A 22-pound bag generates 11 cubic f
of foam. The bags are convenien
sized and are easily carried in a co
ventional backpack (photo 1). E
placement for the shaft closure w
much easier than for the adit, howev
and the installer got fairly covered w
PUF on the adit closure, emphasiz
the need for protective clothing a
gloves. We recommend rubber glo
duct taped to a Level D disposa
Tyvek® hazmat suit. With more pr
tice and experience, the installer m
have fewer problems. Each 22-pou
bag kit is available for $130, wh
amounts to approximately $350
cubic yard of foam generated. D
counts are available for bulk orders

Conclusion

Each application of PUF has mer
and choosing which method or pr
uct to use must be based on factors
site accessibility, availability of pr
ucts and contractors, cost, and job s
PUF has proven to be a useful ma
rial for closing mines especially in
mote areas, at sites with access a
disturbance restrictions, or where
equate backfill material is not availa
For the detailed paper summarizing
four PUF applications tested, ple
contact the National Park Service M
ing and Minerals Branch at (303) 9
2092. §

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

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Listed by Park Code

that have occurred. These changes include complexities of managing large-scale landscapes through ecosystem management principles, acceptance of scientific evidence of environmental issues, and pressures for government reinvention and interagency cooperation. The informally constituted commission will be asked to review the progress of past U.S. MAB efforts, assess the capabilities of the present organization to contribute in the future, suggest what to keep and what to change, and propose new program areas that should be pursued.

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

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

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

Meetings of Interest

MARCH 15-17

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

MARCH 24-29

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

APRIL 3-7

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

APRIL 11

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

APRIL 17-21 (EARTH WEEK)

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

APRIL 24-27

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

AUGUST 12-16

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

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PARK SCIENCE
Integrating Research and Resource Management

olume 15 –Number 2 National Park Service • U.S. Department of the Interior Spring 1995

REOPENING A NICHE AT BADLANDS NATIONAL PARK: THE BLACK-FOOTED FERRET

Prairie dog conservation, not complex biology, holds the key to recovering this Great Plains predator

GLENN E. PLUMB, BRUCE
SSKEN, AND PAUL MARINARI

DO YOU REMEMBER when your science teacher brought out the ystery" box, the one with hole in the side, and asked u to stick your hand inside d identify an item only by ch? You had no idea what ght be encountered. Yet, ce you grasped the object, ur curiosity peaked and the llenge became an exciting portunity! Likewise, biolots and resource managers Badlands National Park, uth Dakota, had been ping for years to find a y to restore one of North erica's most endangered restrial mammals to its irie habitat. Finally, after 6 rs of preparing for reintroction, our moment of disery and triumph came last with the arrival of the first ck-footed ferrets *(Mustela nigripes)* to be seen in the park in er 25 years (fig. 1).

Figure 1. The first black-footed ferret to be set free in the 1994 Badlands National Park reintroduction eyes the open door of its release cage moments before leaving to freedom.

BACKGROUND

The black-footed ferret's nocturnal habits do not lend the species to ready study. For an animal first described in 1851 by Audubon and Bachman, and which once ranged from southern Saskatchewan to northern Mexico, practically all ecological information comes from two small populations in South Dakota and Wyoming that went locally extinct after intense, but limited, study. This animal is a highly specialized predator that depends on a single type of habitat–prairie dog *(Cynomys ludovicianus)* colonies. A member of the Mustelid family, the black-footed ferret uses prairie dog burrows for shelter, family rearing, escape from predators, and access to its primary prey, the prairie dog.

The ferret was listed in 1967 as a federal endangered species and in 1978 as a South Dakota endangered species. The

Continued on Page 16

PARK SCIENCE

Integrating Research and Resource Management

Volume 15—No. 2 • Spring 1995

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

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

The editor welcomes submissions of case studies, feature articles, and regional highlights. See *Park Science* 14(4):13 for submission criteria or contact the editor at:

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Printed on recycled paper

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DEPARTMENTS

FEATURES

IN THE NEXT ISSUE. . .

As fire season begins, look for an article on prescribed natural fire management in Glacier National Park and a fire history reconstruction study near Bandelier National Monument. We will also delve into the crossover area between natural and cultural resource management with an article that details the associations between rising and falling levels of Yellowstone Lake and Paleo-Indians. The second in our series on NBS science centers is presented next time and will be a profile on the Midcontinent Ecological Science Center in Fort Collins, Colorado. Also, vegetation mapping on a landscape scale in the Pacific Northwest, grouse in Acadia National Park, MAB notes, and a book review by Gerry Wright.

Backyard and Beyond

This issue takes us around the country (and around the globe) sampling research and resource management projects from Alaska, the Great Plains, the Virgin Islands, and Gulf Coast, to the eastern piedmont, the desert southwest, and the Rocky Mountains. In several instances the articles point to research applicability beyond the parks or demonstrate the strides we have made in forming partnerships beyond our own agency. For example, satellite radiotelemetry studies (described on page 20) revealed the impressive long-distance falcon migration link between Alaska, Russia, and Argentina. The research technique has worldwide utility and demonstrates the added complexity of preserving certain bird species that are shared international resources. The story on migratorial hawksbill sea turtles at Buck Island Reef National Monument in the Caribbean used similar research techniques, also relied on interagency cooperation, and makes very similar conclusions to the falcon story.

The lead article on ferret reintroduction to Badlands National Park can be viewed as a triumph in wildlife management where legislators, biologists and administrators from several state and federal agencies, and private conservation concerns rallied to return this Great Plains predator to the wild. But it also points out that, while varied, recovering species often has as much to do with bringing people together as using complex biological techniques.

Like the ferret article, others describe resource impacts and solutions that are tied to sources outside park boundaries. Water Resources Division Wetlands Program Leader Joel Wagner describes that at times external threats to water resources can be challenged by legislation designed to help us carry out our mission. Virgin Islands soil erosion and subsequent coral reef impacts are preventable, as researchers Lee MacDonald and Donald Anderson explain, but only with the involvement of islanders living outside the park. In each of these cases, research provides some answers, and the course to be taken in implementing the recommendations requires management skill.

On my mind is seeing the National Biological Service (NBS) succeed in providing us with high quality service. To this end, we begin a series of articles to help us understand how the NBS is organized and how to go about requesting technical assistance. This issue's introductory piece describing science centers in general will be followed next time, and every so often over the next couple of years, by individual science center profiles. The profiles will show the kinds of skills and park-relevant research conducted by the NBS and should help us make the appropriate new contacts for assistance. As a starting point, the science center list on page 31 may prove to be a useful reference in getting to know the available NBS products and services.

Rounding out the selections, paleontologist Vince Santucci sets the record straight on Gettysburg dinosaur tracks, a natural resource that has been misinterpreted for decades. Finally, while research is usually conducted in response to a particular need, its use is sometimes far greater than we could ever imagine. University of New Mexico Biologist Bob Parmenter relates a fascinating story about a connection between his baseline resource study data collected at Pecos National Historical Park and the recent hantavirus epidemic. What begins in parks to find answers to management questions often takes us elsewhere.

Jeff

Yellowstone Computerizes Rare Animal Report System

By Mark Johnson

Before the 1930s, Yellowstone National Park visitors, staff, and researchers recorded rare animal observations primarily in journals, Army scout diaries, Army station records, and administrative reports. During the 1930s, the agency began a more systematic system, with wildlife observations being recorded on wildlife observation cards. The system was further refined in 1986 with the implementation of the rare animal sighting form.

Though these observations contained very important information, the system made data analysis, sorting, retrieval, and summaries very tedious and time-consuming. In an effort to make data analysis more efficient, the Yellowstone Center for Resources updated and computerized the rare animal sighting report system in 1993.

The new computer database breaks down each sighting into 56 information fields that can be quickly sorted and retrieved. It can also be used in conjunction with the park GIS and is compatible with the U.S. Fish and Wildlife Service wolf reporting system and the National Heritage Project conservation data system.

The new program will make the sighting reports much more usable for research and management biologists, resource management coordinators, visitors, and contract researchers. For example, the U.S. Fish and Wildlife Service can use the new system as a tool to help determine if and when wolf packs become established in the Yellowstone ecosystem.

The new database consists of more than 1,000 records from 1986-95, ranging from species as small as amphibians and flying squirrels to as large as gray wolves and mountain goats. Wildlife observation records before 1986 will still be available for use manually, through the earlier wildlife observation card system. PS

Mark Johnson is a Wildlife Veterinarian with the Yellowstone Center for Resources.

NORTH ATLANTIC

Morristown National Historical Park, New Jersey, is the recipient of a $10,000 grant from the National Park Foundation. The park will use the money to conduct its first herbaceous plant survey. Working under a principal investigator contracted through Rutgers University, Garden Club of America volunteers will undertake a systematic inventory of all herbaceous species found in the park. The information acquired from the inventory will assist the park in determining the effect that deer browsing and the spread of exotic species are having on its herbaceous plant population.

MIDWEST

The West Branch Wapsinonoc Creek, which flows through Herbert Hoover National Historic Site in West Branch, Iowa, overflowed its banks several times during 1993. On August 16, the tributary damaged NPS facilities and property in one last, severe flood. At NPS request, the Iowa District of the U.S. Geological Survey (USGS) Water Resources Division conducted a flood risk analysis for the tributary through the historic site.

The analysis confirmed park vulnerability to periodic flooding. On August 16, 1993, the worst day of flooding, the tributary flowed at a peak of 1,650 cfs (cubic feet per second), whereas the capacity of the tributary in the park is limited to 650 cfs. The reading corresponds to a flood frequency discharge of a 25- to 50- year event. Several structures are at risk of flooding, especially the maintenance building, which could be flooded as often as every 10 years. Fortunately, the main floor elevations of the Hoover Library and birthplace cottage are above the 100-year flood elevations, although only by less than a foot.

This flood analysis demonstrates that the USGS is responsive to short-notice management needs for information that can be used in making informed management decisions. We hope that others will explore using their services in this capacity.

REFERENCE

Einhellig, P.E. 1994. Flood analysis, West Branch Wapsinonoc Creek tributary, Herbert Hoover National Historic Site, West Branch, Iowa. U.S. Geological Survey-Iowa District, Water Resources Division.

• • •

Bald eagles symbolize not only the United States of America, but also American environmental quality. Researchers recently developed a protocol for using the bald eagle as a Great Lakes air quality indicator species (Bowerman et al.). The Great Lakes Protection Fund provided grants to develop a protocol through two coordinated research and management studies: a broad, Great Lakes Basin study, and an intensive, localized study of northern Wisconsin.

The basinwide project assessed habitat quality, the role of environmental contaminants, and population dynamics of nesting bald eagles across the Great Lakes Basin. Researchers determined that bald eagles build nests primarily in white pines, except around Lake Erie where they use cottonwoods. Although potential nesting habitat exists along the shorelines of all the Great Lakes, it primarily exists along lakes Huron and Superior. Habitat availability, however, may limit the Lake Erie subpopulation, which has little unoccupied habitat and a high density of nesting eagles. Concentrations of p,p'-DDE or PCBs (polychlorinated biphenyls), but not mercury or selenium, were significantly (and inversely) correlated with regional reproduction and success rates. Concentrations of organochlorine compounds primarily regulate bald eagle reproduction levels along Great Lakes shorelines, whereas bird density-dependent factors regulate productivity in the relatively uncontaminated interior areas.

The intensive local study in northern Wisconsin assessed the role of food availability, weather, and contaminants on bald eagle productivity. Bald eagles nesting on the Lake Superior shoreline in Wisconsin experience significantly lower reproductive rates than those nesting more than 8 km (4.9 mi) *inland* from the Wisconsin lakeshore. The weight of evidence suggests that the most likely cause of lesser productivity on the Wisconsin Lake Superior shoreline is low food availability, with greatest effects measured in bald eagle pairs with two young; however, DDE remains a possible contributing factor.

The bald eagle biosentinel protocol appears to have great utility for organizations that wish to monitor ecosystem components, such as water quality. The state of Michigan has formally adopted the protocol to assess Great Lakes water quality. Later this year, the National Park Service and other federal agencies may adopt the protocol, too.

REFERENCE

Bowerman, W.W., M.W. Meyer, and J.P. Giesy. 1994. Use of bald eagles as ecosystem monitors of Great Lakes water quality: development of a biosentinel protocol. A companion report to Great Lakes Protection Fund Final Reports for Grants # RE792-3092-1 and # RE792-3092-2.

WESTERN

Staff from the regional office and Redwood National Park presented a paper at the annual American Geophysical Union meeting held in San Francis
The paper, "Pool developm
and sediment loads, Redwo
Creek, California," describe
sequence of pool destruction a
partial recovery in a river follo
ing catastrophic flooding a
sedimentation. Pools are an i
portant rearing and hiding ha
tat for salmonids, and populat
densities are associated with p
availability. This study do
mented the recovery of po
over several parts of the wat
shed for a 20-year period.

MID-ATLANTIC

Both Gettysburg Natio
Military Park (NMP) and Eis
hower National Historic S
(NHS) were established to ho
and preserve significant histo
events. Visitors have the opp
tunity to learn about these eve
in part, due to management
jectives adopted to maintain
historic landscapes of each a
However, staff now experie
difficulty maintaining the agri
tural character of these parks,
cause of significant a
sometimes total crop los
caused by white-tailed deer fe
ing. In addition, deer browse
tree seedlings, which threat
the perpetuation of the histo
woodlots.

Addressing these proble
park and regional staff release
draft environmental impact sta
ment late last November prop
ing white-tailed d
management. The draft was co
pleted after research documen
the effects of deer browsing
the historical resources of
parks. According to the A
1994 mean population estim
853 deer occupied the 11-squa
mile study area. The preferred
ternative described in t
environmental impact statem
proposes reducing deer numb
to 80 by increasing hunting
portunities outside the parks a

ıorizing agents to shoot deer
ıe parks. The deer population
ıld be maintained at or near
density by these methods.
roductive intervention (i.e.,
traception), when approved
leer population management,
d also be used in the mainte-
ce phase. The final statement,
ch should be completed this
ımer, will respond to any
ıments received. Manage-
t action could occur as early
)ctober 1995.

• • •

ssateague Island National
shore, Maryland, has com-
ed a draft environmental as-
ment that evaluates the effects
mplementing a program to
age the size of the feral horse
ulation there. Feral horses
act park natural resources.
National Park Service pro-
s to implement a fertility con-
program that uses porcine
a pellucida immunocontra-
ion. The horse population
ld be reduced to approxi-
ely 150 animals and would
maintained at these levels.
ıments will be considered to
rmine whether to proceed
the proposed management
native or prepare an environ-
tal impact statement.

• • •

set of three technical reports
irginia Tech investigators are
lable from Richmond Na-
al Battlefield Park, Virginia.
hnical Report NPS/
RRICH/NRTR-94/059,
History and Fuel Loads of
er Coastal Plain Forests, pre-
s the results of a study that
arched the history and influ-
e of fire on the park, deter-
ed the loading of dead and
n forest fuels in six forest
r types, and examined rela-
ships between the fuels and
vegetation to create fuel load prediction equations. The park forest cover types are described in Technical Report NPS/MARRICH/NRTR-94/060. Included in this report are discussions of specific vegetation management recommendations for meeting park management objectives. The form and function of park forested wetlands are the subject of the third report, Technical Report NPS/MARRICH/NRTR-94/061. During 1992, researchers conducted an inventory to determine the extent of jurisdictional wetlands within the park. They mapped each wetland, inventoried its vegetation, described soil features, and measured average monthly water table depth.

The species composition and structure of plant communities for two forested areas in Hopewell Furnace National Historic Site, Pennsylvania, are described in Technical Report NPS/MARHOFU/NRTR-94/062. Scientists measured trees, shrubs, seedlings, and ground cover from 1991-92 using 30 sampled 20 x 20 m (65.6 x 65.6 ft) plots in each historic stand. Fifteen of each set of 30 plots contain a central fenced 2 x 2 m (6.6 x 6.6 ft) subplot. The results of this study provide a profile of current conditions and background data for future long-term monitoring to determine the effects of feeding by white-tailed deer on forest regeneration. Similar plot systems are also in place at Gettysburg NMP and Valley Forge National Historical Park.

From 1984-86, researchers developed a multiparameter monitoring system emphasizing measurements, as opposed to ratings, and employed it in documenting and evaluating changes in resource conditions on 179 river campsites within Delaware Water Gap National Recreation Area, Pennsylvania. Findings from this survey revealed some problems and resulted in a number of management recommendations with respect to minimizing resource impacts being offered and implemented. Research staff refined monitoring procedures through additional research and reapplied them in 1991. Jeffrey L. Marion presents results in Technical Report NPS/MARDEWA/NRTR-94/063 that show a substantial reduction in all resource impacts assessed by the campsite monitoring programs. In particular, the total area disturbed by camping declined 50% from 1986-91. The report offers additional recommendations and options for management consideration.

Natural Resources Report NPS/MAR/NRR-94/003 describes a case study of public involvement in scoping for environmental impact assessment. The report presents the process used by Gettysburg NMP and Eisenhower NHS to obtain public comment regarding the intent to manage the white-tailed deer population in the parks. Managers chose to involve the public and obtain input in a number of ways, including the use of an informational meeting and a public meeting where they followed the nominal group process as opposed to the formal hearing format. The nominal group process involved soliciting comments from citizens using a structured small group technique in which participants of each group responded to a predefined nominal question. The result of the nominal group meetings was a series of prioritized lists of concerns.

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Accelerated erosion, sedimentation, and associated water quality impacts are ongoing processes at Colonial National Historical Park, Virginia, that affect natural and cultural resources. Additionally, stormwater management problems result in concentrated runoff from parking lots and roadways in and near the park and cause very high rates of channel erosion in gullies and streams along the James and York Rivers. To study these problems, the park recently arranged for North Carolina State University School of Forest Resources to begin an erosion and sedimentation study. Under the cooperative agreement, the investigators will develop a methodology for erosion and sedimentation management, using GIS, to be tested at Colonial and later applied at several other national park system areas. The study should identify area sediment sources, assess erosion severity, and lead to reduction of both sedimentation and erosion in and near the park.

Rocky Mountain

The Environmental Protection Agency (EPA) has initiated a new program to help prevent pollution from occurring in large geographic areas. A twist on the earlier agency focus of cleaning up polluted sites, the new program emphasizes prevention and is geared to foster healthy habitats and encourage ecosystem management. The new program led EPA staff in Denver to explore new ways of doing business with its partners on the Colorado Plateau.

More than a year ago, the Denver EPA office, which was working in national parks teaching pollution prevention techniques, suggested that we take a broader approach on the Colorado Plateau. Subsequently, the NPS Rocky Mountain Region and EPA Region 8 negotiated an in-

Continued on page 6

Continued

teragency agreement that encourages a broader approach for defining and managing healthy, sustainable ecosystems. We signed the Colorado Plateau Ecosystem Partnership Project agreement in August 1994.

Plateau residents are concerned about socioeconomic changes occurring in their neighborhoods. Newcomers seeking alternative lifestyles have shifted demographic trends, and basic economic activities have shifted to service the increasing number of tourists and recreationists. The growth of small plateau communities has placed demands on the ecosystem that may alter its health. Ironically, the exquisite landscape may be harmed by the very people who have come to enjoy it.

Recently joining the NPS-EPA effort are the NBS Midcontinent Ecological Science Center in Fort Collins, Colorado, and the NBS Field Research Station in Flagstaff, Arizona. Both organizations bring special expertise in helping to understand the dynamics of the Colorado Plateau. As part of the partnership, they will provide a clearinghouse function on existing data and conduct original research.

The Flagstaff personnel will help establish a framework to gather and disseminate data and information of use to all plateau researchers, residents, and managers. The clearinghouse function is needed because several plateau studies and inventories are underway simultaneously, often with groups unaware of near-duplicate efforts. Transferring data and sharing research findings is also an important component of the project. Staff will contact federal agency researchers and land managers, researchers in the academic community, tribes, communities, and individuals with plateau knowledge or project interest.

The staff in Fort Collins will gather information and develop models to help understand changing demographics, political culture, institutional frameworks, and economics. Understanding how we interact and make decisions is critical in finding the best means to sustain an ecosystem and the local social and economic environment.

A third effort is underway toward that understanding. The Colorado Plateau Forum is a gestating effort to locate a nongovernmental or special interest voice to represent the whole Colorado Plateau. The forum was initiated by the Western Area Power Authority and quickly joined by representatives of the Grand Canyon Trust, Bureau of Land Management, U.S. Forest Service, tribes, local communities and governments, Northern Arizona University, the National Park Service, and the Environmental Protection Agency.

The organization held a town hall meeting, endorsed and partially supported by the Colorado Plateau Ecosystem Partnership, in early March in Moab, Utah. Participants discussed regional commonalities, landscape changes, and the future of the Colorado Plateau.

The partnership continues to seek collaborators in the expanding effort to find broad solutions to what may seem like local problems. But as scientists have been saying since at least the 1930s, we must act locally while thinking globally in our efforts to understand nature's interconnections.

For more information on the Colorado Plateau Ecosystem Partnership Project contact Peggy Lipson or Bob Spude at the Office of Ecosystem and Strategic Management, Rocky Mountain Region, National Park Service, 12795 W. Alameda Parkway, Denver, CO 80225.

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Yellowstone National Park in cooperation with the Montana Air Quality Bureau and the NPS Air Quality Division recently installed air monitoring equipment at the West Yellowstone park entrance station and in the neighboring town of West Yellowstone. The equipment helped to quantify air pollutant concentrations in these areas. Dispersion modeling using snowmobile exhaust emissions estimates and local weather conditions showed the potential for exceedances of the National Ambient Air Quality Standard (NAAQS) for carbon monoxide (CO) near the park entrance and along park roadways during periods of high snowmobile traffic. The NAAQS for CO is 35 parts per million (ppm) for a 1-hour average or 9 ppm for an 8-hour average.

Air Quality Division staff installed CO and particulate monitoring equipment in mid-January and ran the tests through February 20 (for CO) and March 7 (for particulates), respectively. Data collected east of the park entrance showed air quality concentrations well below national standards for both CO and particulate matter. The maximum 1-hour CO concentrations through that period were less than 10 ppm. However, the worst case conditions (high snowmobile traffic with stable weather conditions) were not observed during the study period. Certainly, the potential for high carbon monoxide concentrations does exist near the entrance and along park roadways during high traffic periods (more than 300 snowmobiles per hour).

Most of the pollution measured at the west entrance station is directly attributed to snowmobile activity. Concentrations w highest in the mornings betw 8 A.M. and noon when snown biles entered the park and in late afternoon between 4-6 when snowmobiles returned town. During other times, pollutant concentrations w very low.

Although the measureme were legally acceptable, the p took actions this winter to red air pollution from snowmo emissions. For example, the p opened an express lane at west entrance during peak vis tion periods. Staff also reques snowmobile operators to turn their engines to reduce exha emissions while idling near Madison Junction warming Finally, the park encouraged erators to keep their snowmob in proper working order to m mize pollution. The park also s entrance passes in advance to t groups to minimize delays to reduce emissions near the trance station.

PACIFIC NORTHWEST

As indispensable as GISs for resource management ap cations, they can create proble for regional applications wh similar data types are coded ferently in different parks. For ample, Mount Rainier, No Cascades, and Olympic Natio Parks use different conventi for coding trail data, and Cra Lake plans to develop this d layer in the future. Some amo of standardization would be sirable, especially when data consolidated for regional use

Park and regional GIS spec ists recently met to discuss st dards for data theme names a attribute definitions. The vari methods for coding the same d result from user needs at the v ous parks. If needs are differ

Continued on page

A NEW PUBLICATION ON MIgratory shore and upland game bird (MSUGB) nagement is available, free of rge, to wildlife managers and archers. The International Asiation of Fish and Wildlife ncies has recently published gratory Shore and Upland me Bird Management in th America. This book is an ated version of their 1977 pubion entitled, Management of gratory Shore and Upland ne Birds in North America. 1977 version was updated ause substantial changes had urred in the status of several UGB species and important published literature had be- available since 1977. For se NPS units that manage one more of these species, this k can provide a wealth of erial. The book covers 14 spe-: mourning dove, white-ged dove, white-tipped dove, d-tailed pigeon, sandhill ne, American woodcock, mon snipe, American coot, mon moorhen, purple gall-e, clapper rail, king rail, Vira rail, and sora.

Each chapter covers a single cies and is written by one or re authors having years of exence studying that particular cies. Chapters are, for the most , similarly organized. As an mple, chapter seven discusses biology and management of American woodcock, Scolominor. This chapter begins n a description of the species provides methods for aging niles and adults. It continues n life history information on ng migration, courtship, nestfall migration, and winter sural. Discussions on breeding winter habitat use, distribuand abundance, harvest data, management and research ds round out the chapter. The gest drawback with this new publication is the decision to exclude nonhunted species. This means that none of our 40 or more migratory, breeding, nongame species are included.

If interested in obtaining a copy of this book, send requests to MSUGB Book, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville, Campus Box 218, Kingsville, Texas 78363.

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Results of published studies vary on which live traps are most effective in capturing small mammals. An unpublished M.S. thesis by Sonia Najera of New Mexico State University compared the effectiveness of Havahart and Sherman live traps in capturing lightweight rodents. Using 7.5 x 9.0 x 23 cm Sherman live traps (2.9 x 3.5 x 9.0 in) and 7.6 x 7.6 x 25.4 cm Havahart live traps (3.0 x 3.0 x 9.9 in), New Mexico biologists set traps in alternating sequence in 50-trap grids or transects. Traps were spaced 5 m apart (16.4 ft) and placed in moist-soil impoundments, sloughs, croplands, and along canals and ditch banks. The biologists set all the traps so that a minimum amount of pressure on the treadle would trigger the release mechanism, allowing capture of lighter weight rodents. After 600 trap nights, they moved the traps.

The authors trapped 4,889 rodents (including individuals of nine species) during 29,259 trap nights. The most common species captured (including recaptures) were white-footed mouse (*Peromyscus leucopus*–2,141), cotton rat (*Sigmodon hispidus*–2,127), western harvest mouse (*Reithrodontomys megalotis*–267), and meadow jumping mouse (*Zapus hudsonius*–164). Havahart live traps caught more mice weighing under 30 grams (1 oz). Conversely, Sherman traps captured more cotton rats, whose weights ranged from 70-200 grams (2.5-7.0 oz). Based on these results, the authors believe Havahart live traps are more effective in capturing lighter weight rodents, whereas Sherman live traps are more effective in capturing heavy rodents. However, Havahart traps comprised 85% of the 2,834 traps that malfunctioned (most were sprung, but empty). Sherman live traps could greatly reduce the time required to run trap grids and trap lines (they require less resetting due to malfunctions and collapse, making them easier to move).

REFERENCE

Najera, S.R. 1994. Meadow jumping mice habitat affinities and capture success in two trap types at Bosque del Apache National Wildlife Refuge. Unpublished M.S. thesis. New Mexico State University. Las Cruces, New Mexico. 86 pp.

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Biologists have often had trouble determining the causes for variations in wildlife populations and plant abundance and their interrelationships. In the wild, food chains prevail and transfer nutrients from the sun to plants, from plants to herbivores, and from herbivores to carnivores. A classic ecological chicken or egg question has always been whether plant abundance determines herbivore (and later carnivore) populations, or vice versa. A problem in finding the answer to this question is the difficulty in first finding an intact food chain that has a large predator, like the wolf.

Wildlife ecologist Rolf O. Peterson of the Michigan Technological University at Houghton, Michigan, and a research partner reported in the December 4 issue of Science (as excerpted from Science News) that they may have found an answer. Studying the interrelationships of moose and wolves at Isle Royale National Park for the past 35 years, biologists have learned much about the interactions of predator and prey. Recently, Peterson research team member Brian McLaren began to add vegetation to the analysis.

Specifically, McLaren noticed that balsam fir (a primary food of moose) growth rings narrowed periodically, indicating cycles of low growth that corresponded to high moose numbers. After graphing the suppressed tree growth periods with both wolf and moose population fluctuations, the scientists found an interesting correlation. Tree rings appear to narrow only after wolves decline and moose increase. More importantly, a 1-2 yr time lag occurs between a decline in wolves, an increase in moose, and suppressed growth in the balsam firs. In the early 1980s, Isle Royale wolves declined markedly, probably due to disease. After a few years, the moose population increased and browsed more heavily on the trees. A year or two later, the trees showed signs of stress.

Accordingly, the researchers have ruled out the idea that vegetation availability regulates moose on the island. Rather, they have subscribed to the notion of top-down regulation. Of course, the study requires more data, but Peterson commented that the study illustrates the broad "repercussions of a few top-level carnivores in an ecosystem."

Editor's note: It will be interesting to watch for changes in the Yellowstone aspen groves (commonly browsed by elk) following wolf release there. PS

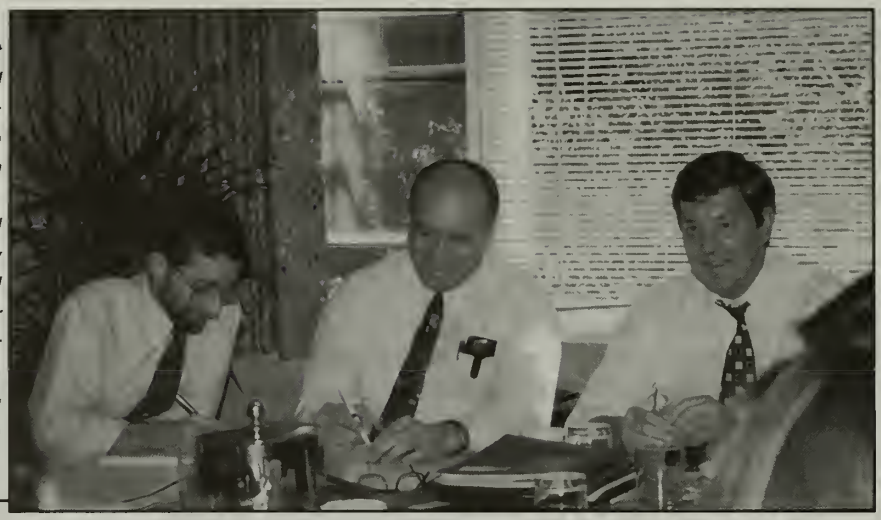

Figure 1. Assistant Secretary for Fish and Wildlife and Parks George Frampton (right), former Acting Associate Director, NPS Natural Resources, Denny Fenn (middle), and Shenandoah Center for Resources Leader Bob Krumenaker at the initial ad hoc working group gathering in October.

Report on the Ad Hoc Task Force on the Future of Natural Resource Management in the National Park Service

By Bob Krumenaker

In recent years, it has seemed as though NPS natural resource management has received lots of rhetorical support but not much else--the establishment of the NBS took away the momentum we had slowly and painstakingly gathered to strengthen our programs, and then restructuring plans appeared ready to sap us further. So when I read the Assistant Secretary George Frampton memo to the Director last fall approving restructuring only if we strengthened natural resources, I eagerly volunteered to be part of the ad hoc group he was forming to make it happen. This appeared to me to be the best--and possibly only--opportunity we would have for a long while to make major changes in the culture of the agency, to (in Frampton's words) make natural resources "flourish."

The ad hoc group convened in Washington last October, with high expectations. Sixteen of us, plus four assistants who became integral participants, attended. Denny Fenn, then Acting Associate Director for Natural Resources, chaired the panel. We came from parks, regions, the Washington Office, and the NBS. We were resource managers, scientists, park managers, planners, and policy people. Director Kennedy and Assistant Secretary Frampton gave us our charge that Monday morning to:

- Redefine natural resource management in the NBS era
- Suggest changes to the restructuring plan as needed to make natural resource management "flourish"
- Define the role of research in a post-NBS, restructured NPS, and suggest enhancements to the NPS-NBS relationship to help assure that our biological research needs are met, and
- Update the 1992 servicewide natural resources strategic plan

Frampton made it clear that he wanted specifics that could be implemented immediately, not a long and bureaucratic report. His enthusiasm and willingness to upset the status quo were infectious, though I think we were nonplussed by the enormity of the changes we were being asked to recommend and the sheer improbability of this opportunity.

Drafting the report required many rewrites before we were satisfied that we had found the right combination of substance, tone, and length to be most effective. Released in late January, this report:

- Articulates guiding p ciples for an enhanced n ral resource managem program
- Outlines a core progra natural resource mana ment services
- Enhances the visibilit natural resources at the director level
- Clarifies the role of the scientists in the new org zation, and
- Recommends reenginee a number of natural reso management processes

More specifically, the ad report recommends:

- Fully supporting, thro the budget process, Stewardship Today Parks tomorrow goa double resource mana ment staff by the year 2 and fully implementing approved Inventory Monitoring Program
- Using incentives to assure that na resource expertise and consideration part of major park decisions
- Increasing natural resource support for clusters to at least 11 FTEs (full- equivalent positions) and establishi research advisor and natural reso management associate director at field director office
- Strengthening the highly specialized pertise of the National Natural Reso Center (NNRC--presently the Wash ton Office Natural Resource Divisio Colorado)
- Accelerating natural resource profess alization in parks
- Preparing managerially skilled reso managers for career advancement
- Creating a national chief scientist p tion to act as liaison between us and NBS, USGS, and other agencies conduct research on our behalf, and ordinate all remaining natural reso research activities conducted interna
- Providing research liaisons to NBS gional offices through field directo fice research advisors

Continued on pag

Late Triassic Dinosaur Tracks Reinterpreted at Gettysburg National Military Park

'incent L. Santucci and Adrian P. Hunt

ONG BEFORE THE FOOTSTEPS OF UNION and confederate soldiers traversed south-central Pennsylvania, early di- urs left their footprints in ancient mud. ilized tracks preserve evidence that di- urs existed in the Gettysburg area over million years ago during a time pe- called the Triassic. The tracks also il- ate another example of a NPS unit, arily focused on cultural resources, must face the challenges of managing nterpreting paleontological resources. he dinosaur tracks are preserved in ks of mudstone that were quarried an area outside park boundaries. vever, the quarried blocks were trans- ed to the park and used in the con- tion of stone bridges during the 1930s. 37, over 50 additional tracks were dis- red in blocks from another nearby ry within Adams County. The park rintendent at that time was especially ested in the fossils and placed some isplay within the park. He encouraged pretation of the tracks and unofficially dinated distribution of some speci- s to the Smithsonian Institution, egie Museum of Natural History in burgh, and the State Museum of Penn- nia in Harrisburg. Today, the tracks nformally monitored by park rangers are interpreted by rangers and essioners alike.

ltogether, tracks are known from two ities in Gettysburg Basin, the Trostle rry in Adams County, and a smaller ry near Goldsboro in York County. All e discovered in the Late Triassic ysburg Shale, a rock formation that occurs within the park. These depos- ere laid down in a gradually deepen- rough of sediments that comprise the ark Supergroup.

he park files at Gettysburg National tary Park identify these fossil tracks as *llator* and *Anchisauripus*. However, e identifications are based upon inter- pretations recognized in the 1930s. Research into fossil tracks has advanced significantly over the past two decades and we are now able to offer a different interpretation of the Gettysburg tracks. The fossil tracks represent the ichnogenus *Atreipus* which was first described by Olsen and Baird in 1986. The tracks can be further identified to the ichnospecies *A. milfordensis*.

Atreipus milfordensis represents, as of yet, an undescribed dinosaur that exhibits a theropodlike pes (foot) in combination with a short-clawed and functionally tridactyl (three-toed) manus (hand). The track pattern indicates that this dinosaur habitually used all four limbs in locomotion. The manus track is incompatible with any known theropod (carnivorous, upright dinosaurs like Tyranosaurs, that usually have small forelimbs). Theropods have large trenchant manus claws that are designed for grasping, not walking. This pattern of manus and pes tracks is unusual and a condition not exhibited in any other described dinosaur tracks.

The tracks are recognized as dinosaurian because of the birdlike tridactyl pattern of the pes track (fig.1). This pattern, represented in the foot skeleton, is a derived character for dinosaurs. Olsen and Baird (1986) suggest that *Atreipus* may represent the track of a very early ornithischian (bird-hipped) dinosaur.

Late Triassic tracks are also known from Dinosaur National Monument and Petrified Forest National Park (Santucci & Hunt 1993). The Late Triassic was the phase of vertebrate history in which the dinosaurs first originated. Research investigations regarding fossil tracks provide information not available solely through the study of fossil bones and teeth. Tracks and trackways can yield information about behavior, locomotion, and paleoecology. Additionally, as with the Gettysburg fossils, tracks can yield information about animals that are not yet known from skeletal material. The presence of early dinosaur tracks at Gettysburg provides park rangers with the opportunity to interpret the local history well before the fateful days in July 1863.

Figure 1. Fossil manus and pes tracks of Atreipus milfordensis *from atop a stone bridge at Gettysburg National Military Park, Pennsylvania.*

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Vince Santucci is a former NPS Park Ranger and resource manager now teaching parks & recreation management, interpretive methods, law enforcement, and general resource management in the Department of Parks and Recreation at Slippery Rock University, Slippery Rock, PA 16047. Adrian Hunt is a Vertebrate Paleontologist in the Department of Geology, University of Colorado at Denver, Denver, CO 80217.

Figure 1. Capulin Volcano National Monument in northeastern New Mexico preserves this classic cinder cone volcano, now thought to be much older than before.

Capulin Volcano is Approximately 59,100 Years Old

Cosmogenic helium aging technique key to clearing up age old question

By William O. Sayre, Michael H. Ort, and David Graham

Capulin Volcano National Monument (fig. 1), located in northeastern New Mexico, preserves a small portion of the Raton-Clayton Volcanic Field. This field contains a surprisingly wide variety of volcanic rock types (Gust 1990). It is the easternmost Cenozoic volcanic field in North America, and is located near the intersection of the Rio Grande Rift and the Jemez Lineament, two zones of crustal weakness. These characteristics make Capulin Volcano an interesting subject for geologic research. Under a cooperative agreement between the park, the NPS Southwest Region, and the College of Santa Fe, we began a geologic research project two years ago. Park staff have been closely involved with the project and Mr. John Morrow and his family have provided access to their ranchlands for mapping lava flows. This report focuses on one facet of the research: the age of the volcano.

Volcanism in the Raton-Clayton Volcanic Field began about 8.2 million years ago and continued until Capulin Volcano erupted (Stormer 1972), the time of interest in our study. Previous attempts at determining the age of Capulin Volcano have focused on its relationship with the nearby Folsom Man site.

Age of the Folsom Man site

Archeologists excavated The Folsom Man site, located about 10 mi (16.1 km) from Capulin Volcano, in 1926. It is famous because the excavators found projectile points in direct association with the remains of an extinct bison (Bison antiquus taylori), indicating that humans were in this region much earlier than had been previously thought (National Park Service 1994). The find is in stream deposits (or alluvia) laid down by the Dry Cimarron River and its tributaries. Haynes et al. (1992) dated a composite sample of five discrete lumps of charcoal from this horizon (the sedimentary layer corresponding to human occupation) using accelerator mass spectrometry, and reported an age of 10,890 ± 50 years before present (B.P.). An earlier carbon 14 (^{14}C) determination on other charcoal yielded a date of 10,000 years B.P. (Muehlberger 1955), and the bison bones revealed a ^{14}C date of 10,260 years B.P. (Anderson and Haynes 1978).

Bryan (1937) was the first to study the geology of the Folsom site, and he identified two alluvial sequences, the lower of which is the Folsom occupation horizon. Charcoal from the upper one, also alluvial in origin, has a ^{14}C date of 4,350 years B.P. (Muehlberger 1955).

Nine miles down the Dry Cimarron from the Folsom site, Muehlberger (1955) identified Capulin Volcano basalt flows sandwiched between w
he interpreted as Brya
two alluvial depos
Hence, the Capulin er
tion was assigned an
range of between 10,
and 4,350 years B.P. S
correlation of stream
posits is very difficult, h
ever, due to discontinu
outcrops, and the date
never been considered
finitive.

Subsequent work sh
ed that this is indeed the case. Ander
and Haynes (1978) identified several
tinct alluvial deposits at the Folsom M
site, and they concluded that the basalt f
in the Dry Cimarron Valley overlies an
luvial sequence older than the Folsom
cupation horizon. They also made a
age determination that confirms this;
age of a baked organic soil from this o
unit yields a date of 22,360 ± 1,160 y
B.P. That was a minimum age; the ac
age could have been older due to conta
nation of the sample by modern p
materials.

Altogether, these studies indicated t
the eruption of Capulin Volcano took p
before 22,000 years B.P., and Folsom hu
ers probably did not observe the erupt
However, these previous studies did
date Capulin Volcano directly.

New age determination

In the most recent study, we determi
the age of a sample of Capulin basalt us
the cosmogenic helium technique. C
mogenic helium dates provide informat
on how long a particular rock sample
been within about 1 m (3.2 ft) of ear
surface (Cerling 1990). Cosmic rays p
duced by the sun and other stars en
earth's atmosphere and travel through
Some of the rays are slowed and stop
due to interaction with the atmosphere,
most make it to earth surface. These c
mic rays spall heavier atoms in the ro
splitting them into smaller atoms, es
cially helium 3 (^3He). The cosmic ray f
is relatively constant, and its small va
tions have been documented in de
Therefore, the production of ^3He, norm
a very scarce isotope, occurs at a stea
known rate at earth surface. The ^3He:
ratio, which compares the amount of c
mogenic helium (^3He formed by cos

bombardment) with normal helium
e, common in the atmosphere and
ks), is then used to determine the
unt of time a rock surface has been
osed to the atmosphere. A correction
ade for altitude and latitude to account
he effects of the atmosphere on cos-
rays.

areful sampling is required to date an
tion age. Researchers must first find a
sample that has been at the surface in
resent orientation since cooling. At
ulin Volcano, we sampled a lava flow
re near the volcano's boca, or mouth
2), that formed when lava was
ezed upward through a crack, creat-

Figure 2. Long ago, during eruption, cinders on Capulin Volcano gave way to lava that opened a vent near its base. Researchers collected a lava sample (below the rock hammer) at this vent or boca for cosmogenic helium dating.

thin spine. This feature has remained
is form, with scrape marks on its side,
the lava flow cooled. It also has a large
of lava rubble around it, with no trees
egetation to shield it from cosmic rays,
it is not in a position for deep snow
up. These circumstances lead us to
pret the cosmogenic helium date as
ge of the lava flow sample.

ur results indicate that Capulin Vol-
is 59,100 years old ± 6,000 years.
m dates can be younger than the true
of a volcano. As already mentioned,
nogenic helium in the rocks results
the amount of time the rocks are ex-
d to cosmic rays. Any rock shading
egetation, overlying soils, snow, etc.,
ld reduce the cosmogenic helium level
e rocks and would result in a younger
However, we carefully chose a sample
that we believe has been exposed to
tmosphere since Capulin erupted. We
therefore suggest that Capulin Volcano is late Pleistocene rather than Holocene in age.

Geomorphic analysis

The geomorphology, or shape, of Capulin volcano also indicates that it is not particularly young. Cinder beds at the outer edge of the rim of the volcano dip inwards toward the crater. If a volcano is young and little affected by erosion, we would expect outward dipping layers. As a volcano ages, outward dipping cinder beds on its rim are likely to be removed by erosion, leaving only the inward dipping portions.

A prominent 30-foot-thick spatter flow is located on the southeastern edge of the rim. A spatter flow resembles a normal basalt flow; however, it is formed by the agglomeration of small amounts of lava (spatter) thrown out of a vent and extends for only a short distance. The rim spatter flow is partially unsupported by cinder and juts out approximately 30 ft from the side of the volcano. If the volcano were young, we would expect the flow to be completely surrounded by cinder. In an older volcano, we would expect erosion to carry away some of the cinder, leaving the spatter flow exposed. Similarly, loose cinders form an apron around the volcano, indicating that they have had time to erode from the main cone, even though erosion is slow in this dry climate.

Further studies

The geomorphic observations and new age determination are compelling; however, we need to conduct further analyses to confirm that the volcano is older than previously understood. We plan to make an additional cosmogenic age determination (using aluminum instead of helium) and another researcher will make an argon-argon age determination. We have already carried out paleomagnetic sampling of the basalts, and will study these data. We plan to submit a final report of this project, including the additional age determinations and a discussion of the other elements of the project, for future publication in *Park Science*.

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Pecos National Historical Park Mammal Survey Data Help Solve Hantavirus Mystery

Figure 1. This adult deer mouse (Peromyscus maniculatus), *collected during the biodiversity baseline survey at Pecos, is several rodent species that carries hantavirus, an organism t causes severe respiratory collapse in humans. Rodent popul increased 10 times during 1992-93 spreading hantavirus and 45 people.*

By Robert R. Parmenter

In the autumn of 1992, the Pecos National Historical Park in northeastern New Mexico began a collaborative wildlife survey with University of New Mexico biologists Dr. Robert R. Parmenter and David C. Lightfoot. The purpose of the baseline survey was to evaluate the vertebrate and invertebrate fauna of the newly acquired Forked Lightning Ranch, which surrounds the existing park. However, with the survey only into its first year, a sudden and unexpected need for the wildlife data emerged.

In the spring of 1993, scientists at the Federal Centers for Disease Control and Prevention (CDC) in Atlanta enlisted the aid of the park project scientists to assist in identifying the ecological relationships of the recent epidemic of Hantavirus Pulmonary Syndrome (HPS) in the southwest. A previously unknown species of hantavirus (family Bunyaviridae) caused the newly identified disease that resulted in 45 deaths.

Hantaviruses comprise the virus group responsible for hemorrhagic fever in Asia and Europe. However, instead of the more typical kidney malfunctions associated with hemorrhagic fever, the new HPS virus (named "Sin Nombre"–Spanish for "without name"–by the CDC) caused rapid and severe respiratory collapse. During 1993, the mortality rate for HPS victims was near 60%. Originally thought to be restricted to the Four-Corners region of New Mexico, Colorado, Arizona, and Utah, the disease has now been documented in 18 states, spanning the continent from the west coast to Florida and New England.

Virologists at CDC identified the virus in June, 1993. The investigating scientists immediately suspected that, as with other Hantaviruses, the likely vector for the disease would be a rodent. Preliminary serological (blood) tests on field-caught rodents from the epidemic region revealed the presence of the virus in several species of deer mice (*Peromyscus* [figures 1 and 2]), wood rats *(Neotoma),* and chipmunks *(Eutamias)* (Childs et al. 1994).

In view of the rodent connection with this disease, medical investigators and public health officials needed ecological information on the deer mouse and other native rodent species. Anecdotal information from residents in the afflicted areas suggested that rodents were exceptionally abundant over the winter of 1992-93, and officials speculated that, if true, the increased potential for rodent-human contact and disease transmission might account for the sudden epidemic.

Biologists with the University of New Mexico and the National Park Service were the only scientists having long-term data on rodent communities in the region. At the request of the CDC and New Mexico Health Department, these researchers provided detailed demographic analyses from 1989-93 for the 22 rodent species inhabiting central and northern New Mexico. The data showed 10-fold population increases in various *Peromyscus* species, wood rats, and chipmunks during 1992 and early 1993. Population increases occurred simultaneously in grasslands, desert-shrublands, and woodlands. Comparisons of the rodent data to regional climatological data indicated that the rodent population dynamics were positively associated with the 19 El Niño and the above-average precip tation during the winter of 1992-93.

These results provided a possible a swer to the question of why the epider had occurred when and where it o With exceptionally high densities of dents in New Mexico in the spring 1993, the probability of human-rod contact was substantially increased, p mitting a concomitant increase in dise transmission. Parmenter presented study findings in mid-July, 1993, a Hantavirus conference at the CDC He quarters in Atlanta, and continued follo up monitoring into 1994.

In addition to addressing the prese day questions on rodent population namics, rodent specimens collec during the Pecos project have also c tributed to answering another questi Is the HPS Sin Nombre virus a "ne evolved" virus, or has it actually beer the region for years? The University New Mexico Museum of Southwest Biology routinely collects rodents museum specimens from all of its st sites. Under the direction of Dr. Terry Yates, Curator of Mammals, field cr collected tissue samples (heart, liver, l ney, spleen, lung, blood) and chrom somes from rodent specimens each y which were then archived in ultra-c museum freezers. University of N Mexico biologists are now collabora

The author holds an adult pinyon mouse
scus truei) during mark-recapture studies at the
historical park. The respirator, goggles, and gloves
dard equipment for rodent surveys now!

standing of the biology of hantaviruses in nature.

Researchers are also using the results of these analyses to develop rodent-virus sampling strategies and disease prevention plans for human populations. New techniques for dealing with rodents in field studies and human dwellings have been developed in collaboration with CDC scientists (e.g., Mills et al. 1995). They are employing predictive relationships to ascertain the likelihood of a sustained population outbreak for the rodents in New Mexico, and to estimate the effectiveness of possible control measures to reduce human-rodent contact. These predictions, along with continued up-to-date measurements of rodent populations at various New Mexico study sites, will contribute insights and direction to the strategies and contingency plans developed by regional public health officials to battle future HPS epidemics. PS

n UNM Medical School researchers CDC scientists in examining the ived rodent tissues to determine if the s has indeed been present historically, gh undetected, in the regional rodent ulations, or if additional new viruses present.

o date, we think that different "spe-" or strains of the virus infect differ- rodent genera, and that the logenetic relationships among the ent and virus groups exhibit a high ree of similarity; this indicates a po- ial coevolutionary history between ents and hantaviruses in North erica (see Hjella et al. 1994). Scientists still analyzing tissue samples taken n the park, along with even older ples from the museum and Texas h University. These studies promise ontribute considerably to our under-

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Regional Highlights Continued from page 6

coding methods are likely to be different, too. While consensus will be difficult, participants learned several data coding methods that will help improve consistency in future data development projects.

The group also discussed the new national metadata standard adopted by the Federal Geographic Data Committee last summer. The voluminous document that communicates the standard must be applied to all geographic data collected after January 1995. Complying with the standard has created such a large workload that the group discussed ways to reduce this burden. One suggestion was to create a database template that would ease data entry when compared with the typical word processor data entry method.

• • •

John Day Fossil Beds National Monument, Oregon, recently consulted with regional staff about the potential uses of a park GIS. High on the park list of needed GIS applications is paleontological research issues. A GIS could be used to maintain vertical and horizontal fossil location data and fossil locality and stratigraphic information. The system could also be used to track fossil prospecting events, which will help ensure that collections are not skewed to only known locations in the park. Other important resource-related uses for the system will be vegetation and fire management and integrated pest management. The park will principally use ArcView 2 software, although they plan to use PC ArcInfo for more complicated vector-based analyses.

Alaska Region

Several new regional publications are available:

Demma N.J., B.W. Dale, L.G. Adams, and K.B. Fox. 1994. Ecology and Demography of a density low wolf population in Yukon-Charley Rivers. NPS/AR/TR 94/21.

Dale B.W., L.G. Adams and W.T. Route. 1995. A relatively inexpensive aerial Moose survey technique designed as replacement to trend surveys. NPS/AR/TR 95/23.

Swanson, D.K. 1995. Landscape Ecosystems of the Kobuk Preserve Unit, Gates of the Arctic National Park, Alaska. NPS/ARRNR/NRTR-95/22. PS

Do Wetlands Regulations Help Protect Park Resources?

By Joel Wagner

National Park Service employees may have mixed feelings about federal wetlands regulations. At times, the regulations implementing Section 404 of the Clean Water Act and the NPS guidelines implementing Executive Order 11990 (Protection of Wetlands) seem unnecessarily convoluted–just more hurdles that slow progress on needed NPS construction and maintenance projects. At other times, these are the tools of choice for protecting park resources from destruction. So I pose the question: Do wetlands regulations facilitate or hinder the NPS mission?

Section 404 as a resource protection tool

Section 404 of the Clean Water Act includes a permit requirement for discharging dredged or fill material into "waters of the United States," including wetlands. Commonly known regulated activities include construction of building pads or road beds in aquatic habitats, but a court has recently ruled that mechanized land clearing and excavation activities are also regulated. The law applies to federal agencies, so we must comply with the same permit procedures required of private builders.

In evaluating the adverse impacts of a proposed activity during the permit review process, the U.S. Army Corps of Engineers (COE) must consider both on-site impacts (i.e., the amount and type of habitat directly displaced by fill) and off-site impacts (e.g., effects of drainage facilities on adjacent property or changes in downstream water quantity or quality). This latter aspect, consideration of off-site impacts, opens the door to NPS input and involvement in COE decisions on permits for projects that, although not on NPS property, may adversely impact NPS resources.

Figure 1. Construction of this drainage ditch in a housing development borde Islands National Seashore was halted using provisions in Section 404 of the C Water Act. Water Resources Division and park staff showed that this ditch wo drained a valuable park pine savannah wetland (right).

A proposed housing development bordering the Davis Bayou Unit of Gulf Islands National Seashore, Mississippi, provides a recent illustration of how the 404 permit process can be used as a tool for protecting park resources. In this case, the subdivision design submitted to the Corps called for a stormwater detention and drainage ditch immediately outside the park boundary (fig. 1). Unfortunately, the Corps did not contact the park regarding this proposal, and permitted the developer to proceed with construction during 1994 under the presumption that there would be no unacceptable impacts on NPS resources. The park first learned of the project after observing ditch construction and landclearing along the park boundary. After consulting with the NPS Water Resources Division regarding 404 regulatory procedures and effects of the project on the hydrology of pine savannah wetlands at Gulf Islands, the park convinced the Corps to issue a stop work order pending evaluation of impacts on this valuable wetland ecosystem.

The halt created some breathing room, during which we conducted groundwater drawdown analyses, provided additional policy-regulatory support to the park, and installed a network of observation wells to evaluate effects of the proposed development on pine savannah wetland hydrology (fig. 2). The Water Resources Divi also is funding a park-proposed stud analyze vegetation, soil, ground water drology, endangered species, and w quality components of this wetland system. Both the park and the Water sources Division believe that through 404 permit process, we can negotiat alternative plan with the developer assures that park resources will not be graded.

A word to the wise: contact the ap priate COE regulatory office to ensure they will notify the superintendent wh ever a regulated activity is proposed in vicinity of your park.

NPS wetland guidance in pa facilities planning

Executive Order 11990 is the basis most NPS wetlands policy. The order ognizes the loss of over 50% of nati wetland resources, and directs each fed agency to develop procedures to "minim the destruction, loss, or degradation of w lands, and to preserve . . . the natural beneficial values of wetlands in carrying the agency's responsibilities." In respo the National Park Service developed NPS Floodplain Management and W lands Protection Guidelines (45 Fed Register 35916). These guidelines di NPS managers to avoid actions with

This Gulf Islands pine savannah wetland ntly spared impacts from adjoining ent outside the park.

ntial for adversely impacting wetlands n there is a practicable alternative, and reserve, enhance, and minimize deg- tion of wetlands when no such alter- ves exist. If a project will adversely act wetlands, staff must attach a state- t of findings to either the finding of no ficant impact or final environmental act statement. The brief statement ex- is the reason for no practicable alter- ves to the proposed action and outlines gating measures to compensate for and loss.

ne wetlands guidelines acknowledge our agency mission is both to provide njoyment of the resources and to pro- them in perpetuity. That is, they do say that we absolutely must not im- wetlands in the course of construct- visitor facilities or that we absolutely t restore all wetlands that have been acted in the past. Rather, they facili- a balance in the mission with respect vetland resources, requiring only that S project planners seek locations and gns that avoid or minimize wetland impacts, while still meeting project objectives. The guidelines also provide managers with guiding principles when considering external proposals for activities or facilities in NPS units.

Easing compliance

One important step in streamlining NPS wetlands compliance occurred in 1994. In response to reports of delays in obtaining required approval signatures for wetlands statements of findings, the director delegated signature authority to regional directors, with Water Resources Division concurrence. Early indications are that this change has eased the compliance process.

Another way to minimize compliance workload is to gather wetland data early in the park planning process. National Wetland Inventory maps, while not of sufficient scale and accuracy for final compliance purposes, are useful as a first step in eliminating undesirable development sites from consideration. Subsequent steps may include wetland reconnaissance by a knowledgeable NPS employee or obtaining services of a professional wetland delineation contractor. Experience shows that it is far easier to avoid wetlands impacts (and the need for subsequent compliance steps) when adequate data are available as alternatives are being developed.

Section 404 of the Clean Water Act clearly facilitates NPS resource protection as illustrated by the Gulf Islands case. For NPS-proposed facilities with potential impacts on wetlands, internal wetlands guidance also facilitates our mission by helping to strike a balance between visitor use and resource protection. The National Park Service has taken steps recently to streamline our internal compliance procedures, and the Water Resources Division will continue to look for opportunities to make the process more efficient.

Joel Wagner is the Wetlands Program Leader for the Water Resources Division in Lakewood, Colorado. His phone number is (303) 969-2955.

Ad hoc report continued from page 8

- Developing a budget initiative to establish NBS field stations within all NPS areas with significant natural resources, and
- Developing methods to ensure that NPS research needs are served by the NBS

By the time our February 15 briefing of the assistant secretary rolled around, the restructuring effort had made it clear that our recommendations would be considered only in light of mandated FTE reductions. Furthermore, we were asked to recommend actions that could be taken now whether or not the natural resource program can flourish. Despite these limitations, the briefing went well, and both the assistant secretary and director agreed in principle with the findings and recommendations of the report. Both also indicated that they want to do something positive for our programs in response.

The ad hoc working group deliberations, the resulting report, and the recent briefing represent a positive step forward for NPS natural resource management in the restructuring effort. Still, we are not sure exactly what will result. A number of additional steps (including March national leadership council consideration of field director offices, system support offices, the National Natural Resource Center, and other central office staffing) must be taken before we will know the ultimate outcome of the ad hoc working group's recommendations. As stated by the assistant secretary, the issue has now been "crystallized" and discussions on this matter are "to be continued."

Bob Krumenaker is the Leader for the Center for Resources at Shenandoah National Park, Virginia, (703) 999-3491.

Ferrets continued from front page

proximate cause of decline is habitat loss due to prairie dog control programs, diseases, and land use changes over the past century. Biologists estimate that prairie dog distribution today is less than 5% of its historic levels. During the early 1970s, attempts at captive breeding with animals from the dwindling South Dakota population failed and the last captive animal from that population died in 1979. As such, biologists considered the black-footed ferret extinct until 1981 when another population was discovered near Meeteetse, Wyoming. Following outbreaks of sylvatic plague and canine distemper in 1985-86, biologists removed the final remaining 18 individuals from the wild to attempt another captive breeding program.

The U.S. Fish and Wildlife Service 1988 *National Black-Footed Ferret Recovery Plan* adopted goals to increase the captive breeding population to 240 breeding adults and to establish a prebreeding population of 1,500 free-ranging adults in 10 or more populations with no fewer than 30 breeding adults in any population. The plan also encouraged the widest possible distribution for reintroduced populations. Subsequently, an intensely successful breeding program at seven facilities in the United States and Canada increased the captive population in excess of 240, the number expected to retain 80% of the genetic diversity of the founders for 200 years. From 1991-93, biologists released 187 ferrets under a nonessential experimental population designation in Shirley Basin, Wyoming. This designation provides flexibility by allowing biological manipulation of the population for recovery purposes.

In 1994, the National Park Service, U.S. Forest Service, and U.S. Fish and Wildlife Service suggested reintroducing the ferret into the Conata Basin-Badlands prairie dog complex of southwestern South Dakota in an interagency environmental impact statement. The Fish and Wildlife Service published a final rule on August 18, 1994, designating a nonessential experimental population area. Subsequently, each agency signed a separate record of decision to implement the preferred alternative to reintroduce black-footed ferrets in Badlands National Park in the fall of 1994. Our goal for South Dakota is to reintroduce 40 black-footed ferrets each year for 5 years beginning in 1994.

Reintroduction

Site Selection and Preparation

During spring 1994, we selected three black-tailed prairie dog colonies (415 park hectares or 1,025 acres), also known as towns, as locales for fall ferret release (fig. 2). Altogether, approximately 3,726 ha (hectares, or 9,200 acres) of suitable prairie dog colonies exist in or adjacent to the park and lie within the prescribed 17,010 ha (42,000 acre) reintroduction area. We chose the release towns based on habitat quality, juxtaposition within the overall complex, remoteness from visitors, and field crew accessibility. A subtle complication was the reintroduction site location within the Badlands Wilderness Area where mechanical transport is prohibited and approximately 550 bison range freely!

We stratified release sites across the three colonies based on topography, level of prairie dog activity, and potential impact to cultural resources. We used a helicopter to airlift over 4 tons of supplies used in constructing 28 release cages-bison exclosures several months before the ferrets arrived. From June through August 1994, we were busy live-trapping and quarantining, for a 10-day minimum, 675 black-tailed prairie dogs. Following veterinary inspection, we sent prairie dogs to captive breeding facilities to give ferrets an opportunity to imprint on (become familiar with) them. In the park, we posted advisory signs telling visitors of the impending reintroduction activities.

Ferret Allocation

Project biologists recommended that a minimum of 20 male and 20 female juveniles be released initially, based on known ferret survivorship data fr Wyoming and South kota. In July 1994, the and Wildlife Service a cated 38 juveniles and adults with unknown ratios and we subseque received 32 juveniles male:12 female) and three-year-old adults male:2 female). Of these were imprinted on live p rie dogs and burrow tems at Sybille Wildlife Conservation Education Center and 19 were unfa iar (naive) with prairie dogs, having b cage-reared at Metro Toronto, Phoe and Henry Doorly Zoos. Project bi gists worked with NBS scientists and erinarians at the two zoos and education center to fit radiotelem

Figure 2. Black-footed ferret reintroduction sites within Badlands National Park, South Dakota.

Figur in po kept in a ferre arriva

e enough to hold a radio collar a briefly anesthetized ferret, s a custom fit from park staff nds reintroduction site. Other llars at zoos before their

Figure 4. Reintroduction staff, carrying ferrets and other supplies, begin a 3-mile hike to the release sites. A minor complication of the reintroduction was the prohibited use of mechanical transport means in delivering materials to the wilderness area release site.

Figure 5. Inside a bison exclosure, staff prepare a typical nest box, including food tube and underground vault (not shown), for black-footed ferret habitation. Corrugated tubing simulated prairie dog burrows and connected the underground vault to the cage above.

rs on 16 ferrets (fig. 3). Upon arrival e park, staff backpacked ferrets di- to their preselected release cages 4). The park encouraged local me- o cover the arrival of the ferrets.

t Husbandry

e captive-bred ferrets used in the roduction came from two different grounds relative to their familiarity prairie dogs, and this necessitated we use two different release strate- accordingly. We held the naive ani- in release cages for a minimum of ys with a minimum 5-day post re- cage-attending period (soft release) rmit them to return to the cages for ded meals. We held preconditioned printed animals in a release cage for ximum of 48 hours with no post- se cage attending (semihard release). All cages included a single nest box (aboveground), food tube, water bowl, and double-sided nest box located in an underground vault and connected to the aboveground cage by 4-in diameter corrugated plastic tubing (fig. 5). Staff examined the ferrets, attended the cages, and collected data on food consumption, ferret and radio collar condition, vault and ground temperature, and weather (temperature, precipitation, air pressure, wind speed). We fed the ferrets approximately 150 g (grams, or 0.4 lb) of black-tailed prairie dog daily.

Cage attendants released the ferrets near sunset by placing a length of 4-in diameter plastic tubing between the cage and nearest active prairie dog burrow (fig. 1, page 1). Although they immediately left the site, attendants reported seeing two ferrets exit the release tube and go directly down a burrow.

Monitoring

Late-summer and early-fall ground temperatures in the Conata Basin-Badlands were hot, reaching over 100° F and averaging 90° F during September. Belowground vaults averaged 75° F during September afternoons and greatly improved conditions for the ferrets during the prerelease phase. In October, the underground vault and aboveground nest box temperatures dropped to a 52° F average.

Badlands National Park operated nighttime aerial telemetric missions along with NBS assistance in telemetry use, training, and study design. Altogether,

Continued on page 18

staff conducted six missions, 3-5 hours each, in parallel with ground telemetry over a 21-day period following release. We detected a total of 62 individual locations, 97% of which occurred within the three release colonies. A majority of telemetric locations (70%) were collected during the first week following release. We noticed that animals moved freely among the three release colonies, but believed their movements within the first 3 weeks after release to be limited to less than 8 km (5 mi). During this time, one radio-collared animal dispersed approximately 8 km (5 mi) and then shed its collar. We also retrieved two other radio collars, but detected no mortalities.

Project staff and volunteers conducted spotlight ground surveys on 21 colonies or focal areas within the reintroduction area (including snowtracking in outlying colonies) over 11 nights from November 28-December 10 (fig. 6). We detected eight ferrets by spotlighting, representing a minimum 22% survivorship 26 days after the last ferret was released; although low, this percentage exceeds the 30-day postrelease survivorship goal of 20%. Before release, we had implanted very tiny transponders (equipped with unique numeric codes) subcutaneously in each ferret to facilitate subsequent identification. After trapping seven of the eight animals and weighing them, we electromagnetically *scanned* each transponder to identity each ferret. Postrelease survival for the identified ferrets ranged from 21 to 82 days, with 71% being preconditioned. Movements of five animals were limited to the three release colonies, while the three other animals moved up to 8 km (5 mi) into adjacent active prairie dog colonies. Subsequently, snowtracking efforts detected several ferrets.

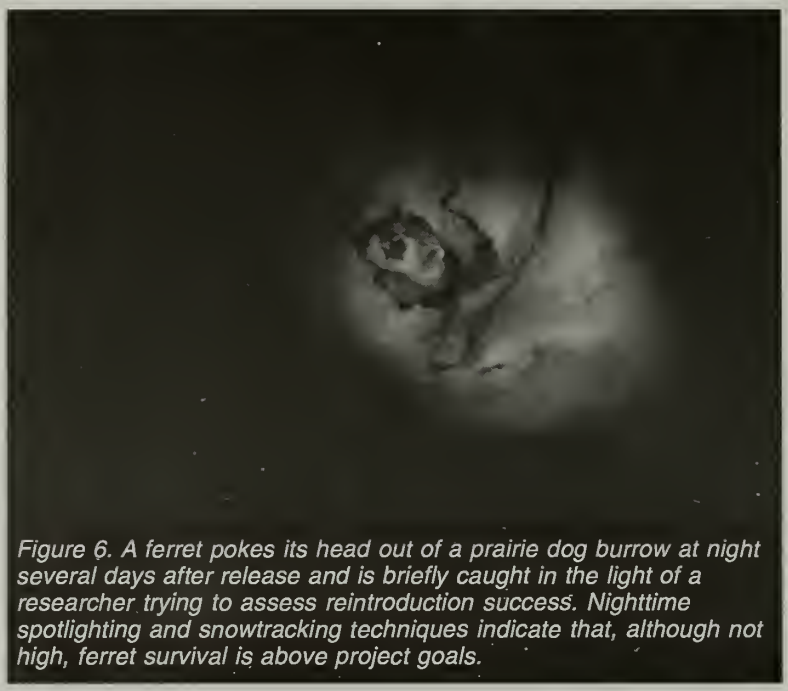

Figure 6. A ferret pokes its head out of a prairie dog burrow at night several days after release and is briefly caught in the light of a researcher trying to assess reintroduction success. Nighttime spotlighting and snowtracking techniques indicate that, although not high, ferret survival is above project goals.

Summary

Recovering the black-footed ferret to a point of delisting is a daunting task. Reintroduction requires maintenance of partnerships and a large contribution of time and resources. At the regional scale, the probability for recovery is a function of available habitat, and habitat lost during the last century is not likely to be recovered. Since 1900, the historic range of the prairie dog has been reduced by approximately 95%, due to disease, agricultural practices, and urban development. Compared with 1870, prairie dogs now occupy only 2% of their historic range (Anderson et al. 1986, *in* Great Basin Naturalist). If the prairie dog ecosystem of the Great Plains is further eroded and fragmented, ferret recovery will become more desperate.

While reintroduction efforts like this help tremendously to recover the ferret, a basic question still remains. Can the black-footed ferret persist in the wild today and in the future under regional land use practices that rendered it nearly extinct? Hope for its recovery lies in the continuation of a strong, but flexible, Endangered Species Act and a prevailing commitment to the conservation of regional prairie dog ecosystems.

Epilogue

Ferret reintroductions continue t year in South Dakota, Wyoming, a Montana. However, the U.S. Fish a Wildlife Service recently released bud priorities for fiscal year 1996 and beyc that jeopardize the captive ret population, the future av ability of reintroducti animals, and the national covery program.

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Dr. Glenn E. Plumb, former Assistant Director of the NPS-University of Wyoming Research Center (CPSU), is Badlands National Park Wildlife Biolo Bruce Bessken, winner of a 1994 regio natural resource management award fo his role in facilitating the ferret reintroduction process at the park, is Ch of Resource Management at Badlands. Paul Marinari, Biotechnician, served a field coordinator-data manager during project and has been involved with fer management since 1989. Contact them Badlands National Park, P.O. Box 6, Interior, SD 57750-0006, (605) 279-2464. Final results of this study will be presented in an April report.

Developing Natural Resource Bibliographies: A Servicewide Project

By R. Gerald Wright and Marilyn Ostergren

ESOURCE MANAGERS HAVE LONG REC-
ognized the need for organized
park-specific information in anno-
bibliographic databases as a precur-
o sound park management and
ing. However, efforts to initiate such
ıcts over the years, have, with the ex-
ɔn of a few parks, largely been unsuc-
ıl. This failure has primarily been
se of limits on the time and money
ıted for such activities, personnel
ers between areas in the park system,
disrupts the continuity of efforts, and
ck of an automated technology to
ɔrt such products. In 1984, Gerry
t at the University of Idaho CPSU
ɔped a plan for a resource biblio-
ic database project in the Pacific
west Region. This project proposed
"mini-computers" and commercial
ase software, technologies which
hen available at universities and were
being introduced into the parks.
Natural Resources Preservation Pro-
eventually funded this project in 1987.
red individuals to travel to each of
arks, computers in hand, and scour
raries, vertical files, local agency files,
ny other information sources sug-
by the park staff or identified in their
s in an effort to find items that would
nterest to researchers, managers, and
reters in the park under study. Project
ntered citation information and as-
ed data along with a few sentences
lain what information was found in
ocument (particularly important
documents are untitled or contain
ıation not alluded to by the title) and
bed where the document was held.
roject went through several iterations
project managers and park advisors
upon the level of detail for each ci-
. This took anywhere from a few
to several months for the work to
mpleted at a given unit. Using the
E database management software,
mpleted this first round work in 1991.
992, the National Park Service initi-
ts comprehensive Inventory and
oring (I&M) Program and published the *Natural Resources Inventory and Monitoring Guideline (NPS-75)*. At the same time, the National Park Service adopted the Pro-Cite bibliographic software as the servicewide standard for resource bibliographies. As a start, the I&M Program funded a pilot project to convert the existing Pacific Northwest park bibliographies to Pro-Cite, install the software on park computers, and provide training on its use. Now the combined Pacific Northwest 16-park database contains almost 9,000 records.

Pro-Cite proved to be a very suitable medium for park resource databases. It is flexible and able to accommodate the wide variety of information typically found in park files. It is menu driven, relatively easy to use, and meshes well with word-processing software like WordPerfect.

Beginning in 1994, the I&M Program, under the direction of its 10-year strategic plan, began to provide funding to selected regional offices for completing natural resource bibliography projects in their selected parks. These projects are to use the format and specifications developed by the Pacific Northwest Region. The goal of the 10-year program is to compile a basic set of resource data for the approximately 250 park units that contain significant natural resources.

Inventory and Monitoring Program staff selected three regions for funding in 1994: Alaska, Rocky Mountain, and Southwest. Projects in several parks in all of these regions have been completed or are now underway. The Alaska Interagency Resource Library is directing the Alaska Region project, the Center for Colorado Plateau Studies at Northern Arizona University in Flagstaff and the Natural Resource Ecology Lab at Colorado State University in Fort Collins are codirecting the Rocky Mountain Region project, and the CPSU at the University of Idaho is directing the Southwest Region project. Funding for all the remaining regions will begin in 1995.

The ultimate goal of the project is to make park-specific information accessible to those who need it. Resource managers and researchers will be able to sit down at a computer and quickly pull up a list of books, maps, journal articles, unpublished reports, and even memos related to a given subject along with a brief description of each document and where that document can be found. Equally as important, the bibliographic database provides a framework for keeping park resource information organized and up-to-date obviating the need for projects like this in the future. The program has been integrally tied to the efforts of–and relied upon the support of–park-, regional-, and Washington-based NPS librarians, and it will rely on their expertise to assure that the databases are maintained in the future.

We have been excited to see the original goals set for the Pacific Northwest Region (idealistic at the outset) become, after more than a decade, a reality in a growing number of parks. Plans are now underway at the University of Idaho CPSU to convert the Pacific Northwest, Southwest Region databases, and possibly others to CD-ROM format. One day, in the not so distant future, if all goes as planned, a servicewide resource bibliography should be available on CD-Rom. Actions are also underway to convert other NPS databases, such as the cultural resource bibliography, to Pro-Cite, making them compatible with the natural resource bibliography.

For further information on this program, contact Larry Pointer, the NPS natural resource bibliography coordinator, at (303) 225-3541. PS

R. Gerald Wright is the National Biological Service Unit Leader for the Cooperative Park Studies Unit at the University of Idaho Department of Wildlife Resources in Moscow. Marilyn Ostergren is Research Associate there, and they can be reached by calling (208) 885-7990.

Satellite Radiotelemetry and Bird Studies in National Parks and Preserves

New data-gathering technique provides alternative for studies of wide-ranging wildlife

NPS ILLUSTRATION B

Figure 1. Small, lightweight, and sophisticated, radio transmitters now communicate with orbiting satellites to relay locations of wide-ranging wildlife species to researchers in their offices. Using this technology, scientists recently learned that Alaskan peregrine falcons winter as far away as Argentina.

By Michael W. Britten, Carol L. McIntyre, and Mary Kralovec

Radiotelemetry has revolutionized wildlife study allowing researchers to identify and locate individual animals remotely. Wildlife scientists have used telemetry for many purposes, including estimating population size and demographic parameters, identifying habitat use, and documenting daily activities and migration and dispersal patterns.

Until recently, most telemetric studies relied on very high frequency (VHF) radios and required ground or aircraft tracking. This conventional radiotelemetric technique is only possible when the transmitter and receiver are close together, usually within about 30 km (19 mi), and nothing, such as a topographic feature, obstructs signal transmission. For animals that move long distances or inhabit remote areas, the high cost of locating radio-tagged individuals limits sample size and, consequently, research results. In these cases, a relatively new research tool, satellite radiotelemetry, may be more appropriate.

Satellite radiotelemetry for tracking wildlife

Satellite radiotelemetry tracking uses special transmitters or platform transmitter terminals (PTTs) worn by wildlife (fig. 1) and receivers on board polar orbiting satellites. The PTTs are located using the Doppler effect, a shift in the frequency of radio waves caused by changes in the relative velocity of the transmitter and receiver as the satellite orbits the earth.

This technique is a cooperative effort between the user, the National Oceanographic and Atmospheric Administration (NOAA), and Service Argos, Inc. Argos, established in a 1978 agreement between NOAA, the National Aeronautics and Space Administration, and the French Space Agency, is a global satellite-based location and data collection system dedicated to environmental applications. Argos receives, processes, and transfers data to the user via electronic mail (including NPS CC:Mail), telephone modem, and fax.

How satellite telemetry works

All PTTs transmit a unique code within their 401.65 MHz signal. As the orbiting satellite "rises" and comes into "view" of a PTT, the satellite picks up the signal identifies the transmitter. The Doppler fect increases the received frequency as satellite approaches. Once the satellit directly overhead, its velocity relative to transmitter is zero and the Doppler ef is absent. As the satellite moves away fr the PTT, the frequency shifts lower. An determines the PTT location by solv the simple relationship between the D pler effect and the angle between the P and the satellite several times during satellite pass.

Location accuracy depends on sev factors including oscillator (frequency s erator) stability, accuracy of the estima satellite location in space, PTT elevat and satellite pass duration. Argos class the data as class one, two, or three co

ding to locations within 1,000, 350, 50 m (1,094, 383, and 164 yd, respecy) of true location. Accuracy suffers never assumptions used to determine ransmitter location (e.g., that the carfrequency is really 401.65 MHz) are ted. In wildlife satellite telemetry the smitters are small and batteries are resulting in poor signal quality and curate locations. For many locations, s gives no estimate of accuracy; howall wildlife locations are classified ining reasons for the inaccuracies. Fancy (1988) assessed the accuracy of satelletermined locations for PTTs at vn locations (some attached to capanimals) and found a mean error of m (907 yd) and a maximum error of m (5.5 mi). In their assessment, 90% e reported locations were within 1.7 1 mi) of the true location. Clark (1988) sured location accuracy of PTTs in ming and Montana and found one dard deviation of 541-645 m (592-705 espectively).

T USES OF SATELLITE IOTELEMETRY

he Argos system has been most heavily by oceanographers, meteorologists, hydrologists for applications such as ing both water and wind currents and ills and relaying hydrologic data from te watersheds. The first successful aptions in wildlife research involved y, bulky instruments designed for ing oceanographic buoys and weather ons (Fancy et al. 1988). An 11.3 kg b) satellite radio collar was used to an adult female elk *(Cervus canadensis)* 9 days in Wyoming in April 1970 ighead et al. 1972). ghead et al. (1971) moni- temperature and light sity in the winter den of ck bear *(Ursus americanvith* a satellite transmitpowered by automobile ries) placed outside the In March 1977, Lentfer DeMaster (1982) used 5.6 kg (12.3 lb) smitters to track polar bears *(Ursus timus)* by satellite.

rly PTTs were too heavy for tracking s. Gradually lighter and smaller PTTs developed and used to track larger s such as bald and golden eagles *liaeetus leucocephalus* and *Aquila chrysaetos*) (James D. Fraser. 1994. Virginia Polytechnic and State University. Blacksburg, Virginia. Personal communication), swans (*Cygnus columbianus*) (Higuchi 1991), cranes (*Grus vipio and G. monacha*) (Higuchi 1992), storks (*Ciconia ciconia*) (Berthold 1992), and albatrosses (*Diomedea exulans*) (Weimerskirch 1993).

Scientists have also studied marine species using satellite telemetry, including loggerhead sea turtles (*Caretta caretta*), dolphins (*Stenella attenuata*), and basking sharks (*Cetorhinus maximus*) (Fancy et al. 1988). Unfortunately, both conventional and satellite telemetry are limited for marine animal studies because water rapidly attenuates radio signals. Some researchers have attached satellite transmitters to floats trailing behind and above the study animal to solve this problem.

Limitations

Satellite radiotelemetry is not currently appropriate when the scale of the movements being studied is small (e.g., habitat use or home range size). The smallest satellite transmitters currently available weigh between 25-30 g (0.9-1.1 oz), limiting their use for small birds (less than 1,000 g or 35 oz) or other small animals. Data can be delayed 20 minutes to 3 hours before being processed by Argos and relayed to the user. Because the satellites are in polar orbit, there are more frequent data collection periods near the poles than near the equator. For example, at 65° north latitude (approximately the latitude of our peregrine falcon studies) the satellite passed overhead an average of 22 times each day, whereas at 30° north the average dropped to nine overpasses per 24 hour period, and at the equator only seven per day. Finally, PTTs cannot be located by researchers using conventional telemetry, making removal and recovery of transmitters difficult. Battery power also limits the use of small transmitters; however, the PTTs can be programmed to transmit at specified target intervals to extend battery life. For example, for the peregrine falcon study, we programmed the PTTs to transmit 8 hours every other day during fall migration and 8 hours every 2 weeks during winter to conserve the expected 500 hours of battery life.

Costs

Satellite telemetry is expensive, with each transmitter costing between $1,800-$3,500 (the PTTs used in our studies cost $2,700 each). We paid Argos approximately $1,000 per PTT for 500 hours of data transmission . By comparison, conventional telemetry is also costly. VHF transmitters cost $150-$350 each, and a receiving system (receiver, antennae, and optional scanner) costs $750-$3,500. Ground tracking requires at least one observer or automated tracking stations, and associated costs. Costs increase dramatically as the study area increases. If large, aerial tracking and associated aircraft, pilot, and fuel costs, becomes necessary. Aerial tracking is also risky for the observer and pilot, as reported in the last issue of *Park Science,* and is a cost that should always be considered. Furthermore, studies of highly mobile species require scientists to mark and track more animals, due to emigration.

Sometimes, satellite telemetry is a cheaper research alternative. No ground observer, tracking vehicle, receiver, aircraft, or pilot is required. Data entry costs nothing and produces no transcription errors (data are received in ASCII text files). Unlike conventional telemetry, satellite radiotracking costs do not increase with the size of the study area and the chances of "losing" animals that leave the tracking area are minimal. Kralovec (1994) found that the cost of locating one bald eagle per day in southeast Alaska was lower using satellite telemetry ($19.39 per location) than conventional telemetry ($33.32 per location).

...Only satellite telemetry provides a means to document entire migratory routes–from Alaska to Argentina and all points in between

Continued on page 22

Satellite telemetry continued

Compared to mark-recapture techniques, satellite telemetry is more efficient. In bird banding studies, for example, recapture rates are very low, often less than 1%, requiring that many animals be marked to achieve adequate sample size. Using satellite telemetry, barring transmitter and harness difficulties, all marked animals can be remotely located and identified. For example, in our study of the migration routes of adult female peregrine falcons, we successfully tracked 11 of 15 marked birds during fall migration and nine of the 15 to their wintering sites. In three cases the birds appeared to have removed the transmitters.

Satellite telemetry is not subject to the same bias as mark-recapture and conventional telemetry methods; once an animal is marked a researcher can relocate it almost anywhere. Researchers have little difficulty discriminating between mortality and emigration.

Tracking birds using satellite telemetry

Juvenile golden eagles in Denali National Park, Alaska

In 1987, the National Park Service began a study of the nesting ecology of golden eagles in Denali National Park, Alaska. One objective was to determine the migratory routes and wintering areas of juvenile birds. Toward this end, we banded juvenile eagles and tagged three nearly fledged golden eagles (one in 1990 and two in 1992) with 90 g (3.2 oz) PTTs using a backpack-style harness. We successfully determined the autumn migration routes and wintering area for two of the young eagles.

In 1990, the first study eagle left the park on September 23 and moved along the northern edge of the Alaska Range until it turned south near Whitehorse, Yukon Territory, Canada. From October 1-17, the bird continued south through interior British Columbia and into east-central Idaho. Between September 23 and October 17, it moved 2,530 km (1,569 mi) from its Denali nest (an average of 97.5 km or 60 mi per day). The eagle remained in east-central Idaho on the western side of the Bitterroot Mountains from October 17, 1990, through February 18, 1991, the last transmission date.

In 1992, a second study eagle left the park on September 27 following nearly the same route as the 1990 bird. However, it crossed the Canadian Rockies and turned southward near Lesser Slave Lake in Alberta. By October 16, the bird passed Saskatoon, Saskatchewan, and on October 22, crossed into northeastern Montana. The eagle remained there until the last transmission on January 18, 1993.

Most golden eagles in interior and northern Alaska are migratory. While these birds may spend as much as 5 months (October through March) away from their breeding grounds, they follow unknown migration routes and winter in unknown locations. Mike Kochert of the Bureau of Land Management in Boise, Idaho, commented in a 1994 conversation that some researchers feel that winter food supplies may be an important factor determining reproductive success of golden eagles. Determining the wintering locations of golden eagles from Denali, therefore, has become an important objective of the current nesting ecology study. Our data, collected by satellite telemetry and banding during this study, provide the only data on migratory pathways and wintering areas of juvenile golden eagles from Alaska.

Bald eagles in Glacier Bay, Alaska

In 1991, Glacier Bay National Park and Preserve and the U.S. Fish and Wildlife Service (FWS) began monitoring the long distance movements of bald eagles using satellite telemetry. The park asked us to determine the movements of adult and fledgling eagles from Glacier Bay, identify their wintering sites, and evaluate the feasibility of using satellites to monitor the movements of free-ranging eagles.

We tagged three adult bald eagles with PTTs in October and November, 1991, and also tagged three and four 8-10 week old nestlings in August 1991 and July 1992, respectively. We attached the 76-157 g (2.7-5.5 oz) PTTs, with an estimated battery life of 12 months, using a backpack harness. We also attached 18 g (0.6 oz) tail-mounted conventional VHF transmitters to the adult eagles to confirm the satellite determined locations.

Adult bald eagles remained near their nests on a year-round basis with short forays to salmon streams inside and outside the park. Two of the three adults traveled to the Chilkat Bald Eagle Preserve, o 60 km (36 mi) northeast of Glacier B for 1-2 months. Using conventional tele etry at the Chilkat River, we found and sually confirmed locations of the adu obtained by satellite. After visiting the b eagle preserve, both eagles returned to th nest sites in Glacier Bay where we ag verified their presence using conventio telemetry.

Fledgling bald eagles left Glacier Bay a longer period and moved away from t park in a southeasterly direction. Six of t seven fledglings left the boundaries of t national park and preserve and were n located there again. Within 4-6 weeks fledging, four of the fledglings traveled the bald eagle preserve where they mained for 1-3 months before leaving i southeasterly direction. We subsequen located the four fledglings throughc southeast Alaska, with one traveling Prince Rupert, British Columbia, a distan of over 430 km (267 mi) from its natal t ritory in Glacier Bay. One fledgling ea appeared to remain in Glacier B throughout the winter and early spri This young eagle moved between its na territory and various salmon streams in a near the national park.

By using satellite-monitored transm ters, we recorded the movements of bc adult and fledgling eagles as they mov within and outside the park. These patte were similar to those seen in other b eagles studies in southeast Alaska. We termined that Glacier Bay bald eagles not year-round residents and identified areas outside the park that they used. B eagle management must transcend p boundaries and include not only regio but also national and international c cerns.

Gyrfalcons on the central Seward Peninsula, Alaska

In 1992, the National Park Service gan a study of the autumn and win movements of juvenile gyrfalcons (*F. rusticolus*) from the Seward Peninsula western Alaska as part of the sha Beringian heritage program. In 1992, tagged two gyrfalcons with 45 g (1.6 PTTs in a pilot study to determine if th birds could be tracked by satellite. 1992 results were successful and in 19 we continued the work by tagging se juvenile gyrfalcons from three nests. T

we used 30 g (1.1 oz) PTTs attached backpack harnesses. We observed the ns carefully after attaching the PTTs found that birds appeared to fly nor- with no noticeable negative effects the PTT or harness.

e are very excited by the results from esearch as they are the first to docu- regular movements of gyrfalcons een Alaska and Russia. Four of the radio-tagged birds crossed the Bering and moved into eastern Russia within eks of fledging; three of the four even- returned to winter in Alaska. One however, moved over 3,500 km (2,170 long the southern coast of Russia and ered in the Shantar Island region in ea of Okhotsk (fig. 2). Although band- lata documented a similar long dis- movement of a juvenile gyrfalcon the Seward Peninsula to the chatka Peninsula in 1971, only satel- elemetry provides a means to docu- the entire migratory route.

her new or noteworthy observations ded the lack of directionality in the ements of the juvenile gyrfalcons from atal area, the independence of sibling ements, movements of juvenile gyrfal- corresponding to changes in the dance of prey, long distance move- s of juvenile gyrfalcons within 3 hs of fledging and the tendency of ile gyrfalcons to use coastal and ri- n areas, where prey may be more dant, in autumn and winter.

ese results provide the most current nation on the movements of juvenile lcons in Alaska. Of the nearly 500 gy- ns banded in Alaska only five have recovered away from their original ing site (Swem et al. 1994). While recoveries provide important data on novements of Alaskan gyrfalcons, the ical costs associated with banding 500 lcons over 20 years are staggering. lts from the current study show that ite radiotelemetry is a cost efficient ffective research tool for studying the ements of large birds in remote areas.

EGRINES IN YUKON-CHARLEY ERS NATIONAL PRESERVE AND N CANYON NATIONAL REATION AREA

1993, the National Park Service and U.S. Fish and Wildlife Service began a erative study of the autumn and win-

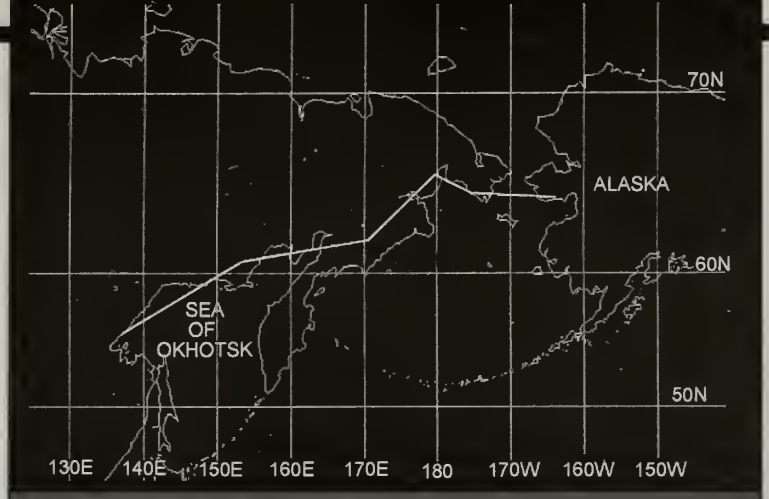

Figure 2. Movements of a juvenile gyrfalcon from Seward Peninsula, Alaska, to Shantar Island, Russia, September to October 1993.

Figure 3. Peregrines in the Alaska and Glen Canyon studies flew without signs of discomfort or hindrance while wearing the satellite transmitters.

ter movements of adult female peregrine falcons *(Falco peregrinus anatum)* that breed in Yukon Charley Rivers National Preserve, Alaska, and Glen Canyon National Recreation Area, Utah and Arizona. In 1993, we tagged two birds from each breeding area with 25-30 g (0.9-1.1 oz) PTTs after the breeding season in a pilot effort to determine if satellite telemetry was feasible to study their migration. Upon release, the birds appeared to fly and hunt normally and seemed unaffected by the transmitter and harness (fig. 3).

Figure 4 on page 24 shows the migration routes of the study peregrines. We tracked the birds through the fall and winter and found that one of the Alaska birds departed in late August and migrated through central North America to southwest Florida where it wintered. The other Yukon-Charley falcon also departed in late August and migrated through central North America, continuing through Mexico to its wintering site in eastern Honduras. In September, the first Glen Canyon bird migrated to the west coast of Mexico, and in early October, we lost its signal. The other Alaskan falcon also departed in September and spent several weeks on the west coast of Mexico before continuing to its wintering site in Nicaragua.

Three of the four pilot study peregrines returned to their territories to breed the following spring and summer. Two were still wearing their PTTs, batteries exhausted, which we removed upon recapturing the birds. The birds appeared healthy and showed no signs of wear or ill effects from the harness or PTT. The fourth bird, identified by its coded color band, had dropped its PTT. We refurbished the recovered transmitters with new batteries (at a cost of $100) for future use.

We initiated the full study following the success of the initial tracking efforts with additional funding provided by the Air Force through the Department of Defense Legacy Resource Management Program. The objectives of the ongoing research are to document the autumn migration routes, any important stopover sites, and wintering areas of peregrines from the two study areas. We will also document and compare

Continued on page 24

differences in migratory patterns and behavior between the high latitude breeding population in Yukon-Charley and the temperate latitude population in Glen Canyon.

Figure 4. Migratory routes and wintering sites of adult female peregrine falcons from Yukon-Charley Rivers National Park and Preserve and Glen Canyon National Recreation Area. Routes from the pilot fall 1993 to winter 1993-94 study are labeled; all other routes are from peregrines studied the following autumn and winter.

In July 1994, we deployed PTTs on 11 adult female peregrines in Yukon-Charley. Three of the birds appeared to drop their transmitters in the park before migrating. The others left the area in late August, with one traveling to British Columbia before we lost its signal. The remaining seven birds migrated to their wintering areas in Cuba, southern Mexico (two birds), El Salvador, Costa Rica, Brazil, and Argentina (fig. 4).

Results of this study indicate that the wintering range of Yukon-Charley peregrines is larger than suggested by band recoveries; more birds winter in Central America and the Caribbean than previously known, and at least some of the Glen Canyon peregrines migrate and leave the United States in the fall and winter. The only previous data, four band recoveries, give no indication that peregrines in the southwest leave the country in winter. Our results shed light on the risks of pesticide contamination to peregrines along their migration routes and on wintering grounds, areas where the use of dangerous pesticides is not regulated as strictly as in the United States. This information bears directly on consideration of proposals to reclassify the peregrine falcon under the Endangered Species Act.

Conclusions

Satellite radiotelemetry proved to be the most efficient research tool available for these projects and will be extremely useful to other researchers interested in the broad-scale movements of larger birds and mammals. The equipment and data costs are high, but the cost per location may often be less than conventional VHF telemetry. The relative cost depends on the species involved and the size, terrain, and remoteness of the study area. Satellite telemetry allows researchers to follow animals almost anywhere regardless of ecological conditions and political boundaries and reduces the number of animals that must be marked to answer most research questions.

Technological advances are also making satellite telemetry more useful. Recently, satellite transmitters have been coupled with global positioning system units to allow extremely accurate locations to be relayed automatically by satellite. In the near future, smaller (20 g or 0.7 oz) PTTs and lightweight solar powered transmitters will be available, including ones with additional sensors (e.g., altitude). Finally, as demand increases, PTTs and satellite telemetry will become less expensive and more important as a tool for wildlife studies. PS

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Skip Ambrose of the FWS Fairbanks office initiated the peregrine, gyrfalcon golden eagle studies. Layne Adams wit the NPS Alaska Regional Office participated in the gyrfalcon and golde eagle studies. James Fraser of Virginia Polytechnic and State University helpe with the golden eagle study, and Dr. Patricia Kennedy of Colorado State University assisted in the peregrine stu

THE HAWKSBILL TURTLES OF BUCK ISLAND REEF NATIONAL MONUMENT:

A Shared Caribbean Resource

ZANDY-MARIE HILLIS

SITUATED NEAR THE CARIBBEAN ISLAND of Saint Croix in the U.S. Virgin Islands, Buck Island Reef National nument is home to a small popula- n of nesting hawksbill sea turtles *etmochelys imbricata)*. Interested in ir nesting activities and seasonal and g-term migration patterns, we began research the turtle in 1988 using a rk-recapture tagging technique. Our mate goal is to develop an effective nagement strategy for this endangered cies.

n the mark-recapture phase of the ject, park staff conducted nightly nest- beach patrols each July through Oc- er from 1988-94 and found hawksbill les returning to nest both within the son and following multiyear intervals. ring this time, we tagged 81 individual ting hawksbill turtles. Of these, 41 e returned to the park for one or more eding seasons. The majority of nest- females returned to nest on an aver- of 2- to 4-year intervals, with only female returning in 1994 after just 1 r. According to cumulative recapture a, we can anticipate that 50-80% of all ged hawksbill turtles will return to nest he park in a subsequent season.

Even after prolonged periods of ab- ce, individual turtles exhibit a very h degree of fidelity to park nesting ches and to specific sections within 1.4-km long (0.9 mi) nesting habitat. ese sections, approximately 300-m 8-yd) long, equal the average length ny one of the three distinct park nest- beaches, and are defined by eroded ms, fallen trees, and rock walls or cliffs. wksbill turtle nesting fidelity is com- able to that reported for green, log- head, and flatback sea turtles. This phasizes the need for careful manage- nt of all sea turtle nesting beaches.

Although hawksbill turtles had proven ir fidelity to Buck Island Reef during study, we had no clue as to where they were coming from. When the program first began, local information and other NPS marine field census studies indicated little to no sightings of adult hawksbill turtles around the monument prior to or after the nesting season. To date, no hawskbills have been seen around either Buck Island Reef or Saint Croix outside the breeding season, and none of the park-tagged turtles have been observed nesting at other patrolled rookeries in the Caribbean.

> *Despite their fidelity to Buck Island Reef, we had no clue where they were coming from*

In 1991, the National Marine Fisheries Service Miami Laboratory reported that the national monument-tagged hawksbill "QQD-033" was recovered from the Miskito Cays, Nicaragua, Central America. A student there had purchased the tag and returned it to the National Marine Fisheries Service return address. We believe that this hawksbill was captured by a fisherman, and we presume it is dead. This was our first monument tag recovery, and the long distance traveled by the turtle automatically raised questions about species migratory range. Individual hawksbill turtles repeatedly return to nest at the monument, and we now had preliminary evidence that they were traveling vast distances to do so.

In 1991 and 1992, we conducted both radio and satellite telemetry tracking studies to identify turtles locations between nestings and to determine whether or not they migrate between feeding and nesting areas. From both boats and stations ashore, we tracked the turtles using radio and sonar telemetry. We found that nesting females reside in nearshore waters (within 1-1.5 km of the monument) between nestings. At the end of the nesting season, after laying three to five egg clutches, four turtles fitted with transmitters disappeared beyond radio range. During the 1992 season, a cooperative NPS-U.S. Fish and Wildlife Service satellite tracking study of seven nesting turtles showed that nesting females dispersed from the park to different regions in the Caribbean at the end of the nesting season. All evidence indicates that hawksbill turtles nesting on Buck Island Reef National Monument do not live in the adjacent reef environment, but are migratory!

Marine turtle conservation is not accomplished solely in the isolation of a nesting beach. To be sure, Caribbean nesting beach studies must organize efforts by standardizing field methodologies and reporting tagging study results to a common regional database where tag recoveries can be coordinated. Studies also need to determine the location of feeding grounds and migratory routes to and from nesting beaches, and provide for their protection. The information gathered by the park and other Caribbean hawksbill projects is critical to understanding our shared hawksbill turtle population and is essential to the management and preservation of this highly migratory species. Finally, this research emphasizes NPS long-term responsibility in maintaining the hawksbill nesting and foraging habitats at Buck Island Reef National Monument.

Zandy-Marie Hillis is with the National Park Service and can be reached at Buck Island Reef National Monument, P.O. Box 160, Christiansted, Saint Croix, U.S. Virgin Islands 00821-0160, (809) 773-1460.

An Investigation of Sediment Sources Affecting Marine Resources at Virgin Islands National Park

By Donald M. Anderson and Lee H. MacDonald

Virgin Islands National Park encompasses more than half of the 50-square kilometer (19-square mile) island of Saint John in the West Indies of the Caribbean. The park also incorporates 23 square kilometers (8.9 square miles) of surrounding marine waters. Popular with tourists, the national park offers a tropical setting, white sand beaches, and diverse ecological communities, including coral reefs. In 1976, UNESCO designated the park an international biosphere reserve, thus focusing additional scientific attention on the natural resources of the island.

Unfortunately, valuable park natural resources are threatened; declining health of the coral reefs surrounding Saint John is of particular concern to park managers. Investigations suggest that coral growth rates have slowed substantially this century (Hubbard et al. 1987). Increased production and delivery of fine sediment to the marine zone is one suspected cause, as coral reefs are highly susceptible to chronic increases in suspended sediment and turbidity (Rogers 1990).

Accelerated development of private and public lands on the island is a likely source of sediments to the marine environment. In 1993, we initiated a study of sediment sources and transport on Saint John through a cooperative agreement with the NPS Water Resources Division and with the help of Trish Patterson of the Southeast Regional Office. The principal objectives were: 1) to identify and map areas of low, medium, and high erosion susceptibility; 2) predict delivery rates of sediment to the marine environment; and 3) recommend practices for minimizing erosion and sediment delivery to the offshore zone. We also wanted to develop a set of analytical procedures integrated with a geographic information system that could be used by the park and the territorial government to assess erosion hazards and sediment sources.

Erosion and sedimentation on Saint John

Saint John is a rugged island characterized by small, steep watersheds, intermittent streams, and many small bays (fig. 1). Over 80% of the island has slopes in excess of 30%. The island supports predominantly dry evergreen and moist forest vegetation, the distribution of which is strongly influenced by elevation and the persistent easterly trade winds. Soils are generally very shallow (<50 cm or 20 in) and exceptionally stony.

The brief field component of our study in late 1993-early 1994 focused on assessing the relative importance of different erosion processes on Saint John and evaluating current sediment delivery rates in a historical context. The excavation of a 40-year-old sediment basin, the assessment of long-term sediment accumulation in conjunction with sea level rise, and the analysis of sediment data from other studies (e.g., Nichols and Brush 1988) led us to conclude that long-term sediment yield, under natural conditions, is about 20, and no more than 40, metric tons per square kilometer per year (57-114 short tons per square mile per year, respectively). This is quite low in comparison to rates reported for many tropical environments (Anderson 1994).

The low rate of erosion and sediment yield on Saint John is probably due to predominantly dry soil conditions (a result of generally brief showers and high evapotranspiration rates), associated low rates of bedrock weathering, and ubiquitous stony soil surfaces that protect the soil aga rainsplash and runoff erosion. Our field connaissance and inspection of air pho also revealed that landslides and de flows are unusual on Saint John, des the very steep slopes and occasion heavy rainstorms.

In contrast, human activities have gre accelerated erosion and sedimentat rates (fig. 2). Our observations indicate although plantation agriculture was a nificant sediment source in the 18th 19th centuries, the rapidly-growing work of unpaved roads is by far the gr est source today. We estimate that m than 100 km (62 mi) of roads exist on S

Figure 1 (above). The Rendezvous Bay area of Saint John is typical of island terrain: steep, forested, and replete with intermittent streams and many small bays.

Figure 3 (right). Dr. Lee MacDonald inspects what once was a smooth road surface. Unpaved roads like this require frequent regrading to remain passable, regularly replenishing the supply of erodible sediment.

Approximately 50 km (31 mi) of unpaved roads, them crudely bulldozed on steep terrain, Saint John Island; they provide a ready source le soil to be carried bayward during longer- rainstorms.

John, and that less than half of these are paved. These roads, many of which are crudely bulldozed access routes to homes, are commonly established at grades of 10-20%. The deeply incised road surfaces, obvious instability of sidecast material, and large quantities of accumulated sediment attest to the severity of road erosion (fig. 3). Unpaved roads on Saint John generally require frequent regrading to remain passable to vehicles, and this regularly replenishes the supply of readily erodible sediment.

Modeling road sediment production

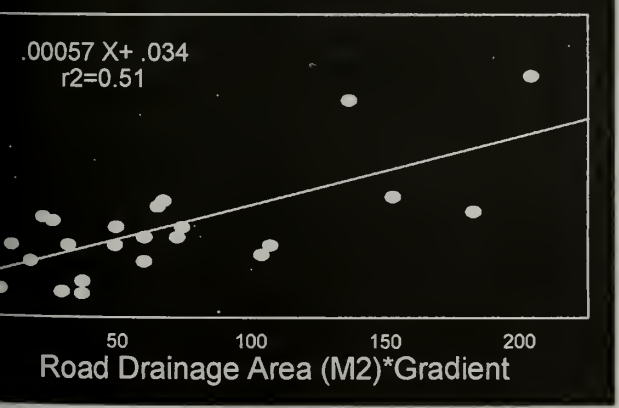
Many studies in temperate and tropical environments show that roads often are the primary source of sediment from rural and forest lands (e.g., Hafley 1975; Ward 1985; Scatena 1993). Road-derived sediment can be generated in a variety of ways, including the erosion of cut and fill surfaces, landslides caused by alterations in slope drainage and stability, and erosion from road surfaces. Our study focused on the latter mechanism, as this was the most obvious and probably largest source of road-derived sediment on Saint John.

We estimated road surface erosion rates at various sites by measuring the cross-sectional road erosion and determining the time since the road was last graded. These measurements indicated that at least 1-2 cm (0.4-0.8 in) of material erodes from the surface of most unpaved roads each year. The erosion rate increases as the runoff-contributing road surface area increases and slope steepens. Figure 4 shows the erosion rate results from 23 study sites in one 6.1-square kilometer (2.4-square mile) catchment.

Linear regression indicates that road grade and drainage area together explain 51% of the variance in road surface erosion (expressed in cubic meters of removed material per linear meter of road per year). Other variables such as road use and road surface characteristics would probably account for some of the unexplained variability in the figure. Unfortunately, limited field time precluded a quantitative investigation of additional variables.

We formalized and largely automated our estimation procedures by writing a program in C, a popular computer programming language, that integrates the regression relationship illustrated in figure 4 with road data compiled using a commercial GIS package (Anderson 1994). This program, called ROADMOD, will allow the park to predict the quantity and location of sediment delivered from a specified road network. Required input data include the width, slope, surface, and drainage characteristics of each road segment.

Erosion rates on unpaved roads in the Fish Bay nt show a correlation with road grade and contributing inage area. Erosion increases with slope (in decimal and road surface area (in square meters).



We applied ROADMOD to road data gathered in the Fish Bay watershed of Saint John (fig. 5–page 28). This catchment has been subject to extensive home building and road construction. Careful mapping of all roads and culverts in this catchment allowed us to estimate the total road surface erosion and the portion of this sediment that is delivered into and through the stream network. The results suggest that road surfaces are responsible for approximately a fourfold increase in average annual sediment delivery to Fish Bay. This is a conservative estimate and does not include erosion from road cuts, fill slopes, or other development activities.

Taking these and other factors into account, we estimate that unpaved roads are increasing the islandwide amount of sediment delivered to the marine environment by a factor of two to ten. This finding has crucial ramifications for resource protection at the park.

Modeling surface erosion susceptibility

At NPS request, we also produced a map showing relative surface erosion susceptibility on Saint John. The purpose of this map is to help land managers identify areas that are particularly susceptible to erosion should vegetation be removed.

We determined erosion susceptibility from three variables: surface erodibility, hillslope gradient, and contributing drainage area. We determined surface erodibility from soil maps and descriptions provided by the Natural Resources Conservation Service (former Soil Conservation Service). Slope gradients and drainage areas for a 10 x 10 m grid of the entire island were estimated using digital elevation data and automated GIS terrain analysis techniques. We included no vegetative cover factor, because we were interested in the likely erosion rate following clearing for development or other purposes.

We used a modified version of the revised Universal Soil Loss Equation (Renard et al. 1991; Moore and Wilson 1992) to predict spatially distributed erosion susceptibilities. Although this equation is not designed or fully validated for steep, forested, tropical regions, it is a widely accepted tool for assessing relative erosion potential. The

Continued on page 28

sensitivity of our predictions to topography and the resulting patterns of surface runoff give us some confidence that this map can help land managers guide development away from areas most prone to surface erosion.

Sediment control practices

Because roads have a disproportionate impact on terrigenous sediment production (oceanic sediment derived from land sources) on Saint John, most of our recommendations address this source. For example, we recommend against the construction or widening of additional roads on the island, and we recommend that existing dirt roads be paved as soon as possible.

Other recommendations address the development review procedures currently in place for the territory of the Virgin Islands. For example, we are troubled that proposed subdivision developments on Saint John are not, as of this writing, subject to a formal public review, despite the great public interest in maintaining healthy marine ecosystems. Effective protection of the marine resources at Virgin Islands National Park will require coordinated efforts by both the National Park Service and the Virgin Islands territorial government.

Follow-up work

This project is part of a larger NPS investigation into the effects of land use on marine resources at the park. Complementary work includes a paired watershed study of stream discharge and sediment delivery by the U.S. Geological Survey, and the collection of turbidity and other water quality data around Saint John by the National Park Service.

The progress we made in identifying and quantifying sediment sources on Saint John greatly enhances our understanding of park marine sediment delivery problems, but much remains to be done. For example, the delivery of sediment from hillslopes, stream channels, salt ponds and mangrove lowlands to the marine environment remains poorly understood. Sediment production from road cuts, fill slopes, and roadside ditches also merits further investigation.

The National Park Service, the National Biological Service, the nonprofit Island Resources Foundation, and the U.S. Environmental Protection Agency have expressed interest in supporting additional research of these issues, and we hope that valuable follow-up work will be performed. However, the results to date already point to the primary source of accelerated sediment production on Saint John. Problems caused by roads can and should be immediately corrected if the marine resources of Virgin Islands National Park are to be adequately protected for future generations.

Figure 5. Road sediment delivery map of Fish Bay predicted by ROADMOD. Heavy lines represent the road network, dotted lines the elevation contours, and numeric values the road sediment delivery volume in cubic meters per year. Roads in the lower left part of the map are paved and have no sediment delivery values.

Donald Anderson is a Hydrologist with the National Weather Service National Operational Hydrologic Remote Sensing Center in Minneapolis, Minnesota, and is a recent M.S. graduate of the Colorado State University Watershed Science Program. Lee MacDonald is an Associate Professor of Land Use Hydrology in the Department of Earth Resources at Colorado State University, Fort Collins, Colorado. *Dr. Bill Dietrich of the University of California at Berkeley provided invaluable assistance during the field component of this project. Virgin Islands National Park and the Island Resources Foundation provided important logistical support.*

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NBS Science Centers: Networking a Key for Technical Assistance

Agencies armed with the best knowledge of NBS structure and a good understanding of agency science centers are likely to receive the best service

THE EDITOR

THE NATIONAL BIOLOGICAL SERVICE began operating in November 1993 with staff from the National Service, Fish and Wildlife Service, Bu- of Land Management, U.S. Geologi- Survey, Bureau of Reclamation, and ers, to provide the scientific understand- and technologies needed to support nd management and conservation of onal biological resources. Several ma- objectives figured in the formation of agency: to increase efficiency in pro- ng biological information and support and managers, to improve objectivity esearch, to anticipate and avoid eco- cal disasters while enhancing natural urce management, and to improve data lity.

n its first year-and-a-half, the agency has ked toward the difficult task of creat- an organization that satisfactorily serves lient agency needs. In this time, high lity long-term research has progressed ly; however, technical assistance has n well below our needs. For parks to uccessful in getting good technical as- ance requires that we tell them our ds as identified through the resource nagement planning process. To do this, need to know how they are organized who to call.

he National Biological Service is orga- d around a directorate in Washington, ., that handles the programmatic ar- of research, information and technol- services, inventory and monitoring, several administrative functions. To y out most of the activities related to earch and technical assistance, the ncy formed four regions, Western, lcontinent, Southern, and Eastern, (fig. hose regional directors entered on duty ebruary. Regions are organized geo- hically, and generally render assistance lient agencies from the states that make he region. Within regions the NBS op- es science centers, an agency strength,

Figure 1. NBS regional boundaries, regional offices, and science center locations.

that manage the research (the biggest program area), inventory and monitoring, information and technology dissemination, and technical assistance activities in support of client agencies. NPS resource managers may be unfamiliar with science centers as the centers grew up under the Fish and Wildlife Service.

Science centers are one of two *hubs* of biological research within the agency and generally coordinate projects within regions by broad ecosystem type (e.g., riparian, montane, grassland areas, etc. [figure 2 on page 30]) or discipline (toxics and aquatics systems, Great Lakes fisheries, vertebrates, wildlife diseases, etc.). In this analogy, field stations are the *spokes* with more specific research scopes (the Colorado Plateau, Glacier National Park, etc.). The four regions can be thought of as the *wheels* and along with their support units they make up the *vehicle*. Altogether, the NBS operates 15 science centers and 88 field stations, many located within national parks.

Another research hub that complements the science centers and their affiliates is the NBS Division of Cooperative Research. Administered nationally, this umbrella organization includes all 60 NBS cooperative research units. Among this group are Cooperative Fish and Wildlife Units that came to the National Biological Service from the U.S. Fish and Wildlife Service, a Raptor Research Unit from the Bureau of Land Management, and 12 Cooperative Park Studies Units dedicated to national park system areas that we provided. We can request research and technical assistance from any of these units, but CPSUs focus on parks, while the fish and wildlife units focus on broader ecological questions. Altogether, the 60 cooperative research units add to vehicle momentum through their parallel research and support efforts.

USING SCIENCE CENTERS

Science centers are very diverse and vary somewhat in expertise and areas of geographic responsibility, although all perform biological research, conduct inventory and monitoring activities, provide some technical support, and produce information products for land managers (see table 1 on page 31). One highly specialized center, the National Wildlife Health Center in Madison, Wisconsin, has expertise in wildlife diseases and serves the entire country. In cases not involving these specialized centers, a research project may still be special-

Continued on page 30

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ized enough, as in the case of migratory birds, to warrant disregard of regional boundaries. Thus, while research is generally organized and managed regionally, the NBS is flexible in providing specialized services across regional boundaries. A problem that we need to work through in the coming years is that some regional centers are so specialized that they cannot serve our broad needs.

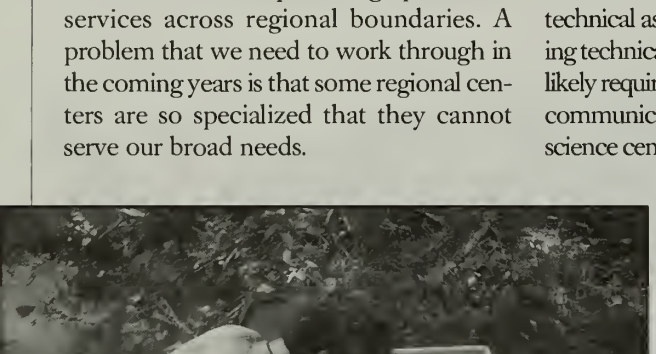

Figure 2. This Midcontinent Ecological Science Center researcher has set up a streamside surgical center *for use in a cool water stream ecology fish tracking study.*

This paradigm of organizing around state boundaries at one level and ecosystems at another appears to be useful, if not somewhat complex. In our own reorganization we have adopted a comparable scheme, although not congruent with that of the National Biological Service. An example of NPS-NBS regional incompatibility to be aware of might involve our proposed restructured Central Region. This region would have to deal with three NBS regions to accomplish research or technical assistance through the NBS. For example, the NBS Midcontinent Region would correspond to the Great Plains states of our Central Region. The NBS Eastern Region would correspond to our Great Lakes parks. And the Southern Region of the NBS would serve our Central Region for Arkansas areas. Conversely, parks in Nevada (new NPS Western Region), North Dakota (Central Region), and New Mexico (Intermountain West Region) would all be served by the NBS Midcontinent Region (although possibly by different science centers). In this scenario, the NBS would deal with three NPS regions and several system support offices. As we inaugurate our new organization in the coming months, this kind of administrative inconvenience must be anticipated in order to enable us to form productive working relationships with the NBS.

How to request technical assistance from an organization that rewards pure research and has no single process for responding to technical assistance needs is not simple; finding technical assistance for the near future will likely require ingenuity, networking, and good communication. First, parks might call the science centers that have geographic responsibilities or specialized expertise relevant to their area to secure a prospectus describing the center, its services, products, and areas of expertise. Much of the information presented in the article profiling the Midcontinent Ecological Science Center came from their prospectus. This kind of document is very helpful in gaining a general orientation to the work and scientists of the center. One of its most helpful features is an index to expertise that is presented in the back of the booklet. By looking up a keyword related to the kind of expertise needed one can quickly reference the correct section at the center to contact.

Another idea is to get in touch with the two NBS information and technology services divisions in Colorado. The NBS information and technology mission is to provide leadership in the development, production, publication and use of a variety of different instruments to transfer pertinent resource information, data (spatial and nonspatial) and techniques among Department of the Interior personnel, NBS partners, and the national and international community of resource managers. Two centers are focal points for these efforts: the Fort Collins, Colorado, Information Transfer Center, (303) 226-9401; and the Technology Transfer Center in Lakewood, Colorado, (303) 969-2590. The latter supports the infrastructure needed to communicate data and has less direct contact with client agencies, while the former can search databases of biological information and projects to help put NPS resource managers in touch with appropriate NBS personnel.

National Park Service regional chief scientists are also a primary resource for field resource managers to contact in seeking NBS technical assistance. Serving as research liaisons, chief scientists can make suggestions o who to call at a science center for a particul area of expertise. Unfortunately, we do n presently know who will perform the scien coordination function at either the syste support offices or field director offices begi ning in May. Another good approach wou be to contact appropriate cooperative unit field station personnel to ask their advice abo the correct person to call for assistance.

The technical assistance arena is much le formal than the area of long-range resear planning. Consequently, requests for techn cal assistance can be made at any of sever NBS organizational levels: field station cooperative research unit, science center, r gion, or national office. Short duration r quests (of just a few days) can often be handl at lower levels of the organization. More i volved requests may be forwarded further the line, as appropriate. Requests that enter a higher-than-appropriate level are reassign to the appropriate level. Still, parks should t to make technical assistance requests direct to the appropriate level. Once a request f assistance becomes more involved than r quiring a few days of help, a more formal a rangement, such as an interagency agreeme or memorandum of understanding, may l necessary.

A park that finds the assistance it is loo ing for (at science centers, field stations, CPSUs) may receive all project funding go with it or may be asked to pay for a po tion. At the science center level, several fun ing scenarios are possible with room for son negotiation. Whatever course is taken in d ciding project funding, NBS staff are sure consider the applicability of research and tec nical assistance results on lands beyond tho of just the requesting park. That is, broad applicability would probably favor higher total funding.

Conclusion

Our concerns about inadequate NBS tec nical assistance are being heard by NBS lea ers, and we can expect the agency to wo toward better service in the coming years. the absence of a formal system for requesti technical support, park resource managers a encouraged to use their networking and n gotiating skills to learn about considerab NBS science center expertise and put it work in parks. We may need to start by lea ing who to call and telling them what v need.

Table 1. NBS Science Centers

Science Center	Expertise	Address
stern Region		
ituxtent Environmental ience Center	Environmental contaminants, migratory birds, and eastern United States endangered species.	12100 Beech Forest Road; Laurel, MD 20708-4039; (301) 497-5500; (301) 497-5505
itional Wildlife Health enter	Research, information, and technical assistance on national and international wildlife health issues.	6006 Shroeder Road; Madison, WI 53711; (608) 264-5411; fax (608) 264-5431
eat Lakes Science Center	Research, inventory and monitoring, and information transfer related to managing, restoring, and protecting organisms and habitats of the Great Lakes basin.	1451 Green Road; Ann Arbor, MI 48105-2899; (313) 994-3331; fax (313) 994-8780
vironmental Management chnical Center	Long-term resource monitoring program for the Upper Mississippi River. Schedule to combine with Upper Mississippi Science Center.	575 Lester Avenue; Onalaska, WI 54650; (608) 783-7550; fax (608) 783-8058
pper Mississippi Science enter	Ecological, toxicological, physiological, and chemical research related to management of fish and wildlife resources with emphasis on the Upper Mississippi River. Scheduled to combine with Environmental Management Technical Center.	2630 Fanta Reed Road; La Crosse, WI 54602-0818; (608) 783-6451fax (608) 783-6066
etown Science Center	Culture, nutrition, genetics, and diseases of anadromous fish; research and studies and monitoring of eastern river systems.	1700 Leetown Road; Kearneysville, WV 25430; (304) 725-8461; fax (304) 728-6203
uthern Region		
utheastern Biological ience Center	Management and conservation of biological resources in the southeastern United States.	7920 NW 71st Street; Gainesville, FL 32653; (904) 378-8181; fax (904) 378-4956
uthern Science Center	Research development related to protecting, restoring, and managing wetlands, migratory birds, and other natural resources along the Gulf Coast.	700 Cajundome Blvd.; Lafayette, LA 70506; (318) 266-8500; fax (318) 226-8513
dcontinent Region		
idwest Science Center	Lead role in NBS for determining existing and potential effects of toxic materials and other aquatic ecosystems stressors.	4200 New Haven Road; Columbia, MO 65201; (314) 875-5399; fax (314) 876-1896
idcontinent Ecological ience Center	Research and technology development for management of biological systems (species to ecosystems) of the interior western United States.	4512 McMurry Avenue; Fort Collins, CO 80525-3400; (303) 226-9100; fax (303) 226-9230
rthern Prairie Science enter	Ecological requirements of wildlife populations of interior grasslands and prairie wetlands of the United States.	8711 37th Street SE; Jamestown, ND 58401-7317; (701) 252-5363; fax (701) 252-4217
estern Region		
rthwest Biological ience Center	Identification and measurement of environmental factors that limit distribution and abundance of western United States fish, especially anadromous species.	Building 204, NAVSTA; Seattle, WA 98115-5007; (206) 526-6282; fax (206) 526-6654
rest and Rangeland osystem Science Center	Northwest forest management research, range quality assessment, wildlife-habitat relationships evaluation, and ecosystems models and analysis.	3200 Jefferson Way; Corvallis, OR 97331; (503) 757-4840; FAX (503) 757-4845
aska Science Center	Field and laboratory research on fish, wildlife, and their habitats in Alaska and other circumpolar ecosystems.	1011 East Tudor Road; Anchorage, AK 99503; (907) 786-3512; fax (907) 786-3636
alifornia Pacific Science enter	Information and technologies for management of California desert, coastal, and nearshore marine ecosystems.	6924 Tremont Road; Dixon, CA 95620; (916) 756-1946; fax (916) 678-5039
acific Islands Science enter	Research, baseline information, and technical assistance related to conservation of indigenous biological resources in Hawaii and the Pacific territories.	Mauna Loa Research Station; P.O. Box 44; Hawaii Volcanoes National Park, HI 96718; (808) 967-7396; fax (808) 967-8568

Meetings of Interest

MAY 15-17

A symposium on outdoor recreation and tourism trends is planned at the Radisson Hotel in Saint Paul, Minnesota in mid-May. It will emphasize international and domestic outdoor recreation and tourism trends, the economics of sustainable outdoor recreation and tourism trends, technology change and new ways to address recreation and tourism planning and management, trends in human dimensions of fish and wildlife planning and management, trail and greenway trends, and other areas. For more information, contact Dave Lime or Jerrilyn Thompson, Cooperative Park Studies Unit, Department of Forest Resources, 115 Green Hall, University of Minnesota, Saint Paul, MN 55108, (612) 624-491-6714.

JUNE 7-11

The annual meeting of the Society for Conservation Biology will take place in Fort Collins, Colorado in June. For more information, contact Richard L. Knight, Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO 80523, (303) 491-6714.

JUNE 21-24

A conference on Who Owns America? Land Resource Tenure Issues in a Changing Environment will meet in Madison, Wisconsin, in early summer. Sponsored by the University of Wisconsin, the conference seeks to bring together nontraditional and traditional voices of policy makers, grassroots activists, academic researchers, and citizens interested in ownership, management, and regulation of land and natural resources. Contact Gene Summers of the Land Tenure Center's North American Program at the University of Wisconsin, 1357 University Avenue, Madison, WI 53715, (608) 262-3658, fax (608) 262-2141, e-mail "summers@soc.ssc.wisc.edu".

AUGUST 12-16

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

SEPTEMBER 24-27

Ecology and Conservation in a Changing Landscape: Third Biennial Scientific Conference on the Greater Yellowstone Ecosystem will take place at the Mammoth Hot Springs Hotel in Yellowstone. Abstracts are due May 1 and should be forwarded to the Conference Program Committee, Yellowstone Center for Resources, P.O. Box 168, Yellowstone National Park, WY 82190.

SEPTEMBER 26-29

Co-hosted by the National Park Service, The Midwest Oak Savannah and Woodland Ecosystem Conference will be held in Springfield, Missouri, at the University Plaza Hotel. A working gathering, the sessions will aim to launch a recovery plan for endangered oak savannah ecosystems throughout the Midwest. Contact Sybill Amelon of the Mark Twain National Forest in Houston, Missouri, at (417) 967-4194 for further information.

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PARK SCIENCE
Integrating Research and Resource Management

Volume 15—Number 3 National Park Service • U.S. Department of the Interior Summer 1995

Beetlemania Sweeps the Hook

Federally threatened northeastern beach tiger beetle on comeback at Sandy Hook Unit of Gateway National Recreation Area

By Bruce Lane

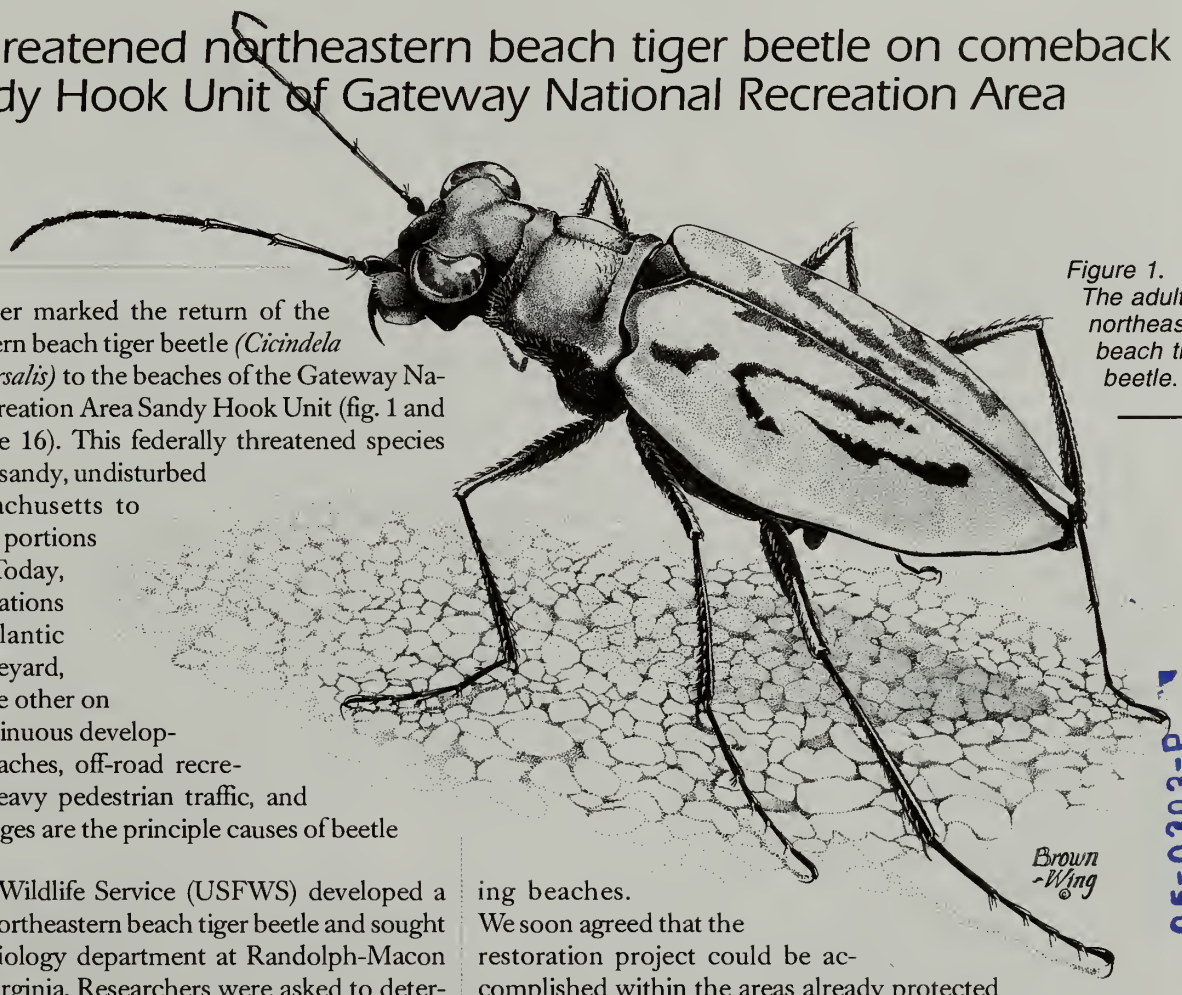

Figure 1. The adult northeastern beach tiger beetle.

Last October marked the return of the northeastern beach tiger beetle *(Cicindela dorsalis dorsalis)* to the beaches of the Gateway National Recreation Area Sandy Hook Unit (fig. 1 and fig. 2, page 16). This federally threatened species was once common on sandy, undisturbed beaches from Massachusetts to New Jersey and along portions of Chesapeake Bay. Today, only two small populations exist, one on the Atlantic coast of Martha's Vineyard, Massachusetts, and the other on Chesapeake Bay. Continuous development along ocean beaches, off-road recreational vehicle use, heavy pedestrian traffic, and the effects of storm surges are the principle causes of beetle decline.

The U.S. Fish and Wildlife Service (USFWS) developed a recovery plan for the northeastern beach tiger beetle and sought the expertise of the biology department at Randolph-Macon College in Ashland, Virginia. Researchers were asked to determine the current population status in New Jersey, conduct site evaluations, and develop procedures for beetle restoration. The researchers found that the conditions on Sandy Hook offered the best chance of survival for restoring a population.

During the summer of 1993, USFWS personnel and the Randolph-Macon biologists met at Sandy Hook with park staff to further evaluate the site and discuss the proposal of an experimental restoration. The park expressed some concern regarding potential conflicts between managing a federally threatened species and providing active recreation on the bathing beaches.

We soon agreed that the restoration project could be accomplished within the areas already protected for nesting shorebirds, including the federally threatened piping plover. Despite the current use level, Sandy Hook remained the best possible site for reestablishing a beetle population.

Over the next year we initiated the formal consultation process as required by section 7 of the Endangered Species Act with the U.S. Fish and Wildlife Service. The agency authorized the removal of up to 1,000 tiger beetle larvae from the Chesapeake Bay population to be released at Sandy Hook. A USFWS

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PARK SCIENCE

Integrating Research and Resource Management

Volume 15—No. 3 • Summer 1995

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

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

The editor welcomes submissions of case studies, feature articles, and highlights. See *Park Science* 14(4):13 for submission criteria or contact the editor at:

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Printed on recycled paper

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FEATURES

IN THE NEXT ISSUE. . .

Native plant and animal species restoration and the connections between archeology and the natural sciences remain themes next time with articles from Indiana Dunes National Recreation Area (grasses and other vegetation), Big South Fork National River and Recreation Area (black bears), and Amistad National Recreation Area (pictographs and their natural accretions), respectively. Also, look for a skunk behavior study at Great Smoky Mountains National Park and a reader survey on natural resource publications, including Park Science.

Business as Usual?

The recent restructuring exercise has many of us making adjustments. Some readers are moving to parks from central offices; others are shifting from regional offices to system support offices and are presently sorting out their relationships with park clusters. While parks no longer report to regional offices, they are preparing for the potential of increased workloads associated with certain resource management tasks that were once performed by regions, but now must be done by parks.

Park Science, too, makes a minor adjustment this issue that reflects our very new way of conducting business organizationally. In adopting our new model of field areas, system support offices, and clusters last May, we consequently made the Regional Highlights department of this publication obsolete (in name only). This most popular collection of brief park research and resource management stories will continue, to be sure, but will now be organized by clusters and will simply be known as Highlights.

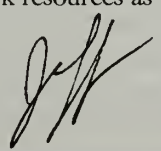
Completely unconcerned with NPS restructuring is the northeastern beach tiger beetle, an insect recently restored to Gateway National Recreation Area. Our cover story reports on the restoration activities on Sandy Hook, New Jersey, and illustrates an important point: *less charismatic microfauna* deserve our efforts, and urban parks (perhaps more than large natural area parks) can make a big difference in recovering threatened and endangered species.

Also making a possible comeback is the spruce grouse of Acadia National Park and Mount Desert Island, Maine. Wildlife Biologist Allan O'Connell assesses their numbers and anticipates possible difficulties with their ongoing natural recovery due to local habitat fragmentation.

Habitat fragmentation on a landscape scale is just one characteristic that the regional GIS vegetation mapping effort (described on page 24) will show in the Pacific Northwest. A multiyear project in the making, this GIS database will be a valuable tool for land managers interested in forming ecosystem management partnerships.

As fire season approaches, one article recounts the dramatic regularity (and later absence) of fire in the Jemez Mountains of New Mexico until around the turn of the century. A second piece on fire reports on the importance of updated fire management plans, sophisticated predictive models, and other techniques we can (and must) employ these days to accommodate this natural force in our parks.

While restructuring represents a dramatic change in our organization and how we conduct some research and resource management business, it does not change the nature of that business. As the articles here remind us, our efforts remain focused on finding answers to resource management questions and applying them in the field for the protection and celebration of park resources as usual.



Errata

In the satellite radiotelemetry article on page 24 last issue James Fraser of Virginia Polytechnic and State University was incorrectly credited with assisting with the Denali golden eagle study; he participated in the Glacier Bay bald eagle study.

Also in that issue, Wildlife Veterinarian Mark Johnson was credited with writing the news brief on page 3 that dealt with computerizing the Yellowstone rare animal report system. The correct authors are Kerry Gunther and John Mack, both of the Yellowstone Center for Resources.

George Wright Conference Sustains Interest

Exploring the theme of sustainability in society and protected areas, the George Wright Society Eighth Conference on Research and Resource Management In Parks and on Public Lands provided valuable discussions on this all-important ideal at a time when environmental protection is being deemphasized and associated laws may be potentially scaled back. With more than 425 people in attendance, the April meeting brought together public and private lands scientists, resource managers, administrators, and other natural and cultural resource leaders for the presentation or attendance of numerous poster sessions and nearly 100 presentations. Five concurrent tracks organized the presentations according to their relevance to the following different aspects of sustainability: sustainable protected area management, planning for use and management, integrating cultural and natural resource management, applying science and technology, or ecosystem management. Three plenary sessions, a day of field trips, an awards banquet, and unlimited opportunities to visit amongst the participants rounded out the valuable and enjoyable four days.

Opening the conference with a presentation that was to become its centerpiece was Senior Research Professor George Stankey of the Oregon State University Department of Forest Resources, College of Forestry. Speaking on the social foundations of sustainability, Stankey assessed our present standing and what we must do to move beyond the current stagnant, even regressive, times. He described sustainability as a philosophical construct that helps society set standards to live by; he also noted that our ideals must be translated into a public discourse that transcends our ideological ignorance and prompts action to reverse our resource- (and self-) destructive ways. Other highlights included a passionate and logical appeal to environmentally responsible land management practices by the Chairman of the Confederated Tribes of the Umatilla (Oregon) Indian Reservation, National Biological Service Director Pulliam's honesty about and hopes for his agency, and Deputy Director Reynolds' call for exemplary NPS actions and operations.

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Continued

In contrast to these, the majority of presentations simply reflected research and resource management work at hand on our public lands. Scientists, resource managers, and land administrators seem to know the importance and practicality of staying focused on projects that create results at home. In this regard, sessions touched on fire management practices, exotic species control and vegetation restoration projects, visitor experience assessment methods and use planning, managing visitor impacts, tourism, international cooperation, the implications of historic Native American impacts on resource management activities, and recent examples of ecosystem management efforts, among many, many others. Making a difference in one's own sphere of influence to further the principles of sustainability was perhaps the biggest take home message from the conference.

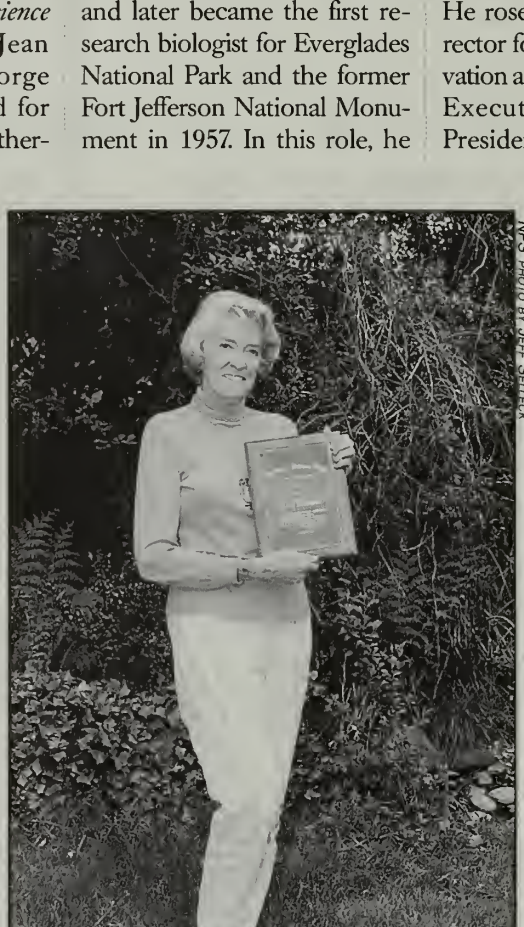
As usual, the conference covered National Park Service concerns and system areas well and boosted science and resource management communications. Forty-one papers are published in a volume available from the George Wright Society (call Bob Linn or Dave Harmon at ((906) 487-9722). The ninth such conference is planned for Albuquerque, New Mexico, in March 1997.

A longer review of the conference by William E. Brown can be found in the summer George Wright Forum (volume 12, no. 2), which should be circulated in early July.

Matthews Honored

The George Wright Society honored former *Park Science* editor and founder Jean Matthews with its George Melendez Wright Award for Excellence at its April gathering in Portland, Oregon. The award is given to research, management, and interpretation professionals in recognition of their lifetime contributions to natural area understanding. Jean was recognized specifically for her lifework in communication bringing the achievements of research to bear on resource management and interpretive programs in national parks and equivalent reserves.

A journalist by training, Matthews worked as a reporter for several newspapers before beginning a government writing career in 1962. Initially a speech writer for Secretary of the Interior Stuart Udall and Ladybird Johnson, Matthews also produced several highly regarded yearbooks on the work and staff of the Department of the Interior. In the early 1970s, Jean began writing speeches for NPS Director George Hartzog and served on an environmental education task force that sought to integrate natural systems concepts into NPS interpretive media. Jean's idea to publicize the marriage of science and resource management came about in 1980 when she launched *Park Science,* a project she oversaw until her retirement in 1994.



NPS PHOTO BY JEFF SELLECK

Jean Matthews—a recipient of the George Melendez Wright Award for Excellence

Also receiving this award were Everglades biologist Bill Robertson and historian Robert Utley. Robertson started his career as a park fire control aid and later became the first research biologist for Everglades National Park and the former Fort Jefferson National Monument in 1957. In this role, he maintained a strong interest in breeding bird populations of tropical Florida in relation to vegetation. For more than 40 years, Robertson's insights into the intricacies of the Everglades ecosystem and his ability to articulate them have proven invaluable.

Robert Utley first worked for the National Park Service in 1947 as a historical aid in the former Custer Battlefield National Monument. He later held numerous historian positions in government including NPS Southwest Regional Historian, NPS Chief Historian, and Director of the Office of Archeology and Historic Preservation. He rose to NPS Assistant Director for Park Historic Preservation and served as the Deputy Executive Director of the President's Advisory Council on Historic Preservation. Also an author, Utley most recently wrote an award winning biography of Sitting Bull.

Bob Krumenaker, Leader of the Shenandoah National Park Center for Resources, won the 1995 George Wright Society Natural Resource Management (Francis Jacot) Award for his leadership in the role of Southwest Region Chief of Resource Management from 1991-1995.

Biologist George Wright was a rising NPS scientist in the 1920s and 1930s when a car accident took his life at the age of 31 in 1936. During his distinguished but short career, Wright championed the importance of science in park management. He also coauthored the classic wildlife treatises Fauna 1 and 2 wherein he recognized that parks alone were not adequately large or ecologically complete for the preservation of large mammals. The awards given in his memory, are the highest honors given by the George Wright Society.

Earthwatch Supports Research

The Center for Field Research invites proposals for 96 field grants awarded by its filiate Earthwatch. Earthatch is an international nonofit organization dedicated to search and public education the sciences and humanities. 1995, Earthwatch is supportg seven park research and reurce inventory projects with proximately $83,000 and 185 lunteers. All funds awarded Earthwatch are derived om the contributions of rthwatch members who pay the opportunity to join scitists in the field and assist th data collection and other search tasks. Inventory and onitoring projects sponsored Earthwatch are eligible for ditional funding through the PS Expedition Into America ogram.

Preliminary proposals for rthwatch field grants should submitted at least 13 months advance of anticipated field tes. Full proposals are invited on review of preliminary oposals. For more informaon about the field grants conct Dee Robbins, Life Sciences ogram Director, The Center Field Research, 680 Mt. Aurn Street, Watertown, MA 172. Phone: (617) 926-8200 fax: (617) 926-8532 or e-mail: robbins@earthwatch.org". r more information about pedition Into America grants ntact Lissa Fox, National rk Service, P.O. Box 37127, ailstop 490, Washington DC 013-7127. Phone (202) 343-22.

Bat Conservation Agreement Signed

The National Park Service recently entered into a memorandum of understanding with Bat Conservation International, a private, nonprofit organization dedicated to sustaining remaining bat populations around the world. The agreement will help both organizations to become more effective in protecting bats and their habitat and educating the public about the environmental contribution made by these often misunderstood mammals.

Both organizations plan to develop joint projects, such as conducting inventories and habitat assessments, and producing educational publications and programs. Presently, Bat Conservation International heads a program to assist land managers in developing bat population assessment and habitat management techniques for caves and abandoned mines. Both organizations are working together to protect these habitats, which are often critical to bats. National Park Service staff will also be able to participate in nationally recognized bat conservation and habitat management workshops put on by the conservation organization in an effort to raise awareness about these animals.

Software Improved for Annual Resource Management Updates

Parks prepared over 14,000 project statements in the 1995 annual resource management plan (RMP) update. The new RMP software (version 2.12) allows park staff to track project funding beyond the previous limitation of 4 years, automatically generate annual accomplishment reports for funded projects, and archive completed project information including the problem statement and description of actions. The archive function should substantially increase the ability of the RMP system to serve as a parkbased data repository of resource management goals, priorities, and accomplishments.

The RMP software also enables park staff to prepare and track project statement information in a consistent format. Administrative offices and program managers use the information provided in the annual updates to ascertain and justify resource management budget requests and allocations. Without the automated RMP annual updates, parks would receive frequent requests for data surveys, project justifications, and status reports.

Another benefit of the RMP update process is the ease with which the project database can be searched. For example, we recently searched the 1995 servicewide RMP data to identify and fund high priority projects meeting the specific criteria of a corporate sponsor providing a $450,000 donation. The rapid identification of specific resource management project types and ability to justify funding requirements with problem statements and action descriptions is only possible through the data and software capabilities provided in the RMP system.

In March, parks gathered information for 2,155 research projects for the 1994 Investigators Annual Report (IAR) update. The IAR system was originally designed to provide park staff with an automated tool for organizing, storing, and tracking annual activities and accomplishments performed by non-NPS researchers. This information includes project objectives, findings, and bibliographic references, which can supplement the long-term history of science within parks.

Computer Specialist Tim Goddard of the NPS Natural Resource Service Center in Fort Collins, Colorado, is redesigning the IAR software so that park staff can store multiple year report data more effectively. This will enhance the functionality of the IAR system to better serve park needs as a repository of research project reports collected over many years. Additional modifications should also enable parks to automate the process of generating and tracking research permits.

Both the resource management plan and investigators annual report systems are useful tools for parks and administrators to track progress toward research and resource management goals. Goddard

Continued on page 13, column 3

Editor's Note: The following contribution from Great Smoky Mountains National Park breaks our pattern of reporting just the national MAB news in this column. Our long-term strategy with MAB Notes is to balance reporting the activities of the national MAB committee with park experiences, like this one, related to the MAB program. Accordingly, parks are invited to contribute to this department.

The Southern Appalachian Mountains, in the southeastern United States, is one of the many biosphere reserves designated by the United Nations Educational, Scientific, and Cultural Organization (UNESCO). As of January 1994, UNESCO had designated 324 biosphere reserves in 82 countries, with 47 occurring in the United States; the majority (30) of United States Man and the Biosphere Program (USMAB) areas are also national park system areas. Although the Southern Appalachian Biosphere Reserve (SAMAB) includes Great Smoky Mountains National Park, it differs from most USMAB areas, as it comprises protected units scattered over 50,000 square miles in Tennessee, Virginia, North and South Carolina, Alabama, and Georgia.

Created "... to foster harmonious relationships between humans and their environment through programs and projects that integrate the social, physical, and biological sciences to address ... problems," SAMAB presents a complex management situation due to its size. To manage the biosphere reserve cooperatively, six federal agencies with southeastern United States land management responsibilities signed interagency and cooperative agreements in 1988 to form the Southern Appalachian Man and the Biosphere Cooperative. The charter members were the U.S. Forest Service, National Park Service, Tennessee Valley Authority (TVA), U.S. Fish and Wildlife Service, Oak Ridge National Laboratory (Department of Energy), and the Economic Development Administration (EDA).

The original partnership has grown steadily and now includes the Environmental Protection Agency, U.S. Geological Survey, U.S. Army Corps of Engineers, National Biological Service, Appalachian Regional Commission, and the states of North Carolina, Georgia, and Tennessee. Other federal agencies and states are expected to join in future years. Private sector involvement and support is achieved through the SAMAB Foundation. First chartered in 1990, the foundation was subsequently granted nonprofit status. In 1990, USMAB and UNESCO recognized SAMAB as the first regional demonstration model for other biosphere reserves across the country.

The management cooperative is governed by an executive committee, comprised of one representative from each federal and state member agency and the chairman of the SAMAB Foundation board of directors. Six committees made up of area specialists from the member agencies do most of the work, enlisting the aid of other specialists from member agencies. These committees are: environmental research and monitoring, sustainable development, environmental education, natural resource management, public affairs, and cultural and historic resources.

Funding for SAMAB comes from the member agencies who, by pooling funds and other resources, sustain the cooperative. The Tennessee Valley Authority and Great Smoky Mountains National Park have been especially supportive. The executive director is a TVA employee assigned full-time to this function, and the agency has also provided administrative, legal, and financial assistance to the cooperative. The park provides office space and related services to the executive director.

Management Units

At the heart of the regional programs are biosphere reserve management units, which are typically geographic areas that are shielded from unbridled development. These units seek cooperative regional programs and share any lessons learned with other management units. Although it started with just two such management units, SAMAB now has five, and expects to add three more in the near future. The current units are the Great Smoky Mountains National Park; the Department of Energy Oak Ridge National Environmental Research Park; the Coweeta Hydrologic Laboratory of the U.S. Forest Service; Mt. Mitchell State Park, which is operated by the State of North Carolina; and Grandfather Mountain, a privately operated environmental park also in North Carolina. Each is recognized by UNESCO as a unit of th larger SAMAB that is part the international biosphere re serve network.

While the SAMAB re search, education, and demo stration ecosyste management programs cent on the management unit they extend outward in a zo of cooperation that embrac the entire biosphere reserv The zone of cooperation w not chosen arbitrarily; rathe it was identified because shares common geologica biological, and cultural re sources. It also lies within th administrative boundaries the southeastern offices of th various federal agencies in th SAMAB cooperative.

Issues

The SAMAB cooperati has proven its usefulness in e ploring solutions to many e vironmental issues an although several have relate directly to Great Smok Mountains National Par three are especially notewo thy:

(1) When the U.S. Fish a Wildlife Service launched program to restore the re wolf in the Great Smok Mountains National Park, th expected public oppositio Through its public affairs a environmental educatio committees and in cooper tion with the NBC Knoxvil Tennessee, affiliate, WBI SAMAB developed a can paign that clarified the tr nature of the red wolf proje and contributed significant to diffusing the sensitive issu Posters, teachers guides, clas room packages, brochure and a TV documentary we all developed and distribute in this initiative.

?) Concerned about runaway ourist development in park ateway communities, the latively small, undeveloped, ark-abutting town of Pittman enter asked SAMAB to help plan for future growth. To-ether with the University of ennessee and the Economic evelopment Administration, AMAB helped Pittman Cen-r develop a strategic plan. his led to additional zoning rdinances in the town, which ere implemented after exten-ve public involvement. A ommunity development plan ased upon the Pittman Cen-r model has been prepared nd widely distributed. An-ther Smokies gateway com-unity, Townsend, is using is plan as are communities Canada and Asia.

) Very serious air quality roblems led SAMAB to con-ene a forum in March 1992 give concerned regional arties an opportunity to dis-uss conflicting viewpoints on e controversial issue. For the rst time, about 125 people om federal and state agen-es, industry, universities, and tizen groups participated in e sometimes emotional dis-ussions. A direct result of the onference was the formation the Southern Appalachian lountain Initiative, a regional artnership of the state air uality regulatory agencies for ddressing southern Appala-ian air quality issues. The nvironmental Protection gency has provided more an $600,000 in support of e program, whose mission to "... remedy ... effects om ... air pollution on the r quality related values ... of e southern Appalachians...." lany of the SAMAB member agencies also participate in this new air quality partnership, which will adopt requirements in addition to those of the Clean Air Act in May 1997.

Currently SAMAB is involved in conducting an assessment of environmental conditions in the southern Appalachian region. The assessment is a joint effort of the various federal and state SAMAB cooperative members. The assessment is scheduled for completion at the end of calendar year 1995 and the results are intended for use in making environmental management decisions.

In view of current federal downsizing and even agency deauthorization discussions, SAMAB cooperative members are concerned about the future willingness of agency managers to continue committing funds and staff to SAMAB. Will managers want to "circle the wagons" and focus exclusively on "their own" missions? As a member agency, we hope not. Member agency personnel constitute a valuable pool of knowledge and experience; SAMAB uses these resources as a conduit for sharing, not only with other cooperative members, but also with public and private land managers throughout the region. Let us hope future managers will see the logic in working toward more cooperation, not less. PS

Readers can contact Joe Abrell, Chief of Resource Management, and Bob Miller, Management Assistant, at Great Smoky Mountains National Park for further information on SAMAB. (615) 436-1207.

The relative abundance of coyotes and gray wolves has changed in disturbed habitats of North America. Hybridization has occurred between these species, where coyote populations have increased in abundance and where gray wolf populations have declined. Genetic divergence among coyotes and gray and red wolf populations in North America was the subject of a recent publication by Michael S. Roy et al. (Molecular Biological Evolution **11(4)**: 553-570, 1994). Researchers selected microsatellite loci to quantify genetic differentiation and hybridization within and between species. These loci exhibit a much higher rate of mutation than that of nuclear loci and consequently are more sensitive to detecting recent genetic divergence. Coyotes show no evidence of genetic subdivision, which is a result of high rates of genetic exchange throughout their recent range expansion. Hybridization between coyotes and gray wolf populations of Minnesota and southern Quebec has significantly affected allele frequencies (alternative gene forms at given locus) of these wolf populations. The analyses also support the hypothesis that the intermediate phenotype of the red wolf is derived from historic hybridization between coyotes and gray wolves. More recently, extensive hybridization occurring between red wolves and coyotes has caused red wolves to become even more genetically similar to coyotes. The authors concluded that continued habitat changes favoring range expansion of coyotes will threaten the genetic integrity of gray wolf populations.

• • •

Biodiversity is most often defined in terms of species richness. A recent publication by R. Gresswell, W. Liss, and G. Larson (Canadian Journal of Fisheries and Aquatic Sciences, 1994, number 51, Supplement 1:298-309) focuses on the importance of recognizing intraspecific variability for maintaining biodiversity at the species level. The authors examined life history organization of Yellowstone cutthroat trout. They also examined in detail subspecies and metapopulation hierarchical levels of differentiation. Variation in life history and morphometric characteristics of Yellowstone cutthroat trout were documented between populations in different lakes and within subpopulations in the same lake. Differences found in life history organizations included reproductive isolation and homing, pattern of spawning migration, initiation and duration of spawning, juvenile emigration and residence, abundance of spawners, age and size of spawners, and male:female ratio and fecundity. The authors concluded that loss of diversity at any hierarchical level jeopardizes the ability of the species to adapt to changing environments and increases the risk of extinction. PS

Editor's Note: *With the recent NPS reorganization and adoption of field areas, system support offices, and clusters in lieu of the traditional regional paradigm, we reorganize regional highlights under the name of simply "Highlights." Newsworthy science and resource management tidbits are presented here under the names of park clusters and their system support offices (16 in all).*

ROCKY MOUNTAIN

In July 1994, anglers caught nonnative lake trout (*Salvelinus namaycush*) in Yellowstone Lake, which represents 80% of the remaining lacustrine range for the world population of Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*). Mitigating the effects of the much larger and predatory lake trout on the native cutthroat trout population is the third priority natural resource management issue in the park resource management plan (March 1995). In response to this potential ecological crisis, Yellowstone National Park held a workshop February 15-17, 1995, with fisheries biologists and managers familiar with salmonids. The majority of participants concluded that "chances are high that [lake trout] cannot be eliminated and will seriously reduce the cutthroat population..." The group also concluded that lake trout abundance can be limited through an aggressive control program, which would require a long-term commitment of expert staff and dedication of supplies and equipment.

The park has outlined a program with the objective to maintain a robust native cutthroat trout population in the Yellowstone Lake-Yellowstone River ecosystem by minimizing the effects of introduced lake trout. A high degree of uncertainty remains as to the extent and status of the lake trout population in Yellowstone Lake. The most immediate needs are (1) to increase the information base about both lake trout and cutthroat trout populations, and (2) to begin suppressing the lake trout population. The experts recommend that a well-designed mechanical removal program that minimizes unintended cutthroat trout loss is most likely to provide both information on and control of lake trout. The park hopes to begin an experimental effort to gillnet lake trout this summer. This effort will allow us to test methods temporarily and geographically prior to developing a long-range action plan to control nonnative lake trout in Yellowstone Lake.

• • •

Visitors are finding something new underfoot in the Old Faithful area of Yellowstone National Park. Last year, the park replaced 30 feet of traditional boardwalk with lumber made from recycled plastic with more to come. In all, 1,000 linear feet of boardwalk in the Upper Geyser Basin will be replaced with the recycled plastic lumber.

Eaglebrook Products, Inc., manufactures the *lumber,* called Durawood. Made of recycled plastic from thick, plastic bottles like milk containers, the lumber is 90% recycled post-consumer plastic.

The lumber used in Yellowstone boardwalks is the color of weathered wood, although many different colors are available. In testing, the color changes very little over time. Durawood will not rot, warp, splinter, or crack from exposure and requires very little maintenance. It can be cut and drilled like wood, and it can be fastened with ordinary screws or nails. However, it is not as rigid as wood and cannot be used in the structural supports of boardwalks. Beneath the uniformly colored walkway is the same wooden structure that holds up the rest of the park boardwalks.

Nancy Ward, Supervisory Environmental Engineer, says there has been no trouble with the new boardwalk, although she points out that using Durawood in a geyser basin boardwalk is experimental. The company is confident of their product, but they acknowledge that it has never been used this way; they have never tested it for buffalo walking on it, for example. She says it costs more than wood, but may be cost effective if it lasts longer than wood.

Lever Brothers Company donated the Durawood to the National Park Foundation to promote creative uses for recycled materials. Nine other national parks will also receive recycled materials, including the Washington, D.C., mall, Martin Luther King, Jr., National Historic Site, Georgia, and Mount Rainier National Park, Washington. Yellowstone is the first to install the donated recycled materials.

PACIFIC-GREAT BASINS

Death Valley National Park hosted the first western area wilderness stewardship session for line officers last May. Planned and instructed by National Park Service, U.S. Fish and Wildlife Service, Bureau of Land Management, and U.S Forest Service staff, this session focused attention on wilderness philosophy, operations constraints inherent in the 1964 Wilderness Act, and resource and visitor management issues in light of the passage of the California Desert Protection Act. A second session will be held in Arizona during October.

• • •

Great Basin National Park installed a remote weather station on the summit of Bald Mountain last September, making it the highest in Nevada and one of the highest in North America. At 11,562 feet above sea level, the new weather station provides data for resource management and research activities and also enhances the safety of park visitors.

The weather station transmits data by radio to a base station at park headquarters. Visitor center staff can query the station at any time in order to inform hikers and climbers of current high elevation weather conditions. This information is especially useful to those who plan to climb 13,063 foot Wheeler Peak, which is located just south of Bald Mountain and is the highest peak in Great Basin National Park.

Currently, the station is programmed to record the hourly average wind speed and direction, air temperature, relative humidity, solar radiation, and maximum wind gust and its direction. To make these measurements, the station uses an anemometer, wind vane, air temperature and relative humidity sensor, and a solar absorption pyranometer. A datalogger controls the sen

ors and is housed in a small ructure that also shelters a lumboldt National Forest ra- io repeater. Solar panels on ne roof of the shelter recharge ne batteries that power the ation. The meteorological nsors are mounted on a 5- eter-tall mast, attached to ne shelter.

This project was three years the planning and took sev- al months of effort during 994 to complete. All park visions and other agencies, cluding the U.S. Forest Ser- ce, the Office of the State limatologist, and the Nevada ir National Guard, helped to tablish the high elevation eather station.

Less than two weeks after eing installed, the new eather station recorded a 6 mph southerly wind gust at occurred during prefron- l conditions. This set a state cord for October, and is one the highest gusts recorded r any month. That same day, e station indicated an aver- ge wind speed for one hour be 86 mph!

HESAPEAKE

Morristown National His- rical Park recently received a 0,000 grant from the Na- nal Park Foundation through e NPS Expedition Into merica Program. The park ill use the money to conduct e first herbaceous plant sur- y within Morristown, as it s neither the staff nor fund- g to conduct this inventory its own means. Plant popu- tion ecology professor Steven andel of Rutgers University is nducting the survey based on sampling design of his own. r. Handel's sampling method sures that all different habitats and forest types are surveyed when flowers are in bloom, facilitating plant identification.

With volunteer help from the Garden Club of America, Dr. Handel and his staff conducted the first survey in late April. While Dr. Handel's team ensured data quality, the volunteers enthusiastically assisted in identifying many spring ephemerals and participated in other hands-on fieldwork.

The information acquired from the inventory will assist the park in determining whether the number and variety of herbaceous plants has declined as a result of white-tailed deer browsing and exotic species spread. Also, volunteers will gain a greater understanding of park natural resource management issues through their close involvement with the program.

The interest, enthusiasm, and knowledge demonstrated by Garden Club of America members proves that small parks located in densely populated areas can attract nearby volunteers to conduct biological inventories. We are hoping that this project will develop a committed pool of long-term volunteers, who will continue to survey and monitor plants in the park.

COLUMBIA CASCADES

Richard Aroksaar, Automation Librarian for the Columbia-Cascades System Support Office Library, is working with a NPS Inventory and Monitoring Program and U.S. Geological Survey (USGS) team to determine the existence, location, scope, and quality of park-related geological maps. The team search-es GEO-REF, a commercial database, and Geoindex, a USGS database, for records concerning parks and downloads them. Aroksaar has developed a program to convert these downloaded records into Pro-Cite, the NPS bibliographic software standard, for use by parks. For more information, contact Aroksaar at (206) 220-4252.

• • •

The system support office recently obtained a copy of Slicer, a 3D viewing software package. This software allows the user to display three dimensional data with shaded renderings, vary the opacity of different areas, rotate volumes, and create cutaway views at any angle. The software might be useful for modeling caves and subsurface hydrology or geology, and may have specific applications at Oregon Caves, Hagerman Fossil Beds, Crater Lake, and Mount Rainier, among others.

• • •

The National Park Service proposed revising the current regulation concerning admission to Oregon Caves National Monument found in 36 *Code of Federal Regulations* 7.49 that prohibits access to children under the age of six years from entering. The proposal would allow children to enter the caves regardless of age. The current age restriction is inequitable and is not necessary to provide safe, high-quality interpretive tours in the caves.

• • •

Wasp and yellowjacket season is upon us in many of our parks. Often a nuisance, bees and wasps commonly congregate in visitor use areas as a result of food residue in trash receptacles. Chemical-free mitigation of hymenopterids can be achieved by regular steam cleaning of trash cans to remove dried syrups and food debris, which provide a reliable food source for the animals. Pesticide application is counterproductive and not justifiable in this circumstance, because it does not remove any food residue.

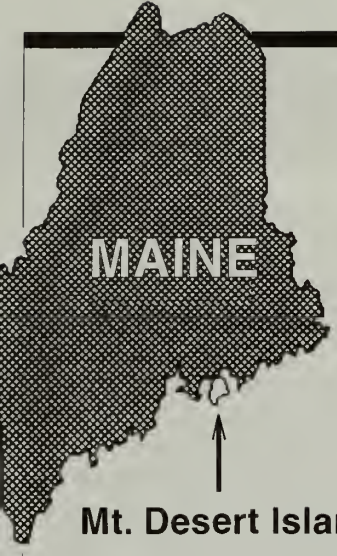
While hymenopterids are protected in parks, as are all native animals, pesticides are justified in some situations. For example, when wasps inhabit an inaccessible wall void or nest under a restroom eaves they create a public health risk that may warrant use of a pesticide. If this is the case, look for a product with pyrethrin or allethrin as the main ingredient. This provides the least toxic and most specific quick knockdown results. Remember to obtain approval prior to purchasing any pesticide and do not overstock on products; the Environmental Protection Agency may change pesticide use status, leaving parks to dispose of hazardous waste.

COLORADO PLATEAU

Last November, the National Park Service reached a milestone in studying carrying capacity limits on park visitors through a process applied at Arches National Park, Utah. Known as visitor experience and resource protection (VERP), the study process determines natural resource and social indicators and standards for the protection of park resources and maintenance of high quality visitor experiences.

Concern over resource and visitor experience degradation associated with the growing popularity of hikes to Delicate

Continued on page 13, column 3



Spruce Grouse on Mt. Desert Island

Fragmented habitat complicates species management

By Allan F. O'Connell, Jr., Frederick A. Servello, and Scott D. Whitcomb

National Park Service managers need reliable scientific data to protect park resources. Yet information needs often extend beyond NPS boundaries and include other public and private lands. Increasingly fragmented landscapes and a scarcity of current inventory and monitoring data increase the difficulty of protecting and managing park natural resources. These circumstances are particularly true in the northeastern United States where park areas are typically small and often within an urban or suburban setting and landscapes are characterized by diverse landownership. Even Acadia National Park (the only national park in the northeastern United States) has a highly fragmented boundary. Located mostly on Mount Desert Island (see locator map), the park can be affected by adjacent land use practices, because 56% of Mount Desert Island does not lie within the park boundaries.

Spruce grouse *(Dendrapagus canadensis),* a common gallinaceous bird of the North American boreal forest, reach their southeastern range limit on Mount Desert Island (fig. 1). Once believed common on the island, this species was thought to have been extirpated in the late 1800s due to land use changes and human impacts. Throughout the 1980s, however, park visitors filed approximately a dozen unverified reports of the bird.

In that Acadia National Park comprises less than half of Mount Desert Island's area, potential spruce grouse habitat reaches beyond park boundaries. As a result, park spruce grouse demographics are likely influenced by the grouse population outside the park. Uncertainty over the status of the population resulted in a park request for funds to document the bird and gather current local ecological information. In this study, we attempted first to document the existence of spruce grouse on Mount Desert Island; later we estimated population size, distribution, and productivity, and evaluated habitat occupancy and dispersal.

Methods

Spruce grouse are conifer specialists and inhabit different conifer types depending on locality and latitude. Researchers in the Adirondacks of northern New York (also along the southeastern edge of spruce grouse range) found that this grouse is restricted to patches of lowland conifer habitat (black spruce and tamarack *[Picea mariana* and *Larix laricina,* respectively]) (Fritz 1979). We delineated all black spruce-tamarack habitat on Mount Desert Island using aerial photographs and vegetation maps. Although mature spruce-fir upland is considered marginal habitat for spruce grouse, we also selected 22 spruce-fir si in order to fully evaluate local occupan of all conifer habitat.

We conducted *call-back surveys* (listen for vocal responses to broadcast tape corded grouse calls) along transects to cate grouse and estimate population si We captured individuals with telesco ing noose poles, marked each with c ored, numbered leg bands, and outfitt females and juveniles with radio transm ters (fig. 2). We grouped potential ha tat patches into three categories: large 26 ha or 64.2 acres), medium (10-26 or 24.7-64.2 acres), and small (4-10 ha 9.9-24.7 acres). We used a minimum c ha (9.9 acres) to evaluate patch occupan based on known spruce grouse ho range requirements. Finally, we det mined spatial characteristics of patch cupancy by using digital data produc from vegetation maps and a perso computer version of Arc-Info softwar

Results and discussion

Minimum breeding population e mates for spruce grouse on the isla were 72 in 1992 and 56 in 1993. Dur

Figure 1. Believed extirpated on the island since the late 1800s, the spruce grouse has be reported occasionally within Acadia National Park since 1980. The study estimated a minimum 1993 breeding population of 56 of the forest dwelling individuals living both within the national park and on nearby private lands.

Figure 2. The wildlife study called for marking birds with colored, numbered leg bands and necklace-mounted radio transmitters for subsequent identification. Study grouse preferred larger habitat patches and tended to cluster in those patches that were closest to one another. The study also showed that compared to other eastern U.S. spruce grouse populations reproductive success is low in the Mount Desert Island population.

ur study, predators killed seven of 18 dio-tagged female grouse (39%), three uring egg-laying, two during incubation, nd two with broods. As of August 28, ne beginning of the late brood rearing eriod, only five females (26%) had suc-essfully raised broods. Initial brood size -3 days after the hatch) ranged from one six birds (x=3.4). Most chick mortal-y (41%) occurred within the first 9 days osthatch, including four entire broods, nd only 11 of 37 (30%) chicks survived ntil August 28. Grouse productivity umber of chicks produced divided by ne number of females) during the first 2 ears of this study was low compared to ther populations in eastern North merica.

The proportion of patches occupied by ruce grouse was related to patch size nd distance between patches. Occupied atch size varied greatly (7.7-269 ha or 9.0-664.4 acres). During this study, rouse occupied both large patches, five f six medium-sized patches, and one of 0 small patches, with a significant dif-erence between small- and medium-zed patch occupancy. Unoccupied atches were farther from the nearest occupied patch (x=2.5 km or 1.6 mi) than were other occupied patches (x=1.2 km 0.7 mi), suggesting that patch size and interpatch distance are important in determining patch occupancy. We only observed two spruce grouse on the 22 spruce-fir sites surveyed, and they were at a distance of <500 m away from suitable lowland sites.

Home ranges for broods ranged from 12.8-26.5 ha (31.6-65.5 acres). Nearly all juveniles dispersed from natal habitat patches and exhibited longer dispersal distances on Mount Desert Island than they did in more contiguous habitats. This may be due to the extensive amount of marginal or unsuitable habitat surrounding patches of suitable lowland-conifer. Six of nine juveniles traveled 8 km (5 mi), and only two of nine located other suitable lowland conifer patches. The remaining seven will probably have to move again in the spring to locate breeding habitat. Juveniles moved through deciduous or mixed deciduous-conifer habitats indicating that these cover types were not the barriers to dispersal that some had thought.

Mount Desert Island spruce grouse resemble a metapopulation, because of their association with patches of black spruce-tamarack scattered across the island. Although we found birds in eight different patches, they were grouped in two clusters, which suggests the importance of interpatch movement. Spruce grouse are listed as a threatened species in New York where small populations are confined to fragmented patches of habitat. Decline of softwoods (by logging or development) and an unknown number killed by hunters each year (because spruce grouse are exceptionally approachable by humans and resemble ruffed grouse) may reduce populations especially in fragmented habitats (Bouta and Chambers 1990). In view of this, and because several Mount Desert Island black spruce-tamarack patches are privately owned, it may be appropriate to incorporate protection of suitable spruce grouse habitat into the Acadia National Park Land Protection Plan. Long-term protection of critical spruce grouse habitat through the purchase or donation of conservation easements also appears appropriate. National Park Service land protection plans should consider future implications for wildlife species like spruce grouse, and parks should note the connection between park resources and adjacent private lands.

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O'Connell is a research Wildlife Biologist with the National Biological Service and serves as the Leader of the CPSU at the University of Maine; (207) 581-2873. Servello is an Associate Professor in the Department of Wildlife Ecology at the University of Maine; (207) 581-2872. Whitcomb is presently a Wildlife Biologist with the Virginia Department of Game and Inland Fisheries. He conducted this spruce grouse study for his M.S. degree at the University of Maine.

Profile of the NBS Midcontinent Ecological Science Center, Fort Collins, Colorado

By the editor

Editor's note: *This is the first of several science center profiles to be published in* Park Science *during the next couple of years. In preparation for the article, the editor visited the center during its second annual meeting with client agencies in February. Also fundamental was the center's prospectus of expertise and services.*

The Midcontinent Ecological Science Center (MESC), located in Fort Collins, Colorado, conducts ecological research and develops technologies to improve the understanding and management of biological systems (species, populations, communities, landscapes, and ecosystems) of the western interior United States. The center also develops and implements inventory and monitoring programs for the accurate assessment of biological status and trends, and provides information, technical services, and training related to the management of biological resources. Like most science centers, MESC generally concentrates on regional ecological research, although there is no requirement to work exclusively within the Midcontinent Region.

One of 15 NBS science centers, MESC is the second largest with 240 employees (42 from NPS) working in 16 locations. At $15 million, the MESC budget is the largest among the science centers. To achieve its mission, the center is divided into 11 sections that are either organized by discipline or geography. The center also maintains 15 field stations that can conduct park research. These stations came to the NBS from various agencies, and several in the NBS Midcontinent Region are located within parks. Additionally, 13 regional cooperative research units (former CPSUs), although administered separately from science centers, are associated with universities throughout the region and conduct research that is often very applicable to parks.

Dr. Rey Stendell, a zoologist and research administrator, heads the science center with assistance from Dr. Tom O'Shea, a mammalogist and conservation biologist. Dr. Cliff Martinka has recently transferred from Glacier National Park to become the Mountain Ecosystems Section Leader. Along with O'Shea (acting in the role of Southwestern Ecosystems Sections Leader), they facilitate research and technical assistance needs among southwestern and northern Rocky Mountain national parks and find funding to accomplish the work.

Generally speaking, long-term (strategic) research priorities are set through an evolving process at the national level that places high value on the natural resource planning that we already do quite well. These projects trickle down to the appropriate regions, science centers, cooperative units, and field stations for implementation. A major area of unrest presently among client agencies is how the NBS addresses more immediate, unplanned requests for tactical research and technical assistance. The recently appointed NBS regional directors, including Midcontinent's Dave Garrett, acknowledge that their agency is not meeting client needs in this area and plan to address this issue as a high priority in the near future.

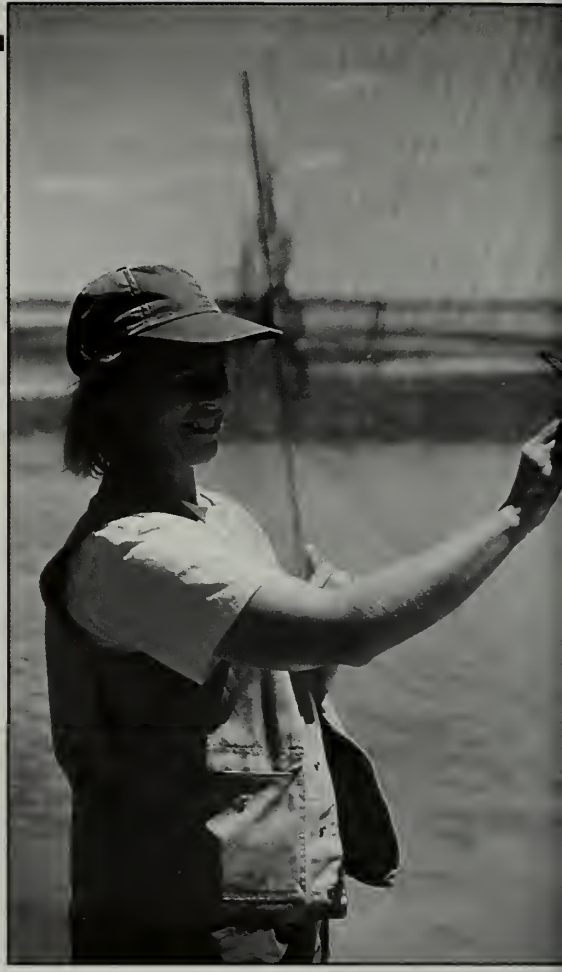


Figure 1. NBS researcher Susan Skagen of the M Vertebrate Ecology Section prepares to band a shorebird in her study on migration ecology. She h to determine species reliance on river corridors an desert oases as neotropical migrant stopover loca

The work of the center is carried ou under three major NBS programmat areas: research, inventory and monito ing, and information and technolog services. The *research* area of MES (see figure 1) strives to improve the u derstanding and management of ec systems, landscapes, communitie populations, and species. Ecosyste research is aimed at understanding th structure and function of montan prairie, and arid lands and associate aquatic habitats while taking into co sideration human impacts and glob change on these systems. Current r search projects that might have utili in parks include impacts of fire an revegetation in selected NPS area evaluating, restoring, and enhancin river corridor ecosystems, and resto ing and creating wetland and ripari ecosystems.

Within this broad research function, he center also emphasizes *population cology*. This area focuses on lemography, population genetics, and he management and biology of small opulations and metapopulations in elation to habitat change and land use atterns. A sample of ongoing investiations of likely interest to parks inludes population genetics of the lack-footed ferret, estimating and naintaining population sizes of endangered fish and amphibians, and developing census techniques and opulation models for other species of oncern.

Species biology research determines he life history, systematics, and habiat requirements of selected species. The National Biological Service emhasizes endangered, declining, and ongame species and those species that nay become candidates for listing. Onoing investigations involve the grizly bear, desert tortoise, bats, mountain lover, and other species of concern in NPS areas.

The *inventory and monitoring* activiies of MESC track the status and rends of biological resources. The cener carries out these activities at the naional level as needed by providing xpertise, developing technologies vith wide applications, and developng spatial and tabular databases to suport inventory and monitoring ctivities. The National Biological Serice is conducting the following activiies that may be of help to parks: etermining the vertebrate faunas and aunal histories of federal lands includng national park areas and managing erbaria and vertebrate repository colections at strategic locations within he region.

A fundamental intent of the National iological Service is to make available nformation on biological resources to Department of the Interior managers and the public, states, etc.), and MESC upports this objective through its *inormation and technology services*. The enter provides information, technical ervices, and training related to the nanagement of biological resources. They also provide expertise on a naional scale for the development of new echnologies and models critical to the management of these resources, and training in the use of these tools. Their strengths include the ability to develop habitat models and provide technical assistance with social, economic, and institutional analyses. In this area the National Biological Service can develop species- and community-level habitat suitability models for habitat management planning, develop GIS to aid analysis of endangered species critical habitat, evaluate social perceptions of natural resource management alternatives, analyze economic impacts of endangered species critical habitat decisions, and develop computer technologies and expert systems for application to biological resource management.

Expertise and recent MESC projects

The formation of the National Biological Service and subsequent restructuring of all land management client agencies has led to a firm beginning in human resources consolidation and ecosystem management. As agencies shrink and are forced to rely more on each other for cooperation and the NBS for biological research and technical assistance, it makes sense economically and organizationally to begin to approach resource management from a more holistic point of view. A few of the projects and services that the scientists at MESC have been working on recently, in addition to those already mentioned, are also beginning to show this orientation toward ecosystem management, perhaps especially at this science center. Table 1 (on page 14) shares a list of MESC sections, leaders, expertise, and selected research activities that are relevant to NPS needs (but by no means complete).

Other common services or products of MESC include scientific design assistance, statistical analysis, GIS, publications, bibliographies, species status and trends reports, global positioning system equipment, training (environmental negotiations, etc.), symposia, book chapters, ecological computer modelling tools, and technical assistance.

Continued on page 14

News & Views continued

will continue refining software periodically to ensure that these systems evolve in order to meet the demands and expectations of NPS information users for planning and documentation. For further information, contact Goddard at (970) 225-3543.

Highlights continued

Arch, Double O Arch, and automobile travel on 4-wheel drive roads led the park and VERP developers to test the process at Arches last fall. The VERP process starts with designation of different management zones based upon different types and amounts of visitor use (e.g., permit-controlled backcountry hiking, unrestricted frontcountry hiking, etc.). Standards for social indicators vary according to the resource and visitor experience objectives of the different management zones.

At the core of the VERP program are the indicators and standards that seek to mitigate resource and visitor experience degradation. When exceeded, the indicators and standards trigger management actions that social conditions back within acceptable limits.

Specifically, the social standard for Delicate Arch requires management action if more than 30 hikers at one time are observed in 10% or more of the samples collected during the peak hours of the peak months of the visitor season. Likewise, visitors will encounter no more than three vehicles per hour or 10 widenings per mile (areas where vegetation and soils are disturbed by vehicles leaving the road) while travelling park 4-wheel drive roads. If these conditions are violated more than 10% of the sampling period, management must take action to bring conditions back within the acceptable limit.

Monitoring will be completed in 1996 and may indicate certain restrictions on some visitor activities in 1997. The VERP process also suggests that a parkwide carrying capacity may be necessary if visitation continues to grow.

Denver Service Center and park staff are currently writing the VERP implementation plan that will explain in detail the management zones, indicators and standards, and management actions that the park will take initially.

Table 1. Profile of MESC sections, leaders, and expertise.

Leader	Expertise	Recent or Ongoing NPS-relevant Study or Product
Social, Economic, and Institutional Analysis Section		
Lee Lamb; (970) 226-9256	Economics, environmental law, institutional analysis, land use policy, legislative process, policy analysis, political science, sociology, water law, and wildlife and habitat values.	Visitor values of Rocky Mountain National Park natural resources (published in Park Science 15(1):10 by Jonathan Taylor).
Southwestern Ecosystems Section		
Tom O'Shea (acting); (970) 226-9398; Field Stations at Los Alamos and Albuquerque, NM, Moab, UT, and Flagstaff, AZ	Arid & montane habitats; biodiversity; disturbance; endangered and declining species; fire ecology; habitat restoration; inventory and monitoring; landscape, plant, & soil ecology; taxonomy & systematics, & vertebrates.	Soil compaction impacts to desert lands (grazing, visito trampling) and effects on biodiversity and plant recover (Jane Belnap).
Mountain Ecosystems Section		
Cliff Martinka; (970) 226-9342; Field stations at West Glacier, MT, Yellowstone, WY, and Fort Collins, CO.	Animal behavior, aquatic systems, global change, landscape ecology, natural areas, plant ecology, threatened species, trend and analysis, and vertebrates of Glacier, Yellowstone, and Rocky Mountain National Parks.	Landscape scale gap analysis program to consolidate data for parks and forests in evaluating patterns of biodiversity (Leo Marnell).
Atmospheric and Watershed Ecosystems Programs Section		
Raymond Hermann; (970) 226-9342	Air pollution dispersion modeling, air quality, biodiversity, GIS, global change, inventory and monitoring, remote sensing, smoke management, water quality monitoring, and watershed science.	Atmospheric inputs and watershed outputs monitoring at Sequoia, Rocky Mountain, Olympic, and Isle Royale National Parks as a way to assess and model ecosystem dynamics (Robert Stottlemeyer).
Vertebrate Ecology Section		
Fritz Knopf; (970) 226-9325	Amphibians, biodiversity, birds, field biology, landscape ecology, mammals, and reptiles.	Restoration ecology of western rangelands using reintroduction of keystone species, such as beaver and prairie dogs (Bruce Baker).
Endangered Species Section		
John Oldemeyer; (970) 226-9491; Field stations at Bozeman, MT, Riverside and Palm Springs, CA, Las Vegas, NV, and Saint George, UT.	Animal behavior, arid habitats, botany, disturbance, endangered species, fire ecology, mammals, plant ecology, predator-prey relations, radiotelemetry, reptiles, threatened species, Great Plains, Mojave Desert, Rocky Mountains, Yellowstone National Park.	Fire effects on Yellowstone grizzly bears (Richard Knight).
Stream and Riparian Ecology Section		
Lee Ischinger; (970) 226-9331	Stream vegetation responses to changes in stream flow.	Contaminant impacts on western stream gravel bed aquatic habitats (Del Nimmo) and relationships betwee biotic indicators of ecosystem health and environmenta variables (Terry Boyle).
River Systems Management Section		
Clair Stalnaker; (970) 226-9332	Ecotoxicological monitoring, geomorphology, habitat restoration, hydraulic and civil engineering, hydrology, impact assessment, invertebrate ecology, plant ecology, riparian and wetland ecology, sediment dynamics, stream ecology, systems modeling, and water quality.	Model development of in stream flow needs for multiple species in southeastern U.S. rivers (Ken Bovee) and multiagency Colorado River management model development using multiple criteria approach (Marshall Flug).
Landscape and Habitat Analysis Section		
Vacant; (970) 226-9305	Agricultural policy, bioenergenetics, birds, forest management, GIS, global change, habitat analysis and modeling, impact assessment, landscape ecology, remote sensing, riparian ecology, statistics, stream ecology, systems modeling, and wetland ecology.	Techniques development for predicting responses of fish and wildlife to changes in habitat and Unix-Internet database of contaminants on federal lands.

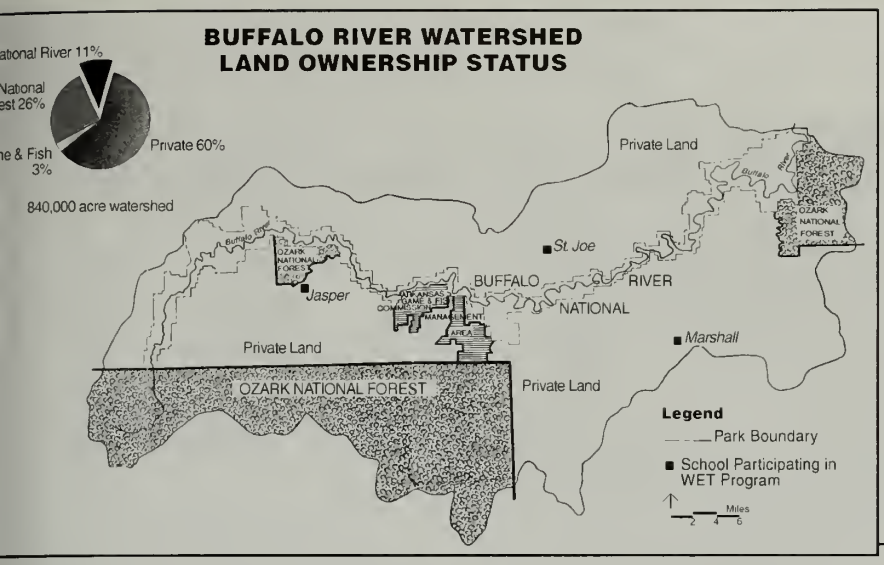


*Figure 1 (left). Buffalo River water quality depends greatly on land use practices outside park, forest, and game and fish management area boundaries, all areas within the Buffalo River watershed. The watershed figure shows land ownership and location of schools participating in the water education team (W*E*T) program.*

*Figure 2 (below). Standing ankle deep in Buffalo River tributary Calf Creek, W*E*T students get an introduction to physical monitoring techniques from U.S. Forest Service Hydrologist Jay Swafford. The two day training combined classroom and field activities to teach students what they need to know to participate in the water quality study program.*

BUFFALO RIVER WATERSHED STUDENTS GET *W*E*T*

By David N. Mott and Michael Naranjo

If ten glasses are filled with water from the Buffalo River, the contents of just one glass originates from inside the ark! In other words, Buffalo National iver manages only 11% of the total wa-ershed, sharing ownership with Ozark lational Forest (26%), Arkansas Game nd Fish Commission (3%), and many rivate land owners (60% [fig. 1]).

Land use activities, such as logging, ravel mining, and agricultural opera-ions, occur within the watershed. Al-hough the quality of the water flowing nto and in the Buffalo River is generally onsidered excellent, these practices ad-ersely affect the river in some areas. With 0% of the watershed being managed rivately, the future of the river may well e in the hands of our upstream neigh-ors.

One strategy for preserving the eco-gical health of the river and its tribu-aries is education. The National Park ervice, U.S. Forest Service, National Park oundation, Arkansas Department of Pol-ution Control and Ecology (ADPCE), nd Arkansas Game and Fish Commis-ion are joint sponsors of W*E*T (Water ducation Team) a pilot interactive wa-er resources education program involv-ng the local schools of Jasper, Marshall, nd Saint Joe (fig. 1). The program is long-erm, emphasizing environmental values and an understanding of the ecological balance of streams. Organizers hope the students will pass along the education to their parents and others.

In order to participate, the schools attend a 2-day training workshop where instructors treat students and teachers as equals. Both are taught about water as a resource, the three components of water quality monitoring (chemical, physical, and biological), and the methodologies used for collecting, analyzing, and recording water samples. Experts and guests from various agencies and organizations participate in the sessions (fig. 2).

Participants choose stations to monitor along various tributaries according to accessibility and logistics. Equipped with field gear, meters, and lab equipment, the schools sample each station every month and conduct follow-up lab tests. In addition, the schools also receive computers, software, and modems for networking and data entry.

Buffalo National River, Ozark National Forest, and ADPCE work closely with the schools to troubleshoot problems, replenish supplies, and analyze samples for nutrients. The students use EPA-approved methods to measure pH, dissolved oxygen, conductivity, temperature, turbidity, fecal coliform bacteria, and identify macroinvertebrates. Program sponsors provide annual refresher training and quality control checks.

The program has been a real success so far. Students and teachers have maintained enthusiasm and remained motivated; some have even taken on special projects. One senior at Jasper High School demonstrated leadership and initiative by designing a sampling regime for additional sites on the Little Buffalo River.

Continued on page 17

Tiger beetle continued from front page

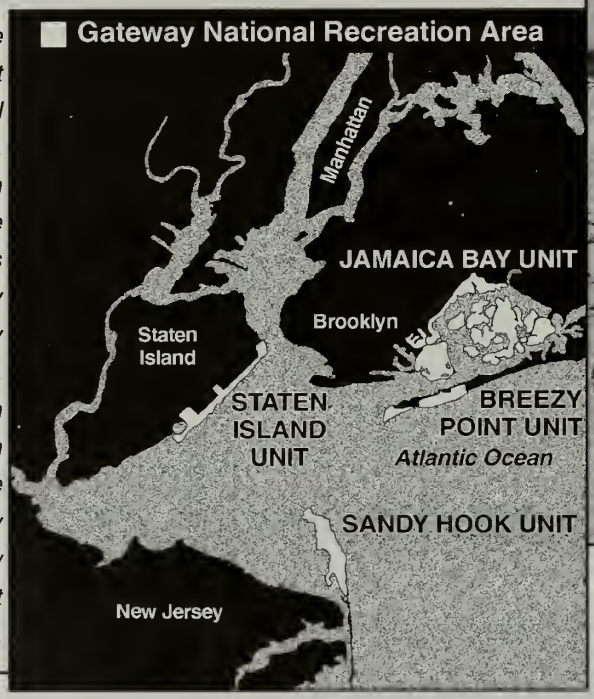


Figure 2. Once resident at Gateway National Recreation Area, the northeastern beach tiger beetle was extirpated as a result of military activity and heavy pedestrian traffic. Restoration activities to return the beetle to the beaches of Sandy Hook, New Jersey, began last October.

Figure 3 (inset, right). After overwintering twice, the half-inch long tiger beetle larva pupates in the bottom of a sand burrow that is up to 18 inches deep; the winged adult (fig. 1, page 1) emerges during the second summer.

Figure 5 (right). Restoration staff placed larvae beneath tiny paper cups until the young insects could dig their own protective burrows.

biological opinion concluded that during the restoration process the entire experimental population could be lost due to severe winter storms, accidental trampling, or the species' inability to adapt to relocation. We developed management recommendations and introduction procedures to minimize the possibility of an "incidental take" while establishing the new population.

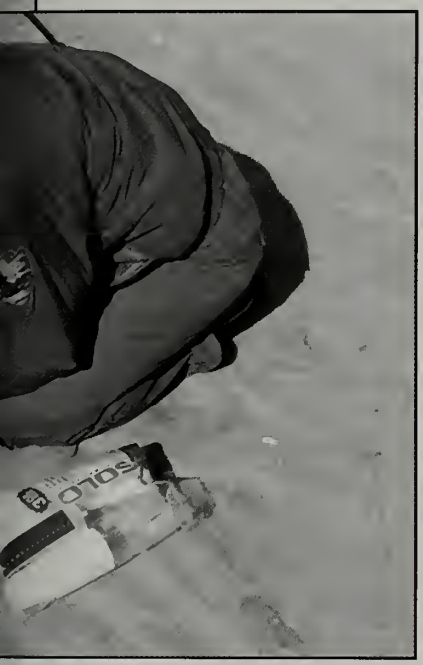
On a warm night in early October the researchers collected approximately 800 tiger beetle larvae from the Chesapeake Bay population (fig. 3). The larvae, which live in vertical tunnels between the high tide and drift line (highest tide line where wood, vegetation, and other debris are deposited), were located by the reflection of their eyes in a flashlight beam. The larvae wait at the mouth of the burrow to catch small prey as they pass by. Project participants had to dig up each of the 800 larvae since they would drop back into their holes. This was no small task considering the larvae are only about a half-inch long and the burrow can be up to 18 inches deep. The researchers placed the beetle larvae in vials containing some sand and transferred the insects to the park along with 50 vials of laboratory-grown larvae.

Employees of the U.S. Fish and Wildlife Service field office in Pleasantville, New Jersey, volunteers, and park staff from all divisions helped to release the tiger beetle larvae on the park beach (fig. 4). We created eight 10 x 10 m plots and evenly spaced 100 larvae in each plot. As we released them from the vials, we covered the larvae with a small paper cup to protect them until they dug a vertical burrow (fig. 5). Over the following several weeks, the researchers returned to assess survival and to place tiny meal worms in the plots to supplement the larvae food supply.

The northeastern beach tiger beetle larvae pass through three developmental stages during a 2-year life cycle, overwintering twice as larvae, pupating at the bottom of their burrows, and emerging as winged adults during their third summer. Depending on the level of development and the survival rate of the introduced larvae, we hope to see some adult tiger beetles this summer and plan to update *Park Scienc* readers about our success in a subse quent issue. Beachgoers concerne over the possibility of more insects o the beach were relieved to learn tha the tiger beetles rely heavily o greenhead and other biting flies as primary food source.

Participating in this project gave u an opportunity to contribute to th conservation of a species threatene with extinction. Although some or per haps all of the larvae may be lost dur ing this attempt to establish a new population, the species will benefi overall because of increased public awareness, our improved knowledge o its habitat requirements, and improve restoration procedures.

Figure 4 (left). The restoration effort required collecting 800 larvae from the Virginia Chesapeake Bay and replacing them evenly in eight restoration plots on the New Jersey beach at Gateway. Staff hopefully await the return of the winged-adult beetle to Sandy Hook this summer.



Gateway beaches have always been aluable resource. They may become en more valuable with the addition the northeastern beach tiger beetle the more remote sections of the rk. This important step will bring us oser to recreating a truly natural ach ecosystem with a complete mplement of native beach organ-ns.

uce Lane is a Supervisory Park nger in the Natural Resources vision at the Gateway National creation Area Sandy Hook Unit. His dress is P.O. Box 530, Fort Hancock, J 07732; phone (908) 872-0115; fax 08) 872-7241. He can also be reached NPS cc:Mail--"Bruce Lane NP-ATE".

Buffalo River Continued

Her project paper received state recognition and a $1,000 Future Farmers of America college scholarship.

The most important thing about this program is how the students feel about their efforts. The following quotes are taken from reaction papers written by students at the end of each year:

"W*E*T is completely different from what I expected. We do a lot more hands on and field work."

Jessie Baker

"I feel working with bugs is helping me decide what career I may want to pursue. When I first joined project W*E*T I would not touch any of the bugs and now I find myself falling in love with the cute little guys."

Nikki Dean

"I ... acquired many new skills. I know how to classify and categorize organisms discovered in the water."

Juliena Arthur

"I learned a lot more than I expected, but the main thing I realized was that everything in the environment affects everything else."

Tara Dawn Cape

"I have ... learned the usefulness and importance of teamwork. Everyone must give one hundred percent effort for the correct results."

Christy Grinder

"W*E*T taught me not only how to gather information, but ... also ... how to apply this information in real life."

Jennifer Richardson

"I have ... learned how people are affecting the rivers ..."

Laura Brinkmeyer

"I have learned to respect the water and not abuse the privilege of having such beautiful creeks around our community."

Reyna Martin

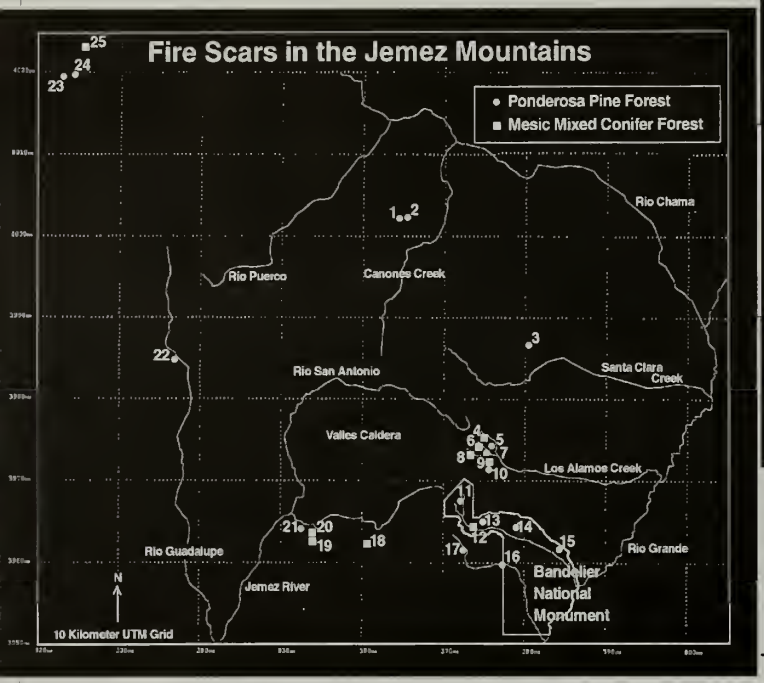
"I feel some responsibility for the polluting of our streams and land. I now try to be more careful with my actions because now I think of how they will affect our ecosystem."

Amanda Weaver

> *"I feel some responsibility for ... our streams and land. I now try to be more careful with my actions because I think of how they will affect our ecosystem."*
>
> *Amanda Weaver*

As sponsors of W*E*T, we are extremely proud of our students and their teachers. We hope this learning program will contribute to the future success of these students and the long-term health of the Buffalo River and its tributaries.

David Mott is a Hydrologist and Michael Naranjo is a Biological Technician. Both are at Buffalo National River, Arkansas, and can be reached at (501) 741-5443, through NPS cc:Mail, or by e-mail: "david_mott@nps.gov" and "mike_naranjo@nps.gov", respectively.



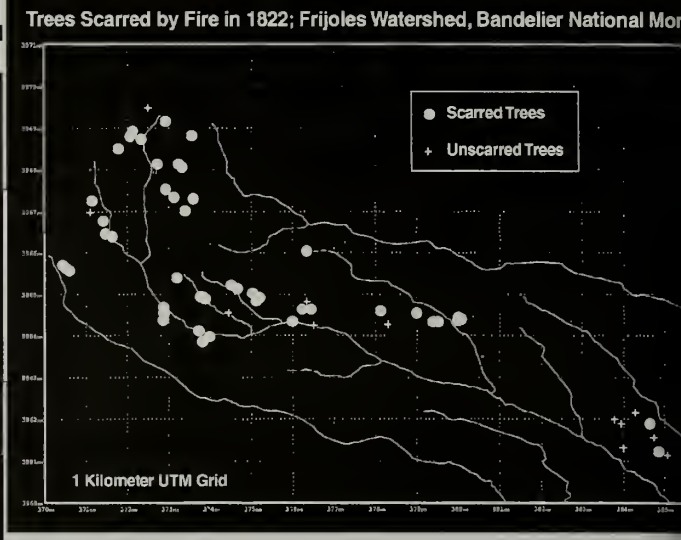


Figure 1 (left). Map of the location and general forest type of sampled for fire scars in the Jemez Mountains.

Figure 2 (above). Close-up of figure 1 sites 11-15 in Bandelier National Monument showing trees scarred by fire in the 1822 Frijoles watershed blaze.

Landscape-Scale Fire History Studies Support Fire Management Action at Bandelier

By Craig D. Allen, Ramzi Touchan, and Thomas W. Swetnam

Fire has long been recognized as a key process determining the ecological structure and function of many southwestern forests (Weaver 1951). Major changes in southwestern fire regimes over the past century (Swetnam 1990) are having correspondingly large ecological effects on southwestern forests, including those of Bandelier National Monument in the Jemez Mountains of northern New Mexico (Allen 1989). Ecologists and managers who seek to understand current landscapes require accurate information on the spatial and temporal variability in past fire regimes. This kind of information provides essential historical context that is needed to properly manage our modern park landscapes.

We are using dendrochronological (tree-ring) methods to reconstruct fire occurrence patterns over the last several hundred years across a variety of vegetation types, topographic situations, and geographic locations in the Jemez Mountains. The work is being accomplished through a cooperative effort between Bandelier National Monument, the National Biological Service, the Santa Fe National Forest, and the University of Arizona Laboratory of Tree-Ring Research (Touchan and Swetnam 1995). We have dated over 3,000 fire scars from 373 trees, snags, logs, and stumps at 25 sites located around an arc 50 km (31 mi) in diameter that circumscribes the Jemez Mountains (fig. 1). Elevations of sampled sites range between 2,000 and 3,000 m (6,562 and 9,843 ft, respectively). Each scar is dated to its precise year of formation, and in most cases even the season in which the fire occurred can be determined. We are using these data to develop fire histories at multiple spatial scales, building up from individual trees through clusters of trees to watersheds (fig. 2) and finally the entire mountain range.

Ponderosa pine *(Pinus ponderosa)* dominates most sample sites, although we also sampled mixed conifer forests that contained Douglas fir *(Pseudotsuga menziesii)*, white fir *(Abies concolor)*, and Engelmann spruce *(Picea engelmanni)*. We collected aspen *(Populus tremuloides)* cores from pure stands adjacent to some mixed conifer sites and crossdated them to determine postfire establishment dates. We also used dendroclimatic methods to reconstruct December-June precipitation back to 1653 A.D. using ring-width chronologies from nine sites in northern New Mexico.

The fire scar chronologies show that f
was frequent and widespread in the Jem
Mountains prior to the 1890s (fig. 3). For e
ample, fire scar samples in Bandelier reco
113 different fire years between 1480 and 18
A.D. *Surface* fires burned in primarily gras
fuels from the lowest elevation mesa-t
stands of ponderosa pine at 2,030 m (6,6
ft) to the summit of the Frijoles Creek wat
shed at over 3,000 m (fig. 2), with avera
intervals between widespread fires rangi
from 5-15 years. In many years climate-sy
chronized fires burned throughout the Jem
Mountains (and even throughout the Sou
west; see Swetnam 1990)–other yea
smaller, patchier fires occurred. We belie
that lightning caused the vast majority of the
fires. Like elsewhere in the Southwest, t
widespread surface fires ceased throughc
the Jemez area in the late 1800s (fig. 3), a
parently because intense grazing by lar
numbers of free-ranging livestock reduced t
grassy fuels through which most fires spre
(Swetnam 1990).

Major fire years tended to be dry in bo
ponderosa pine and mixed conifer forests
the Jemez Mountains. Adjacent ponderc

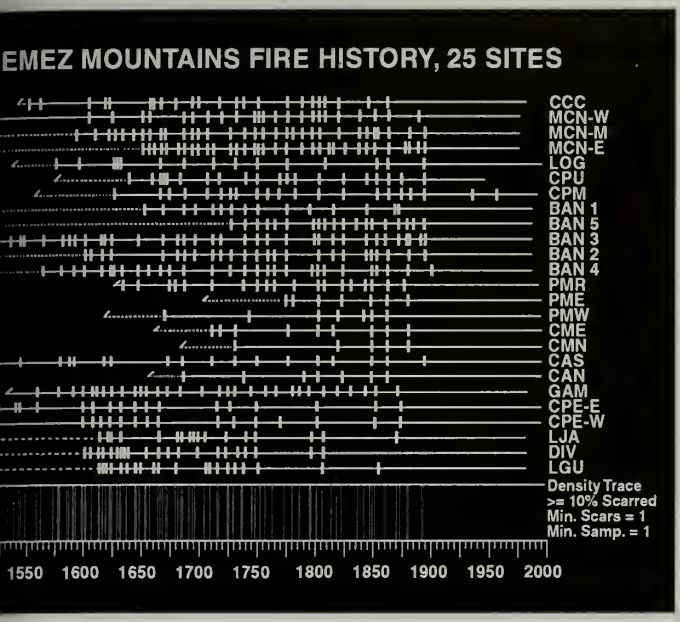


Figure 3. Composite fire history chart for major fires in the Jemez Mountains. Horizontal lines cover the life spans of trees within each site. Short vertical bars are composite fire dates recorded by scars on at least 25% of the trees within each site; thin vertical lines indicate fire dates on the time line. Note the synchrony of fire events between sites and the cessation of recorded fires in the late 1800s. Site code names and numbers (from fig. 1) shown on right margin.

e and mixed conifer forests often, but not ways, recorded synchronous fire events. owever, major fire years in ponderosa pine ests typically occurred with a 2-year lag er significantly greater winter-spring pre- itation; this is not observed in local mixed nifer sites. This suggests that the buildup fine fuels (such as herbaceous vegetation owing a wet year) was an important pre- rsor to spreading fire in ponderosa pine ests, whereas fuel moisture, rather than fine l availability, was more important in de- mining fire occurrence in mesic mixed co- er sites. The lags in fuel-fire relations, and influences of persistent atmospheric phe- mena on fuel accumulation and fire occur- ce in the Southwest (such as the El ño-Southern Oscillation [Swetnam and ancourt 1990]), suggest that long-range fire zard forecasting models could be con- ucted.

The network of 25 fire scar sample sites eals significant spatial variations in past fire imes across the Jemez Mountains. Pon- osa pine forest sites exhibited a range of h frequency surface fire patterns, with re- ced frequencies observed: 1) at low eleva- n sites, which have inherently lower tentials for producing fine fuels; 2) at places t are topographically isolated from the ger matrix of pine forests; and 3) during es that livestock grazing likely reduced the antity and continuity of local surface fuels. st fire regimes in mesic mixed conifer for- s included a combination of surface fires d patchy crown fires at 15-30 year inter- s. Historical lightning fire records from the k indicate that in most years middle el- evation ponderosa pine forests have a greater propensity for sustaining fires than other vegetation types.

Other significant findings include: some of the first quantitative reconstructions of fire history from several southwestern forest types, including riparian mixed conifer, ponderosa pine/piñon-juniper ecotone, spruce-fir; surprisingly frequent fire occurrence from a number of moist or high elevation forest types; proof that essentially all paleofires occurred in spring or early summer, whereas much prescribed burning today occurs in fall for control reasons; indications of possible Native American enhancement of fire frequencies in a few, particular time periods and places; and demonstration of the long-term coexistence of two sensitive species with fire (the endemic Jemez Mountains salamander [*Plethodon neomexicanus,* listed as state-endangered and federal Category 2 Notice-of-Review] and the federally-threatened Mexican spotted owl [*Strix occidentalis lucida*]).

Fire suppression during this century has significantly affected area ecology in a variety of ways, most obviously by allowing the buildup of unnaturally high densities of trees and amounts of ground fuels that were formerly thinned by frequent surface fires. Thus, as across much of the west, fire suppression has promoted conditions today that threaten the health of forests in the Jemez Mountains, with increasingly large, intense, and uncontrollable crown fires. In 1977, one such fire, the La Mesa Fire, burned through the heart of the Bandelier ponderosa pine forests. Scientists have recently completed a dozen linked research projects investigating the ecological effects of the La Mesa Fire and have presented findings on diverse topics (ranging from fire effects on avifauna and nitrogen-cycling to cultural resources) at a well-attended symposium in 1994; the resultant manuscripts are nearly ready for publication.

Summary

Landscape-scale fire history research is providing critical information to initiate, guide, and support extensive use of prescribed fire by multiple agencies to restore this keystone process to forest lands in the Jemez Mountains. Fire history data have been essential to allow fire management programs to (carefully) proceed with burning plans in occupied habitat of such sensitive species as Mexican spotted owl and Jemez Mountains salamander. Overall, this fire history research provides much of the underpinning for the new Bandelier National Monument Fire Management Plan, and it is being used to support similar fire management efforts on surrounding Santa Fe National Forest and Native American lands.

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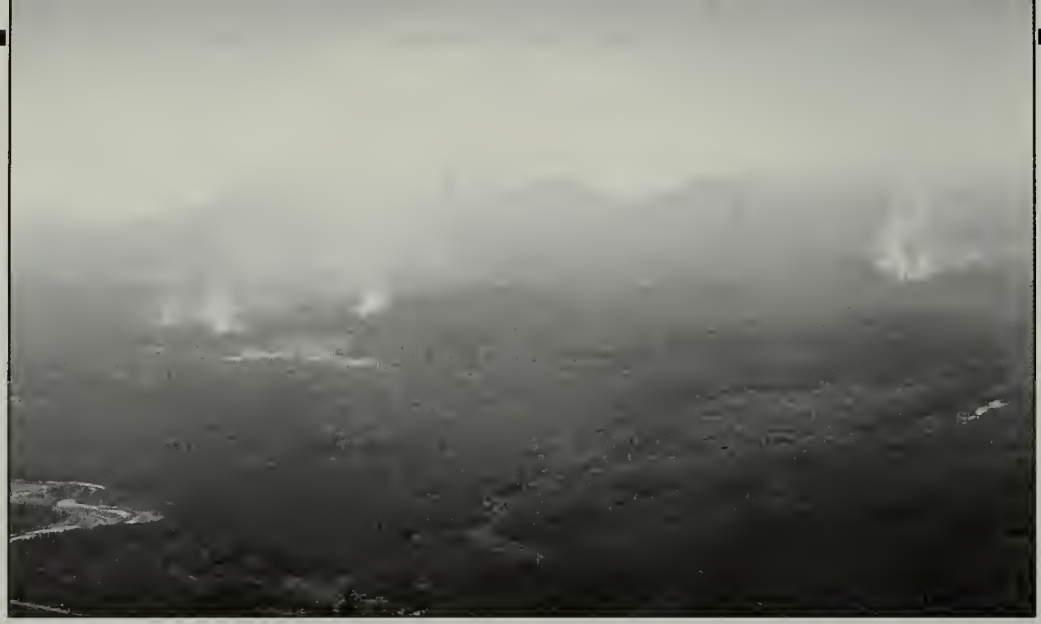

Figure 1. The 1994 fire season challenged park staff and cooperators with managing multiple incidents with different goals: the Starvation Creek (upper left) and Adair #2 wildfir (middle right) were contained, while the Howling Fire (middle left) was allowed to burn within prescription to reap ecological benefits.

Prescribed Natural Fire Management: Lessons Learned in the Glacier National Park Classroom

Resource and fire management integration necessary to reap ecological benefits of fire

By Tom Zimmerman, Fred Vanhorn, Laurie Kurth, and Thad Stewart

The 1994 wildland fire season posed especially long and extensive blazes that challenged many fire managers in the western United States. Numerous fires grew quickly to large sizes and persisted for abnormally long periods of time. Few natural fires were allowed to continue as prescribed natural fires (see the glossary at the end of the article for an explanation of technical fire terms). However, fire managers in Glacier National Park, Montana, successfully managed an early season prescribed natural fire for nearly 15 weeks in conjunction with an above average wildfire workload.

Howling Fire chronology

On June 23, an early season lightning storm ignited a fire in the North Fork area of Glacier National Park near Sullivan Meadow. After initial evaluation and analysis, managers declared the fire a prescribed natural fire and prepared a fire situation analysis and monitoring plan. Early summer fires are uncommon in the park due to high elevations and typically wet conditions in June. Throughout June and July, the "Howling" Prescribed Natural Fire was monitored daily and showed very little activity. By early August staff mapped the fire at just 1 acre (0.4 ha).

The location and fuels of the Howling Fire, however, gave the fire potential to burn a relatively large area. Fire history in the North Fork area of the park showed that most fires burn from west to east due to the prevailing winds. Only once had a fire crossed to the west over the North Fork of the Flathead River into the Flathead National Forest. Glacier National Park fire managers felt that even though the Howling Fire had potential to become large, the probability of it staying within its anticipated boundaries was high.

The park used the latest fire spread prediction techniques to aid in decision making. A prescribed fire behavior analyst performed a rare event and risk assessment probability, a procedure that provides probabilities of rare weather events affecting fire spread and grow The park also used a new compu model, the Fire Area Simula (FARSITE), to project long-term spread. A fire researcher verified, v dated, and refined the model using do mented cases of fire growth. T combined information aided consid ably in the decision making proc However, due to pronounced regio and national fire activity, in-park sources and local fire management co erators were limited.

On August 5, the fire management s met with the superintendent to assess risks and benefits and to determine h to proceed in managing the Howling F scribed Natural Fire. The superintend decided to continue management a prescribed natural fire; however, he that the park needed to meet the follo ing conditions in light of the local regional wildfire needs:

1. Establish a dedicated incident mana ment team with key positions to filled by nonpark personnel.
2. Give public information a high pri ity.
3. Make available as many research portunities as possible.
4. Establish goals specific to the Ho ing Fire.
5. Monitor the fire closely and intensiv

By August 8, an incident managem team made up of staff from other N units was in place. The team updated fire situation analysis and maximum lowable perimeter (MAP). Initially, team managed the Howling Fire prin rily using park resources, and the p

ıtral fire dispatch office continued to ɔrdinate initial attack on new fires, but t was soon to change.

)n August 12, a new fire start (Starva- ı Creek) required separate manage- nt by a type II team. By August 29, st Starvation Creek fire control actions l been completed and operations were ıed back over to the park. At this time, Howling Fire incident management m assumed responsibility for the en- North Fork area of the park (includ- the Howling Fire) due to resource ɔrtages and the continued need for ıtrol actions and initial attack.

Also on August 12, a new fire had been covered near Adair Ridge within the AP of the Howling Fire. Due to na- ıal and regional preparedness level re- ctions, this fire (Adair #2) was not naged as a prescribed natural fire. Af- taking unsuccessful initial attack ac- ns, the team managed it using a finement strategy, as potential costs, nage to park resources, and risks to fighters were all high. On August 29, ther fire (Anaconda) was discovered ween the Howling and the Adair #2 s and was also placed in a confine- nt management strategy.

Through mid-September, the Howling ident management team (now known he North Fork complex incident man- ment team) had managed a prescribed ural fire, two confinement strategy dfires (both within the MAP of the wling Prescribed Natural Fire) and a ıtainment strategy wildfire (in con- ction with British Columbia Forestry Canada [fig. 1]). On September 23, the k reassumed responsibility for the mplex, and by September 25, the wling, the Anaconda, and the Adair fires had burned together. After an ex- ded dry fall, snow fell on October 24.

ONITORING

One element critical to successful man- ment of the Howling Prescribed Natu- Fire was consistent monitoring of ather and fire behavior changes indica- e of the fire exceeding the management ındary or threatening ranger stations hin the boundary. Initially, fire crept ough minuscule pockets of dry needles l the underside of downed logs (fig. As vegetation began to cure in late mmer, tracking live fuel moistures was critical to predict increased fire activity in the understory. A monitor familiar with both the global positioning system and the park GIS mapped the fire perimeter on ground and eventually by air. The Howling Fire demonstrated that experienced monitors with diverse backgrounds are essential to address the myriad of issues that arise.

Cultural resource protection and long-term research

Abundant archeological resources in one portion of the fire area required special attention. A struggling community of loggers, farmers, and bootleggers lived in the area from the 1890s-1930s. Although many antiques appear to have been removed, several fine examples of pioneer farm equipment, including a horse drawn plow, a thresher, and the remains of two wagons were still present (fig. 3). Prior to a backburn operation, monitors conducted an informal yet thorough survey to map the homestead sites and scattered artifacts. Melted glass, broken bottles, and charred fence posts were evidence of previous fire activity. The survey allowed monitors to actively keep fire away from several features, such as wagon wheels and running boards, which warranted protection. With careful observation and planning, the Howling Prescribed Natural Fire had little, if any effect on the archeological integrity of the area.

Ponderosa pine is of particular ecological interest in the fire area. Minimum ponderosa pine reproduction in the park has been attributed partly to fire suppression. In the Howling Fire area this species is present in stands of similar-aged spruce, fir, and larch trees. Vegetation regeneration, particularly ponderosa pine reproduction, will be measured in long-term fire effects monitoring plots established during the Howling Prescribed Natural Fire.

Management recommendations

NPS prescribed natural fire management guidelines can be improved to help parks deal more effectively with complex, long duration prescribed natural fires. First, as in wildfire management, incident management teams are valuable tools in prescribed natural fire management. As *wildfires* escape initial attack, pose significant threats, or have potential to burn for multiple burning periods, parks are directed to seek additional assistance and even encouraged to request incident management team support. It is logical that

Figure 2. The Howling Prescribed Natural Fire burned predictably through initially moist, then drier, forest understory for 15 weeks before being doused by late October snows.

Figure 3. Deliberate and thorough monitoring efforts followed by a successful backburn operation preserved several cultural artifacts, including this pre-1930s wagon wheel, while allowing the prescribed natural fire to burn.

Continued on page 22

parks should also be encouraged to employ outside assistance and even incident management teams when facing potentially lengthy *prescribed natural fires* and complex management circumstances, such as external influences.

The incident command team used in Glacier last summer to manage the Howling Fire for 75 of its 138 day duration, while helpful, also created a need for complex logistical support. This included providing transportation, food, lodging, and communication support for large numbers of personnel in remote areas. Thorough preplanning is required to provide adequate logistical support. Ensuring monitor and crew safety on the ground and in association with air operations must also be properly planned and implemented. Activating a management organization with strictly nonpark personnel permitted proper attention to these concerns and allowed for efficient and safe prescribed natural fire management.

Second, interagency constraints on the prescribed natural fire program should be changed to permit continued management, even during active fire suppression periods. Current preparedness plans have admirably fulfilled a purpose of guiding long-term fire management accountability. These plans, however, unnecessarily restrict or prohibit prescribed fire activities, particularly when such fires could be most ecologically beneficial. These plans should be changed as they presently limit many parks and wilderness areas to natural fires of only small size, short duration, and little ecological significance. Competition with suppression needs will cause prescribed natural fires to lose or be denied resources for monitoring, holding, and contingency actions. Dedicated prescribed natural fire resources would help alleviate this problem.

Other recommendations include:

1. Developing an incident command system organization and certification program that can be used to manage prescribed natural fires.
2. Hiring and training a dedicated 20 person prescribed fire support crew prior to the 1995 fire season.
3. Using the FARSITE predictive model for assessing prescribed natural fire potential on all future prescribed natural fires.

Table 1. Glossary of Selected Fire Terms

Burning Period—That part of each 24-hour period when fires will spread most rapidly.

Complex—Multiple incidents being managed by a single incident management team.

Confine—To restrict the wildfire within determined boundaries, established either prior to, or during the fire. These identified boundaries will confine the fire, with no action being taken on the ground until the fire is out.

Contain—To restrict a wildfire to a defined area, using a combination of natural and constructed barriers that will stop the spread of the fire under the prevailing and forecasted weather conditions, until out.

Control—A wildfire, aggressively fought through the skillful use of personnel, equipment, and aircraft to establish firelines around a fire to halt its spread and to extinguish all hotspots until out.

Incident Command System—Combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure with responsibility for management of assigned resources to effectively accomplish stated objectives pertaining to an incident.

Incident Management Team—A team operating with a common organizational structure, with responsibility for the management of assigned resources to effectively accomplish stated objectives pertaining to an incident. Incident Command System resources (including teams) are "typed" (classified) according to their qualifications and skills to manage large or complex incidents.

Initial Attack—The control efforts taken by resources that are the first to arrive at the incident.

Maximum Allowable Perimeter—A spatial or geographic area defining the maximum prescribed extent of the fire.

Monitoring—Periodic collection of data regarding a fire such as location, size, weather, behavior, fuels, smoke production, and vegetation. Monitoring is used to document basic information, to detect trends, and to ensure that fire and resource management objectives are met.

Natural Fire—A fire of a natural origin (lightning, volcanic, etc.) that is allowed to burn to accomplish one or more resource management objectives.

Prescribed Natural Fire—Fire that meets management objectives and prescriptions to burn. Includes prescribed natural fire and management ignited prescribed fire.

Prescribed Fire—Fires ignited by natural means (usually lightning) that are permitted to burn under specific environmental conditions, in preplanned locations, with adequate fire management personnel and equipment available to achieve defined objectives.

Project Fire—A fire normally of size or complexity that requires a large organization and possibly several days or weeks to extinguish.

Resources—All personnel and major items of equipment available, or potentially available, for assignment to emergencies. Resources are described by kind and type.

Summary

During the Howling Prescribed Natural Fire, NPS managers gained new insights into natural fire management. These experiences have generated procedural change recommendations that will both significantly enhance our ability to successfully administer the prescribed natural fire program and influence changes in program guidelines that will affect all prescribed natural fire managers agencywide.

It is imperative that we continue to learn about prescribed natural fire management and continue to strive for the integration of fire and resource management. The 1994 fire season and the Ho ing Fire are excellent examples of h we have dealt with uncertainty, de oped strategies for continued mana ment, and continued to improve abilities to manage natural fire in w land ecosystems.

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Announcing the New Grand Canyon Science Center

Organization joins science partners with resource management leadership

by David Haskell

Created in April, 1995, the Grand Canyon National Park Science Center is a new concept that responds to initiatives within the Department of the Interior and the National Park Service to improve agency efficiency, public service, and resource protection. Central to this effort is the need to work more closely with associated state and federal agencies, Native American tribes, conservation groups, and other organizations that share an interest in resource stewardship of public lands.

The NPS Strategic Plan (1994) provides a list of the most important things that the agency should do to meet current and future challenges. The first task is to base park management decisions on sound scientific information. In order to accomplish this goal the agency must redefine and strengthen the role of science in park management. The creation and operation of the Grand Canyon Science Center will assist the park and the National Park Service in achieving this goal.

The science center will operate differently than the previous park Resource Management Division. We will focus on four areas in this process:

The name change recognizes that resource management is a responsibility and function of all park divisions. By not having a park division called *resource management* we recognize the contribution other operational units and partners make in achieving our shared resource management mission. The science center will provide leadership, planning, and scientific knowledge of resources. Other park operational units will be engaged in resource education, protection, restoration, and other related activities.

The creation of the science center acknowledges that science is a fundamental part of park management and operations. The quality and scientific credibility of science center programs are being improved by raising staff performance expectations and recruiting new employees with clearly defined scientific capabilities.

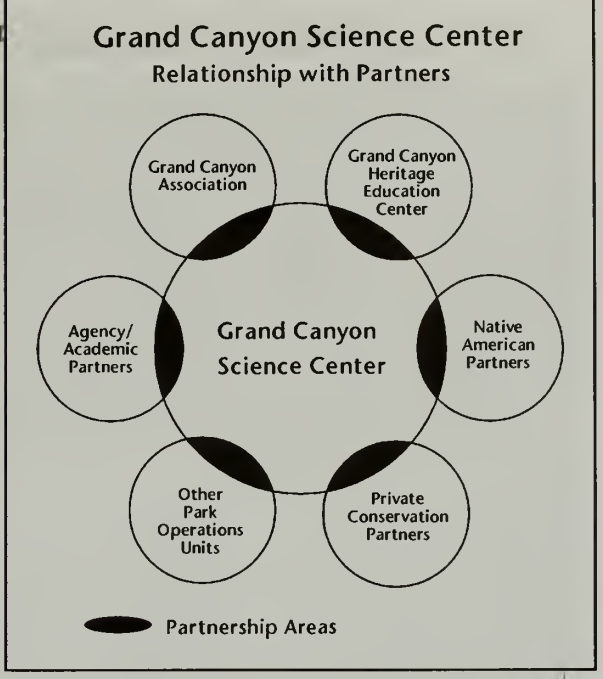
- Operational areas have been defined and are lead by qualified science program managers. These program areas are: research, geographic information systems and data management, natural science programs, cultural programs, social science-recreation programs, and administration.

- Center operations include the regular involvement and participation of six recognized categories of science program partners. These are the Grand Canyon Association, Native American tribes, academic and agency partners, citizen conservation association partners, and other park operational units.

In the context used to describe science center operations, we use the definition of *science* in Webster's Dictionary, which is "The systematic acquisition of knowledge through observation, study and experimentation." The center staff is made up of scientists, historians, curators, archeologists, and other professional subject matter experts, plus technicians who assist in carrying out field operations, and technical and administrative support staff. Together these people, in consultation with science partners, provide the scientific knowledge about park resources necessary to make knowledgeable and informed management decisions. This staff also formulates and prepares resource management plans and provides the leadership to carry out key portions of the park resource stewardship program.

The new science center will engage in many of the same activities that were being accomplished by the old Resource Management Division in the fields of natural, cultural, and recreational resource management. Science operations that are to be expanded include the addition of social science capability, expanding and improving the research program. which will be carried out primarily by partnership agencies and contract research scientists, and the development of a comprehensive long-term monitoring program for both natural and cultural resources. The purpose of expanding the latter two operations is to greatly improve our knowledge and understanding of the condition of park resources. Periodically evaluating the status and trends of resource condition allows park managers to be more effective in reducing threats to resource health and visitor enjoyment before any threats become serious problems.

Accomplishing this newly defined mission for the Grand Canyon Science Center will be a challenge in these times of reduced federal spending, continued increases in park visitation, and intensifying threats to resource health. The National Park Service recognizes that accomplishing the agency mission will require harnessing the energy, creativity, and financial support of partnership agencies and organizations. To accomplish this task, a primary focus of the center operations is to develop well-defined partnerships and to routinely incorporate these partners into center operations.



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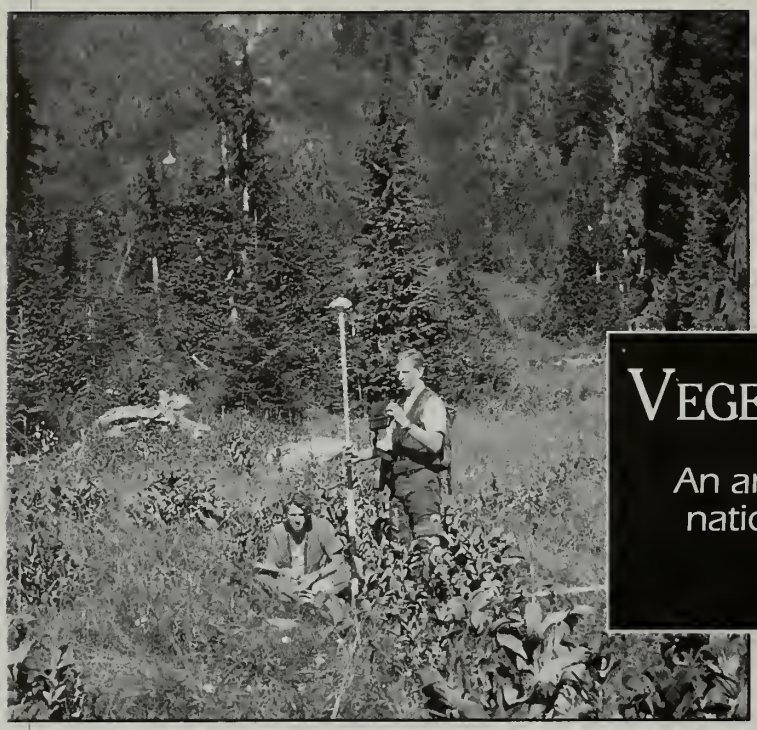

Figure 1. Pacific Meridian Resources personnel Ron Diver and Jeff Campbell (standing) collect vegetation data georeferenced by a global positioning system in the Low Divide area of Olympic National Park, Washington.

Vegetation Mapping in Northw

An ambitious project to develop a regional GIS national parks to develop interagency partner management based on scientific p

By June C. Rugh, David L. Peterson, and Jeff T. Campbell

How much old-growth forest remains for the northern spotted owl in the Pacific Northwest? What proportion of land area in each park is occupied by alpine vegetation? Which watershed has the largest percentage of Douglas fir crown cover?

These are questions that managers in Crater Lake, Mount Rainier, North Cascades, and Olympic National Parks will soon be able to answer with unprecedented accuracy, consistency, and state of the art documentation. The Columbia-Cascades System Support Office is working with Pacific Meridian Resources, Inc., to develop a comprehensive GIS database of vegetative, topographic, and landform data layers. Due for completion in September 1995, this database will increase our knowledge of ecosystems in the four parks, greatly enhancing resource managers' abilities to organize data, analyze relationships between resources in a spatial context, and assess the potential impacts of management decisions.

Until now, the rugged and remote landscapes characteristic of these parks have limited scientists in developing detailed, comprehensive data on vegetation and landforms. Pacific Meridian Resources is tackling this challenge by integrating existing monitoring and research data, extensive field reconnaissance, aerial photography, and satellite imagery into the regional GIS database. Using the various scales and resolutions of each of these database types, Pacific Meridian can obtain detailed information from more easily accessible areas. The detail can then be extrapolated to describe areas in remote locations determined to be similar from the satellite imagery and aerial photography. A GIS database encompassing all regions of the park will result.

Generally speaking, GIS databases describe the physical, biological, and cultural attributes of resources. They link computerized maps (location data) to computerized databases that describe the attributes of a particular location. This link makes possible simultaneous access to both location and attribute data for simulating the effects of management and policy alternatives. GISs are powerful tools, because a single operator can quickly search, display, analyze, and model spatial information. Moreover, maps and data can be updated more rapidly and accurately than with conventional methods.

The core of the Pacific Northwest project is an ecosystem database that focuses on two primary components: 1) characterization of forested and nonforested vegetative types across all park areas, as defined by criteria such as tree species, s density, stand age, crown cover by spec dominant understory species in fores areas, and species cover in nonforested eas; and 2) characterization of topograp and landforms, including developmen data layers for slope, aspect, elevation, landform type.

What makes the Pacific Northw project different from others? After many national parks have description physical and biological components, v some already in digital GIS format. F the innovative use of remote sensing te nology will produce a detailed descript of multiresource landscapes, allowing source managers to address issues in ecosystem context. This dynamic, spa database will enable managers to assess est stand dynamics and wildlife hab with accuracy and thoroughness. Seco the database will provide a comprehens framework on which more extensive detailed information can be built, which will be consistent from park to p Most significantly, the project dem strates a regional approach to ecosyst management by organizing data from four parks into one contiguous datab and by coordinating efforts with adjac

d managers–the U.S. Forest Service, e resource management agencies, and ate timber companies.

he use of satellite image classification litates the regional approach to GIS da- ase development. Satellite imagery not y provides detailed, consistent informa- about NPS lands of interest, but also sents the same detail and consistency of information for lands adjacent to the parks. This insures compatibility between databases among different agencies, which in turn allows for greater potential in data sharing and collaborative resource management. Moreover, this cooperation reflects an increasing commitment on the part of resource man- rs to cross political boundaries in or- to achieve common goals.

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E TECHNICAL APPROACH

he technological hub of the project is ultistage sampling process. The pro- integrates existing data sources, new l data collection (fig. 1), Landsat The- ic Mapper satellite imag- , aerial photography, tal topographic data and er existing GIS data layers, the knowledge and expe- ce of Pacific Northwest logy found within the Pa- c Meridian project team NPS staff. Database de- involves two steps: 1) tifying database standards oth spatial and classifica- accuracy and 2) develop- a preliminary classification tem that identifies the es of variation in vegeta- and landforms of interest he anticipated database us-

patial or positional accu- is defined as the expected iance in the geographic lo- on of an object in the da- se from its true ground position. The ial database standards for this project be largely a function of the scale and lution of various data ranging from 30 33 yd) Landsat Thematic Mapping im- ry and digital elevation data to 1:100,000 and 1:500,000 scale geology map data. All data will be coregistered with the satellite imagery to ensure spatial consistency. Classification accuracy is the probability that the class assigned to a particular location on the map is the same class that would be found at that location in the field. While traditional classification standards imply only true or false classifications, Pacific Meridian is working with NPS staff to incorporate *fuzzy sets* (flexible criteria) into accuracy standards, deriving a set of measures to analyze the nature, frequency, source and relative magnitude of map errors. This will provide us with more complete information on map reliability.

In developing the classification system, landforms are characterized by slope, aspect, elevation, and landform type, including substrata origin and type (such as bedrock type). Landform identification can be highly variable and can range from general descriptions of topographic shapes (mountain, plateau) to specific terms indicating depositional form and process (alluvial fan, glacial moraine). This project is producing a digital geomorphic landform layer that describes substrate origin and type.

Figure 2. Traditionally, landscape information is transferred from hardcopy maps and photos to the GIS through the painstaking process of digitizing. Contractor Pacific Meridian is investigating using a digital shaded relief data technique that would eliminate many of the hardcopy transfer steps.

Landform data can be developed through a variety of methodologies ranging from extensive field reconnaissance to digital data modeling to photo interpretation. The method deemed most efficient and suitable for this project is the interpretation of high altitude aerial photography and topographic base map data. We will interpret landforms from 1:80,000 scale National High Altitude Aerial Photography (NHAAP) and delineated directly onto 1:100,000 scale topographic maps. Interpretation will be aided by review of both the topographic maps and local geologic maps.

Pacific Meridian is also investigating the use of digital shaded relief data developed from 1:24,000 digital elevation area draped with satellite imagery. The digital images could be interpreted with the assistance of NHAAP photography and previously collected field data. Landform characteristics could then be delineated directly on the computer screen. This methodology would eliminate the need for many of the hardcopy transfer and digitizing steps required in the strictly photo-interpreted landform mapping methodology (fig. 2). Where feasible, landform classes will be verified during field reconnaissance efforts associated with the vegetation database development phase of the project. Based on scale limitations of the source data, the minimum mapping unit for landforms will be approximately 40 ha (99 acres).

We will characterize vegetation by several variables: stem density by tree species, stand age by species, tree diameter by tree species, crown diameter by tree species, crown cover by tree species, standing dead trees, dominant understory species in forested areas, and cover of herbaceous plant species in nonforested areas. In developing the vegetation characteristics database, we will use satellite images as a basis for determining the vegetation data themes through the integration of various ancillary data sources. The reason remotely sensed data (such as satellite imagery or aerial photography) can be used to collect vegetation information is because of the high correlation between variation in imagery and actual variation in vegetation.

Continued on page 26

Vegetation mapping continued

Remotely sensed data is particularly effective for mapping the variation in tree canopy characteristics (such as crown diameter by species, crown closure by species) in forested areas, and the soil type, moisture, and nontree vegetation variation in nonforested areas (fig. 3). Thus, satellite imagery can be useful in characterizing much of the variation in vegetation across the national parks. Landform classes will be digitized directly from the topographic maps to form the final landform type layer. Furthermore, land cover classification data from satellite imagery can provide much more detailed intensive information than results from traditional photo-interpreted polygon classifications. For example, while a 5-ha polygon may summarize forest age, canopy cover, structure, and so on, satellite image classification provides information on the variation of forest age, canopy cover, structure, and so on without the 5-ha polygon area.

Vegetation characteristics that cannot be directly mapped from the imagery can be delineated through the development of relationships among the imagery, fire history, and landform characteristics. For example, tree diameter, which cannot be mapped from aerial photos or satellite imagery, is highly correlated with tree canopy diameter, which can be estimated from remotely sensed data. In addition, a multistage sampling process is used to determine the relationships of the imagery of forest canopy characteristics to nonforest cover types; canopy characteristics to subcanopy characteristics; and landform, fire history, and other environmental factors to forest canopy characteristics, forest subcanopy characteristics, and nonforest cover types. Multistage sampling employs the fact that strong relationships exist between some characteristics that are inexpensive to estimate (such as crown diameter) and other variables costly to estimate (such as tree diameter). We will use the combinations of these relationships to develop the database of vegetation characteristics.

Quantitative assessment of map classification accuracy involves comparing the map to reference data (from photo interpretation or field identification, for example), which is assumed to be correct. Because comparison of every spatial point is impractical, sample comparisons are used to estimate the accuracy of maps. Accuracy assessment requires: 1) the design of unbiased and consistent sampling and photo interpretation and field procedures, and 2) rigorous analysis of the sample data. We are using strict quality control and quality assurance procedures in both data collection and subsequent analysis to insure accuracy in the final dataset.

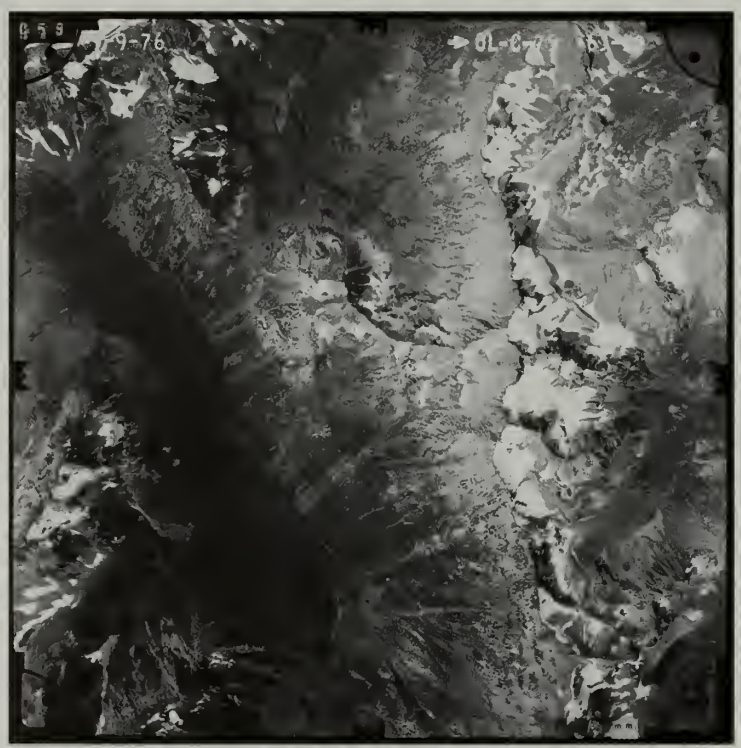

Figure 3. High altitude photographs, like this 1:24,000 scale photograph of Olympic National Park, show contrasts in vegetation types and landforms, and can be used to help GIS production staff classify vegetation.

Looking ahead

The vegetation mapping project currently underway in the Pacific Northwest is an important component of regional programs in inventory and monitoring, resource management, and science. It will also provide information for a wide range of uses. The new database will be a high-quality template for monitoring the condition of natural resources. It will provide a geographically based link to various disciplines within resource management, s as wildlife, hydrology, and fire. The d base will also be an important tool for search scientists in identifying spec vegetative and geomorphic resources, for georeferencing all future scientific tivities in the parks.

The database will provide a framew for increased and more specific coop tion with other agencies and institut Ecosystems do not stop at park bounda and water and wildlife resources cross th boundaries freely. The availability of a c sistent, compatible database will allow tional parks to develop interage partnerships for ecosystem managem based on scientific principles. Broader la scape-regional assessments and mana ment strategies will now be possi Furthermore, the Colum Cascades Cluster will be to cooperate in other sim vegetation efforts (planne under way) by the Nati Park Service, National logical Service, and ot agencies.

Ecosystems are consta changing–sometimes gra ally, sometimes abruptly. new database will be dyna in order to track spatial temporal changes in p natural resources, and it facilitate continual upda over time. It will allow p managers and scientists to termine the influence of la scale disturbances, such as on park landscapes, and potential impacts of lo term phenomena, such as mate change. Other uses, yet envisioned, will certa develop. The new datab will be more than a mere etation map–it will be a p erful managerial and scientific tool many years to come.

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SAVING NATURE'S LEGACY: PROTECTING AND RESTORING BIODIVERSITY

Reed F. Noss and Allen Y. Cooperrider

REVIEW BY R. GERALD WRIGHT

n their epilogue the authors lament the life of the "conference biologist," whose job it is to go to conferences, e lectures, and write obscure papers. ese biologists have now written a book igned to share the science of conser- on biology and the ideas it offers to tect biodiversity with others–particu- y those *others* in the real world–as op- ed to having the subject remain the nain of lecture halls and journals. It uld be nice if this lofty goal could be ieved, but I doubt that it can be.

his book, however, will–or should– l a place on the desks and shelves of professional biologists and resource nagers. Noss and Cooperrider have tten an excellent book whose great- strength is its readable synthesis of the portant aspects of the broad discipline onservation biology. Also, judging by number of times I have already seen book cited in draft manuscripts, it ears to be one of the more influential ks to come out among the prolifera- of recent biodiversity writings. The k reads well. Although the principles t it discusses have broad geographic lication, all of the case examples and st of the discussion of agency man- ment practices are oriented to the ted States, a factor that may enhance ppeal to NPS managers.

he origin of the book was the inabil- of the Keystone National Policy Dia- ue on Biological Diversity to produce cific recommendations. The first two pters introduce the concept of biologi- diversity and why it should be of con- n. This is followed by a presentation he basic concepts of biological con- vation, threats to biological diversity, and the current status of diversity in North America. The meat of the book begins with chapter three, which is a critique of past and present resource management failures and a look to future strategies. Subsequent chapters, e.g., "Managing Forests," "Managing Rangelands," and "Managing Aquatic Ecosystems," include comparisons of traditional resource management practices in the given subject area with those advocated following the principles of conservation biology. These and other chapters make several recommendations for altering current thinking and integrating biodiversity conservation into resource management; they also often contain excellent case examples of how these recommendations can be applied.

I feel one of the strongest chapters is "Designing Reserve Networks." Although most of this material is not new, rather presenting material published elsewhere primarily by the senior author, its thorough compilation and synthesis in one place makes it a valuable reference. The chapter on "Managing Rangelands" is, likewise, very good. It presents, often in a new light, considerable information on the impacts of livestock grazing and livestock management practices on biodiversity. These insights are often highly provocative, and I trust would raise the hackles of at least some traditional range managers. Conversely, I thought the chapter on "Managing Forests" was one of the weakest. Although it critiqued some of the concepts of new forestry, the presentation discussion was less compelling than that of other chapters.

As one would expect of these authors, the book pulls no punches in its examination of the causes underlying the crisis in protecting biodiversity. The ignorance of the general public, the often irrelevant nature of university training, and the foibles of agency land management practices all receive equal and usually valid criticism. The book is an important reference for all individuals involved in the management of parks and protected areas and I highly recommend they read it. PS

Published in 1994, this 416 page book is available from Island Press, Washington, DC; (202) 232-7933.

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Figure 1. Home to adaptable prehistori peoples over the las 15,000 years, the Fishing Bridge Peninsula routinely gained and lost ground to a cyclicall retreating and advancing Yellowstone Lake. T study area revealed complex series of earlier shorelines, some higher, others lower, than the present-day shore a Storm Point.

Caldera Unrest, Lake Levels, and Archeology: The View from Yellowstone Lake

A habitat restoration project prompts cooperative natural and cultural resource researc

By Kenneth P. Cannon, Kenneth L. Pierce, and George M. Crothers

Yellowstone National Park is rehabilitating the Fishing Bridge area on the north shore of Yellowstone Lake. This project will help maintain and protect critical habitat for the grizzly bear and preserve the quality of this diverse, local ecosystem (National Park Service 1984). During 1992-93, prior to the rehabilitation project and proposed reconstruction of the east entrance road, scientists from the NPS Midwest Archeological Center and U.S. Geological Survey conducted geoarcheological research on parts of the peninsula at Fishing Bridge. Although compliance legislation (Section 106 of the National Historic Preservation Act) mandated the research before the two projects could begin, we hoped to use this opportunity to learn more about the complex interactions of lakeshore level changes over time and prehistoric human adaptation to these changes (fig.1). We also hoped to use new techniques in geochemistry and immunological research to learn more about obsidian artifacts found within the study area and at other park sites. The following overview illustrates how geological and archeological observations can be integrated to interpret cultural remains and explain human adaptations to changing lake levels.

We assembled a team, including several researchers already familiar with Fishing Bridge, to provide expertise on local and regional paleoenvironmental patterns, mobility and subsistence patterns, landform history, and other topics. While preliminary, our work complements former studies in assessing the environmental circumstances that prehistoric humans lived with and adapted to.

Fluctuating lake levels

Central to understanding Yellowstone Lake level fluctuations and their effects on prehistoric humans in the Fishing Bridge area is the relationship between lake levels and caldera rise and subsidence at LeHa Rapids on the Yellowstone River. Loca 5 km (3 mi) downstream from the Yell stone Lake outlet at Fishing Brid LeHardy Rapids is a bedrock thresh that controls the level of Yellowstone L by acting as a dam; the intervening stre of river between the outlet and the rap is at present very flat with a total gradi of only about one-quarter meter (less t a foot). From 1923-85, the Yellowst caldera rose about 1 m (3.3 ft) bene LeHardy Rapids (Pelton and Smith 198 Since 1985, the same area has subsided a rate of about 2 cm (0.8 in) a year (Dzur et al. 1990). Explanations for these chan include magma intrusion, tectono-m matic interaction, and–our favored mec nism–geothermal sealing and press buildup followed by cracking and press release (see Pelton and Smith 198 Fournier 1989; Dzurisin et al. 1990).

We wondered if these changes were p of a longer-term process that could be st ied by dating evidence for lake levels b

ve and below the present level. An early
lel for lake level changes proposed by
mond (1976a, 1976b) argues for a pro-
sive, gradual lowering from late Pleis-
ene through Holocene time
roximately 15,000 years ago through
present). He outlines two general ages
horelines: a middle set of terraces 15.2-
, 12.2-13.7, and 9.1-10.6 m (50-55, 40-
0-35 ft, respectively) above present-day
owstone Lake formed between 5,000-
0 years ago and a lower set of terraces
4.6, and 3.0 m (25, 15, and 10 ft, re-
tively) above the lake formed more re-
ly.

rcheological and geomorphological
rmation gathered since Richmond's
k suggests that lake history is more
plicated. For example, Reeve (1989)
ed at the distribution of late Pleis-
ne-early Holocene projectile points.
ound that 10,000-8,000 years B.P., pro-
le points were common on shorelines
Richmond's chronology indicated
ld be younger than 5,000 years old.
ilton (1985) recognized lower-than-
ent lake levels, and later specified that
owstone Lake was below its present
from approximately 9,200-5,400 years
He and Bailey (1990) also postulated
the lake was 5 m (16.4 ft) below present
nd 1600 A.D.

he ages we determined are at least
e as old as those suggested by most
ious researchers (Richmond 1976a,
b; Meyer and Locke 1986; Locke and
er 1994). Shoreline ages have been
e difficult to determine with accuracy,
use most are based on radiocarbon
ples that are younger than the associ-
shoreline, and thus represent only
mum ages. We affirm the conclusion
Meyer and Locke (1986:20) that the
ory of lake levels is apparently more
plex than a simple decline over time."
order to resolve dating problems like
e raised by Reeve (1989) and to un-
tand the impacts and implications of
higher- and lower-than-present lake
s on human habitation, we needed to
er define the history of geomorphic
ges. Using geomorphic studies and
eological excavations, we have identi-
described, and precisely mapped relict
forms that record a cyclical pattern of
t and subsidence on the north shore
ellowstone Lake since deglaciation
oximately 15,000 years ago. Each of these cycles created significant changes in the local landforms, environments, and resources available to humans who lived in the area.

Cycles of uplift and possible subsidence

The current uplift and backflooding cycle observed over most of this century has been going on for about 3,000 years. Backflooding has converted the 5 km (3 mi) segment of the Yellowstone River (from its mouth at Yellowstone Lake to the bedrock threshold at LeHardy Rapids) from a once vigorously flowing river into the present wide pool. Using hand coring techniques, we found river gravels 4 km (2.5 mi) upstream from LeHardy Rapids that are now submerged beneath 4 m (13.1 ft) of mud and sand that started accumulating about 2,700 yr B.P. When deposited by the faster-flowing Yellowstone River, these gravels were several meters higher than the bedrock threshold at LeHardy Rapids. However, the uplift centered at LeHardy Rapids has been enough so that these gravels are actually lower than the bedrock threshold. We estimate that this river segment was tilted back toward the lake approximately 5 m (16 ft) in the last 3,000 years.

Additional evidence for tilt and increase in the level of Yellowstone Lake comes from a submerged valley located 21 km (13 mi) southeast of Fishing Bridge, near West Thumb. A core sample from 5 m (16.4 ft) below the present lake level has an age of 2,800 years B.P. When deposited, the sample material was part of a wetland adjacent to Yellowstone Lake. This shows that Yellowstone Lake here has also risen approximately 5 m in the last 3,000 years, and is consistent with our findings near Fishing Bridge.

Evidence that may define the next older uplift cycle is difficult to unravel, because Yellowstone Lake levels then were close to the present level. However, weakly developed soil and mid-Holocene (approximately 5,000 year old) artifacts observed within a meter (3.1 ft) above the current beach suggest that lake levels were near present levels approximately 5,000 years ago and were probably lower thereafter.

The next older uplift and backflooding cycle is recorded by an S-shaped meander 0-3 m (0-10 ft) above the Yellowstone River. West of the present river, the meander backflooded and Yellowstone Lake built a spit across it (Meyer and Locke 1986; Locke and Meyer 1994). East of the present river, a charcoal sample from between the river gravels and lake deposits shows that backflooding of the once vigorously flowing river was under way by 8,200 yr B.P. This backflooding cycle ended between 6,800-6,680 years ago when the lake level was as high as the prehistoric shoreline that is now preserved at the Fishing Bridge Museum (fig. 2, page 30). The amount of backflooding is the same as that determined for the current uplift cycle (beginning 3,000 years ago) and we think indicates a similar amount of uplift at LeHardy Rapids.

At least three river terraces formed after the glaciers melted and suggest that three additional backflooding cycles may have occurred between 8,500-15,000 years ago. The youngest of these three river terraces ties in with the shoreline at the Hamilton Store level (fig. 2, page 30). Ages determined on charcoal buried beneath dune sand indicate that this shoreline is at least 9,000 years old. In association with this shoreline, we also found Cody Complex artifacts dated between 8,750 and 10,060 B.P. (fig. 3a, page 31) that were used by people who occupied the area then (Frison 1991:table 2.2).

A geologic complexity with the Fishing Bridge area is additional tilting that is distinct from the uplift and subsidence of the central part of the caldera. Meyer and Locke (1986) show that the prehistoric shoreline at Hamilton Store (9,000 years B.P.) is downwarped 3 m (9.8 ft) within 1 km (0.6 mi) of Fishing Bridge, but that the Museum shoreline (about 7,000 years old) is not downwarped. An offshore graben (depressed crust bounded by faults) trends towards Fishing Bridge (Otis et al. 1977; Kaplinski 1991) and might be responsible for this downwarping. However, neither we, nor other researchers have found evidence for extension of this graben on shore.

In summary, we suggest that the central part of the Yellowstone caldera has been uplifting and probably subsiding cyclically. This *heavy breathing* has breaths several thousand years long. For the pattern of uplift and subsidence measured this century, that part between the center of uplift near LeHardy Rapids and Fishing Bridge

Continued on page 30

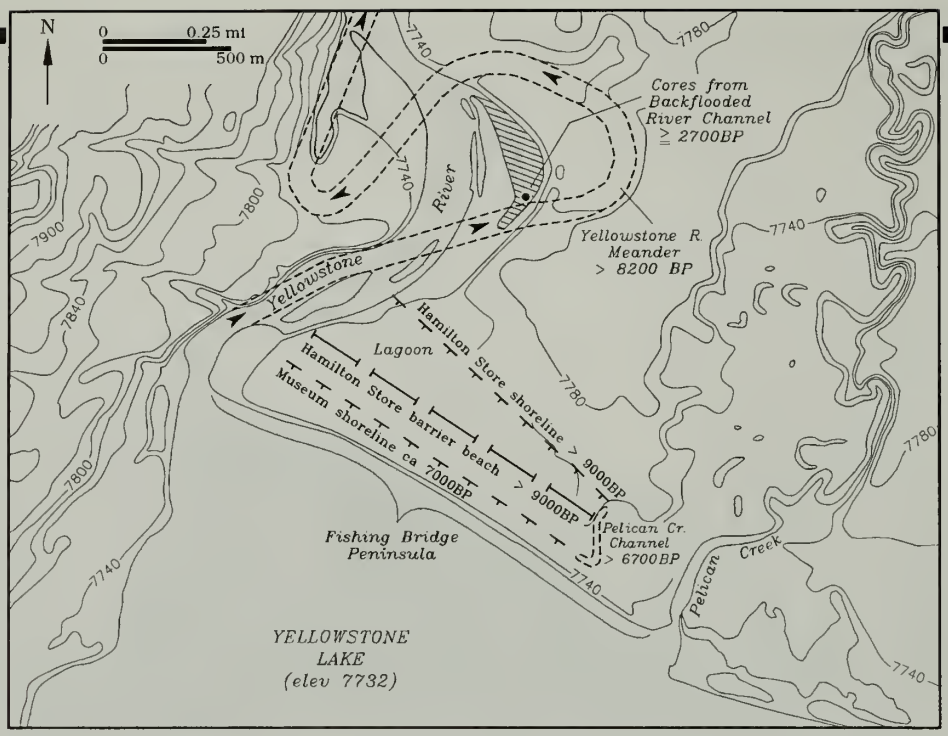

Figure 2. Map of Fishing Bridge Peninsula showing prehistoric shorelines and beaches of Yellowstone Lake, some older courses of the Yellowstone River, and contours (in feet above mean sea level).

measures only the crestal one-fourth of the total span. If the past patterns paralleled those observed this century, the 5 m uplift of LeHardy Rapids relative to Fishing Bridge is only one-fourth of the total uplift. If so, the total uplift for at least two of the cycles was about 20 m. Thus, the heavy breathing of the central part of the Yellowstone caldera has breaths of about 20 m spaced at intervals of perhaps 1,000-4,000 years.

Native American inhabitants of the Fishing Bridge peninsula around 10,000 years ago probably encountered landforms similar to those found at the mouth of Pelican Creek today (see fig. 1). The Hamilton Store shoreline was an active barrier beach, with a shallow lagoon immediately to the north. North of the lagoon, emergent beaches collected windblown sand, and several spits also extended westward into the lagoon.

At around this time, pollen records indicate that the lakeshore was dominated by open grasslands or steppe species. Common members included sagebrush, various grasses of the family Poaceae, sedges, and other herbs. Between 10,500 and 9,000 years ago, lodgepole pine *(Pinus contorta)* began to dominate forests in response to warming and has remained the dominant overstory species ever since (Whitlock 1993). Understanding climate and vegetative change is important for modeling population dynamics of human prey species, such as deer, bison, elk, and bighorn sheep.

Obsidian use

In addition to understanding the Fishing Bridge area paleoenvironment, our research also emphasized settlement and subsistence patterns and tool stone acquisition. Native Americans produced an abundance of stone tools from obsidian obtained from local volcanic exposures (Davis et al. 1992). Geochemical studies over the past 30 years have shown that volcanic flows have distinct chemistry, and by comparing trace elements of known geologic sources with those of prehistoric tools, researchers can develop procurement strategies of tool stone.

Earlier geochemical studies suggested that humans used only local Yellowstone Plateau obsidians in the manufacture of stone tools (e.g., Wright and Chaya 1985). However, over the last 10 years, improvements in trace element analyses and a greater knowledge of regional sources of volcanic glass have increased the number of source areas in the archeological record (Nelson 1984). Our studies have documented at least 10 distinct geochemical types among obsidian projectile points and tools found in Yellowstone. Although Obsidian Cliff is by far the most significant source, a substantial number of nonlocal sources occur (30%), some as far away as 280 km (174 mi) to the southeast in Idaho (Cannon and Hughes 1993). For instance, Paleo-Indian points were manufactured from a greater diversity of sources, and from sources at greater distance than for other time periods. This patt would suggest greater r bility of these grou which is consistent w other Paleo-Indian stud elsewhere in the west.

Blood residue analysis

Middle Rocky Mo tain archeological sites noted for poor preser tion of organic materi This has limited archeo gists' abilities to und stand subsistence patte by direct evidence, such the discarded remains food items. However, cent studies have dem strated that biochem and immunological me ods have the potential to identify ani species from residues (i.e., blood and sue) remaining on stone tools (Newm 1990) and in soils (Newman et al. 19 These techniques have direct implicati for reconstruction of prehistoric sub tence patterns, tool use, a paleoenvironmental studies.

We used a modified version of crosso immunoelectrophoresis analysis. T technique was developed by the Royal nadian Mounted Police Serology Labo tory (Ottawa) and the Centre of Foren Sciences (Toronto) for identification blood residue in criminal investigatio We used the technique to analyze sto tools for prehistoric blood residue (fig. g, page 31). The process returned posit anti-sera reactions for bison, deer, sheep, rabbit, bear, cat, and canid for 2 78 analyzed artifacts (Cannon 1995). versity of faunal species, in contrast to bison-dominated plains economy, been a hallmark of prehistoric mount economies (Frison 1991).

Summary

We have begun piecing together a v exciting record of geomorphic and tecto change, which has directly influenc settlement and subsistence of prehisto groups living on the Fishing Bridge pen sula for millennia. Environmental and v etative changes continually provid hunter-gatherers living in the Yellowsto area new opportunities and challenges. T

enge to archeologists and other Qua-
ary researchers is to decipher these
ms from the limited evidence we are
nted. Our analyses are still ongoing,
our preliminary results are encourag-
We plan to publish a final report on
indings later this year.

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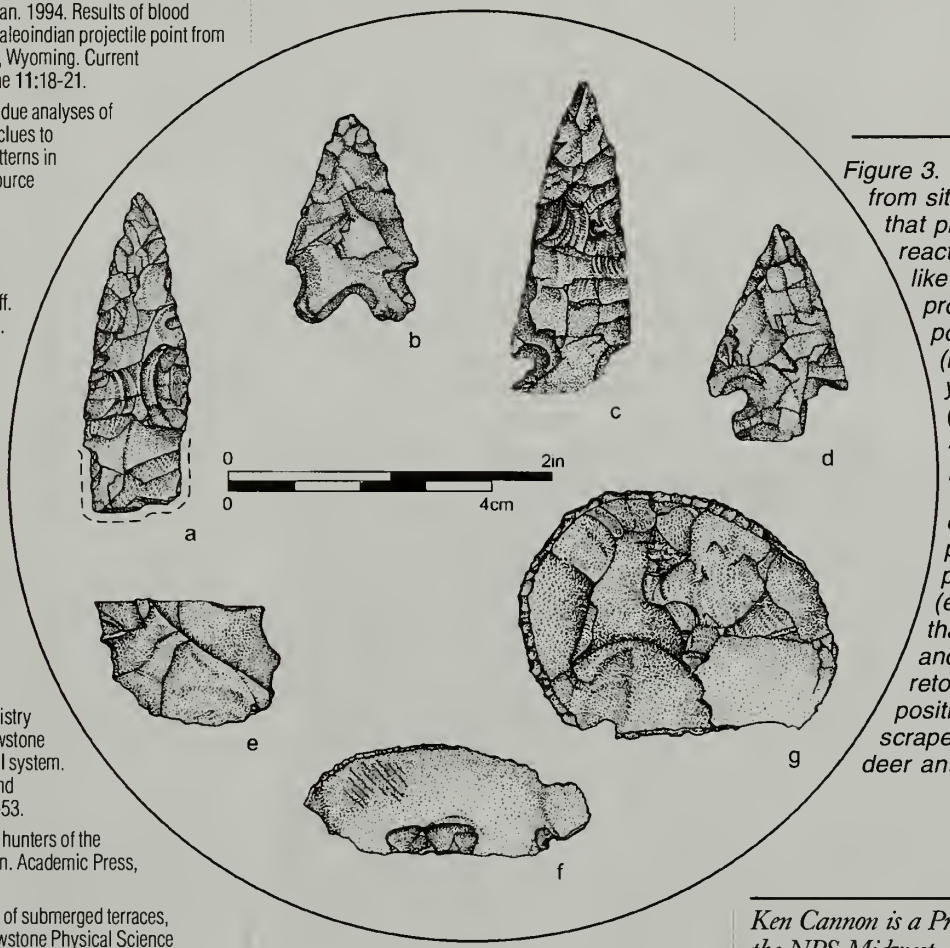

Figure 3. Flake stone tool artifacts from sites around the lakeshore that produced positive anti-sera reactions: (a) chalcedony Cody-like (ca. 9,000 years b.p.) projectile point that tested positive for rabbit anti-sera; (b) basalt Oxbow (ca. 5,000 years b.p.) projectile point; (c) chert Avonlea-like (ca. 2,000 years b.p.) projectile point that tested positive for deer anti-sera; (d) chert corner-notched projectile point basalt that tested positive for bear anti-sera; (e) retouched basalt flake that tested positive for deer and elk anti-sera; (f) chert retouched flake that tested positive for canid; (g) chert scraper that tested positive for deer anti-sera.

Ken Cannon is a Project Archeologist with the NPS Midwest Archeological Center in Lincoln, Nebraska. Since 1989, he has directed numerous archeological projects in Yellowstone. His phone number is (402) 437-5392 and his Internet address is "ken_cannon@nps.gov". Ken Pierce is a Geologist with the U.S. Geological Survey in Denver, Colorado, and his phone number is (303) 236-1244. George M. Crothers is a Ph.D. candidate in anthropology at Washington University in Saint Louis, Missouri; (314) 935-5252, e-mail: "gcrothers@artsci.wustl.edu".

Meetings of Interest

August 8-10 Contact the Office of Conference Services at Colorado State University, Fort Collins, CO 80523 for details of the Symposium on Repellents in Wildlife Management to be held in Denver, Colorado.

September 12-17 Portland, Oregon, plays host to this year's Annual Meeting of The Wildlife Society. Plenary sessions will focus on long-term research on keystone species with implications for ecosystem management. For more information, contact The Wildlife Society, 5410 Grosvenor Lane, Bethesda, MD 20814-2197; (301) 897-9770.

September 14-16 The northwest chapter of the Society for Ecological Restoration is sponsoring the conference Taking a Broader View to be held in Seattle, Washington. Session topics include: wetland, stream, arid lands, alpine, urban, and wilderness restoration; exotic plant and animal control, mining revegetation, coastal systems, restoration philosophy, and the role of native plant nurseries in restoration, etc. For more information, contact Tim White (206) 453-5000, Sono Hashisaki (206) 545-1117, or conference registration, 1207 Seminole Highway, Madison, WI 53711; (608) 262-9547.

September 17-20 Yellowstone National Park will host Symposium on Biodiversity, Ecology, and Evolution of Thermophiles (organisms that thrive in hot water) at the Old Faithful area. Participants will discuss biodiversity prospecting in national parks with special attention given to the recent debate over commercial development of publicly owned, financially valuable research specimens, such as *Thermus aquaticus*. For more information, contact Bob Lindstrom at (307) 344-2234 or through e-mail at "bob_lindstrom@nps. gov".

October 1-5 Partners In Flight, the international neotropical migratory bird conservation organization, will hold an international workshop in Cape May, New Jersey. Entitled, Building Consensus for Action: Developing a Strategy for a National Conservation Plan, the talks will focus on research, monitoring, management, education, fund-raising, and cooperation. For more information, contact Partners In Flight, c/o D. Lawrence Planners, 1125 Atlantic Avenue, suite 634, Atlantic City, NJ 08401; fax (609) 348-4433.

October 5-9 The National Recreation and Park Association will hold its annual conference in San Antonio, Texas. Contact the association for further information: 2775 S. Quincy St., Suite 300, Arlington, VA 22206; (703) 820-4940.

October 8-14 The Smithsonian Institution will hold a training workshop on GIS and remote sensing in Front Royal, Virginia. To participate, get in touch with Rose Meier, Conservation and Research Center, Smithsonian Institution, Front Royal, VA 22630; (703) 635-6500 and e-mail "nzpcrc01@sivm.si.edu".

October 18-22 The 53rd Annual Plains Anthropological Conference gears up this fall in Laramie, Wyoming. Contact Sue Powell at (307) 766-2124 or e-mail "olbconf@uwyo.edu" for more information.

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Permit No. G-83

PARK SCIENCE
National Park Service
Natural Resources Publication Office
12795 W. Alameda Parkway
P.O. Box 25287 (WASO—NRPO)

*GPO 673—049

PARK SCIENCE
Integrating Research and Resource Management

Volume 15 – Number 4 National Park Service • U.S. Department of the Interior Fall 1995

A Close Look at the Rock Art of Amistad National Recreation Area, Texas

Pictograph Paint and Accretion Analysis Techniques Improve Understanding of Rock Art Deterioration and Preservation Processes

Warna Kaluarachchi, Joseph H. Labadie, and Jon Russ

Most national park system units in the western United States have a variety of Native American cultural sites. Many parks have prehistoric or historic sacred paintings, own to archeologists as pictographs . 1); petroglyphs are made by incising scratching designs into rock surfaces. hough pictographs represent an im- tant component of many early societ- the scientific study of these artifacts been fraught with frustration due pri- rily to the inability to affiliate the art h the cultures that produced it. This l soon change with the recent devel- ments in techniques for analyzing pre- toric paints. Samples of paint so small o not compromise the artifact can now collected and analyzed to determine age and chemical composition. A mpletely new source of archeological ormation is now at hand that will be- to allow these important artifacts to integrated into cultural reconstructions. n most cases rock surfaces that con- prehistoric paints are not static; in- ad they are active biogeochemical tems. The result of this activity is the mation of rock accretions. These natu- accretions often cover the prehistoric nts, sometimes protecting them, but also causing them to appear faded. Because the processes that form the accretion may affect the paint materials, accurate and reliable analyses of the paints require that we understand the relationship between the paint components and the natural rock substrate-accretion system. This information is also particularly

Figure 1. Large, multicolored, Pecos River style pictographs such as this shaman scene number in the thousands at Amistad National Recreation Area and are a testament to a period of highest cultural activity 3,000-4,200 years ago. Scientists are now using new radiocarbon paint dating and accretion analysis techniques to date the art and assess the processes of deterioration.

Continued on page 16

PARK SCIENCE

Integrating Research and Resource Management

Volume 15—No. 4 • Fall 1995

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

DIRECTOR
Roger G. Kennedy

ASSOCIATE DIRECTOR, NATURAL RESOURCES
Michael Soukup

EDITOR
Jeff Selleck

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

The editor welcomes submissions of case studies, feature articles, and highlights. See *Park Science* 14(4):13 for submission criteria or contact the editor at:

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Printed on recycled paper

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DEPARTMENTS

FEATURES

IN THE NEXT ISSUE. . .

Several contributors will report the results of conferences around the country. We'll hear about hot water organism research and the debate over commercial development of publicly owned, financially valuable, research specimens at Yellowstone; the Greater Yellowstone Ecosystem conference; the Partners in Flight gathering In New Jersey; and the Wildlife Society conclave in Portland. Also look for articles on retrieving biological information over the Internet for park cc:Mail users, landslide assessment at Hagerman Fossil Beds, and a look back at the first class of natural resource management trainees from 1984.

Gauging Progress

Fifteen years ago this fall, Pacific Park Science, the precursor to this publication, made its debut with the goal of exploring, amplifying, and relating the links between research and resource management. This focus has been the hallmark of the publication since its inception, and the articles have traced our development in bringing science to bear on the resource management activities in the parks. This issue, we pay homage to our roots by looking back on two stories carried in that premier issue in a new department called, "Fifteen Years Ago in Park Science."

Appearing from time to time, this section will revisit natural resource and science issues that commanded our attention 15 years ago. These brief follow-up articles will point out how far we've come since then, whether we've changed much in our application of science, which resource management techniques have proven to be especially useful, and in which areas we've progressed or lost ground. At their best, they will provoke thought on where we're headed, based on where we've been. Most of the time, however, they will simply be fun and interesting to read.

In some cases, as with computer technology (the subject of a special *Park Science* issue in 1984), we are sure to chuckle as we remember the venerable and frustratingly slow 8088 processor machines that were state of the art then. On the other hand, issues like bear management (the main follow-up story this issue) illustrate a more substantive point. An unfolding story 15 years ago about Sierra Nevada bear management reads very differently from the version told today, due to improvements in both resource management techniques and the information available to managers from further research. Resource management tools and the science that supports them only develop given time, and this new department will allow us to tell the rest of the story.

Following up on early articles, is no more important, certainly, than reporting new research and resource management work as it occurs. This is our bread and butter, our focus, and I want to encourage everyone to continue contributing to Park Science. As always, we need your input on feature articles, case studies, brief highlights of park happenings, and bits that apply broadly to the park system. Also of interest are research and resource management travel opportunities, reviews of books and other articles that you would like to share with others.

This publication is about sharing. We share what we know, what we don't know, what we would like to know, how we go about getting the answers, and what we do with them once we've got them. The question we begin to investigate today, like the resource management technique we begin to employ, is an investment that pays dividends as we learn more and perfect our use of these tools. Looking back is one way to gauge our progress.

Jeff

News & Views

Errata

Last issue, a News & Views story on resource management plan and Investigators Annual Report software updates on page 5 incorrectly credited Tim Goddard with software development. Walter Sydoriak, now with the NPS Boise Interagency Fire Center, is the author of the software.

• • •

Tom Zimmerman, also at the Idaho fire center, points out that the definitions for prescribed natural fire and prescribed fire presented last issue in the table 1 glossary of selected fire terms on page 22 were reversed.

Park Science Text Files Available

Articles comprising this and subsequent issues of Park Science are available as ASCII text files and can be obtained by contacting the editor over cc:Mail or Internet e-mail. Text files have many uses, one of which is to allow sight-disabled readers to enjoy the publication by way of a text file reader.

President Addresses Fisheries Management

On June 8, the President signed the Recreational Fisheries Stewardship Executive Order, requiring federal agencies to develop a comprehensive recreational fishery resources conservation plan within the next 12 months. The order further directs federal agencies to:

1. Develop and encourage partnerships,
2. Identify fisheries limited by poor water quality,
3. Foster aquatic conservation and restoration,
4. Provide access to and promote awareness of recreational fishing opportunities,
5. Support outreach programs to stimulate angler participation in conservation and restoration of aquatic systems,
6. Establish cost-share programs for conservation projects, and,
7. Assist private landowners with conservation plans.

In addition, the U.S. Fish and Wildlife Service and National Marine Fisheries Service are directed to establish a joint policy for administering the Endangered Species Act in a way that identifies and minimizes conflicts between recreational fisheries and the act.

I & M Video in Competition

A just-completed NPS video entitled "Vital Signs" has been submitted to the 9th International Festival of Documentary Films on Parks to be held in Sondrio, Italy, October 9-14, 1995. This renowned forum presents a great opportunity to share NPS views on the importance of the resource Inventory and Monitoring Program in preserving parklands while increasing conservation awareness around the globe. Produced by Larry Pointer of the National Natural Resource Program Center in Fort Collins, Colorado, with help from Kristen Ramsey of Yosemite

Continued on page 5

JULY NATIONAL COMMITTEE MEETING REPORT

THE UNITED STATES Man and the Biosphere Committee met at Camp Hoover in Shenandoah National Park, Virginia, on July 25-26. Approximately a dozen member agencies attended, including, for the first time, the Bureau of Land Management. The principal agenda items focused on the United States Man and the Biosphere Program (USMAB) response to the final report of a blue ribbon commission, convened by Man and the Biosphere Program (MAB) Chairman Dean Bibles earlier this year to review MAB and recommend future directions, and to allocate remaining fiscal year 1995 funds.

The commission report made numerous recommendations aimed at increasing MAB visibility, financial and institutional support from government and the private sector, and contributions to ecosystem sustainability. In accepting the commission's report, the committee...

1. Adopted the proposed mission and goal statement for USMAB,

2. Requested the chairman to immediately convene special task forces to assess and recommend ways to better integrate components of MAB (i.e., interdisciplinary ecosystem-based research, regional partnerships, biosphere reserves, and international networks) and substantially increase MAB financial and institutional support from government and the private sector,

3. Increased its support of the USMAB secretariat by hiring a new clerical position and placing a fellowship recipient to coordinate the EcoNet America Program. The chair will continue efforts to arrange a detail from a member agency to coordinate the U.S. biosphere reserve program (possibly in lieu of direct annual contributions).

4. Asked each federal agency to recommend ways for USMAB to strengthen its support for MAB, for example, through briefings of senior management on MAB accomplishments and new directions.

The 1995 MAB budget of $1.1 million includes contributions from 11 federal agencies and bureaus. The committee allocated the remaining $506,000 of unobligated funds based on proposals from MAB directorates and several nonsolicited proposals (from the secretariat and Human Biology Association).

The committee increased its support of the Biosphere Reserve Directorate for developing the U.S. Biosphere Reserve Program in accord with the strategic plan approved last year. The committee funded the following projects:

1. Network review, including preliminary gap analysis and functional evaluation,

2. Second U.S. Biosphere Reserve Managers' Workshop (October 30-November 1),

3. Catalytic small grants to support development of U.S. biosphere reserve partnerships and activities,

4. Brochure and slide presentation media development,

5. Biosphere Reserve Integrate Monitoring Program suppo for U.S. biosphere reserv electronic directory MABFlora and MABFaun databases, and network co nectivity strengthening,

6. United States-Russia coop erative watershed and ec system research,

7. International "targets of op portunity."

The High Latitude Ecosy tems Directorate received su port for a series of worksho to present the results of com parative interdisciplinary re search on caribo comanagement systems in th United States and Canada. T be held in Alaska, the presenta tions will be directed to feder agencies, advisory councils, an native wildlife management o ganizations.

The Marine and Coasta Ecosystems Directorate re ceived continued support fo

"The mission of the U.S. Man and the Biosphere Program and encourage harmonious relationships between pe on the network of biosphere reserves and [conducting]

e second year of a three-year terdisciplinary study of access anagement strategies and ma- ıe biodiversity.

The Temperate Ecosystems irectorate received support for operation with MAB Ger- any on techniques for inte- ating social and biological formation in assessing ecosys- m change in biosphere re- rves.

The committee also ap- oved several new directorate embers: a BLM representa- e will serve on the Biosphere eserve Directorate; six new embers, including Gary Davis m the NBS Channel Islands eld Station, will serve on the oastal-Marine Directorate. ıe committee also agreed to ntinue supporting the na- nal committee, the six MAB rectorates, and U.S. participa- n in biosphere reserve net- orks (EcoNet America and roMAB) and the Northern ience Network.

New MAB publications, ailable from the MAB Secre- iat, OES/ETC/MAB, SA- C, Department of State, ashington, D.C. 20522-4401; 02) 776-8318; FAX (202) 776- 67, include:

- Biosphere Reserves in Action (12 U.S. case studies)
- La Selva Maya

Unpublished reports include a status report on Human Dominated Ecosystems Research on Ecological Sustainability of SouthFlorida, MAB Fauna–a Handbook for Users of the MAB Biological Inventory System (includes software), University of California, Davis, and the Constable Commission–Final Report.

Bill Gregg, who contirubted this report, is International Affairs Officer for the National Biological Service and can be reached at (202) 208-1502, fax (202) 208-7275, or by Internet, "william_gregg@nbs.gov".

re, demonstrate, promote, ıeir environments [by] building linary research."

Biosphere Reserve Strategic Plan

Brochures on USMAB and the Biosphere Reserve Integrated Monitoring Program

Continued

National Park, California, the video explains the importance of inventory and monitoring work to park managers. For more information on the video, contact Larry Pointer at (970) 225-3541.

Integrated Pest Management Findings

The Department of the Navy recently evaluated its pest control programs through its environmental compliance section and found many shortcomings. A quick review of some of the common findings listed below may help parks improve their IPM programs.

- Unlabeled pesticide containers
- Canceled products on shelves
- Improperly stored containers
- Pesticide spills on floors and shelves
- Flammable pesticides not stored in fire resistant locker
- Respirator and cartridges stored in mixing areas
- Spill and evacuation plans not in pest control shop
- Pest management records not on file
- Copy of contractor business certificate missing or expired
- Depredation permit not on file
- Pest management plan not approved or professionally reviewed annually
- Carpet and wood used in storage room
- Improper disposal of pesticides
- Reuse of empty pesticide containers
- Food presence in mixing and storage areas
- Staff smoking in storage and mixing areas.

National Research Needs Prioritized

The National Park Service recently prioritized its needs for National Biological Service research for the preservation of national park system natural resources and other attributes. The areas needing greatest attention are listed in descending priority order:

- Amphibian decline
- Survey and ranking of nonindigenous plants for management and control
- Effects of regional air pollutants on park resources
- Fish management impacts to natural aquatic systems in national parks
- Population trends and habitats of neotropical migratory birds in the parks
- Effects of native animal species overpopulation in parks
- Development of protocols for aquatic inventories, assessments, and monitoring
- Status of invertebrate biodiversity and establishment of monitoring methods in national parks
- Risk assessment of zebra mussel establishment in national parks
- Efficacy of replenishment zones in restoring harvested marine ecosystems.

NBS Databases Accessible Over Internet

Several bird-related databases are available over the Internet through the home page of the NBS Patuxent Environmental Science Center on the World Wide Web. Users can access the information by using the URL (uniform resource locator) address "http://www.im.nbs.gov/bbs/bbs.html". Once on the home page, various pointers will direct users to the following databases:

- North American breeding bird survey
- Breeding bird census
- Christmas bird count
- Bird banding

NBS Releases First Technical I&M Report

"Our Living Resources" is the first report released by the National Biological Service (NBS) Inventory and Monitoring Activity. Written in nontechnical language suitable for the lay person, this compendium of nearly 200 peer-reviewed articles and overviews is authored by researchers from the NBS and other federal and state agencies, academia, and the private sector. Tabular and graphical data also make the report valuable to resource managers, environmental scientists, planners, policy makers, and conservation organizations. An open request throughout the scientific community resulted in these articles that share current information on the abundance, distribution, health, and trends of national biological resources.

The 530-page, full-color report is organized by chapters that address taxonomic groups (birds, mammals, fish, reptiles and amphibians, plants, and invertebrates); geographic areas (Alaska, Hawaii, Great Plains, and interior west); ecosystem types (aquatic, riparian, terrestrial, and coastal marine), and impact assessments (global climate change, human influences, nonnative species, and habitat assessments). A glossary and index are provided.

Hard copies of the report can be purchased for $44.00 (including postage) from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. In late 1995, the report should be available through the NBS home page on the Internet and on CD-ROM. For further information, contact Michael J. Mac, National Biological Service, Inventory and Monitoring, Mailstop 3660 MIB, 1849 C Street NW, Washington, D.C. 20240; phone (202) 482-2929; fax (202) 273-0825; e-mail "michael_mac@nbs.gov".

New Journal Available Through E-Mail

Conservation Ecology is a new peer-reviewed journal of the Ecological Society of America. With article preparation, submission, review, and publication to be entirely electronic, Conservation Ecology is intended to supplement, rather than supplant, similar extant periodicals. Papers will range from theoretical to applied and will focus on, (1) the ecological bases for the conservation of ecosystems, landscapes, species, populations, and genetic diversity, (2) habitat restoration, and (3) resource management.

On-line access and subscriptions are offered without charge. Access to the journal will be via the World Wide Web, Gopher, and e-mail over the Internet. Those intrigued will be able to find Conservation Ecology by browsing the web and searching under "Electronic Journals" or by connecting directly to URL "http://journal.biology.carleton.ca/Journal/Overview.html".

Once it is up and running, the publication will also be available by connecting to Gopher at "journal.biology.carleton.ca" for text-only access. Internet users can subscribe by sending an e-mail message to "subscribe@journal.biology.carleton.ca" that contains the following message: subscribe conservation-ecology <reader's full e-mail address>. The first issue will be available in early 1996.

Turf Grass Research Reported in Monthly Newsletter

The July issue of *TurfGrass Trends* (ISSN 1076-7207), a monthly periodical devoted to turfgrass (rolled sod) research, reported on the art and science (and complexity) of diagnosing turfgrass diseases. Commonly used as groundcover at historical parks and sites, monuments, and memorials, turf often poses perplexing pest problems for the manager. While weed and insect infestations are readily identifiable by eye, turf disease pathogens are microscopic, and their activities can be seen only indirectly, by noting the responses of the infected plants.

Diagnosis requires 10 logic steps, as described in the issu from affected plant identifica tion to pathogen managemer strategy, and the issue takes th reader through each step wit easy to understand explanation of the processes. The autho cites examples of various dis eases and the species they af fect, explaining the symptom that accompany the disease Also important in the discov ery process is examination o the entire affected area, lookin for abiotic causes for what ma otherwise appear to be mani festations of disease. Thorough field examination for pathoge structures, environmental con ditions, and the history of irri gation, fertilization, etc., of th affected area also provide muc needed information for follow up laboratory clinical diagnosis the last stage before addressin management strategy. Finally correct diagnosis allows th manager to choose from vari ous control options that ar appropriate for the site.

As in this article, TurfGras Trends translates science int practical tools for the turf man ager. The monthly is availabl through subscription ($120 pe year) by contacting publicatio staff at 1775 T Street NW, Wash ington, D.C. 20009-7124, phon (202) 483-TURF, Fax (202 483-5797, and e-mai "76517.2451@compuserve.com Upcoming issues will cover fer tility and soil chemistry biocontrols, integrated pes management, weeds, diseases new grass varieties, nontarge effects, insects and chemical an products studies.

ants Return to Oil ick Perimeter

Scientists reported in the July issue of Nature (as summaed in Science News [volume 8, no. 6]) that wildflowers *Compositae)* have begun to relonize the perimeters of oily es created by the destruction oil pipelines and wells from e 1991 Gulf War in the Pern Gulf region. Biologists anaing this surprising phenomon see a potential connection tween oil spill recovery and nt cultivation.

The microbiologists upoted plants growing amidst e oil-soaked soils and found at their roots were healthy d oil-free. Hypothesizing that e roots recruited commonce oil-degrading microbes to l in the clean up, the scients cultured bacteria and fungi iding in the petroleum-laced nd. They discovered that, ined, the plant root zone was h in the well-known oil-meolizing organisms. Ninetye percent of the microbes ere a bacterium, Anthrocter, that resided nearest the nt, but a different community fungi and other bacteria occrred about 1 cm (0.4 in) fur-er away from the wildflower ots.

The group repeated the exriment in controlled condins, planting other species to e what would happen. Most the species grew into normal oking plants, although most ere 25%-40% smaller than ose reared in clean sand. The gars, amino acids, oxygen, d vitamins associated with nt root zones, evidently, cre-e an environment that attracts e oil-loving microorganisms. ae investigators conclude that rt of the answer to cleaning up the extensive desert pollution is densely cultivating suitable plants known for this phenomenon. They add that this "solar-powered" bioremediation approach may also prove useful elsewhere in the world and with contaminants other than oil.

Mitigation of Radiological Hazards in Parks Explained

During compilation of the NPS inventory of abandoned mineral lands, Colorado Plateau park managers raised concern over the issue of radiation at abandoned uranium mine and mill sites. Geologist John Burghardt, with the NPS Geologic Resources Division in Denver, has recently written the paper, "Effective Understanding and Management of Radiological Hazards at Abandoned Uranium Mine and Mill Sites," in response to these concerns.

The paper describes that the Colorado Plateau was heavily mined for uranium from the late 1940s through the 1950s, and that uranium mining has continued on a small scale through the present. These sites, and others that were mined for different commodities that contained radioactive elements in their ore, are hazardous due to potentially elevated radioactive emissions. While guidelines are available for land management agencies to establish their own regulations and policies, no federal regulations presently address management of the hazardous sites. Burghardt describes effective and safe management of these sites beginning with the fundamental concepts of radioactivity, environmental characterization methods, pathways of exposure, and data interpretation. Further discussion links site management and cleanup to the planned uses of the sites, their levels of radioactivity, and typical duration of public exposure anticipated.

Contact the author, John Burghardt, at National Park Service, Geologic Resources Division, P.O. Box 25287, Denver, CO 80225-0287; phone (303) 969-2099; fax (303) 969-2822; e-mail "john_burghardt@nos.gov", to receive a copy of the paper.

Murrelet Report Available

A 420-page tome, "Ecology and Conservation of the Marbled Murrelet," Pacific Southwest Research Station, General Technical Report PSW-GTR-152, February 1995, is available free by calling (510) 559-6300. Edited by C. John Ralph, George L. Hunt, Jr., Martin G. Raphael, and John F. Piatt, this document was compiled by the interagency marbled murrelet conservation assessment core team. The 37 chapters cover both original studies and literature reviews of the species' biology, ecology, and conservation needs. It includes new information on forest habitat, marine distribution, and demographic analyses; and describes past and potential effects of humans on the species' habitats. Future research needs and possible management strategies for both marine and forest habitats are suggested.

Climate Change Book Just Out

David L. Peterson and Darryl R. Johnson of the University of Washington Cooperative Park Studies Unit have just edited the book, "Human Ecology and Climate Change: People and Resources in the Far North." Published by Taylor and Francis, Washington, D.C., 1995, the book is the first of its kind, exploring how global change might affect the ecosystems and cultures of the far north during the next century. The work brings together biologists, anthropologists, sociologists, and resource managers to contribute their diverse knowledge and insight in an interdisciplinary approach to this important topic. The book takes an objective look into the future and offers suggestions for further research. It is meant to be a positive step toward sound future managerial policy in the region. Some of the topics covered include: demography and socioeconomics, wildlife biology, ethnography and archeology, global warming, meteorology and climatic modeling, environmental values, resource use and management. With additional funding from the National Biological Service, the U.S. Forest Service, and the George Wright Society, the book concept was developed at a workshop sponsored by the National Park Service. PS

GREAT PLAIN

Ferrets *Sighted* for Littering

Biologists and resource managers reported on the involved restoration last summer and fall of black-footed ferrets to three areas of Badlands National Park, South Dakota, in the spring (volume 15, number 2) issue of *Park Science*. They now add that park spotlighting crews have located five black-footed ferret kits in two litters and their female parents in the park wilderness area release site during surveys conducted in July and August. The nighttime researchers also located a third female in the core release prairie dog colonies (separate from the wilderness release site) where biologists released 36 captive-reared animals last fall. Two of the three adult female ferrets had been exposed to live prairie dogs and their burrow systems within miniature prairie dog towns contained in outdoor pens at ferret breeding locales before release; one female ferret was *naive,* having had no previous contact with the prairie dog environment before being given its freedom. Two of the females detected this summer had not been seen during intense postrelease spotlight surveys during December 1994, opening the possibility that more of the animals have survived, but remain undetected. The park considers reproduction a landmark achievement that validates the restoration methods being used.

The goal of the National Park Service, U.S. Fish and Wildlife Service, U.S. Forest Service, and South Dakota Department of Game, Fish, and Parks is to establish a self-sustaining population of ferrets within the Conata Basin/Badlands prairie dog complex located within Badlands National Park and the adjoining Buffalo Gap National Grassland. The ferret reintroduction plan calls for annual releases in South Dakota over the next 5 years. These ferrets, being raised in seven breeding facilities, are scheduled for release in South Dakota and Montana this fall.

Reintroduction sites in Wyoming and Montana also have recorded successful breeding and survival of young this year. This gives hope that the black-footed ferret, North America's most endangered mammal and once believed to have been extinct in the wild, may yet be part of the prairie community.

ROCKY MOUNTAIN

Three-way Weed Control Program

In its 40-year struggle to control the nonnative, noxious weed leafy spurge *(Euphorbia esula)*, Devils Tower National Monument, Wyoming, recently completed its most successful and productive year to date. The park is phasing out its traditional heavy use of the broadleaf herbicide Tordon (Picloram) in favor of herbivorous insects of the genus *Aphthona* that eat the invasive plant exclusively.

Introduced from grain seed stocks brought to the area by eastern European homesteaders, leafy spurge has infested the flood plain of the Belle Fourche River valley in northeastern Wyoming for 50 years. Unfortunately, the natural control predator, the *Aphthona* flea beetle, did not come with the invasion. Instead, the U.S. Department of Agriculture, through its APHIS-PPQ program, imported the beetle from Canada in 1990, where the insect had already been introduced. The University of Wyoming, Crook County Weed and Pest District, and the USDA set up a cooperative *insectary* called the "Ike ranch site" in Crook County in 1990 that would in the future produce millions of insects for collection and redistribution around the county and state.

Park field crews collected and distributed 35,000 biological control insects from the insectary in 1994 and 188,000 in 1995. In addition to these, crews gathered and redistributed 41,000 of the flea beetles from insectaries established at Devils Tower in 1991 and 1992 with the help of the same partners. Altogether, field crews have collected some 250,000 biological control insects and released them at 160 sites within the monument.

While the spurge eradication program has shifted its focus to the ecologically sound, long-term, biological control method, herbicide use continues (to a lesser degree), and other herbivores augment the work of the beetle. This year, crews spot treated about 100 acres of spurge using herbicide. At the same time, a flock of 400 Angora goats chewed through an additional 200 acres of thick spurge along the river flood plain.

Only in its second summer, this integrated, tripartite, leafy spurge control program has become a model for neighboring cattle ranchers. Initially skeptical, local ranchers now have started using goats and sheep to consume spurge on their lands. To further aid park neighbors, and in the spirit of ecosystem management, the monument has facilitated t
insect collection days and
structed the five participati
area landowners in how
manage the insects for the p
poses of spurge reduction.
together, park neighb
collected 26,000 biological c
trol insects in the two-day
tivity. Park neighbors and De
Tower National Monume
alike plan to expand the use
goats and insects next year b
within and outside the mo
ment.

SOUTHWEST

"Adopt-A-Bat" Donatio Fund Research

Deep in Carlsbad Caver
almost 1,000 feet below the s
face, lives a small colony
fringed myotis bats *(Myo
thysanodes)*. Numbering arou
100 individuals, this matern
colony lives just above Lake
the Clouds. With knowled
that the bats roosted deep in t
cave, over a mile from a
known opening, researche
wanted to learn the route us
by the bats in reaching t
desert world above grou
They also were interested
other basic information, such
the time of emergence, the
ration of the exit flight, and d
tination springs used by the b
for drinking, that might aid
conserving the species. In m
July, researchers Ken Gelu
and Troy Best outfitted 13
these bats (comprised of ma
and females) with transmitte
Weighing about one-eighth
an ounce, only slightly thick
than a dime, and placed on t
tiny mammals with a glue th
deteriorates in about ten da
these transmitters enabled t
scientists to follow the bats

ey exited the cave, fed, and turned during the 8 following ays.

On most evenings, the bats ft along with the outflight of e abundant Mexican free-iled bat *(Tadarida brasiliensis)*. he fringed myotis principally ited via the *larger* natural en-ance, although a few departed rough the *smaller* natural en-ance. Curiously, lights that ere left on during 2 days of the udy in the below-ground cave nchroom, due to uncharacter-ic emergency maintenance, layed the emergence of the nged myotis by 2 hours. The hts also seemed to have al-red their flight path on these ys sending some of the bats a narrower, vertical cave pas-geway (not used by people). ocated some 200 yards from e main bat exit point, this ening had been surrounded a fence on the surface to keep eople out. Initially, some bats w into the fence and got ught. Following this discov-y, staff repositioned the fence rther from the opening to al-w the bats to gain more el-ation before heading off to sert feeding and drinking lo-les.

Although it is not listed as reatened or endangered, the nged myotis is a category 2 ecies and is protected under e Endangered Species Act. ategory 2 species are those for hich inadequate scientific in-rmation is available to deter-ine if listing is warranted. The oject was funded with $5,300 om the park "adopt-a-bat" nd, a nonprofit fund derived om park visitor donations in pport of research and educa-on.

Gulf Coast

Chinch Bugs at Biscayne

A menace to turf grasses, chinch bugs infested sod adjacent to the Biscayne National Park, Florida, visitor center in 1993. Chinch bugs love St. Augustine grass, and the Biscayne visitor center was planted with it right up to the shoreline. The troublesome Hemipterans suck fluids from the grass blades, causing yellowing, dieback, and eventually death of the turf. In 1995, resource managers began replacing an area of turf grass along the shore with a strip of perennial native plants. The mix included sea daisy, *Gailardia,* blue porter weed, yellowtop, and beach sunflower. These native plants tolerate the climate and remain healthy with no pest problems. Integration of other management actions will ensure long-term sustainable management, and may spell the end for the chinch bug.

For the future, park staff are working with the Denver Service Center to suggest the best design for new visitor center groundscaping. The native grass *Distichlis,* well suited to the coastal climate, has been suggested. Selecting native plants that are well suited to the site will create low maintenance areas and healthy plants–the very best defense against pests.

• • •

Least Terns Nest in Biscayne

During a Biscayne National Park sea turtle nesting survey, resource managers observed terns flying in isolated rocky areas on Soldiers Key. With the help of the Florida Game and Freshwater Fish Commission, staff identified the birds as least terns *(Sterna antillarum),* a species listed as threatened by the state of Florida. The resource managers surveyed the island and identified two nests with two eggs in each nest. On a return trip to the island they observed three fledglings.

Park managers responded to the information by closing the nesting keys through the end of the nesting season (April-August). The park will continue to monitor these birds and their future nesting activities.

Park staff had presumed that least terns nested here, but had not confirmed this until the recent sightings. Now, the Florida Game and Freshwater Fish Commission has added Soldiers Key and Ragged Key #1 in Biscayne National Park to their database of active nesting sites. Least tern nesting habitat has been greatly reduced and these park islands represent some of the few known nesting sites in South Florida.

Columbia-Cascades

Fort Vancouver Develops Pest Plan

Park staff at Fort Vancouver, Washington, recently convened an integrated pest management (IPM) scoping session at the fort to begin writing a plan for the management of biological threats there. The participants, which included park natural and cultural resource staff, maintenance personnel, and system support office and Washington Office staff, outlined the new plan by dividing the park into two zones, each of which was further divided into subzones, as follows:

- Landscapes
  - turf
  - trees and ornamental beds
  - agricultural
  - garden
  - orchard
  - revegetation
- Structures
  - exterior
  - modern
  - historic
  - interior
  - modern exhibits, museum collections, historic furnished areas
  - office, shop, work areas

Once the group defined the zones, they identified the expertise needed to develop objectives for each zone. After experts gather to complete the objectives, a contractor will complete the plan with extensive help from the park. This format for IPM plans is being developed as a model that has the potential to be used servicewide with park-specific modifications.

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USGS Help Sought

Looking for opportunities to apply their research efforts to federal lands, the U.S. Geological Survey recently entered into a memorandum of understanding with the National Park Service and requested project proposals in support of park research, resource management, and interpretation. Columbia Cascades Cluster parks have been busy preparing eight proposals that take advantage of USGS mapping and other expertise.

Research and resource management applications range from assessing the stability of

Continued on page 10

Continued

Mount Rainier, Washington, and investigating the relationship of its geology to volcanic hazards, producing a suite of resource maps for City of Rocks National Reserve, Idaho, to detailed facies mapping at Hagermann Fossil Beds National Monument, Idaho, and landform and soil mapping at North Cascades National Park, Washington. Interpretation related projects include producing videos on Crater Lake and Mount Mazama, Oregon, geology and research, a geologic handbook of scientific investigations at Hagermann Fossil Beds, and a guidebook of the geology of the North Cascades and San Juan Islands, Washington.

CHESAPEAKE

Flood Assessment in Shenandoah

"It was as if someone were pouring water out of a glass." That is how one resource specialist described the relentless rainstorm that caused extensive flooding in central Virginia and Shenandoah National Park late last June. After 5 days of soaking rain, the storm delivered 12 inches more that fell on already-saturated ground in a period of a few hours. Outside the park, the storm killed eight people, displaced 800 residents, and damaged 2,000 area homes. Within the park, numerous landslides rerouted and reshaped entire drainages (see photo). The barrage of water carried massive boulders down streams and even cut channels 15-20 feet down to bedrock in some areas. Tree-covered, bubbling mountain stream channels once 15-30 feet wide were "blown out" and are now 150-200 feet wide, treeless, and filled with rocks and large debris dams of debarked trees. The concentrated erosion and landslides altered some administrative roads beyond repair, but only affected 37 miles of the over 500 miles of park trails.

Although devastating to people and property, the flood was a natural, albeit rare, event. Floods of this magnitude occur at an estimated interval of approximately 100-1,000 years. The opportunity to understand geologic processes and ecological recovery from catastrophic disturbance is rare and Shenandoah intends to make the most of it.

Park managers asked that resources and facilities be assessed for safety hazards, management options, and short- and long-term resource monitoring. The park set up an incident command team to deal with assessment planning and coordination. The scientific assessment team consisted of experts from Shenandoah National Park, Assateague Island National Seashore, University of Virginia, U.S. Geological Survey, NPS Water Resources Division, NPS Geologic Resources Division, Virginia Tech, and Virginia Department of Game and Inland Fisheries. The team examined existing and potential geohazards, slope stability, hydrology, fisheries, aquatic ecology, and vegetation affected by the flooding. Shenandoah and Assateague staff recorded the information collected by members of the team on the park Geographic Information System using global positioning system units.

The team observed impacts that were caused by both large volumes of water (flood) and the mass movement of rocks, sediments, and woody debris in a slurry with water (debris flow, debris torrent). They recommended that the park restrict or discourage use of former trails or roads with undercut banks and "toe" areas at the base of the most unstable debris flows. The team strongly recommended against stabilization of debris slopes. Trail or road re-building, if done at all, should wait until after next winter to allow some settling, continued slumping, and rockfall to occur. Some trail rerouting to more stable slopes was also recommended.

Days of relentless rainfall caused landslides in Shenandoah National Park, Virginia, including these 2-5 acre (0.8-2.0 hectare) slides in the Moormans River drainage. While flood impacts were considerable throughout the park and region, the rare natural event provides scientists the opportunity to study geologic processes and ecological recovery.

As part of the NPS prototype Inventory and Monitoring Program, Shenandoah had detailed information from many park watersheds on water chemistry, geology, fisheries, amphibians and aquatic insects before the storm. In fact, the watershed with the greatest flood impact was also, fortuitously, the one with the most preflood data. Gathered over a period of several years, the information will greatly help the park assess ecosystem changes with respect to the severe storm. When compared with postflood surveys of the same areas, the data already show a marked change in watershed fish. Just one week before the storm over 800 fish of 15 species along 100 meters of stream were counted. A week after the flood, the same area had only 6 fish of 4 species. Biological recovery of these streams to support trout populations will require perhaps as little as 3 years to 30 years or more and will vary from one watershed to the next.

More biological resource assessment information will follow in the report to be written by the scientific assessment team. Also expected in this report are assessments of the park infrastructure and a strategy for interpreting the flood and its effects to park visitors.

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These American Lands: Parks, Wilderness, and the Public Lands

Dyan Zaslowsky and T.H. Watkins

Review by William Tweed

For as long as our republic has existed, critics have remarked upon its lack of a sense of history. owhere is this more true today than in ie management of our public lands. The irrent intense political debate over the te of these lands seldom pays much at-ntion to history. Political discussions bout issues like the ancient forests, spot-d owls, public lands grazing, or Alas-an North Slope oil almost never dwell any length on the historic origins of ese controversies. Generally, we are uch more interested in where we are ing than in where we have been.

In *These American Lands* authors Dyan aslowsky and T.H. Watkins address this sue by presenting a history of federal ublic land management in the United tates. This is not a simple story, and to ake it more approachable, Zaslowsky nd Watkins have abandoned the histori-n's traditional strategy of integrated chro-ology for a more topical approach. ather than attempt a broad synthesized istory of federal public land manage-ent, the authors provide separate histo-es for each of the major federal land anagement programs. Separate chapters mmarize the histories of the national ark system, national forest system, na-onal resource lands (Bureau of Land anagement), national refuge system, ational wilderness preservation system, ational wild and scenic rivers and na-onal trails systems, and the national in-erest lands of Alaska. Appendixes ocument critical legislation and list the nits of each system.

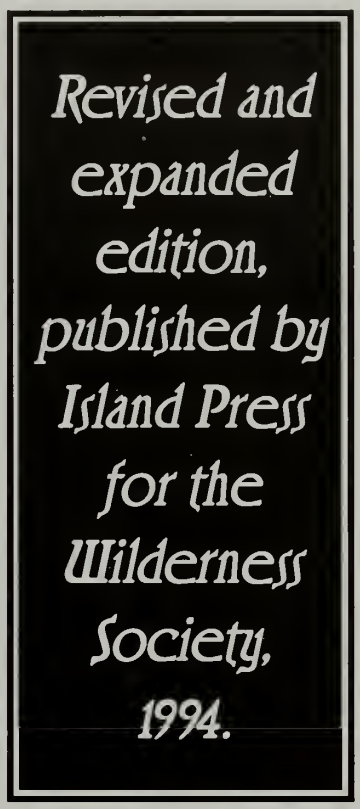
In pursuing this approach the authors ave both provided a major resource to nyone interested in public lands and pro-uced a flawed book.

The value of the book is that it provides quick and relatively simple access to the basic events that have shaped our public lands policy and the institutions that carry it out. The book's flaws, which are not fatal, result from how it approaches the discipline of history.

An essential starting point for understanding *These American Lands* is that the book is an advocacy document not a neutral analysis. Counselor to the Wilderness Society Gaylord Nelson's foreword details how the conservation organization came to publish its vision of federal land management history. The theme is further reinforced by the fact that each chapter ends with Wilderness Society recommendations for the future management of the resources in question.

Because the book represents an advocacy organization's view of public land history, it offers not so much analysis as carefully honed interpretation. The story has clear heroes and villains. It also has a strong sense of historical direction that verges on inevitability. In attempting the admittedly difficult task of condensing these complex stories into simple narratives, the social context of American thought and behavior has been largely left behind in favor of a story line in which aware people slowly wear down and outwit wasteful, destructive opponents.

This sense of the inevitability of the right thing eventually happening shows especially in Nelson's foreword, written in April 1994, that suggests that with the election of Bill Clinton, "a new age of responsibility and stewardship clearly has begun." As the past year has clearly demonstrated, American history is far too complex and unpredictable to fit well into any simple deterministic pattern. We are a large and complicated people, and we have a long way yet to go before we resolve the question of how we are to balance the goals of individual freedom and collective good.



Read with caution, *These American Lands* is a useful introduction to how preservationists view the evolution of public lands management. It is not, however, the same sort of high quality analytical history that coauthor Watkins has produced on other occasions, most notably in *Righteous Pilgrim,* his superb biography of Harold Ickes. PS

William Tweed is Management Assistant at Sequoia and Kings Canyons National Parks, California. His phone number is (209) 565-3102.

Not since the 1970s has Joshua Tree National Park taken census of its desert bighorn sheep, a species that frequents springs. The Canon funds will enable staff to test a noninvasive inventorying technique where researchers identify sheep from unique natural markings, such as scars and horn characteristics. Also funded are projects to convert spring location data into GIS-compatible format and remove tamarisk (a nonnative tree that transpires water and impedes sheep access to the springs) from the water sources.

Inventory and Monitoring Projects Get $1,200,000 Boost

By Lissa Fox

An unexpected $1,200,000 corporate grant from Canon USA will put 35 inventory, monitoring, and restoration projects on the ground over the next 2 years. In the first year, volunteers will help 20 parks inventory and monitor their biological resources. These projects will provide resource managers with information vitally needed to make scientifically based management decisions. In the second year, the grant will send volunteers into 15 of the original 20 parks to work on habitat restoration. Canon will also donate equipment such as laptop computers, cameras, and binoculars to the parks.

The biological inventory and monitoring projects supported by the Canon grant will bring the National Park Service closer to its goal of completing baseline inventories of biological and geophysical resources in the approximately 250 parks with significant natural resources. Grants such as this allow the National Park Service to accomplish projects that would not otherwise be possible in this time of shrinking budgets and fewer federal employees.

This grant opportunity came up fast and with an extremely short turnaround time. The National Park Foundation, which raises money to support NPS programs, managed to pique Canon's interest in the four-year-old program called Expedition Into America. This program was designed to stretch park biological inventory and monitoring budgets by providing volunteer labor and funding. All projects considered for the Canon program, now called "Expedition Into the Parks: Preserving America's National Treasures," had to be biological inventory or monitoring projects and needed to include volunteers.

The responsibility for pulling together this program fell to Larry May, then NPS Wildlife and Vegetation Division Chief, and Lissa Fox, the author of this article and Expedition Into America program manager. For Larry, this opportunity was a harbinger of things to come. Under the new NPS organization of Natural Resources Stewardship and Science, the need for someone to develop these kinds of relationships had already been identified. Now serving as Partnerships Program Manager, Larry will be directly responsible for developing similar partnerships with other agencies and funding sources to support natural resource projects and programs. These partnerships will be designed to complement and supplement NPS programs that support NPS natural resource management policies and goals.

To produce a list of projects fo Canon to review, division staff selecte proposals submitted for other grant and relied heavily on the resource man agement plan (RMP) database. Tim Goddard, the RMP database manage searched RMP project statements fo the key words "inventory" or "monitor ing" and "volunteers" to find project that met program criteria. Parks con tacted responded quickly to short-no tice demands for additiona information, and Canon received a lis of 30 projects in 1 week!

According to the National Park Foun dation, grants to support natural re sources work are hard to com by–most foundations or corporation do not have a basic understanding o the importance of natural resourc management. However, Canon has sup ported other environmental cause prior to this donation. Their five-year old Clean Earth Campaign has resulte in over 6,000,000 recycled copier an facsimile cartridges and substantial do nations to the Nature Conservancy an the National Wildlife Federation.

While concerns remain about "sell ing" the NPS to the highest bidder, ev ery precaution is being taken by th National Park Service and National Par Foundation to ensure the continue integrity of the NPS image. Guideline

pedition Into the Parks Projects:

Big Bend National Park: inventory and preserve two candidate plant species, tall paintbrush and Guadalupe fescue

Buffalo National River: plant inventory of selected springs and seeps within the park

Crater Lake National Park: inventory and monitor rare plant, Mount Mazama collomia

Fire Island National Seashore: inventory and monitor effects of sand compaction or burial on soft-bodied beach insects, including threatened northeastern beach tiger beetle

Gateway NRA—Breezy Point and Jamaica Bay units: conduct limnological monitoring of east and west ponds

Golden Gate National Recreation Area: determine wildlife habitat relationships and monitor ecology

Grand Canyon National Park: monitor brown-headed cowbird impact on nesting neotropical migrant birds

Great Smoky Mountains National Part: inventory brook trout distribution and implement restoration efforts

Gulf Islands National Seashore: monitor populations and restore habitat for the recovery of the endangered Perdido Key beach mouse

Hawaii Volcanoes National Part: inventory and monitor populations of rare lowland plants

Joshua Tree National Park: inventory bighorn sheep at Stubbe Springs (see photo)

Mammoth Cave National Park: inventory cultural and paleontological resources in Mammoth Cave

Olympic National Park: monitor visitor impacts on wilderness resources and rehabilitate targeted areas

Padre Island National Seashore: inventory and monitor threatened and endangered sea turtles

Rocky Mountain National Park: Determine productivity and survivorship of songbirds in elk winter habitat

Santa Monica Mountains National Recreation Area: determine status and distribution of large carnivores

Shenandoah National Park: study impacts of white-tailed deer on forest communities in the eastern United States

Yosemite National Park: inventory nonnative fish in alpine lakes

Yellowstone National Park: survey for *Agrostis rossiae* and *Abronia ammophila*

Cape Cod National Seashore: restore kettle pond habitats

elineating NPS behavior direct all activities. Among the rules are that NPS mployees cannot endorse a product nd that no NPS uniforms can appear corporate advertising. All promoonal activities and materials are reewed by technical and policy experts. order to direct the focus of the prootional materials produced by Canon, he NPS provided the company with ealistic, technically accurate descripons of each project, potential prodcts, and general ideas they could mphasize, such as the threats to natul resources, the importance of inforation gathering, and the connection etween a single species and its habit. To date, Canon has been cooperative and quite willing to help us spread the story of our threatened natural resources to the public.

Lissa Fox is a Writer-editor with the new NPS Natural Resources Information Division. Her office is in Harpers Ferry, West Virginia, and she can be reached at (304) 535-6283.

Highlights continued

Colorado Plateau

Senior Scientist Joins Grand Canyon Staff

After years of effort, a new position of Grand Canyon Senior Scientist has become a reality. Dr. Robert Winfree will join the newly organized Grand Canyon National Park Science Center this fall. A past U.S. Fish and Wildlife Service scientist, Bob comes from the National Biological Service Leetown Science Center in West Virginia. His background is primarily fisheries, but he is also certified as a wildlife biologist and has a keen interest in cave resources. Grand Canyon Science Center Director Dave Haskell is thrilled to have Bob in this position to provide leadership for the park research program and to be engaged in the many park-related interagency science programs.

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Support for Peregrine Delisting

Based on sound scientific evidence provided by an extensive monitoring program, NPS officials are able to support delisting the peregrine falcon in Arizona from endangered to threatened. The number of Arizona breeding pairs far exceeds the recovery goals for this species. The estimated 90 pairs of falcons breeding within the park represent a significant portion of the state's viable population and a majority of the population located within a totally protected area, which graphically points out the value of national parks as refugia for species at risk. This support, however, is based on continued U.S. Fish and Wildlife Service funding of the long-term species monitoring in the park.

The Glen Canyon Dam

Clustering Makes Sense for Colorado Plateau Parks Concerned with Water Resources

By Susan Dodson

Centrally located on the Colorado Plateau on the Utah-Arizona border, Glen Canyon National Recreation Area sports premier water resources and aquatic systems that include spectacular Lake Powell, and portions of the Colorado, San Juan, Escalante, Dirty Devil, and Paria Rivers. Adjacent upstream along the Colorado River lies Canyonlands National Park, Utah, another wonderland of Colorado Plateau and related water resources. Downstream along the Colorado River lies the Grand Canyon, Arizona, associated very closely with the national recreation area and the Glen Canyon Dam (photo) that controls river flow through the park.

The operation of the Glen Canyon Dam is the topic of an environmental impact statement (EIS) that is currently awaiting a record of decision by the Secretary of the Interior. Issues related to the Grand Canyon Protection Act and Endangered Species Act are considerations of the EIS. These issues are politically and environmentally complex; the new cluster park concept makes good sense for resource managers along the Colorado River corridor to work together to assess and manage the river resources and processes as one system. Aquatic ecology study at Glen Canyon is just one area that offers opportunities for cluster park cooperation and collective knowledge benefits that can aid many Colorado Plateau parks.

Water Quality

Over 3 million visitors come to Glen Canyon National Recreation Area each year for a total of 2.4 million visitor days. The average stay of 4 nights on the Lake Powell shoreline results in water quality impacts from improper human waste disposal. Glen Canyon staff presently monitor water quality along Lake Powell and Colorado River shoreline sites for fecal coliform bacteria, the indicator organism for human waste. State and federal water quality standards for contact recreation include fecal coliform not to exceed 200 colony forming units per 100 milliliters of water (200cfu/100ml).

Lake Powell is so vast that the park operates two 1994 Utah-Department-of-Health-certified environmental laboratories, one at Bullfrog and one at Wahweap, in order to meet analysis holding times. During peak season, Memorial Day to Labor Day, the park samples 54 sites on Lake Powell every other Monday, and seven sites once a month along the river below Glen Canyon Dam to Lees Ferry. During winter months staff discontinue river sampling and scale back lake sampling to fewer sites once a month.

This year, above average precipitation caused Lake Powell to rise over 50 feet to within 5 feet of full! As rising lake waters inundated popular camping beaches, bacterial levels at 11 sites exceeded standards. To protect public health and safety, Superintendent Joe Alston closed those beaches to swimming until bacterial levels became acceptable. Most of the closed sites are vehicle-accessible and experience heavy use; additionally, most closed sites have restroom facilities. Fluctuating lake levels dictate that bathrooms be located above high water, which can pose an inconveniently long walk to visitors when the lake is low. Misplaced *catholes,* RV dumping, and pets are other potential bacteria sources when water levels rise above recently contaminated beaches.

Media coverage and public concern prompted over 100 phone calls a day during beach closures. Overwhelming community and visitor support was channeled into a volunteer outreach program to edu cate visitors to the problem and prop human waste disposal practices.

In a water resources study of a diffe ent nature, park staff and USGS scientis sampled park springs for physical, chem cal, and biological characteristics in 199 95 in an interagency seep and sprin monitoring program. The USGS will sul mit a final report to include a long-ter monitoring strategy for seeps and spring within the unit.

Fish

Glen Canyon also has outstanding re reational fishing opportunities and com plex management concerns due to th demise of native fishes. The native fis community in the Colorado River syste has declined since the creation of Gle Canyon Dam. Most notable in their d cline are the four endemic "big river" fis which include the federally endangere Colorado squawfish *(Ptychocheilus lucius* humpback chub *(Gila cypha),* bonyta chub *(Gila elegans),* and razorback suck *(Xyrauchen texanus).* Some of these sp cies still occupy habitats within the par

One entity that focuses on the pligh of the native fish is the Lake Powell N tive Fish Group. Initiated in 1993, th group includes members from the N tional Biological Service, U.S. Fish an Wildlife Service, Bureau of Reclamatio National Park Service, state game and fis departments, academia, and private env ronmental consulting firms. It acts as a ad hoc group of biologists who partn for the conservation and management native fishes in Lake Powell and the re reation area. Using information poole from the native fish group, the Nation Park Service, Arizona, and Utah are d veloping an interagency fish managemen plan for Glen Canyon National Recr ation Area. This plan provides a foru

Continued, left column, page

Wolf Recovery in Upper Michigan

Regional Partnerships Key to Natural Wolf Recovery at Pictured Rocks National Lakeshore and Beyond

Brian Kenner

In recent years, as seemingly endless controversy has been swirling around wolf reintroduction in Yellowone, something has been happening ewhere in the lower 48 states perhaps least as significant for the wolf in North nerica. Without benefit of an environental impact statement, congressional public hearings, national media attenn, or direct human intervention, wolves ve returned to the Michigan Upper ninsula (see map, page 27). In early 95, Michigan Department of Natural esources winter surveys confirmed a pulation of 80 wolves, with a minimum twelve packs (each consisting of at least preeding pair). This is a significant inease from 57 wolves in 1994, 30 in 1993, d 21 in 1992. The habitat is believed to capable of supporting a population of 0-500 animals, indicating that contind significant population increases are ely.

Wolves were essentially extirpated from ichigan via direct persecution by 1960 xcept for the isolated Isle Royale popuion). Fortunately, travel corridors from maining populations in northern Minnesota and Canada endured, as did large tracts of sparsely populated north woods habitat with abundant prey (deer, beaver, and small game). Occasional reports of individual wolves persisted to 1989, when a pair of wolves was found in the western Upper Peninsula. That pair produced pups in 1991 and 1992, thus becoming the first known pack in Michigan since the 1950s. Other packs soon established territories in the western Upper Peninsula–the result of dispersion from populations in northern Minnesota and northern Wisconsin. Wolves have also been found in the eastern Upper Peninsula, most likely Canadian dispersers crossing the ice of the Saint Marys River, which joins Lake Superior with Lake Huron.

To what can this dramatic recovery be attributed? While undoubtedly many reasons exist, the results of a 1990 survey of Michigan's human population provided one answer. The study found surprisingly high support for wolf recovery, particularly among hunters and trappers. Not surprising was the less enthusiastic response from farmers, but a majority of all respondents supported wolf recovery as long as it came about naturally without expenditure of large amounts of tax dollars and did not cause undue public lands use restrictions. Public attitudes have changed significantly in 20 years–the people of the Upper Peninsula now seem willing to live with the wolf.

How do the National Park Service and Pictured Rocks National Lakeshore fit into the wolf equation? Pictured Rocks (35,000 federal acres, 35,000 nonfederal) is part of an expanse of largely protected habitat stretching across the central Upper Peninsula from Lake Superior to Lake Michigan and including a national forest, a national wildlife refuge, commercial timber lands, and state forest lands (see map, page 27). The last known pack and verified pup production in Michigan prior to 1991 was in 1956 within what is now the park (established in 1966). Observations and other evidence (scat and tracks) are now fairly common within and near the lakeshore, and in October 1994 a local resident reported seeing an adult wolf with two pups within the lakeshore boundary.

The NPS is cooperating with the Michigan Department of Natural Resources and other agencies to monitor wolf activity. Thus far, most effort has been directed toward the western Upper Peninsula, but the recent increase in sightings and evidence of pack establishment in the central and eastern parts of the peninsula demand more effort in those areas. In 1995, the National Park Service, through a challenge-cost share grant, purchased radio collars for the natural resources department trapping team to collar wolves near the park to determine pack size, movements, home range and reproduction in the north central Upper Peninsula. Unfortunately, trappers have not yet been able to capture any wolves in the park area, but more effort will be focused there in 1996. Habitat assessments of historic deer yards (areas of winter congregation) are needed, as are studies of seasonal deer movements. To

Continued, middle column, page 27

Pictographs continued from front page

important for developing informed conservation strategies.

This paper presents recent research on the prehistoric rock paints and the natural accretion from sites in and adjacent to the Amistad National Recreation area in southwest Texas. The aim of this study is to characterize the accretion, determine how it formed, and establish the relationship between the ancient paints and the natural rock crust.

The Amistad NRA Pictographs

Located in southwest Texas and northern Coahuila, Mexico, Amistad International Reservoir was created in 1969 by damming the Pecos, Devils, and Rio Grande rivers. The region surrounding the intersection of these three major rivers, the Lower Pecos region, contains one of the longest continuous records of human occupation in North America (Turpin 1982). Over 9,000 years ago, hunter-gatherers began inhabiting the numerous rock shelters along the steep limestone cliffs that dominate the region. Archeological research prior to the construction of the Amistad Dam firmly established the existence of literally thousands of prehistoric pictograph and archeological sites.

Archeologists have defined four major prehistoric rock art styles, each with temporal and cultural implications. The oldest and most common style, the Pecos River style, generally features large (up to 4 m or 13.1 ft), multicolored, anthropomorphic figures in multiple panels, which can cover more than 30 m (98.4 ft) of rockshelter wall (fig. 1, page 1). The first New World pictograph to be directly dated was a Pecos River style pictograph located in Seminole Canyon Historical State Park (Russ et al. 1990). Using a new technique, researchers extracted and radiocarbon dated organic carbon incorporated in the ancient paint. Three Pecos River style pictographs have now been dated with the results ranging from 3,000 to 4,200 years B.P. (Russ et al. 1992). These ages correspond to a period when cultural activity in the area was at a maximum (Turpin 1991).

A NPS rock art deterioration study (Labadie 1990) established that many national recreation area pictographs are deteriorating, due primarily to natural causes. However, vandals have intentionally destroyed some sites by carving, scratching, pecking, spray painting, and using the paintings for target practice. Early photographers in the region often used water or kerosene to enhance the contrasts in the pictographs, not knowing the long-term effect of repeated dousing with liquids. Still others have been damaged by modern campfires or are submerged under the waters of Amistad International Reservoir.

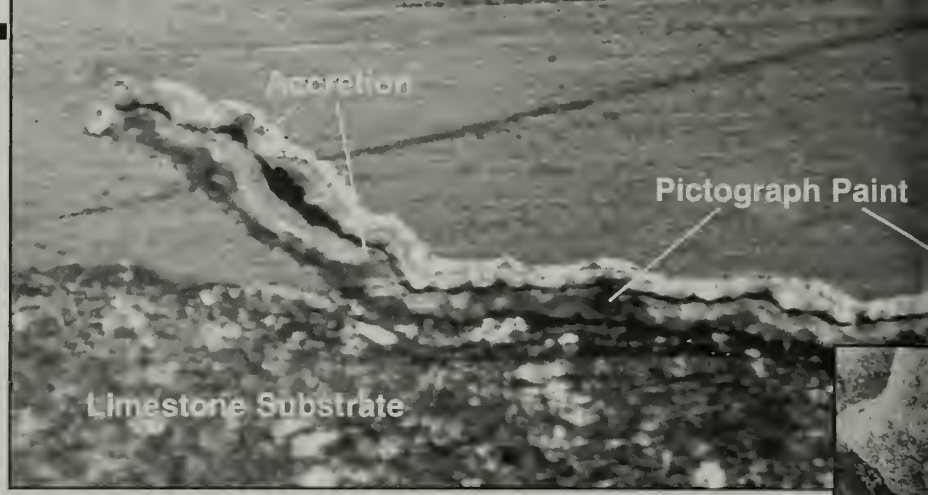


Figure 2 (above). The pictograph study technique involves examining paint encapsulated within a rare mineral accretion that serves both to protect and obscure the art. An optical photomicrograph of a thin-sectioned paint sample reveals the ancient paint, just 0.1 mm thick, encapsulated within a thicker layer of natural accretion.

Figure 3 (right). Scanning electron microscope image shows the surface of the rock accretion. Features indicate past lichen activity as the likely source of the whewellite-rich accretion. Although a nuisance to viewing the pictographs, the accretions pose less of a threat to the panels than freeze-thaw cycles or vandalism.

The Natural Rock Accretion

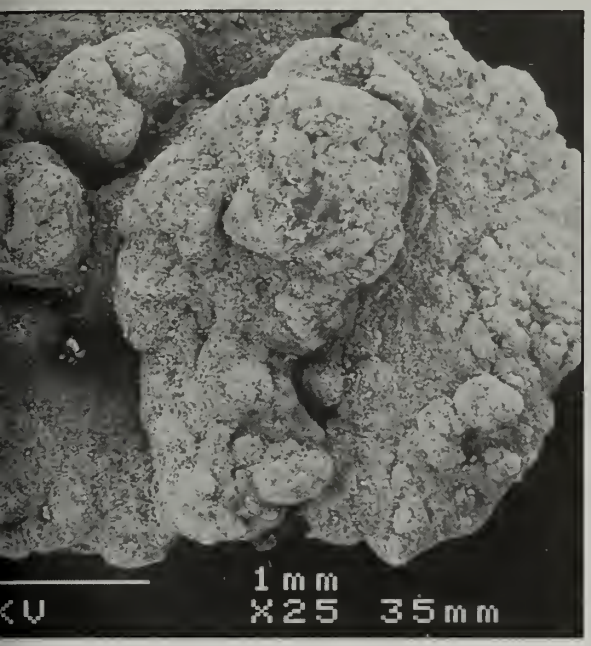
To the naked eye, most of the pictographic paints appear to be on the surface of the limestone rock. In actuality, the paints are covered with a thin veneer of natural accretion. In many of the samples that we have studied the accretion occurs both above and below the paint layer, thus encapsulating the ancient paints (fig. 2). The primary substance in this accretion is *whewellite* (Russ et al. 1994), a calcium oxalate mineral (human urinary tract stones are also composed of calcium oxalate). Although whewellite is generally regarded as rare in geological environments, it has recently been discovered in rock accretions in Australia, Italy, California, and now Texas. The origin of whewellite in rock accretions is not fully understood.

The limestone walls inside the rock shelters in and adjacent to the park are completely covered with the whewellite-rich rock crust. This accretion is typically less than 0.5 mm thick and imparts a yellow to brown color to the limestone. Gypsum, quartz, and clays are the other principal components in the accretion. The whewellite, gypsum, and quartz are sufficiently translucent that the pictographs are clearly seen. However, accretions with high concentrations of clay tend to obscure the pictographs, causing them to appear faded or to be completely blocked from view.

A Microscopic View of the Paints and Accretion

Using scanning electron microscopy (SEM), we analyzed samples of prehistoric paints and accretion from Amistad (fig. 3). The SEM allows us to image and analyze individual particles that are 0.5 μ (micron–1,000 μ = 1 mm). Presented here are some of the results of this study.

Lichen living on or near the surface of e limestone produced the whewellite. e observe whewellite structures that are ikingly similar to lichen (and fungi) fea- es at the surface and within the accre- n. High magnification of the accretion face reveals structures that resemble



crocolonial fungi and lichen; below the face the morphology of the whewellite similar to lichen thalli. In essence, we observing the fossilized remains of the nen that produced the calcium oxalate me lichen are known to produce this mpound). Finally, radiocarbon dating the whewellite confirms a biological gin and indicates that the mineral was oduced periodically over the last 5,500 ars (Russ et al. 1995).

The source of the gypsum is the lime- ne substrate. Water moving through es in the limestone carries dissolved fate and calcium ions to the rock sur- e. Gypsum (calcium sulfate) precipi- es as the ions reach the surface by a ocess known as efflorescence.

The clay and quartz are primarily from ian (airborne) matter adhering to the ckshelter wall. These materials adhere the shelter wall usually when they are oist from high humidity. The silicate terials are then incorporated within the cretion as it continues to form.

Some of the accretions have multiple nellae, suggesting that they were pro- ced by different mechanisms at differ- t times. We are currently investigating relationships between accretion processes and major shifts in the regional climate over the last 6,000 years.

The prehistoric paints are generally 30-100 µ (0.3-0.1 mm) below the surface of the accretion and are about 100 µ (0.1 mm) thick. Zolensky (1982) identified the principal pigments in the prehistoric paints as iron oxide minerals for red paints and manganese oxides for black paints. We not only observe a high incidence of iron and manganese in the paints, but also a significant clay component. Thus, the paints are composed mainly of a mixture of clay and oxide minerals.

Conclusions

The primary source of the accretion covering the park pictographs was lichen activity on the surface of the limestone inside the rock shelters. Very little evidence of oxalate-producing lichen exists currently in the shelters. The primary growth of the accretion at this time is the gypsum efflorescence, indicating that water is moving through the substrate, paints, and accretion. The water should have little effect on the paint materials since paints are composed of highly insoluble clays and oxide minerals.

The current deterioration of the pictographs is not due to surface decay. In fact, the accretion may be the most important factor in how the pictographs have remained intact on the shelter walls over the last four millennia. Preserved within these natural materials, they are protected from attack by chemical and physical weathering agents. At this time, the crust is only a nuisance by causing the paintings to appear faded. Removing the accretion simply to make the paintings appear brighter will be unproductive since it may accelerate biological growth and dissolution processes on the exposed surfaces.

The major force in the deterioration of the pictographs is related to frost action within the limestone substrate (see Winkler 1975). The reality is that the rock art will not last forever. Forces beyond our control will eventually erase this phase of human prehistory. The new methods for analyzing the ancient paints will revolutionize the study of prehistoric art, and increase our understanding of these enigmatic artifacts. With these studies our ability to preserve them will also improve.

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Figure 1. Successf establishment of th planted native spe represented by ho weed (Mornarda punctata) *and blac eyed Susan* (Rude beckia serotina), *i herbicide plot (Pla and a sod removal (Plate B) where ex grasses were erad cated. Plates C an show a fire plot an control plot, respec where exotic grass represented by blu grass* (Poa pratens *and quackgrass* (A pyron repens), *still dominate.*

Restoring Native Vegetation on Indiana Dunes Razed Residential Sites

By Young D. Choi, Ph.D. and Noel B. Pavlovic, Ph.D.

Editor's note: *See the reference* Choi and Pavlovic 1994 *for a more thorough write-up of exotics control.*

Sand dunes of the Lake Michigan shoreline within Indiana Dunes National Lakeshore are home to over 1,000 native plant species and more than 100 Indiana endangered and threatened plant taxa (Wilhelm 1990). This 40 km (25 mi) long dune and swale complex is also home to unusual plant combinations, like prickly pear cactus *(Opuntia humifusa)* and arctic bearberry *(Arctostaphylos uviursi coactilis),* that led early botanist Henry Cowles (1899) to develop important principles of local plant succession. Unfortunately, human activities have disturbed much of this flora (Hiebert 1990a). Bowles et al. (1990) noted that these activities, including home construction and subsequent abandonment, disturbed 35 of 81 Indiana endangered and threatened plants studied.

Park resource managers have prioritized that native vegetation be restored to more than 800 abandoned residential sites located within the park. However, extensive exotic plant infestation is a major obstacle that must be overcome in accomplishing the restoration goals (Hiebert 1990b). To find the best feasible ways of eradicating exotic species and restoring native species, we compared the effects of fire, herbicide, and sod removal on native vegetation restoration in xeric (dry) razed residential sites (fig. 1).

Methods

In May 1993, we established 24 experimental plots with four treatment groups (control, herbicide application, sod removal and prescribed burning) in three razed residential sites within the park. We then used a rotary seed broadcaster in each plot to sow a mixture of seeds (627 g) consisting of nine native species (table 1).

In September 1994, two growing seasons after site preparation and seeding, we collected vegetation data. We grouped all identified plant species into three categories: (1) planted native–native species seeded in 1993, (2) voluntary native–na tive species occurring voluntarily (i.e without being planted in 1993), and (3 exotic–(table 1). Using a point contac frame we also estimated vegetative co ers and, using the paired t-test, compare these data with pretreatment data fro August 1992 (table 2).

Results and Discussion—Fire

Although prescribed fire has bee widely used elsewhere to control exot species (Olson 1975, Apfelbaum an Rouffa 1983, Cole 1991), we found tha fire did not successfully eradicate exot species (e.g., blue grass–*Poa pratensis* an quickgrass–*Agropyron repens*). Voluntar native species coverage (e.g., hairy le grass–*Paspalum stramineum* and umbrel sedges–*Cyperus* spp.) did not change sig nificantly. Conversely, planted native spe cies, represented by little blue ste *(Andropogon scoparius),* increased signif cantly from 2.7% to 16.0%. This increas however, was not much different from th

Table 1. Three categories of plant species sampled in experimental restoration plots in three razed residential sites within Indiana Dunes National Lakeshore.

Category	Genus & Species	Common Name
Planted Native		
	Andropogon scoparius	little blue stem
	Elymus canadensis	Canada rye grass
	Koeleria cristata	junegrass
	Oenothera biennis	evening primrose
	Panicum virgatum	switch grass
	Monarda punctata	horseweed
	Rudbeckia serotina	black-eyed Susan
	Stipa spartea	porcupine grass
	Sorghastrum nutans	Indian grass
Voluntary Native		
	Aster sp.[1]	aster
	Cyperus spp.[2]	umbrella sedges
	Erigeron annuus	horseweed
	Eragrostis spp.[3]	lovegrass
	Paspalum stramineum	hairy lens grass
	Sporobolus cryptandrus	sand dropseed
	Solidago canadensis	Canada goldenrod
	Tradescantia ohiensis	spiderwort
	Verbascum thapsus	common mullein
Exotic		
	Agropyron repens	quackgrass
	Ambrosia artemisiifolia	ragweed
	Bromus tectorum	downy chess grass
	Digitaria sanguinalis	crabgrass
	Festuca sp.[4]	fescue grass
	Galium spp.[5]	bedstraws
	Lepidum campestre	field peppergrass
	Melilotus spp.[6]	sweet clovers
	Physalis heterophylla	clammy groundcherry
	Plantago lanceolata	English plantain
	Poa pratensis	blue grass
	Rumex acetosella	field sorrel
	Saponaria officinalis	soapwort
	Solanum carolinense	horse nettle
	Stellaria media	common chickweed

1. This could not be identified at the species level, but is presumed to be native.
2. Cyperus filicumulis, C. schewinitzii, and C. strigosus
3. Eragostis hypnoides and E. spectabilis
4. Festuca elatior, F. ovina, and F. rubra
5. Galium aparine and G. mollugo
6. Melilotus alba and M. officinalis

Table 2. Changes in cover of restored native, nonrestored native, and exotic species from 1992 (pretreatment year) to 1994 (posttreatment year) in the experimental restoration plots

	Cover (Mean±SE[1])		
Category/Treatment	**1992**	**1994**	**p[2]**
Exotic			
Control	83.0+11.8	78.8+18.4	0.85
Fire	94.5+9.0	98.8+14.7	0.93
Herbicide	81.8+14.6	24.6+7.1	0.01
Sod Removal	85.2+6.5	11.7+1.7	<0.01
Voluntary Native			
Control	16.2+8.4	17.3+7.6	0.92
Fire	27.0+13.8	25.5+9.7	0.93
Herbicide	28.6+13.0	35.2+7.8	0.68
Sod Removal	20.3+6.4	26.5+3.6	0.42
Planted Native			
Control	8.5+2.6	17.5+6.6	0.23
Fire	2.7+1.6	16.0+4.0	0.01
Herbicide	3.6+1.7	48.6+4.4	<0.01
Sod Removal	13.3+4.6	55.2+3.8	<0.01

1. Standard error of mean.
2. Probability of type I error from the paired t-test.

control plots, and it was not as significant as we found in the herbicide or sod removal plots (table 2).

These results clearly demonstrate that fire was not effective to control the fire-adaptive grasses in our study plots. In extreme cases, these exotic grasses reclaimed dominance quickly and reestablished ground cover to the prefire level within 2 weeks after the fire. Repeated fires and growing-season fires may be considered as alternatives. Further study is needed to investigate the effects of these alternatives and to determine the timing and frequencies of fires for maximum benefits.

Herbicide

We noted that the herbicide Round-up successfully controlled exotic grasses, and similar studies (e.g., Bingham et al. 1980, Marquis et al. 1984, Nuzzo 1991) support herbicide use for this purpose. Planted native species, including little blue stem, Indian grass *(Sorghastrum nutans)*, horseweed *(Monarda punctata)* black-eyed Susan *(Rudbeckia serotina)*, and Canada rye grass *(Elymus canadensis)*, have established 49% ground cover in our herbicide plots where we removed most exotic species. Herbicide treatment did not affect voluntary native species (e.g., lover grasses–*Eragostis* spp. and umbrella sedges) as shown in table 2.

Despite its success in eradicating exotic species, herbicide application still remains questionable; some roots, seeds, and other exotic species propagules are probably viable in the topsoil implicating a potential competition with native species for resources and space. A seed bank study or a longer vegetation change monitoring study may provide useful information to answer this question.

Continued on page 20

Sod Removal

Mechanical removal of exotic sods and topsoils can benefit native species by (1) providing a sandy and relatively infertile substrate–a natural characteristic of the Lake Michigan sand dune ecosystems–and (2) avoiding potential competition with existing exotic species. This method caused a response similar to the herbicide treatment. Exotic species cover, mostly blue grass and quackgrass, decreased significantly, whereas planted native species cover (little blue stem, Indian grass, horseweed, black-eyed susan, and evening primrose *(Oenothera biennis)* increased to 55%. Voluntary native species cover (e.g., love grasses and umbrella sedges) did not change significantly (table 2). Although the entire removal of sod may pose a potential risk of losing existing native species seed banks, it has proven to be very effective in preparing the sites for native vegetation reestablishment.

bor-intensive and expensive than the herbicide option. Using two or three crews to remove trees, shrubs, and sod for each razed residential site, this option would take approximately 800 work days (a day per site). Total cost would depend on labor costs, but can be based on a total of 12,800-19,200 crew hours. Typical NBS seasonal staff wages at Indiana Dunes are $10 per hour, making the total cost of the sod removal option $64,000-$192,000. This option costs three to six times more than the herbicide option and seems prohibitively expensive. However, this cost can be reduced by using a park volunteer work force.

Recommendations

Based on our 3-year study, we recommend that prescribed fire not be used to eradicate the exotic grasses in the razed residential sites. Both herbicide application and sod removal are equally effective and preferable in controlling the exotic grasses. Herbicide application is less laborious and expensive than sod removal; however, the latter option is better suited

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Both herbicide application and sod removal are equally effective in controlling the exotic grasses.

Management Implications

As discussed, prescribed fire did not control the exotic grasses in our study plots. Meanwhile, herbicide application and sod removal were very effective for this purpose. Herbicide treatment costs approximately $50 per acre. Treating 800 razed residential sites (approximately 400-1,600 acres in total [162-648 ha]) using this method would cost approximately $20,000-$80,000 and seems to be affordable if spread over several years. Nevertheless, massive application of the herbicide Round-up, despite its relatively short half-life (about 60 days) and lower toxicity than the other commercial herbicide brands, conflicts with park policy. This is due to the potential for soil and water contamination by herbicide residue.

Sod removal is better accepted by park managers, because it is pollution-free. However, this option is much more labor to the park policy of avoiding chemical use. Sod removal is also more feasible than herbicide application if labor costs are subsidized significantly by a volunteer work force. PS

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Land Use History of North America:

An Emerging Project of the National Biological Service

By Thomas D. Sisk and Barry R. Noon

Value of a Land Use History

Efforts to manage the nation's biological resources are hampered by the lack of a historical perspective n conditions prior to European settlement nd subsequent changes in the North merican landscape. Much of the impact hat people have had on the environment an be viewed as a series of unplanned exeriments, with particular perturbations enerating measurable responses, in the orm of contractions in the ranges of some pecies and expansions in the ranges of oths. Within the context of these temporal ynamics, species extinctions and the pread of nonindigenous species may be een as the extreme cases, where biological ements are lost or introduced. These exeriments have been run, and environmenl scientists are beginning to assemble the ata needed to assess the results. The first sk is to develop a clearer understanding of he historic changes in the distributions of lants and animals and their relation to huan-induced changes to the landscape. iven this understanding, land managers ill be able to review the effects of past perrbations and apply this information when tempting to evaluate the likely outcomes f future land changes.

Much of the data needed to construct ch a retrospective view have already been llected; information on landscape change ans the period of human habitation of orth America. Impressive regional efforts ave been undertaken to synthesize the vailable information regarding land use hange and its impact on ecological sysms, but these projects have generally been mited to relatively small areas and short me lines. Large quantities of valuable biogical and physical information remain unplored, warehoused in different locations, nd maintained by different organizations.

Consider the abundant information on rehistoric land cover and species distribuons accumulated through the creative efrts of paleoecologists. Integration of coarse-resolution data such as these with information derived from original land surveys of the country (e.g., data archived by the Bureau of Land Management), and the U.S. Forest Service data on the fire history of North America, for example, could make the characterization of historic landscape change quite tractable. When these data are combined with aerial photography from the extensive surveys started in the 1930s, and remotely sensed data from advanced satellite imagery, it will be possible to stitch together a continuous time line, from prehistoric times to the present. Catalyzing such an effort is the intent of the National Biological Service's Land Use History of North America project (LUHNA).

Launching the Project

This is an ambitious project, one that will require the collaboration of many different individuals and agencies, both within and outside government. In August, the National Biological Service (NBS) convened a workshop to help define the scope and intent of the LUHNA effort, and to identify a strategy for fostering the multidisciplinary collaboration that it will require. Representatives from six government agencies, six universities, and three not-for-profit organizations established a framework for building a broader LUHNA effort. The National Biological Service will serve as the organizer and initial "home base" for the project, but the agency cannot possibly carry out such a large project alone or fund all the work that will be required. Instead, the NBS will provide a forum for discussion, communication, and scoping of the project and the initiative for developing the interdisciplinary relationships that LUHNA will require. We will also approach other organizations for cooperation and funding support.

Your comments are invited. The NBS headquarters in Washington has established an electronic mail account that will be used exclusively for the LUHNA project. Currently, we have limited staff assigned to this project, so several of us will be replying to your messages as time allows. In the near future, we will move to a bulletin board format, permitting an open exchange of ideas among all collaborators and interested parties. The e-mail address is "luhna@ibis.mib.nbs.gov".

We will assemble a directory of individuals and organizations interested in LUHNA and a bibliography of important publications related to the LUHNA concept. We would appreciate your contributions, submitted in the following formats:

Directory:

Last name, First name MI (title)
Organization
Address
City, State Zip
Tel (xxx)xxx-xxxx; Fax (xxx)xxx-xxxx
e-mail address

Bibliography:

Last name, First name MI, and First name MI Last name. Year. Title of article. Journal volume:pp-pp.

For book chapters:

Last name, First name MI, and First name MI Last name. Year. Title of chapter. Pp-pp. in First name MI Last name (editor) BookTitle. Publisher, City, State, Country.

Submissions to both documents will be compiled and distributed electronically to all respondents, unless you request otherwise. If you wish to be on the mailing list but not in the directory, please indicate that on the line immediately above your name.

We look forward to your comments and our continuing interaction on this project.

Thomas D. Sisk is an ecologist, and Barry R. Noon is Acting Chief Scientist. Both are with the National Biological Service, U.S. Department of the Interior, Washington, D.C.

Behavioral Ecology and Management of Striped Skunks in Great Smoky Mountains National Park

By Daniel R. Tardona and Andrea Bixler

One of the many exciting wildlife encounters experienced by visitors to Great Smoky Mountains National Park, Tennessee, is meeting a striped skunk *(Mephitis mephitis)*. Such encounters often produce wonderment, fear, and ambivalent actions by visitors. What will the skunk do? What will the visitors do? What kind of behavior will the encounter elicit from the skunk? Animal behavior in the wild and in situations where human contact is probable yields information about the biology and ecology of the animal that may influence management decisions affecting this valuable wild natural resource. Researchers at the University of Tennessee, Knoxville, are currently studying the striped skunk in Great Smoky Mountains National Park in order to better understand its behavioral ecology in the wild and to produce information that will be helpful to park natural resource managers and interpretive staff.

Coauthor Andrea Bixler weighs an anesthetized skunk that was probably less than 2 months old. Researchers measured each captured skunk for weight, head-body length, tail length, and upper canine length.

While many behaviors of striped skunks, such as reproductive and denning behaviors, have been studied, many facets are still not fully understood. A mustelid, the striped skunk is a solitary carnivore. It does not behave like social animals in that it does not cooperate with other members of the species to find food, defend territory, locate shelter, or select a mate. This does not mean that skunks do not interact at all with other skunks. Skunks have been observed to den in groups of up to 19 in Canada (Gunson and Bjorge, 1979). Park rangers and visitors report observing adult striped skunks (presumably mother skunks) often accompanied by 3-5 young trailing behind in the early evening hours in park campgrounds.

Researchers in the Smokies are attempting to understand the home ranges of the striped skunk. Home range is an important facet of behavior to study because it may yield information that not only helps behavioral ecologists learn more about the behavior of this solitary carnivore, but also may help park personnel manage this important member of the mountain community. For example, we do not know how striped skunk relatedness affects home range overlap. If relatedness is an important component in determining home range, how do individual striped skunks communicate relatedness? Knowledge of this behavior would influence decisions regarding relocation of individual striped skunks when necessary.

Skunks are well known for their ability to spray musk when frightened or threatened. A long held belief is that this noxious spray evolved exclusively for defense against predators such as bobcats, coyotes, foxes, and owls (although it is not effective against owls as owls are unable to smell!). However, it is possible that skunks also could use this powerful and persistent odor to communicate with other skunks. Communication by odor (chemocommunication) is often observed among solitary carnivores and may be used to convey information about genetic relatedness, among other things (Gorman and Trowbridge 1989). Individual differences in the composition of the mus sprayed by striped skunks may represe genetic differences useful in kin recogn tion. Striped skunks may be able to re ognize kin and respond differentially t them based on scent differences. It is als possible that differences in spray compo sition are due to sex, age, diet, body siz or time since the skunk last sprayed.

Skunks may also space their hom ranges according to relatedness. In oth members of the mustelid family, whi male and female ranges commonly ove lap, males possess home ranges exclusiv of other males, and females possess hom ranges exclusive of other females (Powe 1979). However, a trap-recapture study Cades Cove campground of Great Smok Mountains National Park found that bot male and female home ranges overlappe each other (Goldsmith 1980). Researc currently in progress in the larger Cad Cove subdistrict may yield similar find ings on skunk home range area and ove lap.

From January 1993 through February 995 researchers devoted over 260 nights o trapping and radio-tracking skunks in he Cades Cove area of the park. By Feb- uary 1995 over 2,500 trap nights with a rap success of about 2.5% (56 skunks not ncluding 14 recaptures) had been com- pleted. Trap success has varied from nonth to month with most captures oc- urring during February. This is probably ecause skunks leave their winter dens nd move extensively in search of food nd mates during this time.

BLE 1 PRELIMINARY HOME RANGES COMPUTED FOR 9 COLLARED STRIPED SKUNKS

# Locations	# Nights	Home Range
157	84	1.35 km²
133	51	0.45 km²
96	53	0.54 km²
230	102	1.05 km²
184	125	1.27 km²
51	34	1.69 km²
62	45	0.58 km²
64	45	0.92 km²
137	90	0.90 km²

m²=0.386 square miles)

Preliminary home ranges computed for ine radio-collared animals using the ninimum convex polygon method from VildTrak software is presented in table . Only those skunks located at least 50 imes are included. Since multiple loca- ions were sometimes made on the same ight, the number of nights the research- rs tracked each animal is also given. The ights were not necessarily consecutive.

All skunks inhabiting home ranges vithin 2 km (1.2 mi) of the Cades Cove icnic area and campground make occa- ional forays into these areas. This has im- lications for skunk management, as elocation of skunks found in the picnic rea and campground over a period of a ew days would not eliminate all the kunks that use the area. Data collected hus far indicate that female skunk home anges overlap extensively, up to 90% of ach animal's total range. Male skunk anges overlap as much as 85%, and males overlap females by 10% of total range. These data suggest that many more skunks may inhabit an area than is apparent from just the size of their home ranges.

Through the use of radiotelemetry, researchers are monitoring skunk movements and home ranges. Laboratory analyses of blood and genetic assays are being used to see whether and how relatedness is associated with spacing patterns in the wild. The scientists are also conducting biochemical analyses of the composition of musk to see if spacing patterns are mediated by individual odors. Analyses of collected scent samples are continuing. These careful field studies are exploring the behavioral ecology of the striped skunk and are increasing our knowledge of this animal.

In contrast to these studies, which give a more complete picture of the species, visitors often glimpse the striped skunk only in park campgrounds when the creatures make their nightly rounds in search of food. While sightings like this can be a source of enjoyment for many visitors, the experience is often artificial and not an accurate view of the natural world.

In the wild, striped skunks forage and hunt at night locating prey primarily by smell and sound. Their natural diet includes various insects and insect larvae that they acquire by clawing holes in the ground. Striped skunks eat small reptiles and amphibians such as lizards and frogs. Skunks also will eat carrion and occasionally will stalk and take smaller mammals. The skunks also range beyond campgrounds; according to Linzey and Linzey (1971), the striped skunk has been observed at elevations up to 5,200 feet in the park. Viewing these animals scavenging through picnic and campground trash may not be the lasting impression of the wild that will insure public support for the continued preservation of wildlife.

A better understanding of the behavior of these animals can help guide natural resource managers to make good decisions for the benefit of the animal, to use appropriate management techniques, and to provide visitors with the best of experiences the natural world has to offer. The results of behavioral research can also provide interpreters with interesting and accurate information that can be passed on to park visitors, enhancing visitor appreciation and understanding of wildlife. The ongoing study of the behavioral ecology of striped skunks is an important step in the understanding and management of this beautiful, solitary carnivore of Great Smoky Mountains National Park.

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The research was supported by the University of Tennessee Division of Biology, the Theodore Roosevelt Memorial Grant of the American Museum of Natural History, and the Great Smoky Mountains Conservation Association.

The restoration plan calls for relocating hibernating black bears from their dens in Great Smoky Mountains National Park, 80 miles to the east, to surrogate dens within Big South Fork. Scientists hope that the winter release will entice the bears to stay in their new home, and managers will study success of the experiment before a permanent restoration ensues.

Stage Set For Black Bear Restoration at Big South Fork

1995-96 plan calls for staff readiness, experimental winter and summer releases, and scientific follow-up

By Arthur McDade and Robert Emmott

Recent media attention on the wolf restorations in the Great Smoky Mountains and Yellowstone National Parks has highlighted the resource management and scientific work ongoing in various national park system units. Wildlife reintroduction projects are very popular with the media and the public, and the success of the National Park Service in restoring native fauna to historic range has both scientific and public relations value. Each success story helps foster a positive scientific and public relations climate for other parks to engage in wildlife restoration projects.

An example can be found in the Big South Fork National River and Recreation Area in the mountains of eastern Tennessee and Kentucky. Park managers and biologists are studying restoring *Ursus americanus,* the black bear, to the rugged backcountry of the Big South Fork drainage (fig. 1). The park straddles the Tennessee and Kentucky borders in the Cumberland mountains (fig. 2). It is a rugged area, comprising 122,000 NPS acres (49,393 ha), bordered by approximately 80,000 additional acres (32,389 ha) of the Stearns District of the Daniel Boone National Forest.

The park is a relatively new addition to the park system, established in 1974, but the landscape is ancient. The Big South Fork of the Cumberland River winds through deep canyons carved out of the 240 million year old Paleozoic Era sandstone. For over 10,000 years the canyons of the Big South Fork provided rock shelters and hunting grounds for the Paleo-, Archaic, and Woodland Indian peoples, who hunted the rich fauna of the area. Until about 1900, the fauna included the black bear. Overhunting, habitat destruction, and timber operations in the 20th Century took their toll on the bears. Save for an occasional lone transient, black bears have been extirpated from these mountains.

Interest in black bears in the southern mountains has always been high. Tales of early European contact with bears, and spirited bear hunts, are a standard of southern Appalachian folklore. The Great Smoky Mountains National Park, 133 kilometers (80 miles) to the east, sustains 400-600 black bears , a considerable attraction to the 8 million visitors who go there annually, many with the express desire of observing bears in the wild. Because of the great interest in this southern Appalachian symbol, several organizations in the late 1980s considered the idea of restoring black bears to the Big South Fork area.

In 1987, the Tennessee Bear and Boar Association suggested to the National Park Service and the Tennessee Wildlife Resources Agency (TWRA) restori bears in the Big South Fork area. A wor ing group consisting of representativ from the NPS, TWRA, the U.S. Fore Service (USFS), the U.S. Fish and Wil life Service, and the Kentucky Departme of Fish and Wildlife Resources (KDFW studied the merits of the black bear pr posal. The working group determined t need for a habitat suitability study to e amine the feasibility of bear restorati in the area. Researchers from the Unive sity of Tennessee Department of Forest Wildlife, and Fisheries undertook t study.

Habitat Suitability Study

The area study examined road densit human population, and the availability food and cover. Black bears eat a varie of foods in different seasons in the sout ern Appalachians, consuming herbs a some insects and carrion in the spring. the summer, an abundance of berries a fruits (soft mast) satisfy the bruin's nee In the middle and late fall, acorns, hicko nuts, and beech nuts (hard mast) dom nate the bear's diet. These dietary nee would have to be available in the B South Fork area for a successful restor tion.

e 1. Angel Falls of the Big South Fork of the Cumberland River, Tennessee, and other rugged backcountry locales were once home to now extirpated black bears. If all goes as planned, may begin to make their reappearance in the Big South Fork National River and Recreation as soon as late fall, 1995.

Completed in 1990, the habitat suitability study concluded that the Big South Fork area provided adequate summer and fall food production for bears (Van Manen). It also determined that denning cover was adequate, and that the maturing forest provided escape cover. Improved road density was determined to be low, although logging and dirt roads throughout the area are of higher density. One major element of the study was the prediction that as the second-growth forest matures in the next 5-10 years, hard mast production would improve, with optimal levels reached by the end of the century.

Preliminary Research Proposal and Environmental Assessment

In order to test the habitat study conclusions and to explore potential human-bear interactions, TWRA drafted a preliminary proposal for an experimental release (Wathen 1992). This proposal recommended a 2-year program in which 12 bears would be released and radio tracked in the west-central area of the park. National Park Service biologist Steve Bakaletz and Ron Cornelius, then Chief of Resource Management at the park, began refining the proposal. Ultimately, they drafted and circulated for public comment an environmental assessment of the proposed experimental project (Emmott, 1994). The draft described the potential impacts of the experimental bear releases on the physical, biological, and human environments, and outlined steps to mitigate these impacts. The draft also outlined several project alternatives and described comments received from the public in 1993 regarding the proposed bear relocations.

Specific Research Proposal

In November 1994, representatives from the cooperating agencies met and agreed that a research proposal should be completed. Dr. Joseph Clark of the National Biological Service (Southern Field Laboratory, Knoxville, Tennessee), working with NPS Resource Management Specialist Robert Emmott, completed a draft proposal consisting of a 2½-year project involving 12 released bears (Clark 1994). The proposal recommended securing the bears from the Great Smoky Mountains National Park and gave the following objectives:

- Determine dispersal and mortality rates of reintroduced bears

Figure 2. Located along the Tennessee-Kentucky border, the park preserves forests of the Cumberland Plateau and over 75 miles of the Big South Fork of the Cumberland River and a few of its tributaries. Now maturing, the second-growth mixed forest should produce optimal bear forage by the end of the century.

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Bear restoration continued

- Assess bear habitat use based upon Van Manen's habitat study
- Evaluate effects of bear-human interactions and document any damage to private property
- Determine effects of age, sex, release method, or other factor on mortality and postrelease movements
- Assess feasibility and probable success of a gradual, long-term bear release to establish a permanent, viable population at Big South Fork

Permanent Restoration to be Evaluated

At the end of the 2½-year experimental releases, park managers will be better able to determine whether a permanent restoration program should be initiated. With the results of the experimental project, managers can base this decision on scientific data regarding habitat adequacy, home range establishment, and human contact.

The park is gearing up for the potential 1995 experimental releases, and Superintendent Lee Davis is enthusiastic about the project. He shares the belief that hold public information meetings along with home visits to park neighbors to explain the project. Backcountry hikers will receive literature about the bear reintroductions, and temporary bear ecology exhibits are planned for the two park visitor centers. Park interpreters will provide formal and informal presentations on the continuing bear project during the 2-year experimental phase.

The cooperating agencies have agreed to fund the project. At present, we anticipate a winter 1995-96 relocation of bears from the Great Smokies to the Big South Fork.

...wild bears will be captured in their dens in the Smokies and relocated to the Big South Fork during winter where they will resume hibernation in the new location.

Clark proposes releasing the bears in both summer and winter. For the winter releases, he will use a variation of a soft release; (a soft release involves a period of acclimation with food and shelter in an enclosure area prior to release to the wild). This includes capturing wild bears in the Smokies, relocating them to the Big South Fork, and releasing them into denning locations during the winter. To accomplish this, selected Smokies bears will be trapped and radio collared in the summer, then later tracked to their winter dens. Biologists will sedate these hibernating bears and transport them to the Big South Fork. The bears will resume hibernation in the new location, and in the spring, venture out into the new habitat acclimated to their new home range. Bears have a strong homing instinct, and we hope that the winter release will provide the acclimation needed to prevent the bears from trying to return to the Smokies.

Clark's proposal also calls for summer releases, whereby bears will be translocated from the Smokies to the Big South Fork with a short confinement period in acclimation pens. During the project, researchers from the University of Tennessee will radio track the bears until home ranges are established.

the National Park Service has a role to play in restoring native fauna to historic range, where feasible. His enthusiasm is balanced by a healthy regard for the concerns of park neighbors, however. He does not want the experimental bear releases to fail due to adverse public relations concerns, which could jeopardize a future permanent bear release. Consequently, he has been an engaged participant in the planning.

The Acting Chief of Resource Management, John Cannon, is making plans for release site protection. Rangers will closely monitor the remote release area and work jointly with cooperating agencies to establish security for the bear releases. Cannon, who came to the Big South Fork from the Great Smokies, believes that the bears will be a biological bonus for the area, restoring a native species to its historic range, and may provide an economic boost to the surrounding human communities.

The park also plans to interpret the significant project. The bear project has generated considerable interest amongst constituency groups, such as hikers, conservation organizations, and hunting and fishing clubs. Steve Seven, Chief of Interpretation, plans on using the park interpretive newspaper to highlight the ongoing experimental reintroduction project. He also plans on having site bulletins at backcountry trailheads with information on the bear project. Staff will

The intense scientific planning over 3 years at the Big South Fork is nearing fruition; the park is gearing up for an exciting and scientifically challenging research project. Between the hard science in the field and the interpretation ongoing throughout the park, the public will be able to follow the experimental release of *Ursus americanus* to a part of its former range. PS

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Clustering continued from page 14

or cooperative, integrated fisheries management as directed in the recent presidential order on recreational fishing.

Mustering the Cluster

In recognizing that several parks are located along the Colorado River corridor, one must also recognize that the cluster park concept will allow aquatic ecology to expand beyond the lines on a map that we call boundaries. Clearly, the river and reservoir processes here are only a part of a larger system that affects water quality and fish movement among the several parks. This concept has been pioneered in recent years by regional fisheries biologist Ed Wick. Wick's studies of native fishes have taken him to spawning bars in Dinosaur National Monument, Colorado, and through Canyonlands National Park as he followed the newly hatched larvae drifting with the current all the way into Lake Powell at Glen Canyon National Recreation Area. Researchers have also monitored adult endangered fish migrating hundreds of miles through this corridor of parks. Broadening our scope among cluster parks will offer the ability to share resources, expertise, and management options.

Mandates of the Grand Canyon Protection Act require a long-term monitoring component to assess impacts of the operation of Glen Canyon Dam upon resources in Grand Canyon National Park and Glen Canyon National Recreation Area. An interagency monitoring group is organizing for the long-term, and NPS Colorado Plateau cluster parks are working together to identify issues and roles in this process. These mechanisms only help us to stand unified in our mission to preserve and protect our precious natural heritage, the national parks along the Colorado River on the Colorado Plateau. PS

Susan Dodson is an aquatic ecologist at Glen Canyon National Recreation Area. Her phone number is (520) 608-6266.

Wolves continued from page 14

facilitate integration of resource data with other agencies and regional level analyses, Pictured Rocks has been building its GIS database. Also, NPS representatives are actively involved with the Michigan Gray Wolf Recovery Team, a group that is working hard to develop a recovery plan to ensure full recovery to a sustainable population. The recovery team was established in 1992 with early evidence of packs forming, and has found itself in the awkward, yet not unpleasant, position of trying to keep planning efforts in step with a rapidly recovering population.

Education is, of course, key to the recovery. Active wolf support and education groups have sprouted up in Michigan, Minnesota, and Wisconsin to serve a vital role in keeping public attitudes positive. Their volunteer outreach programs have proven quite successful. National Park Service interpreters and rangers will be joining these groups to direct more effort to public education programs, particularly during the critical deer hunting season when hundreds of anxious hunters are roaming the woods (hunting is legal in Pictured Rocks).

While the outlook appears pretty sunny for the wolf in Upper Michigan, dark clouds also loom. Diseases such as sarcoptic mange and canine parvovirus may have significant impacts on the population; mange is believed to account for substantial mortality. Habitat loss through development and fragmentation is also a concern; a United States Coast Guard proposal to maintain shipping through the Saint Marys River in winter via icebreaker is considered to be a significant threat to movement between Canadian and Upper Peninsula populations. Perhaps the greatest threat is the possibility of a change in public attitudes. The Michigan Militia and antigovernment sentiment are strong in the Upper Peninsula; any protective action by a public agency that may be perceived as heavy-handed (particularly road closures) could cause a serious antiwolf backlash. Although farming is not a common livelihood in most of Upper Michigan, livestock depredation is also a concern. The recovery team recognizes the need for quick assessment and effective response to depredation claims, and is seeking funding from nongovernmental organizations for a reimbursement fund.

While the wolf is perhaps the definitive *charismatic megafauna* and can be dismissed as an example of politicized endangered species issues, its return to the Michigan Upper Peninsula is important for several reasons. First, it demonstrates a positive, fundamental change in attitudes in an area where long-established antipredator sentiments die hard. This change can be built upon to broaden knowledge and gain support for other environmental issues. Second, it provides some evidence of overall ecosystem health for a large chunk of land near the country's industrial heartland (within 350 miles of both Chicago and Detroit). Third, it forces state and federal agencies to go beyond happy policy statements about "ecosystem management" and "preserving biodiversity" to actually taking positive, cooperative management actions across boundaries to benefit both human and natural environments. Pictured Rocks National Lakeshore intends to be an active partner in this endeavor. PS

Brian Kenner is a Natural Resource Management Specialist at Pictured Rocks National Lakeshore. His phone number is (906) 387- 2607.

Figure 1. This nonnative coastal mountain grassland at Santa Monica Mountains National Recreation Area in southern California comprised the southern portion of the 32-acre site chosen for riparian vegetation restoration. The lone mature sycamore, one of a few remaining native plants, may soon be joined by other native trees, shrubs, herbs, and grasses planted by more than 250 people along the base of Boney Ridge (background) in the Potrero Creek restoration project.

Partnerships in Resource Management: The Potrero Creek Restoration Project

By Rose M. Rumball-Petre

Park partnerships and interagency cooperation are essential ingredients in conducting successful projects in the Santa Monica Mountains National Recreation Area in southern California. Unlike most national parks, we will never own all, or even most, of the land within the boundary. Rather, the park demonstrates a cooperative effort itself, where the lands of private citizens and local, state, and federal governments mesh. Therefore, conducting park projects in a broad context of openness and cooperation is critical. Engendering community support for the park is essential to preserving its resources.

Background

Community support for the park paid big dividends last year when area cooperators helped to revegetate the Potrero Creek drainage following severe wildfires. Planning for the Potrero Creek Restoration Project began when, in the aftermath of the fall 1993 fires, Kraft General Foods, Inc., donated $10,000 through the National Park Foundation (NPF) for revegetation. However, since the National Park Service does not routinely revegetate after wildfires, we chose to use the grant for a high priority riparian restoration project, consistent with the development concept plan for Rancho Sierra Vista/Satwiwa (1984) and acceptable to Kraft as an alternative. This area was one of the first burned by the 1993 Greenmeadow fire, which burned over 38,000 acres (15,385 hectares) within the park.

Potrero Creek traverses a highly disturbed grassland at the base of Boney Ridge in the western end of the Santa Monica Mountains (fig. 1). Beginning around the turn of the century, well before NPS management, the restoration area was the site of a large cattle and sheep ranch; later, a citrus farm prevailed; and still later, during NPS management, the tract served as a dryland farm that partially supported a local college agricultural program through a cooperative agreement. These activities, including removal of large oaks and sycamores in support of historic ranching and farming, left Potrero Creek with little native vegetation regeneration. The development concept plan for the area and the park resource management plan both prescribed native vegetation restoration, especially in riparian areas, as a high priority. The wildfire prompted funding, helped us rally support, and moved us to plan for this cooperative revegetation project.

Planning

Initial planning and research for the project entailed publicizing the grant from the National Park Foundation and contacting a variety of individuals and agencies for information regarding similar restoration projects. We incorporated this information into a detailed restoration plan that adopted recommendations of other existing area plans to place a 400-foot (122 meter) riparian buffer along Potrero Creek through the dryland farming zone.

The Potrero Creek Restoration Plan describes the need for restoration and discusses the overall and site-related importance of riparian restoration. The document also analyzes the proposed restoration area in terms of its physical and biological site characteristics (soil, topography, hydrology, existing vegetation, succession, wildlife use). Finally, it identifies planning considerations and the goals and

objectives for the project, based on research into the successes and failures of riparian restoration projects conducted throughout the west. In addition, the restoration plan presents monitoring data from a reference site and describes the implications of the project site characteristics on implementation.

We analyzed aerial photos and selected similar sites for use as reference areas to determine the project boundary, implementation strategy, existing plant species, planting density, and planting zonation. Finally, to develop a planting plan, we prepared a detailed site map, selected an irrigation system, and designed a monitoring program that would address the overall restoration project goals and objectives. Table 1 shows the native species we chose to plant in the restoration project.

Throughout the restoration plan literature citations of documented riparian restoration projects refer to actual implementation objectives, such as whether or not to mulch, what planting density to use with walnuts, the depth to achieve when augering holes, etc. However, little information was available on the success and failure of riparian restoration efforts. As a result, we engaged in great debates over whether or not to fertilize the plants. Lacking consensus, we decided to test the need for fertilization through this project.

The overall project area encompasses a potential of 32.2 acres (13 hectares), of which approximately 13.8 acres (5.6 hectares [1,500 x 400 ft]) have been restored. We augered holes, set up a fertilization test, and installed a drip irrigation system for 1,020 plants of seven riparian species and two coastal sage scrub affiliates. In the end, the California Department of Parks and Recreation, Topanga-Las Virgenes Resource Conservation District, City of Malibu, California Department of Fish and Game, NPS Western Regional Office, Channel Islands National Park, TreePeople, James H. Cowan and Associates, Coast Irrigation, Inc., and Tree of Life Wholesale Nursery provided valuable comments during the planning process; some even assisted in implementation.

Engendering community support for the park is essential to preserving its resources.

Funding and Donations

One of the first contacts we had with a cooperator who would help us carry out the restoration occurred even before we received the NPF grant. TreePeople, a local tree-planting activist organization, had approached us following the fall 1993 wildfires to offer assistance in planting trees in the park. Although Potrero Creek was evaluated for an initial cooperative venture, it was not selected because it lacked a restoration plan. Instead, we cooperated to revegetate Happy Hollow Campground and replaced nonnative trees, killed by the wildfires, with native trees and shrubs.

While waiting for the grant and developing the restoration plan for Potrero Creek, we also sought additional funding and support for the project through donations. Regular conversations with interested park and interagency staff led to over $45,000 in donations of materials and volunteer time (calculated at $7.50/hour, essentially a GS-3 wage), which more than quadrupled the original donation. TreePeople set aside money and contracted staff time in anticipation of the project, and when we received the NPF grant, their interest escalated.

The NPF grant was used to purchase materials and supplies to prepare for the planting date and the temporary drip irrigation system. Remaining grant funds are being used to pay for 2 years of dry-season watering. The bulk of the project, however, was implemented as the result of donations from the huge variety of individuals and community organizations that supported the project, including TreePeople, Tree of Life Nursery, the Malibu Forestry Unit (nursery) of the L.A. County Fire Department, several local tree trimming businesses, and many others.

Planting and Monitoring

The fall planting date attracted an all-time record turnout for a volunteer event in the park, gathering over 250 participants from a variety of Los Angeles and Ventura County community organizations, such as the Roosevelt High School Ecology Club, the Los Angeles Junior Chamber of Commerce, and a number of scout groups. The largest single "group" of individuals participating in the project, however, were volunteers from the neighborhoods bordering the restoration site.

Table 1. Native Vegetation Planted at the Potrero Creek Restoration Project Site

Trees	
California black walnut	*Juglans californica*
Western sycamore	*Platanus racemosa*
Coast live oak	*Quercus agrifolia*
Valley oak	*Quercus lobata*
Shrubs & Subshrubs	
California sagebrush	*Artemesia californica*
Coyote bush	*Baccharis pilularis*
Mule fat	*Baccharis glutinosa (salicifolia)*
Purple sage	*Salvia leucophylla*
Wild rose	*Rosa californica*
Mexican elderberry	*Sambucus mexicana*
Grasses, Sedges, Rushes	
Creeping wildrye	*Elymus triticoides*

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The first phase of monitoring is nearing completion. Plant growth and survival has been extremely variable, with elderberries *(Sambucus mexicana)* sustaining a 71% mortality rate, but with individuals attaining the greatest growth, with a range of 13.7-76.9 in (35.1-197.2 cm) and stem diameters of greater than 1.4 in (3.6 cm). Sycamores *(Platanus racemosa)* on the other hand, had an initial survival of 90% but attained virtually no additional height (range 2.3-40.6 in [5.9-104.1 cm]) due to a widespread fungus infestation that caused the trees to die back after early spring growth and then resprout from the base, with varying vigor. Wild rose *(Rosa californica* [fig. 2]*)* has had an 85% survival rate, and has attained heights ranging from 5.9-51.5 in (15.1-132.1 cm), with a large number, like the surviving elderberries, also producing both flowers and seeds. Live oaks *(Quercus agrifolia)* and valley oaks *(Q. lobata)* had survival rates of 78% and 62%, respectively, with height ranges of 3.3-40.6 in (8.5 cm-104.1 cm) and 5.1-55.4 in (13.1-142.1 cm), respectively.

Ongoing maintenance of the drip irrigation system will be required for at least 2 years to ensure plant establishment. Monitoring of the project will continue indefinitely, occurring at least annually, in the spring. Additional monitoring of a reference plot in the project area, weeding and alien plant removal, site maintenance, removal of cages and, possibly, follow-up planting will also occur as needed.

Visitors and park neighbors passing adjacent to the project area on Potrero Road, may still see multicolored landscaping flags denoting the wide variety of plants and ongoing efforts of park staff and volunteers to monitor the plants and to maintain the irrigation system. The wide, mowed field with huge truckload-sized piles of mulch is now gone and once again offers its previously disturbed appearance. However, upon closer inspection, the native vegetation has returned at irregular intervals. With continued care these plants will dominate the now nonnative landscape of the restoration area.

*Figure 2. One of the many shrubs planted, wild rose (*Rosa californica*) has had an 85% success rate with some individuals flowering, going to seed, and reaching 52 inches in height. A drip irrigation system will water the new plants for at least two years to help them become established.*

Conclusion

The total cost for the project to date is $63,149 of which more than 70% ($45,552) has come from donations or volunteer time. Much of the rest can be attributed to staff time spent on developing the restoration plan, augering holes, coordinating planting, maintaining the irrigation system, and monitoring. Without the thoroughly researched restoration plan, the willingness of park staff to participate in the project, and the excellent cooperative relationships established through informal connections, this project would not have been possible.

The "devastation" caused by the Greenmeadow fire was put to rights in the minds of park neighbors and volunteers by focusing on repairing the real devastation caused to a native community by years of insensitive land use. An idea, a little seed money, and numerous partnerships created the Potrero Creek restoration project, which, if all goes well, will fulfill the park enabling legislation to "enhance" the natural resources of the Santa Monica Mountains for decades to come. PS

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would help serve this purpose and bring the management dimension of the science and resource management mix more to the foreground. Dickenson portrayed science and management as a process that needed to be emphasized and improved, and he saw Pacific Park Science, then reporting just from the western United States, as a vehicle to foster the growth of this process.

RS AGO IN PARK SCIENCE

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Also that issue, Sequoia-Kings Canyon National Park Research Scientist Dave Graber reported on his graduate studies of black bears in Yosemite National Park. While the immense frontcountry problem of bears dining on poorly stored campground food and frequently injuring campers had been on the decline since the mid-1970s, encounters between backcountry users and bears appeared to be on the rise. Graber discovered that when bears could get high quality backcountry camper food in combination with the bulk of less nutritious herbs and grasses, they could make use of otherwise marginal habitat. The bears were clearly thriving and backcountry incidents with bears were also unacceptably high.

Since 1980, research on dozens of translocated radio-collared bears indicated that translocation did not keep a bear out of trouble or even alive. Many translocated bears wandered out of the parks and were hunted or otherwise destroyed. Based on these findings, Sequoia abandoned translocation as a management tool, concentrated its efforts on food management, and destroyed those bears that had become dangerous, habitual, campground problems. On the other hand, the combination of installing bear-proof camp boxes in frontcountry (in both parks) and some backcountry campsites (in Sequoia only) and backpacker- carried food canisters greatly reduced bear incidents and both parks are now destroying fewer bears.

Graber still does not know if high-elevation bear populations have been reduced, due to the food management and early translocation efforts. However, follow-up research on young male bears demonstrated that by the age of 2½, most had dispersed far from natal ranges–many outside the parks where they were typically killed. In other words, the park had become a source, and the surrounding lands a sink, for bears.

From 1980-84, Graber trapped and tracked bears both in a developed portion of Sequoia and in another area with no human use. Not surprisingly, he found the wild bears to be smaller, long-lived, and less fertile than the Yosemite superbears of the 1970s. Interestingly, as food lockers and enforcement were introduced to Giant Forest and Lodgepole (Sequoia), that bear population came to look less like a habituated Yosemite population and more like its wild kin. While bear problems are still chronic and persistent in both parks today, injuries, property damage, and bear deaths are all far lower than 21 years ago when Graber started his Yosemite research. PS

Meetings of Interest

OCTOBER 25-28 Gathering near Mitchell, Indiana, at Spring Mill State Park, the twelfth national cave management symposium, "Quality Cave Management Involves Everyone," will emphasize the importance of cooperative efforts in dealing with cave management issues. Field trips will focus on local cave management practices and problems related to urbanization and road construction in karst areas. For more information, contact Keith Dunlap, Indiana Karst Conservancy, P.O. Box 2401, Indianapolis, Indiana 46206; (317) 242-2505; e-mail "kdunlap@atd.gmeds.com".

OCTOBER 26-28 An international conference and training workshop on "Conservation and Ecology of Grassland Birds" will team up with the 1995 annual meeting of the Association of Field Ornithologists in Tulsa, Oklahoma. Areas and issues to be discussed include, landscape ecology, grazing and burning, agriculture, farmland structure, residential and commercial development, grassland management, and regional planning. Contact Dan Reinking or Ron Rohrbaugh, Sutton Avian Research Center (918) 336-7778, e-mail "gmsare@aol.com", for more information.

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Meetings of Interest (cont'd)

NOVEMBER 7-8 The Canadian Council on Ecological Areas is sponsoring a brief conference on protected areas in resource-based economies. Entitled, "Sustaining Biodiversity and Ecological Integrity," the miniconference will be held in Calgary, Alberta. For more information, contact Robyn Usher, Conference Registrar, 1122 4th Street SW, Suite 200, Calgary, Alberta, Canada T2N 1M1; (403) 269-9466.

NOVEMBER 13-15 The International Association of Wildland Fire is sponsoring, "Fire Effects on Threatened and Endangered Species and Habitats," to be held in Coeur d'Alene, Idaho. The session seeks to improve our understanding of fire in habitat dynamics and has the goal of bringing together policy makers, public land managers, and conservation groups to promote dialog about the interactions of fire and imperiled species and habitats. For more information, contact the Association of Wildland Fire, P.O. Box 328, Fairfield, Washington 99012; (509) 283-2397.

NOVEMBER 16-17 Tufts University, the American Farmland Trust, and the Henry A. Wallace Institute for Alternative Agriculture are sponsoring the "Conference on Environmental Enhancement Through Agriculture," to be held in Boston, Massachusetts. The meeting is intended to foster creative thinking about agriculture that can serve both pure agricultural and environmental interests. For more information, contact William Lockeretz, School of Nutrition, Tufts University, Medford, Massachusetts 02155; (617) 627-3223; e-mail "wlockeretz@infonet.tufts.edu".

NOVEMBER 16-19 Reno, Nevada, will host the 27th Annual Meeting of the Desert Fishes Council. The conclave will consist of technical and agency reports, posters, and the symposium, "Translocation as a Conservation Tool for Preserving Native Fishes," which will be followed by a translocation workshop. For more information, contact E. Phil Pister, Desert Fishes Council, P.O. Box 337, Bishop, California 93515; (619) 872-8751.

JANUARY 21-25, 1996 The Third International Conference and Workshop on Integrating GIS and Environmental Modeling will take place in Santa Fe, New Mexico. Participants will emphasize the development of environmental models and the near future improved integration of geographic information technologies, especially GIS, and modeling. For more information, contact the National Center for Geographic Information and Analysis, Phelps Hall 3510, University of California, Santa Barbara, CA 93106-4060; (805) 893-8224; fax (805) 893-8617; e-mail "sandi@ncgia.ucsb.edu".

MAY 7-10 The 20th Tall Timbers Fire Ecology Conference will get under way next spring in Boise, Idaho. Entitled, "Fire in Ecosystem Management: Shifting the Paradigm from Suppression to Prescription," the conference aims to discuss specific prescribed fire regime alternatives in the context of modern natural resource management and policy. Many sessions will adopt a case study approach and will link the use of prescribed fire with long-term management objectives to achieve specific future forest, shrub, or grassland ecosystem conditions. Contact Leonard Brennan, Director of Research, Tall Timbers Research Station, Route 1, Box 678, Tallahassee, Florida 32312; FAX (904) 668-7781 for more information.

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