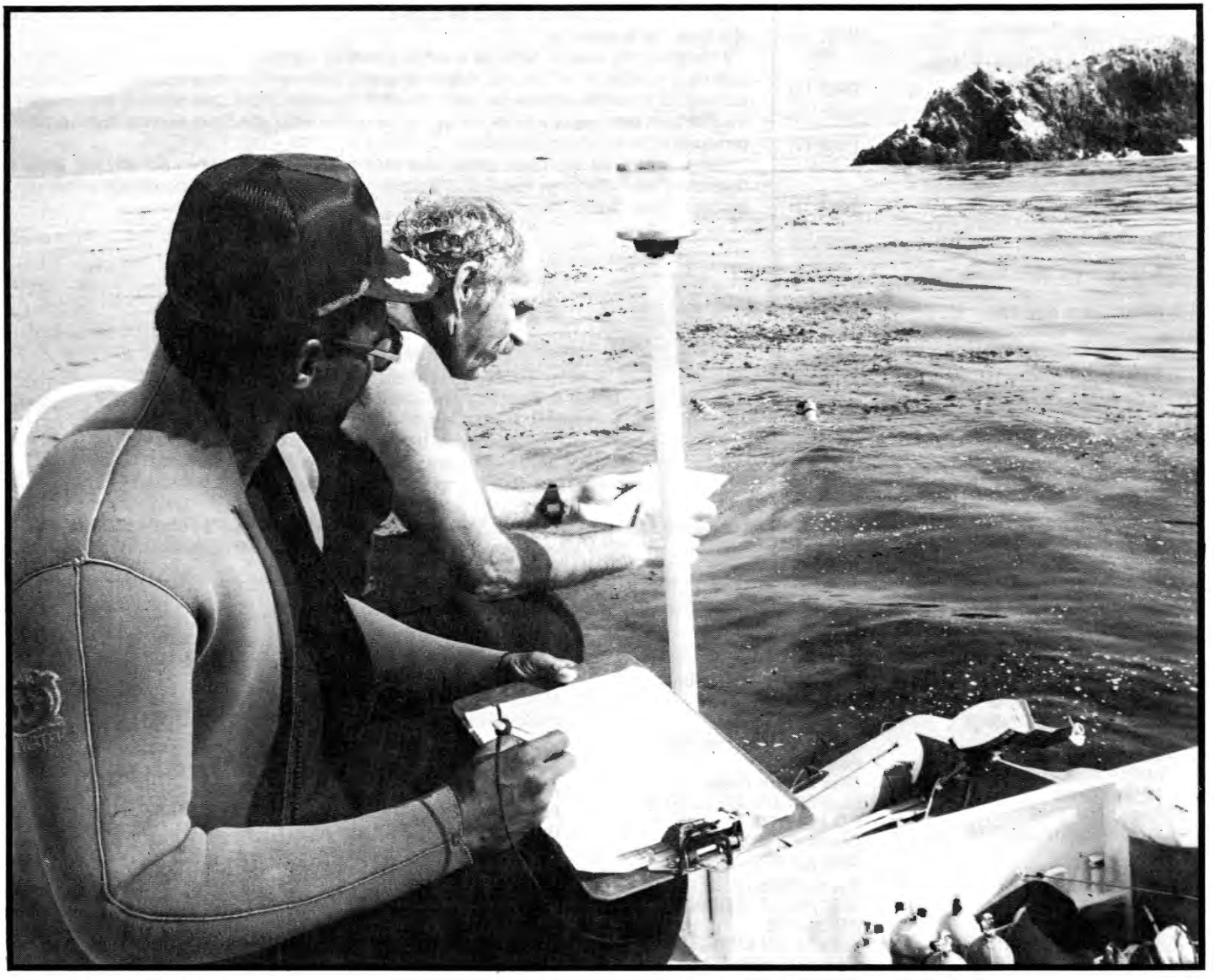
PARK SCIENCE

A RESOURCE MANAGEMENT BULLETIN

NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR

VOLUME 2 – NUMBER 3 SPRING 1982



PARK SCIENCE

NATIONAL PARK SERVICE

SPRING 1982

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

In This Issue

Cover Photo: *Park Rangers J.T. Reynolds and Craig Johnson take a turn topside as dive masters recording dive times and checking divers in and out of the water at Santa Cruz Island during the resources monitoring project at Channel Islands National Park.* *(Story on p. 3)*

From the Editor,

Science is stirring and reaching out beyond its own. Three National Park science conferences are reported elsewhere in these pages, and a fourth allied conference is scheduled by the George Wright Society. Most of them have been arranged with the idea of management transfer built in; at least one of them, contains a primary thrust toward bringing in and involving the citizens who live around and react to the host park and its resources and problems.

A key phrase in one of the conference announcements is "anyone who has conducted research in parks or is interested in National Park Service research and resource management, including administrators, scientists, students, and laypersons." According to the brochure, "That's WHO it's for."

If general systems principles can be held to apply in human systems as well as the better understood, so-called "natural" systems of earth, then this move toward better communication between science and management and between parks and the surrounding communities was predictable. Both the aim and the outcome involve tighter connections, improved feedback, enhanced efficiency – all the responses systems tend to display when faced with diminishing resources and/or energy.

So it speaks well for parks, for park science, and for park management that these joint efforts, based on research into and management of one of the nation's most admired Systems should be occurring "within the house of science," so to speak.

If human society could be expected to exhibit something beyond the unconscious self-designing of nature's systems, it might be the self-insightful notion that communication with the whole of society should accompany the exchange of information between two segments within the system (in this case, scientists and managers.) Thus, it is a matter of some reason for pride that we find "the outside world" specifically invited to attend, to contribute, to participate in the scheduled proceedings.

Heaven knows, the park-based people have much to tell the world. Heavan probably also knows that the "laypersons" who view things from a slightly different angle, may have something valuable of their own to toss into the conference pot.

Jean Matthews, Editor: Oregon State University NPS/CPSU, Room 126 Forestry Sciences Lab, 3200 Jefferson Way, Corvallis, OR 97331 (503) 757-4579; 8-420-4579

Please address requests for information to appropriate Regional Chief Scientists:

Anderson, William H.
NATIONAL CAPITAL REGION
1100 Ohio Drive, S.W.
Washington, D.C. 20242
8-426-6660 (202) 426-6660

Buckley, Paul A.
NORTH ATLANTIC REGION
15 State Street
Boston, MA 02109
8-223-7765 (617) 223-7765

Fenn, Dennis B.
WESTERN REGION
450 Golden Gate Avenue
P.O. Box 36063
San Francisco, CA 94102
8-556-4968 (415) 556-4968

Field, Donald R.
PACIFIC NORTHWEST REGION
Room 1920 Westin Building
9001 Sixth Avenue
Seattle, WA 98121
8-399-1355 (206) 442-1355

Fleet, Harvey
Chief, Science Center
DENVER SERVICE CENTER
P.O. Box 25287
Denver, CO 80225
(303) 234-4527

Fletcher, Milford F.
SOUTHWEST REGION
P.O. Box 728
Santa Fe, NM 87501
8-476-6412 (505) 988-6412

Gogue, G. Jay
SOUTHEAST REGION
75 Spring St. S.W.
Atlanta, GA 30303
8-242-3643 (404) 221-3643

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

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

Lovaas, Allan L.
ALASKA REGION
540 W. Fifth Avenue, Room 202
Anchorage, AK 99501
8 (907) 271-4212

Reid, Neil J. (Jim)
ROCKY MOUNTAIN REGION
P.O. Box 25827
Denver, CO 80225
8-234-2764 (303) 234-2764

Population Dynamics Monitoring Of Living Marine Resources in Channel Islands National Park

By Gary Davis

In the summer of 1981, Channel Islands NP began an innovative resource monitoring project. Nearly two miles of underwater transect lines were laid to help research scientists and resource managers from the State of California and the National Park Service monitor the population dynamics of marine plants and animals in the park. Such research and resource monitoring in the ocean is extremely complex and costly. The broad array of required knowledge and skills range from the practical application of offshore navigation, boat operation, SCUBA diving and underwater construction to scientific expertise in marine ecology, sampling theory, and statistical analysis.

The need for accurate, up-to-date information on marine resources in Channel Islands NP is acute. Spectacular concentrations of breeding seals, sea lions, and sea birds depend on the marine food chain. Although one mile of water around each of the five islands in the park is included in the park boundary (about 125,000 acres), the living marine resources are managed by the State of California, with virtually unlimited total harvest of fish, lobster, abalone, and other marine organisms. This direct impact, plus impending threats from adjacent petroleum extraction activities, pose the potential for major human disturbance of these ecosystems. The cost of providing information to make wise decisions about these resources is high, but in line with the NPS mandate, the need is urgent.

The Channel Islands NP marine resources monitoring project is being conducted jointly by NPS and the California Department of Fish and Game (CDFG). Objectives for the first year (1981) were to select study sites and species to monitor that represent the broad array of biogeographical, ecological, and human activities found in the park. For the first field season, the specific goal was to establish 24 permanent 100-meter transects upon which long-term repetitive biological sampling will be based.

In January 1981, I sat down with an Ad Hoc committee of senior biologists from CDFG led by Herbert W. Frey and began discussions of the project. During the next six months we developed project objectives, established criteria for selection of species to monitor, selected species, and prepared a study proposal. Funding for initiation of the project in FY 1981 was approved in July, and the first field work was conducted in August and September.

Project Objectives

The Channel Islands NP enabling legislation (PL 96-199) (passed in 1980 to expand the park and give it National Park status) provides clear direction for management, stating: "the park shall be administered on a low-intensity, limited-entry basis." The law further requires detailed monitoring of the population dynamics of both terrestrial and marine species in the park, with biennial reports to the Congress for 10 years. These Resource Study Reports are also to include "recommendations as to what actions should be considered for adoption to better protect the natural resources of the park."

The first objective for the living marine resources project is to summarize the historical data on population dynamics of selected 'indicator' species. The information summarized will include data on abundance, distribution, reproductive efforts, recruitment to the population, phenology, population age and sex compositions, growth rates, and mortality rates.

The second objective is to design and implement a sampling program to determine the population dynamics of the 'indicator' species.

The last objective is to develop and implement a data management system for storage, retrieval, and reporting of population parameters.

Indicator Species and Study Sites

In selecting marine plants and animals to monitor, a list of nearly 1,000 species compiled by Dr. John M. Engle at the University of Southern California Catalina Marine Science Center was reviewed. Five criteria were used to select species from the list: (1) legally protected species (i.e. rare or endangered), (2) species constituting critical habitat for endangered species, (3) harvested species, (4) species dominant in or characteristic of major ecosystems, (5) large showy 'heroic' species. Using these criteria, 12 plants, 37 invertebrates, and 13 fishes were selected for long-term monitoring. A list of the selected species may be obtained from me at Channel Islands NP Headquarters, 1901 Spinnaker Dr., Ventura, CA 93003.

The waters of Channel Islands NP harbor an ecologically diverse array of species assemblages. The park sits at the boundary of two major biogeographical provinces: the Oregonian province to the north and the Californian to the south. The western Park islands, San Miguel and Santa Rosa, are bathed by northern waters carried south by the California current and therefore reflect the biological assemblages of the Oregonian province. Waters around the eastern park islands of Anacapa and Santa Barbara come from the south along the mainland coast and support the warm temperate biota characteristic of the Californian province. Around Santa Cruz Island, at the boundary of these two provinces, a broad

***Clean record** is the boast of the diving effort. Although 643 Scuba dives were conducted during the 1981 field season, no dive related accidents of any kind occurred, thanks to Western Regional Diving Officer David McLean and the Channel Islands NP diving team who organized and carried out the operation.*

***Stern deck** of the Motor Vessel Pacific Ranger was the scene of intense activity as research personnel and dive team members went through their summer monitoring paces.*

transition zone is characterized by a special assemblage of plant and animal species from both provinces that are capable of adapting to these unique and variable conditions.

Prevailing winds and the bathymetry of adjacent basins also greatly influence marine communities in the park. Strong north winds buffet the north sides of the islands, while the biota of the southern coasts reflect their more sheltered positions. Upwelling nutrients from 2,000 meter-deep basins to the south and west of the park produce exceptionally productive food webs and temperate regimes that differ significantly from the shallow northern sides of the islands.

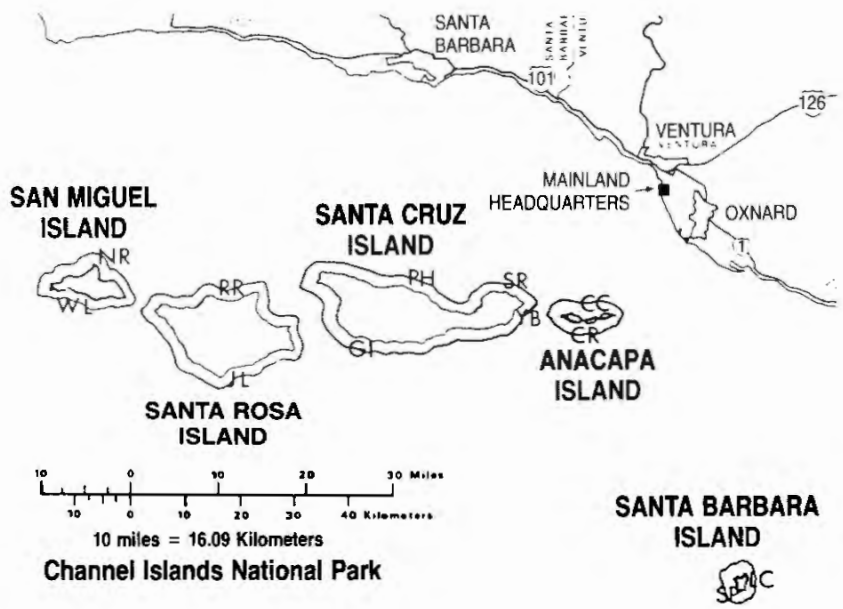
Sampling sites selected for long-term population monitoring reflect the broad range of conditions and biological assemblages in the park. Twelve locations representing the north and south sides of each of the islands and the east-west transition from Californian to Oregonian provinces, were selected (see map). At each of these locations, two 100-meter-long transects were established to provide a basis for precise, repetitive measurements of plant and animal populations.

Transects Established

Using the NPS's 17 meter-long motor vehicle Pacific Ranger as a base of operation, a total of 45 SCUBA divers conducted 643 dives in locating and establishing the 24 100-meter transects in August and September, 1981. Six week-long cruises were conducted, with 8 to 10 divers on each cruise. Five CDFG diving biologists – Dan Gotshall, Ken Wilson, Dave Parker, Pete Haaker, and Kristine Henderson – assisted me in selecting and marking the transects during the first cruise, August 18-21. On the remaining cruises, 33 divers from the NPS Western Region dive team and 7 scientists from local universities and National Marine Fisheries Service established the permanent transect lines on the sea floor . . . involving a sequence of operations, specialized equipment, and skills developed specifically for this project.

Stick 'em Down! *At each of the 24 study sites, 11 stainless steel eyebolts were epoxied into holes drilled into the rocky bottom at 10-meter intervals along a 100-meter long transect. The epoxy was injected with a pneumatic caulking gun operated off of Deckhand David Stoltz' SCUBA tank.*

Locations Selected for Long-Term Population Dynamics Monitoring in Channel Islands National Park, California



Location	Island	Map Symbol
Nifty Rock	San Miguel	NR
Wycoff Ledge	San Miguel	WL
Johnsons Lee	Santa Rosa	JL
Rodes Reef	Santa Rosa	RR
Gull Island	Santa Cruz	GI
Yellow Banks	Santa Cruz	YB
Scorpion Rock	Santa Cruz	SR
Pelican Harbor	Santa Cruz	PH
Cathedral Cove	Anacapa	CC
Cat Rock	Anacapa	CR
Landing Cove	Santa Barbara	LC
Signal Peak	Santa Barbara	SP

Emplacement procedures were conducted in stages by a series of divers because the time a diver can spend underwater without risk of decompression sickness (the bends) is extremely limited. Even at the relatively shallow 18-meter maximum depth of the transects, a diver can spend only two hours per day on the bottom. Each finished transect line consists of 11 stainless steel eyebolts anchored in bedrock at 10 meter intervals, connected by 10 lengths of leadcore nylon line. The advantages of this design are that the 11 eyebolts provide precise locations to which various biological sampling schemes may be referenced, loss of an entire transect line to storm or a boat anchor dragged across the line is greatly reduced, and if an entire line were lost, relocation would be much easier and quicker with several eyebolts for which to search. Complete details on the diving and emplacement operations are available upon request from me, care of the park.

Future Plans

In the second year of the project, historical data on the population dynamics of selected species will be gathered and summarized from cruise reports, dive logs, and other unpublished materials in the CDFG library in Long Beach, Calif., as well as from the published scientific literature. These summaries will be included in the first of the five biennial Resource Study Reports to be submitted to Congress in October, 1982. During the winter and spring of 1982, sampling programs for each of the plants and animals will be designed and tested in the field. Techniques to be evaluated include photogrammetric plots, bait stations, line intercept transects, cinetransects and an experimental marine electroshocker. Some are standard applications of known methods, while others represent entirely new approaches to sampling marine organisms.

The first samples for routine monitoring will be taken in July and August, 1982, during another series of week-long cruises on the Pacific Ranger. Monitoring the health and condition of the complex marine ecosystems in Channel Islands NP is imperative and the methodology developed in the effort will be readily applicable to many parks and ecosystems.

Editor's Note: Park Science *will carry accounts of the findings at Channel Islands as the monitoring proceeds.*

Increasing the Survivability of Trees in the Urban Landscape

By Ann F. Rhoads and Paul W. Meyer

Growing trees in an urban park requires special attention to assure success since the highly modified environment of the city imposes multiple stresses. In order to better understand the factors involved, the Morris Arboretum of the University of Pennsylvania entered into a contract with the Mid-Atlantic Region of NPS for a study of Independence National Historical Park.

This 47-acre park was established in the mid-1950s in the heart of downtown Philadelphia. All but one small area contained buildings which were razed to create open space. The park has been landscaped with relatively diverse plantings over the past 25 years and now contains approximately 1,900 trees, representing 100 species or cultivars. Trees are planted in sites ranging from open lawn to curbside planting pits.

In 1976-77, the Morris Arboretum carried out a survey of the trees in Independence National Historical Park. All trees were individually evaluated for overall condition and specific insect, disease, or environmental stress problems. Where necessary, laboratory diagnoses were carried out to identify pests. Site characteristics also were noted, including the nature of the surrounding surface, the area of exposed soil, and proximity to buildings or the street. Following completion of the initial survey, spot checks of new and recurrent problems were made in 1978 and 1979.

Information regarding the adaptability of various tree species to urban growing conditions was collected and analyzed. The important stress factors limiting tree growth have been identified and cultural and maintenance practices were recommended which can increase survivability of trees in the city.

Among the specific problems affecting tree growth, soil related factors rank near the top. Excessive soil moisture due to poor drainage, soil compaction, salt accumulation, and alkaline conditions all pose severe limitations to tree growth.

Trees depend on their roots for absorption of water and dissolved minerals, anchorage, and storage of energy-rich carbohydrates over the winter. Roots are a living, growing part of the tree and must continually expand into new areas of soil to accomplish these necessary functions.

Disturbed urban soils often consist of rubble and "fill dirt" and thus bear little resemblance to a normal soil profile which includes layers of humus, topsoil and subsoil underlain by parent rock. Drainage conditions are often poor or uneven and the presence of masonry debris may create highly alkaline conditions. Organic material is usually lacking. Soil compaction is a common problem resulting from constant heavy traffic over clay and silt fill materials. Compaction reduces soil air space to the point that roots may suffocate from lack of oxygen. Compacted soil drains poorly, thereby leading to periodic conditions of water saturation which further aggravate the lack of oxygen. Another factor that can seriously reduce soil oxygen content is the production of methane in old landfill areas as buried organic debris undergo anerobic decomposition.

The use of de-icing salts on streets and sidewalks results in salt buildup in curbside planting pits and causes leaf scorch and eventual death of such sensitive trees as maples and lindens.

Trunk wounds are a commonly occurring form of mechanical damage, especially on curbside trees. These wounds frequently become entry points for wood decay fungi, other pathogens, and insects. Basal wounds also are common on lawn specimens as a result of poor maintenance practices. Repeated wounding with lawn mowers has weakened plants and led to invasion by crown canker and other disease and insect problems.

Another form of mechanical damage results from vandalism. Branches and entire trees have been broken off when nursery stock was not of sufficiently large size.

Air pollution injury caused by the photochemical pollutant ozone is likely to occur on certain sensitive plants. In Philadelphia, ozone damage, which consists of a fine dark red or black stippling of the upper leaf surface, has been found on White Basswood, Sweetgum, Cockspur Hawthorn and London Planetree. In general, this injury does not appear to be a serious threat to tree health. Occasionally, a very sensitive plant may be affected to the extent of partial defoliation.

Temperature is another problem. Extremes of heat or cold can cause damage in some plants. Summer heat, reflected from surrounding surfaces, can cause leaf scorch. In winter, bark scald and/or frost cracks develop when tree trunks are sun-warmed and undergo rapid changes in temperature. Species with dark colored bark are more susceptible to winter damage than those with light colored bark.

Insect and disease problems increase in incidence and severity when trees are subjected to environmental stress. Soil compaction, salt, extremes of temperature, air pollution and mechanical wounding all reduce a tree's natural defenses and its ability to resist threats to health. One or more of these stress factors are common in most city planting sites. The pest problems cited below were found to be most prevalent in the survey of Independence NHP.

Scale insects are widespread in urban planting. Obscure Scale is especially troublesome on Red Oak, Scarlet Oak, and Willow Oak growing in curbside planting pits. Kermes Oak Scale is often present on these same species. Severe infestations of scale can seriously weaken trees and even kill them. Trees in open lawn settings are less frequently infested, presumably due to the reduced degree of stress under which they are growing.

Bagworms are another common pest in city plantings. These caterpillars feed on the leaves of deciduous and evergreen trees. Concealed in bags constructed of silk and bits of plant debris which hang from the branches, they are most visible in the wintertime.

Another insect problem, which may be unique to city planting sites, is termites. The Eastern Subterranean Termite may attack apparently vigorous and otherwise intact young trees. In one location in Independence Park, termites invaded newly planted Ginkgo and Thornless Honeylocust trees under cover of the paper trunk wrap used to protect the trees from sunscald.

Borers are another category of insects frequently found in urban plantings. The Lilac Borer attacks Ash and Lilac; the Dogwood Borer and Rhododendron Borer also are troublesome.

Certain disease problems caused by parastic fungi, bacteria, viruses and nematodes are to be expected in city plantings. In some cases, increased disease susceptibility is clearly related to environmental stress factors. The severe problem with Bleeding Necrosis disease of Sweetgum trees in Independence Park is an example. Susceptibility to the fungus which causes this disease has been associated with low moisture and low temperature stress.

Foliage diseases, although unsightly, are not as serious a threat to tree survival. In a number of cases, disease incidence can be reduced through use of resistant cultivars. Anthracnose of London Planetree is common in cities where this tree has been used extensively in street plantings. In a cool, wet spring, this disease can cause nearly complete defoliation. How-

***Honeylocust trees** shade Locust Street in Independence National Historical Park.*

ever, the trees will recover within a month or so. The London Planetree cultivar, Bloodgood, resistant to anthracnose, has performed exceptionally well in Independence Park. Apple scab and Powdery Mildew are common on susceptible crabapple trees. Resistant cultivars are available and should be specified in all cases.

Species diversity emerged as a major deterrent to plant problems in city parks. Far too often entire parks are planted with only two or three kinds of trees. This not only leads to a visually dull landscape, but it also can create later horticultural problems if insect or disease problems arise.

The devastation wrought by Dutch Elm Disease is a classic example of the danger of overuse of a single tree species. The American Elm, once planted almost exclusively in many areas of the northeast and midwest, has been virtually wiped out as Dutch Elm Disease swept across the country. By increasing the diversity of species selected for our urban landscapes, the potential for similar devastating epidemics can be minimized.

Increased survivability for urban park trees can be promoted in two equally important ways; one way involves plant selection and the other, site preparation.

A knowledge of the cultural requirements and adaptability of tree species and cultivars is essential to planning a successful, low maintenance urban planting. Only salt-tolerant species should be planted in areas where de-icing salts will be used. Selections with resistance to specific pest problems should be used in areas where the pests are known to occur. Avoiding a problem is always preferable to having to treat it later. Some examples which are now available, in addition to anthracnose-resistant varieties of London PlaneTree, are scab and rust-resistant crabapples, species of elm resistant to Dutch Elm Disease, and even tree species which the gypsy moth avoid (native American tulip tree). Large plantings should always contain a diversity of species to minimize the spread of specific pests.

Site preparation is equally important. Where plants are to be part of the urban landscape, site design should take into consideration the biological needs of living plants. In existing areas, some modifications to provide more favorable growing conditions may be possible. Improved drainage and reduction of soil compaction may be accomplished by construction of raised planting beds. In addition, planting trees three to four inches above grade will help to alleviate problems arising from reduced soil oxygen content.

Additional root space can be accomplished also by constructing expanded or interconnected tree pits partially topped with bricks or paving stones laid in sand. Trees in lawn areas should be planted high and protected from mechanical injury by a mulched zone at least three feet in diameter

Living trees are a valuable addition to the urban park. Their significance warrants more attention to site preparation, selection and care. Reduced stress on trees will result in increased survivability and reduced maintenance costs.

***Ann Rhoads and Paul Meyer** inspect a newly planted tree in Independence National Historical Park.*

Ann Rhoads is Plant Pathologist and Paul Meyer is Curator of the Living Collection, Morris Arboretum, University of Pennsylvania; 9414 Meadowbrook Avenue, Philadelphia, PA 19118.

superintendents' corner

Crater Lake is listed as one of the natural wonders of the world, and its status as one of the superlative crown jewels in the National Park System is not questioned. This magnificent beauty and interesting geological creation has entranced people for nearly a hundred years. Yet we scarcely have begun to comprehend the characteristics and life of this unique resource.

We easily recognize and accept the fact that our mission as custodians of this priceless scenic and scientific wonder is to preserve it for present and future generations and to assume that natural processes dictate the continuing nature of the lake. It was with this recognition that, during the past three years of preparation of our natural resource management plans, we placed the need for increased research and monitoring of the lake as our highest priority. Our concern for this matter was heightened in 1979 when results of lake clarity studies indicated some loss had occurred since 1968.

As we finalized our natural resource management plan in 1981, we realized the necessity for establishing a developed, long-range research and monitoring program for the Crater Lake ecosystem. With the cooperative assistance of the Regional Science and Technology office, and the Cooperative Park Studies Unit at Oregon State University, we scheduled a Crater Lake Research Workshop on January 27 and 28, 1982 at OSU. The purpose of this workshop was to explore means by which existing information can be applied to our understanding of the Crater Lake ecosystem and to formulate a research/monitoring program to fill critical data gaps in response to short-term and long-term management needs.

From this productive session developed an action plan that already is underway. The 1982 season will see a research boat (a new purchase this year), a new research technician (seasonal) to assist the various research data collection activities, and the technical limnological research services of Dr. Douglas Larson. Additionally, we will be obtaining a few specialized scientific instruments for necessary data collection. Along with temperature and clarity studies, information will be collected on water pH, and analysis of the phytoplankton and chlorophyll amounts.

There will continue to be geological studies of the caldera and analysis of information that investigators now have, which tells us there are thermal springs that are discharging into the deep water and that have a dramatic effect on the temperature, stratification, circulation and chemistry of these waters.

All of these complex limnological and geological processes contribute to an exciting and perhaps mysterious life style of Crater Lake . . . which leads back to our need to learn all we can of what is happening naturally within the lake and whatever may be indirectly caused by man. Once we begin to understand better these vital signs – to comprehend the forces that are "driving" the lake – we will be in a more knowledgeable position to make sound management decisions about actions that could affect the lake ecosystem.

In the meantime, park management will continue to exercise the highest protective measures possible to assure that Crater Lake is perpetuated and preserved undisturbed for the enjoyment of future generations.

James S. Rouse, Superintendent
Crater Lake National Park, OR 97601

Research Improves Prediction of Yosemite NP Fire Behavior

By Jim Benedict and Jan van Wagtendonk

Fire has played a dynamic role for millenia in Sierra Nevada forests. Many plant communities in Yosemite have been adversely affected by years of suppressing naturally occurring fires. Trends in plant community succession have been altered, resulting in unnatural shifts in the composition and structure of Park ecosystems. The natural mosaic of diverse vegetation types is slowly being replaced by dense stands of fire-intolerant plants, especially at lower elevations of the Park. Yosemite's forests also have become increasingly susceptible to catastrophic wildfire as both living and dead fuel loads continue to increase.

To restore fire as a natural process in Yosemite's forests it is necessary to have information about fire behavior in the various Park ecosystems. Fire behavior is dependent on weather, topography and fuels. Of these, data on fuels are the most difficult to obtain. Prescribed burning, natural fire management, and fire suppression programs all require both generalized and detailed information on the abundance, distribution, and characteristics of ground fuels within Park ecosystems.

Fuels information gathered prior to a burn aids fire behavior prediction; fuels data gathered before and after a burn reflects fire effects on fuel loads. The commonly used methods for estimating pre- and post-burn ground fuel loading include: (1) fuel sample collection for laboratory drying and weighing; (2) a planar intersect technique; and (3) photo series for estimating forest residues.

Each of these methods has specific applications for fire management planning. Fuel sample collection and analysis was found to be extremely time consuming and burdensome for most management purposes; it is now used primarily for fire research purposes. Brown's (1974) planar intersect technique derives fuel loadings from calculations using intercept tallies, average diameter measurements, correction factors and constants. However, as ground fuels become less uniform in size, shape, distribution and orientation, the length of intersect line required to estimate the average fuel loading on an area increases dramatically (Pickford and Hazard 1978).

Photo Method

An even quicker inventory method eliminates the need to tally fuel particle intercepts on tens of thousands of feet of intersect line. Photo series were developed to make fast, easy, and inexpensive estimates of residue which are adequate for most management needs (Maxwell and Ward 1980). The user is required only to match an observed fuel characteristic with a series of photographs that depict various cover types and stand ages at different fuel loading levels. The user obtains fuel loading values from the data sheet accompanying the selected photo (or interpolates a value between photos).

Knowledge of Sierra fuel characteristics is extremely limited. Research being conducted in Yosemite was designed to build upon and expand the fuel inventory techniques described above. Brown developed his technique for inventorying dead and down woody fuels using data from northern Rocky Mountain conifers. Work by Ryan and Pickford (1978) in the Blue Mountains of Oregon and Washington and by Sackett (1980) in the Southwest has revealed that use of Brown's Rocky Mountain data can result in significant differences in estimating fuel loadings when comparisons are made based on locally collected correction factors.

Measuring and collecting *ground fuels beneath a pure stand of old-growth white fir* (Abies concolor).

The first objective of the fuels research has been to quantify for the 22 Sierra conifers the factors required in Brown's fuel loading equations. Species specific data were collected on specific gravity, squared average-quadradic mean diameters, and the average secant of non-horizontal particle angles. These values will not only increase the reliability of fuel loading estimates but also will increase the accuracy of the photo series developed to quantify forest fuels in the Sierra in which only Brown's inventory technique was used to estimate fuel loadings within the photographed stands (Maxwell and Ward 1979, Blonski and Schramel 1981).

Duff Correlations

The second objective of the fuels research has been to develop correlations between duff depth and duff weight for forest floor fuels beneath each of the 22 conifers. Within Sierra forests the quantity of fuels within the duff layers frequently exceeds the quantity of dead and down woody fuels on the surface of the forest floor. Duff fuels are an important component of the forest fuels of the Sierra, yet Brown's inventory technique provides only for the averaging of three duff depth measurements with no calculations of duff weight or other characteristics. These correlations will permit the manager to make depth measure-

Collecting ground fuels *beneath a pure stand of old-growth red fir* (Abies magnifica)

ments and predict the loading of duff fuels.

The third objective of the fuels research is to use fuel characteristics information to develop a fuel model for each of the Park's forest types. Fire behavior prediction requires that fuels data be incorporated into fuel models. Computer based models of wildland fire behavior (Albini 1976) currently use 13 stylized fuel models to characterize a variety of vegetation types throughout the country. These models generalize the fuel characteristics of the vegetation being burned. In addition to fuel loadings by size class, the fuel models include values for surface-to-volume ratios, fuel density, heat of combustion, total mineral content, and silica-free ash content. These values are being collected. Use of the fuel models requires a great deal of professional or subjective judgement.

Fuel Models

There has been a strongly felt need among fire managers and researchers for a method to interface fuel inventory procedures in natural fuels with fire behavior prediction models. To meet this need Burgan and Rothermel (1979) at the Northern Forest Fire Laboratory in Missoula have developed an interactive, tutorial computer program that utilizes field fuel inventory information to develop site-specific fuel models. The fuel models are compatible with current fire behavior prediction models, such as the TI-59 Fire Behavior CROM (Burgan 1979). Fuels data from the Sierra will be used in the fuel model computer program to develop a site-specific fuel model for each of the Park's forest types. These models will improve the Yosemite fire management staff's ability to predict fire intensity and rate of spread within each of the Park's 15 forest types.

All of the field work and most of the laboratory work have been completed. The results from data analyses will be available in three to six months. The published results will appear in a year or a year-and-a-half.

Benedict is research biologist and van Wagtendonk is research scientist with the National Park Service at Yosemite NP.

Because of the usefulness to management of the listed publications, the entire* Literature Cited *is herewith reproduced.

Albini, F.A. 1976. Estimating wildfire behavior and effects. USDA Forest Service, Intermtn. For. & Rng. Exp. St., General Technical Report INT-30. 92 p.

Blonski, K.S. and J.S. Schramel. 1981. Photo series for quantifying natural forest residues: southern Cascades, northern Sierra Nevada. USDA Forest Service, Pacific Southwest For. & Rng. Exp. St., General Technical Report PSW-56. 145 p.

Brown, J.K. 1974. Handbook for inventorying downed woody material. USDA Forest Service, Intermtn. For. & Rng. Exp. St., General Technical Report INT-16. 24 p.

Burgan, R.E. 1979. Fire danger/fire behavior computations with the Texas Instruments TI-59 calculator: user's manual. USDA Forest Service, Intermtn. For. & Rng. Exp. St., General Technical Report INT-61. 25 p.

Burgan, R.E. and R.C. Rothermel. 1979. A method for developing site-specific fire behavior fuel models: study plan. USDA Forest Service, Intermtn. For. & Rng. Exp. St., Northern Forest Fire Laboratory, Missoula, MT. 17 p.

Maxwell, W.G., and F.R. Ward. 1979. Photo series for quantifying forest residues in: Sierra mixed-conifer type and Sierra true fir type. USDA Forest Service, Pacific Northwest For. & Rng. Exp. St., General Technical Report PNW-95. 79 p.

Maxwell, W.G. and F.R. Ward. 1980. Guidelines for developing or supplementing natural photo series. USDA Forest Service, Pacific Northwest For. & Rng. Exp. St., Research Note PNW-358. 16 p.

Pickford, S.G. and J.W. Hazard. 1978. Simulation studies on line intersect sampling of forest residue. Forest Science 24(4): 469-483.

Ryan, K.C., and S.G. Pickford. 1978. Physical properties of woody fuels in the Blue Mountains of Oregon and Washington. USDA Forest Service, Pacific Northwest For. & Rng. Exp. St., Research Note PNW-315. 9 p.

Sackett, S.S. 1980. Woody fuel particle size and specific gravity of Southwestern tree species. USDA Forest Service, Rocky Mtn. For. & Rng. Exp. St., Research Note RM-389. 4 p.

Callipers and protactor level *used to measure the diameters and non-horizontal angles of intersected dead and down woody fuel particles.*

Cutting a section *out of a log that was located within a 20 x 50 cm. sampling frame beneath a pure polestand of lodgepole pine* (Pinus contorta *var.* murrayana).

research notes

The 1981 Progress Report on **Ecology and Management of Mountain Goats in Olympic National Park,** the first of a series, will become available in mid-May from Olympic NP Supt. Roger Contor. The report, by John Aho, Doug Houston, Bruce Moorhead, Ed Schreiner, and Richard Starr, describes the 1981 goat management operation, including goat removal by helicopter from Klahhane Ridge. Another 52 animals will be taken off the Ridge again in 1982, beginning about the end of June.

Information Crossfile

The Fall 1982 issue of *Trends,* focusing on applied research in parks, will feature a detailed article by John Tanacredi, Natural Resource Management Specialist at Gateway NRA, on shoreline stabilization through marsh restoration. Tanacredi and co-author Bonnie Lou Gay describe the successful counter-attack mounted by the park against coastal erosion. The specific experiment described involved working "with nature" to protect the natural setting of shoreline areas at Plumb Beach – once an island of low-lying hassocks of marsh, now the site of one of Brooklyn's major highways – the Belt Parkway. Marsh restoration, to save the shoreline and the highway, involved "tire mattresses" and a dominant intertidal species known as *Spartina alterniflora.* This hardy marsh grass is an unsurpassed nutrient source, a natural breakwater, and an absorber of sewage effluent.

⁂

Pacific Northwest Regional Forest Service Newsletter, *Greensheet,* in its April 2 issue describes an elk trapping project that started last summer on the east slopes of the Cascades – to identify herd size and migration routes of the Roosevelt elk. A spike bull, a yearling cow and a 2-year-old cow were trapped, fitted with radio transmitting collars, and tracked throughout the year. In October they moved west, upslope to the Cascade Divide. Communications established with personnel on the Willamette and Umpqua National Forests enabled the Deschutes NF personnel (who initiated the study) to monitor the three elk through their meander onto the west slopes and onto their wintering ground in the Umpqua drainage. Ted Lewis, Crescent District Ranger, and Norm Behrens, Oregon State Department of Fish and Wildlife biologist, initiated the project.

⁂

"Long-Term Economic Rx: Research" is the title of the guest editorial in the March 26 issue of *Science.* Sen. John H. Glenn ascribes the United States position as "the dominant technological force in the world" to "research and development supported by both government and private sources." He reflects on the possible consequences of shrinking research support and concludes: "I urge the science community to help us get back on the right track."

⁂

"Desert Bighorn Zoogeography and Adaptation in Relation to Historic Land Use" is the title of an article by Henry E. McCutchen, NPS Rocky Mountain Region biologist, appearing in the Fall 1981 issue of the *Wildlife Society Bulletin* (Vol. 9:3). Over the past several years, some bighorn biologists have contended that desert bighorns are maladapted to their environment. This implies, according to McCutchen, that decreases in the population are due to natural forces. McCutchen analyzes this hypothesis and submits another; namely, that desert bighorns are well adapted to their environment but have become secondary relics due to man's impacts.

Reprints of the article are available from McCutchen at Rocky Mountain Region headquarters, Box 25287, Denver, CO 80225.

The March 1982 issue of *Synthesis,* the teaching, research and service newsletter of the College of Forestry, Wildlife and Range Sciences, University of Idaho, carries the news that Gary Machlis assumed co-editorship, with the spring issue, of the Association of Interpretive Naturalists *Journal of Interpretation.* The journal, published semiannually for some 1,800 subscribers, is an important communications

Volume 7 • Number 1 • 1982

JOURNAL OF INTERPRETATION

College of Forestry, Wildlife and Range Sciences
University of Idaho, Moscow, Idaho 83843

k among interpretive naturalists, addressing a broad variety of subjects related to communicating about the natural environment and cultural heritage. Commentary for the May issue was provided by NPS Director Russel Dickenson.

⁂

"Ecological Benefits of Large Organic Debris in Streams" is the title of an article by Sam Frear in *Forestry Research West,* February 1982. Frear lists the guidelines now being used by many FS foresters to help minimize the impacts of human activity on stream environments. Technical papers on which the article is built are available from the Publications Dept., Pacific Northwest Forest & Range Experiment Station, 809 N.E. Sixth Ave., Portland, OR 97232. They are "Large Organic Debris in Pacific Northwest Streams," (GTR-PNW-69) by Frederick J. Swanson and George W. Lienkaemper; "History, Physical Effects, and Management Implication of Large Organic Debris in Western Oregon Streams," (GTR-PNW-56) by Swanson, Lienkaemper and James R. Sedell, and "Ecological Characteristics of Old-Growth Douglas-fir Forests," (GTR-PNW-118) by Jerry F. Franklin et al.

The same issue of *Forestry Research West* also carries a piece by Marcia Wood of the Pacific Southwest Station on "Managing California's Young-growth Forests."

⁂

"Could a cotton plant be bred to exude a chemical that repels boll weevils? Could a rare Alpine plant's ability to produce a medicinal compound be transferred to a plant that flourishes in New Jersey soil?"

These questions and a dozen others, all with important economic and social consequences, were discussed in a *New York Times* story carried around the country on the NYT network in February 1982. At a time when native plants now listed as endangered species are being reviewed, botanists are pointing out that 25 percent of the drugs prescribed in this country contain compounds extracted from plants, and that these medicinal compounds were found in 50 species – which is one percent – of the 5,000 species so far investigated for the presence of useful drugs.

Dr. Norman R. Farnsworth of the University of Illinois College of Pharmacy in Chicago, told an audience at the recent annual meeting of the American Association for the Advancement of Science that one percent of the approximately 500,000 plant species of the world may have medicinal value. U.S. Fish and Wildlife Service botanists estimate that 3,000 plant species in the U.S. may disappear in the next few decades unless they receive government protection.

This massive loss of genetic material comes at precisely the moment when the new technology of gene transfer is making giant advances. "The implications of this new technology are tremendous, and the extinction of species now takes on a new meaning." Dr. Thomas Eisner, a Cornell University biologist, told a Senate committee hearing recently convened to consider reauthorization of the Endangered Species Act.

⁂

"A short, narrative history of the Roosevelt elk, covering the period from 1800 to the present and authored by Jim Harper, assistant chief of the Oregon State Department of Fish and Wildlife's Wildlife Division, appears in the April issue of *Oregon Wildlife.* Notes from the 1805 journal of Meriwether Lewis give short shrift to elk as table fare. Wrote Lewis: "I have become so perfectly reconciled to the dog that I think it an agreeable food and would prefer it vastly to lean venison or elk." The article traces the population ups and downs, and the various methods tried for transplantation of elk. With elk today providing sport for more than 30,000 hunters a year, Harper calls the history "a success story we can all appreciate."

⁂

The Wilderness Resource Distinguished Lecture delivered at the University of Idaho in 1981 by NPS Director Russell E. Dickenson is now available in a beautifully printed edition for 25 cents (to cover postage and handling) from the Editor, Forest, Wildlife and Range Experiment Station, University of Idaho, Moscow, ID 83843. "Wilderness Values in the National Parks" is the title of the Dickenson lecture. The handsome 14-page pamphlet is illustrated with both photograph and drawings.

⁂

Reprints of a paper given at the 46th North American Wildlife Conference in Portland, Oregon in March, "Old Growth Forests as Wildlife Habitat" by E. Charles Meslow, Chris Maser and Jared Verner, are available from the Pacific NW Forest & Range Experiment Station in Portland (809 N.E. Sixth Ave., 97332). The paper describes old growth forests, management problems and strategies, and suggested actions.

Biological Effects of Air Pollution: A Nationwide Perspective

By James P. Bennett

Many of our natural area national parks are experiencing elevated concentrations of air pollutants, including ozone (O_3), sulfur dioxide (SO_2), fluoride (F), toxic trace elements (lead, cadmium, etc.) and acidic precipitation. The effect of these pollutants on the biological resources of our parks has become a matter of widespread concern.

The Air Quality Division of the Office of Science and Technology recently has begun a program to address these concerns: the Air Quality Related Values Effects Research and Biomonitoring Program. It is called this because the legislative authority for the program, the Clean Air Act as amended in 1977, defined air pollution sensitive resources as Air Quality Related Values (AQRVs).

The National Park Service has a mandate under the Act to protect AQRVs from adverse impacts of air pollutants from sources located or planning to locate outside of the national parks. Most of the emphasis of the program is on biological resources, although some considerations for cultural resources are being made. Acid precipitation effects studies have been assigned to the Water Resources Division for programmatic reasons, primarily because aquatic resources are more sensitive than terrestrial resources.

The effects research and biomonitoring needs of the Service have been determined to establish a structure for projects by asking five essential questions:

1. What is sensitive to air pollution?
2. What are their responses and how much do they respond?
3. How does this affect the entire park ecosystem?
4. How much could the park ecosystem change?
5. What is the significance of the change?

These questions provide the backbone for the AQRV Plan, which contains studies in 5 sections corresponding to the questions:

Sections and Generic Studies:

1. Sensitive Receptor Identification
   - -Screening studies
   - -Biomonitoring plans
   - -Effects literature review
   - -Ecosystem analysis
2. Sensitive Receptor Quantification
   - -Dose/response studies
   - -Spatial analyses
3. Ecosystem Integration
   - -Primary & secondary productivity
   - -Food web dynamics
   - -Population growth rates
4. Ecosystem Prediction
   - -Temporal
   - -Spatial
   - -Reversibility
5. Value Judgements
   - -Probability & risk analyses
   - -Adverse impact determinations

Various factors contribute to determining the biological impacts of an air pollutant, including the toxicity of the pollutant; the importance of the receptor in the ecosystem; the type of effect, whether acute or chronic; the scale of the effect, from the individual up to the whole ecosystem; the exposure of the individual; the potential for synergisms with other pollutants; and the persistence of the pollutants in the environment. These factors combined with the AQRV Plan and the knowledge of current air quality conditions in the parks led to the establishment of a program to fund projects addressing the data needs of the parks. A set of criteria was developed to rank projects (these criteria are not in any order):

1. Is the resource threatened now by air pollution?
2. Is the resource threatened in the future by many sources, or only one?
3. Are additional funds available from other interested parties?
4. What is the value of the product?
5. Is air quality monitoring equipment already present?
6. Legal mandate, e.g. required for a permit review?
7. What management decisions will the data benefit?

Most of the projects involve work on vegetation rather than wildlife because a great deal of work on plant effects has been done and a good body of literature already exists. Most of it, however, is on agricultural crop species and forest trees and very little on native vegetation. For this reason, many projects will focus on field studies of observable air pollution effects on either dominant species, bioindicator species, or endangered and threatened species in parks that have existing air pollution. In parks without existing air pollution, studies will focus on experimental plant fumigations with controlled levels of pollutants.

Titles and brief descriptions of projects under way are given below for illustration:

Geographic Extent of Air Pollution Injury in Shenandoah National Park – A survey of the conditions of bioindicator species at predetermined locations throughout the park.

Sensitivities of Rare & Endangered Species in Shenandoah National Park – Species will be grown in the greenhouse and exposed to pollutants in fumigation chambers to determine injury symptoms, then checked in the field for the symptoms. A protocol has been established to prevent further endangering the status of the species.

Biomonitoring Plan for Colorado National Monument – Development of methods to survey bioindicator species throughout the park in anticipation of future air pollution. Collection of baseline biological data.

Wildlife AQRVs at Congaree Swamp National Monument – Identification of wildlife species potentially susceptible to air pollutants and predictions of probable effects in anticipation of air pollution.

Sensitivity of Tulip Poplar to Oxidants in Shenandoah National Park – Screening of tulip poplar populations for genetic sensitivity differences using air pollutant exclosure chambers in the park.

Elevated Lead Concentrations in Gt. Smoky Mountains National Park – Detailed examination of lead burdens in 4 tree species and source of lead in leaf litter.

Fluoride Baseline Concentrations in Gt. Smoky Mountains National Park – Detailed examination of F in foliage and soil of selected species downwind of a F source.

FORAST Plots in Shenandoah, Great Smoky Mountains, and Acadia National Parks – Adds 3 parks to a regional project run by Oak Ridge National Lab, looking at regional effects of air pollutants on forest growth using tree ring analysis.

Lichen Studies – A long-term contract with Dr. Clifford Wetmore, University of Minnesota to do air pollution lichen studies at many parks, including Voyageurs, Theodore Roosevelt, Grand Canyon, Acadia, Chiricahua, and others. Lichens are sensitive bioindicators of SO_2 pollution. A symposium on air pollution and lichens is also being planned for a 1983 national society meeting.

Projects being developed include:

Air Pollution Sensitivities of Epiphytes in Everglades National Park

Trace Elements in Bryophytes of Isle Royale National Park

Bioindicator Survey at Saguaro National Monument

Field Assessments of AQRVs at Selected Parks

In addition, several projects of a service-wide nature are being conducted and developed:

Ranking of Park Service Class I Areas – A project using the Oak Ridge Geoecology Database to rank class I parks for potential sensitivities to air pollutants. Sensitivity indices and existing air quality data will be combined into a single index for each of the 48 class I parks. Class I parks were identified in the Clean Air Act as those requiring the most stringent level of protection from air pollutants.

Survey of Adverse Impact Definitions – An evaluation of the state of the art regarding the question of what constitutes significant impairment to an ecosystem, including a survey of definitions and methods of measurement and recommendations for use by the NPS.

Computerized Flora of the Class I Parks – A contract with the Denver Service Center to computerize the existing floras and checklists of the class I parks. A hierarchical database management package (System 2000) will be used to match the taxonomic nomenlature in current use. Entries will be checked for synonomy and scored for native versus exotic status.

Finally, the Air Quality Division is considering the development of an air pollution fumigation facility to enable the Park Service to determine the sensitivities of native plants in various park units to specific air pollutants. Various fumigation techniques are currently under review so that the Service can have the best methods available for use. Different location options for the facility are being considered. The facility is intended only for preliminary screening to determine the relative sensitivities of susceptible plant species in park units with significant air pollution problems.

Planning for FY 1983 is underway and for project information contact Dr. Bennett, program manager, at FTS 234-6620, NPS Air Quality Division, Box 25287, Denver, CO 80225.

One Piece of the Research Action: Theodore Roosevelt NP

By Ray "Skip" Snow

As early as 1859, the declining lichen flora of South Lancashire (Britain) was attributed to increasing air pollution and, in 1866, it was concluded from studies in Paris that lichens might serve as practical indicators of air quality. Since then, studies in over 400 scientific publications and from areas in Europe, Japan, New Zealand, North and South America and the U.S.S.R. have supported this view.

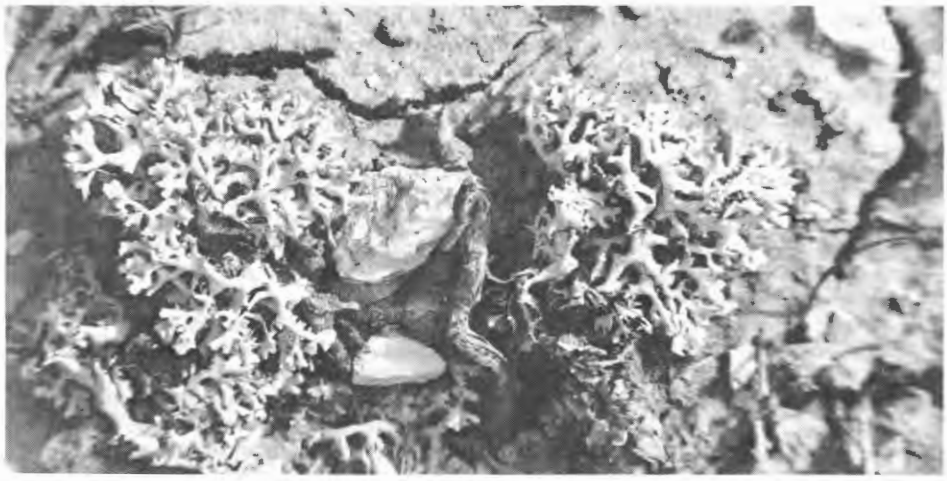
As a result of increasing energy development, the air quality of many of our national parks is threatened with deterioration. Surrounded by oil and gas fields, adjacent to proposed federal coal leases and proposed gasification plants, Theodore Roosevelt National Park (North Dakota) is no exception. Many fruticose (hair-like, shrubby or finger-like) and some foliose (leaty and flattened) lichens are killed by low levels of sulfur dioxide, and so the disappearance of sensitive lichen species in an area can indicate deteriorating air quality. For national parks not to proceed with the orderly acquisition of baseline data on lichens is much the same as not installing a battery in your smoke alarm.

Lichens are composed of two quite different organisms, a fungus and an alga, in a symbiotic (living-together) relationship. Lichens are an outstandingly successful group of symbiotic organisms; perhaps more than 18,000 species exploit habitats throughout the world. An enigmatic group of plants in many ways, lichens often receive only scant attention in national parks.

While lichens are one of the easiest groups of plants to collect and preserve and most lichens are no more difficult to identify than the majority of flowering plants, many genera are poorly known with highly variable and confusing species requiring the assistance of specialists to identify them. *Usnea* (the "goat's beard" lichens) and *Cladonia* ("British soldiers," for example) are two commonly collected genera with many "hybrids." The serious naturalist or resource manager can often obtain assistance in identification or verification from lichenologists at universities or museums. Professional etiquette demands that only good, well labeled specimens be sent.

For the park library, few reference works exist for lichen collection and identification. The best on the market at this time is the second edition (1979) of *How To Know the Lichens* by Mason E. Hale of the Smithsonian Institution. This is a Pictured Key Nature Series book published by Wm. C. Brown Company. Price $5.95. Out of date and out of print, B. Fink's (1935) *The Lichen Flora of the United States* (University of Michigan Press) is the only overall reference for the crustose (crust-like) genera. The second edition (1974) of *The Biology of Lichens*, authored by Mason E. Hale, Jr., provides one of the few concise and contemporary surveys of lichenology. A well illustrated paperback, this college-level text is published by Edward Arnold (Publishers) Ltd., 25 Hill Street, London WIX 8LL, England. Price $11.95.

Another reference is the Institute of Biology's Studies in Biology no. 66, *Lichens as Pollution Monitors* (1976) by David L. Hawksworth and Francis Rose. This small (60pp.) and practical work assumes no previous knowledge and includes an account of the biology of lichens as well as a discussion of their relationship to environmental pollution and their value in monitoring it. The work describes a series of simple experiments and suggested air pollution survey methodologies – including investigations appropriate for schoolchildren. It is clear from this book that the survey of lichen flora is appropriate for rural, urban, natural, and cultural units of the National Park System. The book is available from University Park Press, 233 East Redwood Street, Baltimore, Maryland 21202, for $7.95. A more advanced treatment of the subject can be found in the college-level text edited by B.W. Ferry, M.S. Baddeley and D.L. Hawksworth (1973). Entitled *Air Pollution and Lichens*, this book is published by Athlone Press of the University of London.



Lichen xanthoparmelia *is shown here, growing on the ground at Theodore Roosevelt NP.*

The Bryologist, the official journal of the American Bryological and Lichenological Society, is responsible for publishing much of the research on North American lichens. It is published by the Missouri Botanical Garden, P.O. Box 299, St. Louis, Missouri 63166. *The Lichenologist,* the official journal of the British Lichen Society, routinely summarizes the current literature on air pollution and lichens. It is published by Academic Press Inc. (London) Ltd., 24-28 Oval Road, London NW1 7DX, England. Articles from both journals, as well as the books mentioned above, are available through interlibrary loan services.

The assessment of a national park's lichen flora is responsive to more than one of the conclusions reached by the recent U.S. National Parks' servicewide survey entitled "State of the Parks – 1980: A Report to Congress." Specifically, the collection and identification of lichens addresses the report's conclusive remark, to "establish accurate baseline data on park resources and conduct comprehensive monitoring programs designated to detect and measure changes . . ." By studying the lichens of an area, baseline lists can be prepared for use later in comparing the lichen flora over a period of time.

Personnel at Theodore Roosevelt NP have negotiated a proposal with lichenologist Clifford M. Wetmore of the University of Minnesota, whose publications include articles on the lichens of Big Bend and Voyageurs National Parks (see *The Bryologist* (1981) 84(3), in press and 84(4) in press, respectively).

Dr. Wetmore will provide Theodore Roosevelt NP with (1) a set of identified and labeled specimens for the park herbarium, (2) a list of localities where collections were made, (3) a list of species found within the park indicating localities where each was found, (4) a list of lichens that might be useful in monitoring air quality changes, (5) suggestions concerning critical areas for lichens in the park, and (6) suggestions for future research. He will also provide willing park personnel with training in collection and identification of common lichens, as well as their interpretation.

The work will take approximately 18 months and cost $2000. Funding for transportation, supplies, and materials has been made available from a research fund established and administered by the Theodore Roosevelt Nature and History Association. The Association is a non-profit organization, established to serve the interpretive, educational, scientific, and research programs of the park. Membership in the Association is open to the public.

While Theodore Roosevelt NP continues to be involved in the recording of instrument readings for air chemistry, visibility, and atmospheric deposition, these can only determine whether or not air quality meets legislated standards. Lichens can provide a more direct biological test. Many lichens are far more intolerant of pollutants than are higher plants, animals, and people. Thus, careful surveys of lichens in national parks can be an important adjunct of air pollution monitoring – a kind of early warning system like miners' canaries and smoke alarms.

The staff at Theodore Roosevelt National Park is interested in hearing from other parks which are conducting or proposing similar investigations.

Snow is district naturalist at the North Unit of Theodore Roosevelt NP.

Three Strikes but NOT OUT—An Endangered Species Continues to Hang on in Big Bend

By Gerard A. Hoddenbach

One of the more precariously balanced endangered species in existence, a small top-water minnow *(Gambusia gaigei)*, still exists in West Texas' Big Bend National Park. This species, already three times previously reduced to a mere handful of individuals, is now receiving special management attention to provide for its survival in a natural environment.

Frederick M. Gaige, the noted University of Michigan biologist who first described numerous vertebrate species from the West-Texas area, collected a sample of a then-unknown fish in August 1928, from "... a marshy cattail slough fed by springs located close to the Rio Grande River at Boquillas, Brewster County, Texas ..." The next year, Dr. Carl Hubbs identified, described, and named those specimens in honor of Dr. Gaige as a new fish species, differing in a number of ways from its closely related parental stock *(Gambusia senilis)*.

Twenty-six years passed before *Gambusia gaigei* would be collected again. Then, in 1954, it was again collected – this time from the same general locality as Gaige's original collection, but more specifically from Graham Ranch Warm Springs, a pond 20 feet wide, 40 feet long, 4 feet deep, but now obliterated by a modern campground development. Considerable confusion still exists regarding the exact spring from which Gaige collected the 1928 sample of Big Bend Gambusia, but even more confusion surrounds the question of how widely distributed the species originally was. Over the years, former natural springs and topographic features have been severely altered by floods on the Rio Grande and by human developments. However, it is crystal clear that today's entire, naturally surviving world population of *gaigei* exists only in a single, artificial warm-water pond ... and, that pond requires a continually running electric pump to maintain water flow and temperature regimes.

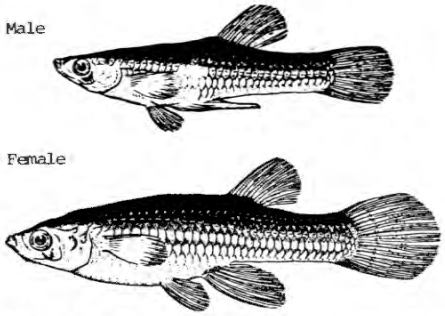
In 1956, the discovery of *Gambusia affinis*, catfish and perch in the Graham Ranch pond created the first clear potential for extinction of Big Bend Gambusia. *Gambusia affinis*, a common top-water minnow of the Southern states, and at least partially inter-specifically fertile with *gaigei*, potentially altering genetic makeup, is a species which outcompetes *gaigei* in calm water. Catfish and perch are both carnivorous predators. The already tenuous survival of *gaigei* in the pond was threatened. This clearly required the pond be seined to save as many individual Big Bend Gambusia as possible. The waters were then treated with rotenone (a fish poison) in what would eventually prove to be a futile effort to eradicate all remaining *affinis*. Only 25 *gaigei* were saved; 15 were placed in three nearby natural springs but, presumably, died within a short time; six others of the original group were stocked in an artificial pond near Panther Junction but two of the six died immediately and the other four and their progeny died during severely cold winter weather conditions in 1957; the last four of the original group of 25 were transported to laboratories of the University of Texas at Austin where they were maintained in an aquarium. The death of one of those aquarium housed fish reduced the total world population of *gaigei* to one female and two males. A severe crisis, indeed!

The three individuals surviving the winter in Austin were returned to Big Bend during the spring of 1958, and placed in a pool specifically constructed for them. That single female and her young were quite prolific and, for a time, *gaigei* flourished and all seemed well. However, the *gaigei* pool became contaminated again by water overflowing from the nearby campground. Once again, *affinis* and carnivorous green sunfish were found in the *gaigei* pond and for a second time, only 15 *gaigei* were saved and transported to Austin, Texas. Two of that group died en route but 40 young soon born into the group increased the species' population number to 53. As additional insurance against catastrophe, 16 *gaigei* were flown to the University of Michigan and housed in laboratory aquaria.

The present artificial refugium pond in Big Bend, constructed in 1960, was filled with water from a nearby spring which historically had provided original *gaigei* habitat. Twenty of the 37 fish from the Austin laboratory population were transported to Big Bend in August 1960, and released into the new pond. When specialists determined a viable population existed in Big Bend, Michigan stocks were discontinued and the remaining 17 fish at Austin were moved to the Brackenridge Field Laboratory where they were continuously cultured for the next 15 years.

Again, in 1968, green sunfish were found in the refugium at Big Bend – probably placed there by well-meaning sport fishermen. Once the sunfish were removed, the *gaigei* population again temporarily flourished until another cold snap, in 1975-76, killed nearly all the fish in the Big Bend pond. The 17 remaining fish at Austin were sent to Big Bend to restock the pond, and, simultaneously, alterations were made to the pond to moderate the effect of winter temperatures and to combat the ever present problems of evaporation and falling water level. An electric pump was installed on another nearby (but lower elevation) warm spring to maintain a small but continuous flow of water to the *gaigei* refugium pond. Additionally, the logistical problems which, at Austin, had long existed in culturing *gaigei* were resolved by moving the reserve and backup *gaigei* population to the National Fish Hatchery in Dexter, New Mexico.

The trip starts here *at Big Bend National Park, where Buddy Jensen of the U.S. Fish and Wildlife Service collects* Gambusia gaigei *for transport to the Dexter, New Mexico Fish Hatchery.*



Seldom longer *than 50mm, the small Gambusia is shown here about 1½ life size. The pictured fish is actually* Gambusia affinis, *the common southern U.S. form. The* gaigei *is separable from* affinis *only in the depth of the portion of body immediately in front of the tail. In the* gaigei, *that portion is larger than in the pictured* affinis.

The entire world population of *Gambusia gaigei*, already three times reduced to but a few surviving individuals, still comfortably lives in both Big Bend and Dexter refugia. Over the years, aquatic and climatic events have taken their tolls. Although complete restoration of the Dexter population has had to take place three times, it seems unlikely now that weather conditions will ever simultaneously be so bad at both locations that all existing *gaigei* perish. Still, an urgent need exists to establish *gaigei* in a naturally maintained habitat and as safe as possible from either man-induced or natural catastrophe.

Dr. Clark Hubbs of the University of Texas Department of Zoology, the U.S. Fish and Wildlife Service Office of Endangered Species, and the Southwest Regional Office of the National Park Service collaborated in 1977 to write the Habitat Management Plan for Big Bend Gambusia. Included within that plan are specific recommendations to:

– Remove the well house over the spring which furnishes water to the present refugium and restore conditions permitting a spring flow into a new channel.

– Establish *gaigei* in that channel from the present refugium pond.

– Once the stream population has been determined to be successful, eliminate the run-off channel so *gaigei* will be permitted to naturally occupy a spring-fed stream habitat.

Present problems regarding implementation of this plan involve tracing the spring aquifer to a higher elevation stratum, and then drilling a well to permit natural spring out-flow to run downhill from the well site. Studies, now in the initial stages, to do those things are pending. Upon their completion, *Gambusia gaigei* will once again exist in a natural and running water environment rather than as a caged zoo animal. Having already closely escaped total extinction three times, perhaps, at last, *gaigei* will be restored its own and unique place in our modern world.

Gerard Hoddenbach is the Regional Biologist and Endangered Species Coordinator for the Southwest Regional Office, P.O. Box 728, Santa Fe, New Mexico 87501.

Southeast Region Training Institute for Resource Management Held at Clemson University

By Brian J. Mihalik

The need for continued professional training has always been known within the National Park Service. The Mather and Albright Training Centers were established for such a purpose. However, with training facilities at only two locations within the National Park System, it is difficult to provide training opportunities for everyone needing further education. To help continue in-service training in view of these restrictions, NPS representatives in the Southeast Regional Office turned to the university sector with its established educational history for some of its training needs.

G. Jay Gogue, Southeast Regional Chief Scientist, and Steve Smith, Southeast Regional Resource Management Specialist, met with Bert Brantley, Associate Dean, and myself, from the Clemson University Department of Recreation and Park Administration. Our task was to plan a useful resource management training course for Southeast Regional park rangers and technicians. Planning information was first generated from a questionnaire mailed to all 53 park units in the Southeast Region. In this survey, park superintendents were asked to indicate their preferences for a workshop – the time of year it should be held, the desired grade and series of the workshop participants, and the topics in which more training was needed.

From this information, plans were made and a week-long training institute was held at the Clemson University Outdoor Recreation Research Laboratory on Sept. 28-Oct. 1, 1981; 31 NPS rangers and technicians participated. The course utilized a unique format of concurrent educational sessions headed by representatives from NPS, the U.S. Forest Service, and the U.S. Fish and Wildlife Service, and university faculty from Virginia Polytechnic Institute, Syracuse, Louisiana State, Tennessee, and Clemson Universities. These instructors spiced their lectures with "hands-on" field exercises dealing with resource manangement issues.

The sessions included the human side of resource management, addressed by Southeast Regional Director Robert Baker; mandates, policies, programs, commitments, barriers, approaches, and case studies dealing with integrated pest management, presented by George Gardner and William and Olga Olkowski of the John Muir Institute for Environmental Studies; and critical aquatic problems in the southeast national parks, composition of aquatic communities and energy flow, and monitoring contaminant problems in aquatic habitats and tidewater ecosystems, given by several aquatic specialists.

Wildlife management topics also were covered and included the development of a management plan, census techniques, sex and age determination, habitat survey, and deer and endangered species manangement. NPS speakers Dave Butts and Scott Erickson of the Boise Interagency Fire Center conducted fire management sessions on the physical components of fire and NPS fire policy guidelines and planning. They concluded their sessions by asking students to develop a practical fire management plan for Cumberland Island. Other concurrent sessions dealt with vegetation management – front and back country considerations, design implications, monitoring of vegetation use, the decision making process in vegetation management and human impacts on stream bank vegetation.

The training institute concluded with sessions on water quality monitoring and mapping. Don Cherry of Virginia Tech gave an overview of water quality monitoring and spoke on specific water quality monitoring approaches. Bill Shain of Clemson University addressed remote sensing in resource mapping, using the third dimension of aerial photography in planning and developing various resource maps.

Other than the concurrent educational sessions which required pre-registration, all participants were brought together twice a day to hear one-hour presentations from a variety of speakers. These presentations included threats to the parks, basic ecological principles, environmental laws, the NPS budget process, evolution of science in the Park Service, the relationship between science and resource management, research methods and the need for cooperation with other agencies.

Throughout the institute, participants were able to spend more time listening than taking notes due to the prior preparation of two reference notebooks which included handouts related to the courses. These two notebooks provided excellent references containing hundreds of pages of resource manangement information on all subjects covered.

After the course, a review of participant evaluations indicated that the training institute: (1) was one of the best programs each participant received, (2) will prove beneficial in the future job performance of each participant, and (3) warranted continuation. Because of the success of this institute, a second training program is planned for May 17-21, 1982.

Mihalik is Coordinator of Extension at Clemson University, Clemson, SC.

GWS Conference Slated

The George Wright Society will hold a national conference in Washington, D.C., October 18-20, according to Al Greene, conference chairman. Invited papers will be presented, within the framework of the title: "Strategy Conference on the Protection of Cultural and Natural Resources: Research and Education Agenda for North America." Details of the conference will be carried in the George Wright Society FORUM and in the Summer issue of *Park Science.*

Water Resources Lab Completes First Year

The NPS Water Resources Field Support Laboratory at Fort Collins, Colorado, is winding up its first year of operation as a provider of a multi-disciplined support function to WASO, the Regions, and parks. Lab Director Ray Herrmann reports that he and his staff have been involved in hydrological, geological, and ecological water resource investigations and cooperative support activities in more than 20 parks in 9 NPS Regions.

In an anniversary reminder to the entire Service, Herrmann described active Laboratory programs to assist with better park resource protection efforts. (See box)

Jay Bassin, Chief, Water Resources Division, WASO, pointed out that the Lab was established "because of our recognition of a need to efficiently provide professional water resource staff capability to parks and Regions in a number of national focus areas where NPS lacks needed resource management data."

Bassin described the Lab staff as able to respond quickly to a varied set of issues and added, "I encourage park management to employ the Lab's services."

Herrmann is available to provide information, answer questions, and receive comments, at the NPS Water Resources Field Support Lab, 107C Natural Resources, Colorado State University, Fort Collins, CO 80523. (303) 491-7573.

The Water Resources Field Support Lab can help Regions and parks in the following ways:

(1) collection and analysis of baseline data for maintaining, enhancing, or restoring water quantity and quality;

(2) understanding the hydrological processes affecting evaluations of potential impacts in Park System areas;

(3) investigating trends in acidification of streams and lakes;

(4) investigating the ecological resources of park riparian habitats that may be changing due to water resource developments external to the parks; and

(5) providing assistance to specific areas in developing water resource management plans and/or monitoring programs.

regional highlights

Pacific Northwest Region

Two "candidate areas" for the status of Research Natural Areas within the Pacific Northwest Region were proposed in the latest listing of such areas in National Park, Forest Service, and Bureau of Land Management lands in Oregon and Washington. The two candidate areas are Ridley Lake in the North Cascades NP, Washington, and a 250 acre area near the Cant ranch at John Day Fossil Beds NM, Oregon. Sarah Greene, research natural area scientist for the Pacific Northwest Region RNA Committee, in a March 10 memo to all members of the RNA Committee, explained the relationships between the Federal RNAs and the Oregon/Washington Heritage Programs. Anyone seeking clarification of this sometimes confusing topic may obtain the memo from Ms. Greene at the Forestry Sciences Lab, 3200 Jefferson Way, Corvallis, OR 97331.

⁂

The annual Science Report for CY 1981 in the Pacific Northwest Region went to press early in April. Copies will be available from Pacific Northwest Regional headquarters. The 1981 Annual Report from the University of Idaho CPSU was published in March as CPSU/UI SB 82-1.

⁂

Jim Rouse's 1981 Annual Report for Crater Lake describes a test rehabilitation plot established along the Annie Springs entrance road. Two road scars, thinned of small lodgepole pine by approximately 65 percent, were managed in such a way that (through lodgepole manipulation and blending) the area was made to appear as one natural reproduction site. Aesthetically pleasing, with a natural appearance, the manipulation provides the remaining trees with more space for accelerated growth.

⁂

In a step designed to save money and better coordinate entomology research with the work of the National Forest System and other agencies, the Pacific Northwest Forest and Range Experiment Station moved its research unit on population ecology and integrated pest management strategies for Western Forest defoliators from Corvallis to La Grande, OR. The move, effective May 1, 1982, emphasizes the integrated approach to control of four primary insect pests: the Douglas-fir tussock moth, the mountain pine beetle, the western spruce budworm, and the larch casebearer. The integrated approach to pest management seeks to provide forest managers with information on the impact of forest pests and suggest

Spotlight On A Region

Science in the North Atlantic Region

The science program was established with the inception of the North Atlantic Region in 1974 as the Office of Scientific Studies. From a one-man operation (P.A. Buckley) it has grown to include a deputy chief (and limnologist, Michael Soukup), an air quality specialist (Mary K. Foley), research biologist (John Portnoy), a coastal geomorphologist (James R. Allen), a water resources specialist (Nora Mitchell), an environmental protection assistant (Barbara Dorn), and a computer trainee (Elba Rivera). It now includes a growing water resources program as well.

Although we have several cooperative agreements with local universities, we have no NARO scientific staff stationed at CRUs; except for John Portnoy, (duty-stationed at Cape Cod NS) there are no scientists stationed at NAR parks. Consequently, we serve our parks directly from the regional office. To keep in close touch with our parks, as well as to maintain credibility with our academic colleagues, NARO scientists maintain small but active research programs in NARO parks. They also are active in their own professional scientific organizations, and publish in their disciplines' primary scientific literature on a regular basis. Since 1974 many areas of management concern have been addressed by the Office of Scientific Studies.

Our most extensive series of studies has been associated with evaluation of off-road vehicle (ORV) impacts in the Coastal ecosystem. Culminating in a 13-volume treatise with a management overview (by Drs. Paul Godfrey and Steve Leatherman, UMass/NPS/CRU), the results quantify the effect of various levels of ORV traffic in such habitats as the *Ammophila* (beach grass)/dune system, the salt marsh intertidal mudflat/sand flat, etc. These results were the foundation for the recently adopted regulations excluding ORVs from among areas previously open within Cape Cod National Seashore. Monitoring of ecologic recovery following ORV trail closure is now underway.

Colonial Waterbird Management, the specialty of Dr. Buckley, has been an area of active research along the Northeast coastline. Many of the results have been incorporated into the *Guidelines for the Protection and Management of Colonially Nesting Waterbirds* (by P.A. and Francine Buckley) which has been adopted as USFWS policy and is in its 4th printing. This work has filled a surprisingly wide need and stimulated worldwide reprint requests. Detailed annual helicopter censuses of colonial waterbirds populations at Gateway NRA and Fire Island NS, when integrated with similar data for the entirety of Long Island, have resulted in active management programs at both parks relating to these animals. Basic information on their biology, especially on colony site utilization patterns (including development of a new statistic for site-use trends also has resulted from the Buckleys' work. It was this research that pinpointed the danger confronting North American roseate terns; their regression models predict extirpation by about the year 2000, given present conditions.

Water-related problems within the region generally are approached from a classic limnological perspective. Characterization by locals of the kettle ponds of Cape Code NS as public health hazardes has been disproven by the UMass CRU and by our limnologist Dr. Soukup.

One major project nearing completion is a mathematical model of groundwater/lake interactions combined with phosphorus and nitrogen budgets for Gull Pond; the biogeochemical impact of use of this seepage kettle by large populations of gull species also is being quantified. Soukup has furnished the research basis for the Service's first Water Resource Management Plan with full environmental compliance documentation and public involvement. "The Analysis of Water Resource Management Alternatives – for Cape Cod NS," with our water resource specialist, Nora Mitchell, as senior author, is now undergoing public review. It addresses critical problems such as water supply deficits in abutting towns, pond eutrophication, and mosquito control impacts. Other regional problems such as avian botulism (at Gateway NRA), benthos population surveys at Jamaica Bay, landfill impacts at several parks, deer impacts at Acadia NP, impacts from municipal wells and mosquito ditching also are under study, and additional Water Resource management plans now are in progress.

Dr. Allen, our new (and NPS's only) coastal geomorphologist was active in NAR coastal research during his previous tenure in academia. He was involved in the intensive coastal geomorphic study of Sandy Hook (Gateway NRA) by the Rutgers CRU that has generated more than 20 professional articles. He developed an analytical computer model of spit dynamics that has evolved into a predictive tool for use in management strategy evaluation. Such an evaluation was needed to cope with the critical beach erosion at the end of a seawall which terminates just inside the park boundary. The model predicts that Sandy Hook will become an island if a remedy is not forthcoming soon. Congress, fearing another "Cape Hatteras" situation, has not yet made appropriations to deal with the problem. Jim continues to monitor the dynamics of the beaches at Sandy Hook and is expanding this program to include both short- and long-term changes at all of the recreational beaches in the region, especially where structures are involved.

Currently, our office is involved in the Interagency team (along with US Army Corps of Engineer, US Fish and Wildlife Service, National Marine Fisheries, and EPA) effort "Reformulation Study of Beach Erosion Control and Hurricane Protection on the South Shore of Long Island" (wherein Fire Island NS comprises a major component in the barrier system). Jim is a project officer on the research contracts for metric mapping, aeolian sediment budget, and geologic analysis, all funded by the Corps of Engineers. This scientific study represents a major effort to conclusively evaluate a barrier system in its totality with regard to coastal management and was promulgated by our conflict (and CEQ referral) with the original U.S. Army Corps of Engineer plan for the area.

Air quality has been, not unexpectedly, an issue here in the northeast, especially at Acadia NP – the Region's only Class I area. Proposals for new major emitting facilities and the numerous coal conversions require modeling critiques and constant vigilance to determine possible resource impacts. An extensive climatological investigation of air pollution episodes is being conducted by Mary K. Foley (the Service's first

strategies and tactics to prevent populations from increasing to levels that threaten management goals. These strategies are based on understanding of forest ecosystems and the role of parasites, predators, and climate in controlling the pests naturally.

*
**

A Regional Resource Center, manned by a professional librarian with experience in setting up and operating library facilities is now in place in the Pacific Northwest Regional headquarters, Seattle. Ellen Traxel, librarian, is setting up the Center and will be in charge of film lending, an archival slide and black and white photo file, and the library of science reports and general background material from the individual divisions and branches. The former HCRS people who have joined the PNR have brought with them technical assistance resources that will be added to the Center's store of materials.

Eventually, computer connections with libraries all over the country are planned. Meanwhile, Ellen is available to advise small libraries in the field. Most recently she was engaged in library work for the U.S. Corps of Engineers in the Puget Sound area.

Regional air quality specialist) at Acadia. Fire history research, including paleoclimatological studies at Cape Cod National Seashore and Acadia NP will aid the preparation of the first Fire Management Plans in the North Atlantic Region.

As a means of accommodating regional research projects, the Atlantic Coastal Laboratory (ACL) was carved out of several abandoned Cape Cod buildings, with the help and support of the UMass researchers and the Cape Cod National Seashore staff. Championed by Paul Godfrey, a WAE research biologist attached to Washington, the old MITRE corporation buildings have become a functional support entity within the regional science program. This year it also has become a NADP acid rain monitoring site. One of the heaviest users of the laboratory (along with researchers from UMass, Williams College, Tufts, Yale, Boston University) has been our Cultural Resources Division for their massive and pioneering, scientific approach to archeological surveying at Cape Cod.

Utilizing Denver Service Center's Remote Sensing Team, we are providing up-to-date vegetation mapping as the basis for the fire management plans at Acadia, Cape Cod and Minute Man National Historical Park, as well as other resource management work. One current example of the latter is an investigation by Buckley, Soukup, and Portnoy of 20 years of change in vegetation at Cape Cod, capitalizing on an earlier vegetation map produced during the inception of the Seashore. The Denver Service Center Team's computerized mapping capabilities are being used to determine successional rates for selected populations as well as to sort out induced acceleration in those rates associated with the practice of mosquito ditching.

Routine participation by the Office of Scientific Studies in such varied projects as the Plan for a Pine Barrens Natural Reserve and the Fire Island Master Plan, and environmental documents continues and ensures management the benefit of scientific input to its planning and management strategems.

We will expand on some of these projects in later issues but in the meantime we welcome any questions, discussions, and opportunities for coordination on the above projects in any areas of mutual interest across the Service.

This report was submitted by Mike Soukup. Park Science *welcomes such regionwide science roundups.*

Alaska Region

Al Lovaas, Alaska Regional Chief Scientist, reports that he and two other new employees, Gary Ahlstrand, fire ecologist, and Francis Singer, wildlife biologist, have made it through their first winter in Alaska and are no longer "Cheechakos." Their first field season was spent assessing fire management research needs, particularly with regard to fire behavior, effects and history establishing plots in 1981 burns in Gates of the Arctic, Kobuk Valley, Denali, Wrangell-St. Elias, and Yukon-Charley Rivers; aerial Dall sheep and mountain goat classification and census in Denali, Wrangell-St. Elias, Lake Clark, and Kenai Fjords, and studies of caribou calving on the Dunkle Hills mining area of Denali NP. Contract researchers with COR Ross Kavanagh, completed the first year of intensified work on the effects of motorized watercraft on endangered humpback whales in Glacier Bay.

*
**

On December 31, 1981, Will Troyer retired after seven years' work with the National Park Service in Alaska and 28 years of Federal Service there. Will is a flying wildlife biologist, who devoted most of his National Park Service time to aerial moose surveys in Katmai and Denali, brown bear dennings and movement studies in Katmai, bald eagle nesting surveys, and caribou movements and productivity studies in Denali. Troyer's experience and familiarity with much of the state, his easy going personality and ability to get along with people, his pilot abilities, and his love of field work will make him (according to NPS personnel in Alaska) "very difficult to replace."

Rocky Mountain Region

The National Park Service and its Canadian counterpart, Parks Canada, are co-hosts this June 22-24 of a science-oriented conference in Kalispell, Montana, "Toward the Biosphere Reserves: Exploring Relationships Between Parks and Adjacent Lands." According to Clifford Martinka, Glacier NP supervisory biologist, the conference will be attended, in addition to scientists, by county commissioners, industry representatives, Chamber of Commerce members, and others whose lives are embedded in the area – the park, Flathead River and Lake, and the proposed Cabin Creek coal mine operation proposed for the area by Sage Creek Coal Ltd., of British Columbia.

Southwest Region

A fire symposium jointly sponsored by the NPS and the SW Fire Council at the Los Alamos National Laboratory, held in October 1981, explored four years of data about soils, erosion, plants, birds, and small mammals in a 15,000-acre burn area in and around Bandelier National Monument in New Mexico. There, a man-caused fire began on June 16, 1977, quickly becoming an interagency fire involving the U.S. Forest Service, NPS, and the Department of Energy.

Before the fire, various ecological studies were conducted in both Bandelier NM and Los Alamos National Lab. They provided baseline data for post-fire studies related to the effects of wildfire on the flora and fauna. Other studies initiated after the fire investigated its effects on soils, water quality, archeology, and geomorphism.

Copies of the Proceedings are now available and may be obtained from Milford Fletcher, Chief, Natural Resources Management, NPS, P.O. Box 728, Santa Fe, NM 87501.

Western Region

Two science conferences will take place this year in the Western Region. The first, June 2-4, the Fourth Conference in Natural Sciences, is co-sponsored by NPS, the CPSU at the University of Hawaii, and the Hawaii Natural History Association, and will be held at the Hawaii Field Research Center, Hawaii Volcanoes NP. The objective is to bring together scientists and managers studying Hawaiian natural systems, flora and fauna, for exchange of information and presentation of papers.

On Sept. 9 and 10, the First Biennial Conference on Research in California's National Parks will be held at the NPS/CPSU at the University of California, Davis. Charles van Riper III, who is heading up the conference arrangements, says the conference will cover biological and sociological research in California's National Parks.

Bratton Takes New Job

Susan P. Bratton, formerly research biologist at Uplands Field Research Laboratory, Great Smoky Mountains NP, recently transferred to the NPS Cooperative Research Unit at the Institute of Ecology, University of Georgia.

A native of Delaware, Susan earned her B.A. in biology at Barnard College, Columbia University and her Ph.D. in plant ecology at Cornell University. She began her career with the National Park Service as a biologist stationed at Western Carolina University, Cullowhee, North Carolina, in 1974. In 1975 she moved to Great Smoky Mountains National Park, where she served as research coordinator of the Uplands Lab for four years. She remained at the Great Smokies until her reassignment to the University of Georgia last November.

Susan has conducted a wide range of research, including studies of exotic European wild boar rooting in Great Smoky Mountains National Park and a study on the control and eradication of exotic kudzu in several southeastern parks. She also has authored numerous papers on ecological monitoring in biosphere reserves, rare and endangered plants, and backcountry visitor use.

At the University of Georgia, Susan will undertake a study of boat impacts on grass beds at Canaveral National Seashore, a fire history and analysis of Cumberland Island and Canaveral National Seashores, an ecosystem study of Congaree Swamp National Monument, and vegetation surveys of Fort Frederica National Monument and Shiloh National Military Park.

PARK SCIENCE

NATIONAL PARK SERVICE
U.S. Department of the Interior

Research Underway on Rare Cave Shrimp

By Jim Wood, Southeast Regional Writer/Editor

On November 29, 1980, scuba divers operating 360 feet deep within an underground river at Mammoth Cave NP were surprised to see several tiny, transluscent shrimp scurrying along the bottom. It was the first live sighting of the Kentucky Cave Shrimp *(Palaemonias ganteri* Hay) in many years.

This unique waterborne, cave-dwelling creature was last seen alive in 1967. It was thought to be extremely rare and perhaps extinct until the discovery of a single dead shrimp in 1979.

Diver Stephen D. Maegerlein of Williams, Indiana, first spotted the elusive shrimp with his underwater flashlight about 120 feet from the park's Echo River boat landing. He saw three individuals about 25mm (1 inch) long. John W. Dickerson, an NPS ranger, also observed 6 of the shrimp in an underwater tube about 4 feet wide by 2 feet high. He captured one for scientific study and for positive identification by officials of the U.S. Fish and Wildlife Service (USFWS). The shrimp was examined, photographed, and released in its original habitat the following day.

The Kentucky Cave Shrimp, once abundant in an area of Mammoth Cave known as Roaring River, recently has been proposed for Endangered Species status by the USFWS. The cave system of Mammoth Cave apparently is the critical habitat for the shrimp.

The discovery also prompted the NPS and the USFWS to support jointly a one-year contracted research study for an ecological analysis of the shrimp. A work proposal was sent to several area universities for competitive bidding and the contract was let to Terry Leitheuser of the Department of Biological Sciences, Old Dominion University, Norfolk, Virginia.

Leitheuser's study will attempt to establish the population size of the shrimp, its distribution, and its habitat requirements. In addition, the research information is urgently needed by both the NPS and USFWS for decisions regarding the Corps of Engineers' proposed plans to remove Lock and Dam No. 6 on the Green River. Removal of this lock and dam would have a pronounced effect on the water levels of Mammoth Cave. It is not known how these water level changes will affect the shrimp. It could result in total loss of the shrimp or it could create more favorable habitats for the shrimp. NPS and FWS officials do not know enough about the shrimp to predict which route would be most favorable for the endangered species. Leitheuser's research findings will be available around the end of the year.

In the Next Issue: "A Boreal Forest Park," by Glen F. Cole; "Aquatic Studies at Indiana Dunes," by Doug Wilcox; and "Biological Studies and Materials Comparisons on a Puget Sound Artificial Reef," by Jeffrey C. Laufle; "Integrated Shark Slough Study in the Everglades," by Gary Hendrix; and "Recreating an Animal Community at Jamaica Bay," by Robert Cook.