

PARK SCIENCE

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PARK SCIENCE

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

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Editorial

Science has long been recognized as an essential tool in the management of our National Parks. A major "new look" at its role and function is now underway again (see pages 16, 17). More and more, science is finding an equally essential place in park interpretation.

This issue contains a number of articles and items dealing directly with interpretation of scientific information about parks. It seems editorially worthwhile to point out that interpreters can benefit, and so can their receiving publics, from an acquaintance with the general contents of *Park Science*.

Scientific research and the application of its results to park management can be a fascinating ingredient of park interpretation. Visitors love to feel that they are peeking behind the scenes at what lies back of all the beauty and splendor they came to see. Even more important perhaps is the *human* level and the very real advantages that can derive from a public with a deeper appreciation and understanding of park ecology and park management. This is the realm of *social* science, which rides and operates on top of all the physics and chemistry and biology whose *conclad* laws govern parks.

Only an enlightened, involved, enthused public can provide the support that parks must have if they are to continue to offer the quality experiences they now afford. Interpretation needs every ounce of knowledge – about both parks and visitors – that it can muster if it is to serve both the parks and the public at the highest level of professionalism.

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Conservation Education in Hawaii: Perspectives From a Park

By Charles P. Stone and Danielle B. Stone

Exciting events are under way in Hawaiian conservation biology circles.

Late in 1987, the John D. and Catherine T. MacArthur Foundation of Chicago donated \$3.5 million to programs in Hawaii. The B.P. Bishop Museum of Honolulu received \$765,000 of this to develop an educational program for island public schools, and \$45,000 for research on terrestrial invertebrates, a critical and little-known part of Hawaii's unique fauna. The Nature Conservancy of Hawaii received \$1.3 million for an "Islands of Life" campaign to identify, acquire, and manage imperiled Hawaiian ecosystems, and another \$500,000 to begin a Conservation Biology Initiative (CBI), a cooperative effort focusing on management and research on already-protected lands. In addition, the Sierra Club Legal Defense Fund received \$450,000 to continue legal work, the National Audubon Society \$275,000 to open an office in Hawaii, and the Natural Resources Defense Council, about \$85,000 to open a Hawaii office and attempt to influence the State government to better manage tropical forests. These events, made possible by MacArthur Foundation's generosity and concern for the nation's tropical forests, have encouraged and will stimulate other positive effects and cooperative attitudes in Hawaii.

A related and very encouraging sign is the appropriation of \$750,000 by the State legislature, for the first time, which will allow management, monitoring, and research activities on the State Natural Area Reserve System (NARS). Hawaii has 18 areas in this system, totaling over 100,000 acres, which have largely been "paper parks" until now. Although continual appropriations are needed, a start has finally been made in determining the status of the resources on the areas.

A recent focus on Hawaii's natural resources in the printed media also is apparent. The July 1987 issue of *Trends in Ecology and Evolution*, an article entitled "Aloha and SOS" in the February 2 *Boston Globe Magazine*, and the April 1988 special issue of *Bioscience* (see article by Stone, this issue) are some important examples.

The National Park Service has had a role in all these events, through leadership in natural resource management and research programs in Hawaii and participation in numerous planning, board, and committee meetings.

A Conservation Education Workshop

Another encouraging event, and the subject of the rest of this article, was a Conservation Education Workshop held in November 1987 at Hawaii Volcanoes National Park (HAVO). The four-day workshop was organized by the HAVO Research group in cooperation with the Divisions of Interpretation and Resources Management and was co-sponsored by the Hawaii Natural History Association. Initially, the Workshop was to have focused on Island Ecosystems, one of a successful series of Resource Management/Interpretation workshops started by WRO Chief Interpreter Dick Cunningham. However, for a number of reasons, WRO joined the Southeastern Region for an "Island Parks" workshop in Key Biscayne, Florida, instead of at Hawaii Volcanoes. Since we at Hawaii Volcanoes had already set the date and sent out preliminary announcements of a meeting with an island ecosystems/education emphasis, we decided to proceed on our own – our own financing, our

own agenda, our own speakers, and our own focus – conservation education.

A conservation education workshop in Hawaii was a natural followup to the symposiums on native ecosystems and alien plants we organized in 1984 and 1986. Hawaii is the best evolutionary theater in the U.S. and has the only tropical rain forests in the 50 states; it also has one of the worst problems with invasions of alien plants and animals anywhere. Yet public knowledge about the value of the State's natural heritage and the problems in protecting biological uniqueness and diversity is terribly inadequate.

Although the natural resources are of intergalactic value scientifically and at least of worldwide importance aesthetically and culturally, Hawaii has at present an environmental education program in only a few of the public schools, no structured interpretation or research capability in the State natural resource agency, no national Sierra Club or Audubon field offices, essentially no management (including inventory) of the State Natural Areas Reserve System, no coherent environmental voice, and no environmental magazine (although a conservation emphasis is now on the increase in other media). There is very limited access to natural areas on Oahu (the most populated island) for school children, and the natural resources of the other Islands (folks on Oahu call them the "Outer Islands") are rarely and barely mentioned – much less understood – by the vast majority of the State's population. We have one state university with graduate programs, but conservation biology is not a formal discipline there, nor is it emphasized in the curriculum.

The Workshop focused on Hawaii's problems in conservation education, and we tried to gather a *diversity* of speakers, points of view, agencies and organizations, and relevant occupations to exchange ideas and information about the conservation situation here and how to improve it. The usual interchange of ideas among people with diverse responsibilities and goals was certainly one

objective. But we also wanted to provide some basic information in non-technical language, for use by educators, lay persons, and decision-makers, about Hawaii's biological importance, uniqueness, and problems. And we hoped to help stimulate better participation in conservation education in Hawaii in active and effective ways.

How Was the Workshop Structured?

We stacked the deck toward human diversity. From a pre-registration sign-up we selected participants with diverse interests and occupations as well as affiliations. Attendance was limited by the accommodations, but we ended up with approximately 100 attendees (standing room only on the first day) plus another 30 or so who submitted papers and/or served as speakers, facilitators, and summarizers. Occupations or principal activities of all the participants in the Workshop, including those who wrote papers but did not actually attend, those who came to present their talks, those who came only to listen, and those who came to discuss issues, are listed in Table 1.

We grouped the presentations at the Workshop into seven sections, as follows:

Island Ecosystems – what's different, what's important?

Biological Diversity – what is it, what should be emphasized?

Human Impacts – what's important, what's negotiable?

Alien Plants and Animals – management, research, interpretation

Making Choices – what to do when you can't do it all

Communicating – television, written media, public programs

Conservation Education – what could/should we do in Hawaii?

We assembled, in time for handing out at the Workshop, drafts of 23 papers on key topics in Hawaiian



Interpretive walks, an old NPS standby, are still among the most effective introductory approaches to understanding.

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conservation biology, including conservation education. The authors of the essays are professionals more used to communicating in the jargon of their occupations, but we stressed the need for brevity, clarity, and non-technical writing, so that non-specialists would be able to extract meaning and messages to share with others. We were surprised at the enthusiasm and the good results when technical experts try to communicate with the lay public!

Realizing that followup is essential if there is an attempt to change the *status quo*, we asked for evaluations of the Workshop and the topic papers. Also, discussion periods of an hour or so for audience and speaker interaction, and a short synopsis and evaluation, were an integral part of each of the seven sessions.

We encouraged hands-on experiences: interpreted field trips to Special Ecological Areas (see Tunison, Stone, and Cuddihy 1986) (including a muddy rain forest); to a state-of-the-art interpretation facility, Thomas A. Jaggar Museum (featuring Hawaiian volcanism); and to the active lava flows. Workshop participants were also the target audience for outdoor education programs of the State Department of Education and the HAVO Division of Interpretation. Entertainment at the Workshop dinner was provided by a popular environmental education group, "Puppets on the Path," which in four years has spread the message of Hawaii's biological heritage through home-made puppets and original songs to audiences of all ages all over Hawaii and in various locations on the U.S. Mainland.

How to Package the Message

Experts counseled simplification, factuality, emotional involvement, accuracy, and even "eco-sleaze" to improve the process of getting conservation messages to audiences. A major message addressed to **scientists and resource managers** in NPS and other organizations is that some simplification, emotion, and a sense of fun and wonder help get points across more effectively than a deluge of accurate facts presented in precise scientific terms. Scientists and managers also were

encouraged to consider problems more in the context of others' needs and views, including developers.

Conservationists and educators need to consider which messages are most important and how and when to deliver them to selected audiences. For example, in Hawaii a major conservation goal is to keep ecosystems *intact* and *not invaded* by alien plants and animals. It follows that we usually manage for biological *diversity*, not *dominance* by one or a few species. Another message for us all is that conservation education is *necessary*, not just *nice*. Education is an integral part of the conservation effort, and educators need to know their subject matter. We need more emphasis on *specific messages* for target audiences rather than *mass media* for the general public. In effect, educators in all occupations can be part of a responsible management "team" for helping to preserve natural values.

We were amazed that at least one educator, who uses mass media primarily, seemed to feel that his objectivity and/or artistic freedom would be threatened by being even an abstract part of such a "team." Perhaps others would rather work independently too, but we think that the "team" concept is important, if only in the occasional and "sometimes" category.



Sole cleansing the shoes of runners in the Kilauea Marathon and Rim Runs at Hawaii Volcanoes NP is a ritual that has cut considerably the chances of introducing weed seeds from other areas and islands. About 18 species of alien plants were generated from unscrubbed soles in a previous year.

Administrators also were offered a variety of suggestions. Destrý Jarvis, Vice President of the National Parks and Conservation Association, pointed to lack of a legislative mandate for interpretation and science comparable to that for law enforcement in NPS. Low budgets, lack of continuity, shifting (not necessarily shifty) leadership, and lack of effective integration of educators into the mission seem to be common problems of many organizations. Destrý pointed out that organizational structure – high-level positions and accountability – in addition to adequate budgets is essential if objectives are to be accomplished. Wayne Gagné, B.P. Bishop Museum, suggested that streamlined bureaucracies can lead to more effective action and interaction. Most bureaucracies are resistant to new initiatives, including education, without a mandated organizational structure to accommodate them.

One speaker noted that "the future doesn't vote" and another, that there is a "lack of political will" in Hawaii to make decisions. Decisions often seem to be made far away by people with "money motives." State Representative Virginia Isbell urged conservationists to run for office and get the government to respond to the needs. Gary Machlis, University of Idaho, provided facts and figures about public apathy in the U.S. in contrast to wide public interest in risk-and-crisis situations (e.g. a baby trapped in a well). Hawaii radio and TV personality Michael W. Perry described the secret of his success as the "art of sleaze" – emphasizing the biggest, fastest, shortest, strongest, greediest – whatever, as shown by experience, "grabs" the audience.

Whatever Turns You On

Lorin Gill, Educational Director of Moanalua Gardens Foundation, noted that establishing relevance (usually with risk such as emotional or personal involvement) and hands-on activities or experience were the two principles he has found most effective in conservation education. The attention of the public and of politicians can be attracted, interest aroused, and action or change provoked when audience and presenter meet on common ground and are involved together.

Wayne Gagné noted that the status of conservation education in Hawaii is that it has none! Others suggested that support – political, financial, material, and moral – is still badly needed. Lorin Gill stated that educators are being criticized because of three decades of frustration by "the secure, the arrived, and the scientifically astute"; however, educators are just beginning to get the support mentioned above. The need to bring Hawaii's limited human resources and expertise to bear on effective education about Hawaii's rapidly dwindling natural resources in the face of increasing threats was a theme that emerged strongly.

Where Do We Go From Here?

The workshop has already produced several results. **First**, proceedings, which we expect will provide "how-to" insights as well as summarize current thoughts and



Hawaiian geese, or ne ne, are Hawaii's state bird.

Table 1. Representation of various occupations at Conservation Education in Hawaii Workshop, based on official registration/participation list.

Occupation/Affiliation	Number of Participants	Percent of Total Participants
Interpreters/NPS	16	12.9
Educators/Schools	14	11.3
Educators/Private Sector	13	10.5
Educators/Scientists*	16	12.9
Scientists**	16	12.9
Natural Resources Managers/Federal	7	5.6
Natural Resources Managers/State, County	8	6.5
Natural Resources Managers/Private	1	0.8
Planners/State and County	3	2.4
Conservation Organization Representatives	6	4.8
Politicians/State	1	0.8
Attorneys	2	1.6
Mass Media/TV, Radio, Writing	4	3.2
Administrators/Federal, State, Private	12	9.7
All Others	5	4.0
TOTALS	124	99.9

* Combination of education and research functions

** Primarily research function

Conservation Biology in Hawaii: Highlights of April 1988 Issue of *Bioscience*

By Charles P. Stone

The Hawaiian Islands are renowned as a theater for evolutionary biology and are receiving increasing recognition as the site of the only tropical forests in the U.S. (except for Puerto Rico and the Trust Territories). Yet the emphasis in the April 1988 *Bioscience* Special Issue on Hawaii is not really "Hawaii's unique biology," as the cover says. Nor does the main message really address biological diversity of tropical rain forests. The underlying theme is most definitely the *conservation* of Hawaii's unique biology. Six of the seven articles (including the introductory feature by Laura Tangley) have a strong conservation focus. Throughout, there is the emphasis that unless we become more effective advocates and activists, Hawaii's unique ecosystems and species may be just something we read about in the next century.

What Articles Does the Special Issue Contain?

An article on deforestation at home (Laura Tangley) helps set the stage for the rest of the issue and discusses current developments. Hawaiian natural history

and conservation efforts are outlined by Frank Howarth and colleagues, and conservation of Hawaii's avifauna is discussed by Mike Scott and associates (including NPS scientist Charles van Riper III). Additional articles on translocation of endangered species by Sheila Conant, speciation in Hawaiian *Drosophila* by Ken Kaneshiro, conservation priorities by Wayne Gagné, and comparative conservation biology of oceanic archipelagoes by NPS scientist Lloyd Loope and associates (including NPS scientist Chuck Stone) round out the issue. Lacking is a focus on marine ecosystems and other aquatic environments impacted by tourists and residents alike, and an emphasis on the strengths and weaknesses of Hawaii's natural areas as acquired and managed by different agencies and organizations. (Invasions of alien species are covered in the Loope article.)

What Are Some Salient Points?

The most serious problems facing the native Hawaiian biota are introduced species and the degradation of aquatic ecosystems, according to one observer. Others

would point to these as symptoms of "inadequate government action" (specifics in Tangley's article) and lack of awareness and knowledge by decision-makers and public alike, caused by deficiencies in conservation education and research and management support. An additional problem is the difficulty of advocating values that sometimes seem remote and impractical.

Funding by the MacArthur Foundation of Chicago (see Stone and Stone, this issue) expresses a "recognition of the islands' global significance from the point of view of biological diversity" and begins to address many of the deficiencies. It also provides a challenge to state and federal governmental agencies to "more energetically protect Hawaii's endangered ecosystems in the future." This challenge has to be accepted, even in the face of budget constraints. As Faith T. Campbell, Natural Resources Defense Council, states, "in Hawaii, you lose it if you leave it alone."

Howarth and colleagues stress the importance of the islands as a laboratory for evolutionary ecology and

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good discussion, have been transcribed and await editing time. **Second**, a book of 34 essays, some handed out to Workshop participants for evaluation as to usefulness, format, level of presentation, and so forth, is scheduled for publication in 1988. The title of the volume is **Conservation Biology in Hawaii**. This paperback trade book will provide valuable source material on conservation biology in Hawaii in non-technical language and will include an extensive glossary.

Third, considerable publicity about conservation biology and education appeared in Hawaiian newspapers following the Workshop, and this is continuing. Portions of a few of the essays handed out at the Workshop have already been used in other outlets. **Fourth**, key working relationships have been strengthened or established among State, Federal, and private groups and among various individuals. For example, coordination of Hawaii Volcanoes NP research, interpretation, and resource management functions has increased, partly as a result of teamwork reinforced in organizing the Workshop. All participants agreed that a major followup effort would be a renewed emphasis on conservation education in Hawaii's schools. The Conservation Council of Hawaii and the Moanalua Gardens Foundation in Honolulu were chosen to lead this effort and have begun several major thrusts (helped by MacArthur Foundation grants to Bishop Museum), according to J. TenBruggencate (1988). They include:

1. Creating a permanent position for the State Environmental Education Specialist.
2. Developing a system to allow high school students to work independently on environmental education with graduate students or conservation organizations.
3. Researching the possibility of making environmental education a core curriculum (like math or English) in schools.

A **fifth** effect of the Workshop, and perhaps the most important, is the realization by representatives of many segments of society that conservation education for adults and young people must become a much more important part of conservation in Hawaii today. Without participation by the different ingredients in our "unmixed



Hawaii's natural history comes alive when *Puppets on the Path* perform stories, skits and songs depicting how ocean and forest creatures interact within Hawaii's unique ecosystem. Three women (The Anthurium Sisters) and more than 50 original puppets delight and enlighten Hawaiian audiences.

melting pot," much of Hawaii's biological heritage will be compromised even more before most citizens know its real value. The focus of our efforts must be sharpened, the efforts increased, and the public and key decision-makers must be better educated to the choices ahead.

C.P. Stone is a Research Scientist and D.B. Stone is assistant to the Research Scientists at Hawaii Volcanoes NP.

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Interpreters Urged To Tell Story Of Illegal Trade in Plants, Animals

"Some interpretive thoughts and information on the international trade in plants and animals" is the modest, low key title to a broadside challenge leveled at NPS interpreters by Western Region Chief of Interpretation Dick Cunningham.

The barrage is fully loaded – 19 pages packed with case incidents, grim statistics, ecological ramifications, and implications for the National Park System. It cites chapter and verse about the international trade in mammals, birds, reptiles, amphibians, invertebrates, and plants. It covers major U.S. species in demand internationally and lists retail prices (from USFWS information) for selected U.S. reptiles and amphibians.

It also acquaints the reader with diseases spread and ecosystem havoc wrought by alien plants and animals. And it describes CITES – the Convention on International Trade in Endangered Species an agreement that has been ratified by 90 nations since its inception in 1973.

How the international trade in plants and animals affects the National Park System "should be obvious," Cunningham says. "To put it simply, we have what the collectors and the poachers want." Cunningham asks NPS interpreters to be alert to poaching and collection. "Into our trust," he says, "the American people have put the management responsibility for the protection and preservation of the very basic resources of the National Parks – their plants and animals."

Examples of possible "collectibles" are given (viz. Big Bend mud turtles, Mission Blue butterfly, San Francisco garter snake, Channel Islands slender salamander, etc.), and a "case in point," Shenandoah NP is cited:

"Black Bear and White-Tailed Deer are under constant poaching pressure. Commercial hunting involves the selling of whole animals to restaurants and to other individuals and such animal parts as bear teeth, gall bladders, bear and deer hides, and deer antlers. Bear gall bladders have been traced to the Oriental market. The situation is serious enough for the park to have established an Anti-Hunting Strike Team. A recent undercover operation resulted in the arrest of 23 people across the U.S. who were involved in illegal poaching activities. Eleven of the arrests were associated with bear poaching in and around Shenandoah NP."

Noting that the National Parks are a microcosm of what is going on worldwide, Cunningham urges interpreters to incorporate wild animal and plant trade themes into their programs – especially in parks that contain species that could enter the illegal markets if collected or poached. He challenges interpreters with five specific responsibilities:

1. We interpreters need to know what species of plants and animals occur in our parks – better comprehension of the biotic composition of our parks, especially rare, threatened, or endangered species.
2. We interpreters need close cooperation and

communication with park scientists, outside scientists, and park resource management specialists.

3. We interpreters need to develop creative, factual, and honest interpretation program activities about the international trade in animals and plants.

4. We interpreters need to have close cooperation and communication with commissioned park rangers and others with law enforcement responsibilities for protection of park wildlife and plants.

5. Park staff needs to have local community support and assistance in curtailing collecting and poaching of park plants and animals. Interpretation is a means of soliciting visitor participation in a park-sponsored Wildlife Watch program – information about whom to call if one observes someone collecting or poaching in a park.

Cunningham then lists sources of help, such as the Wildlife Trade Education Kit, produced by TRAFFIC (U.S.A.), a branch of the World Wildlife Fund. Contact for this kit is Lynne C. Hardie, Public Information and Education Specialist, TRAFFIC (U.S.A.), World Wildlife Fund, 1250 24th St., N.W., Washington, DC 20037, 202) 778-9503.

In addition, Cunningham's paper lists 37 selected references for additional interpretive fodder. His paper may be had by writing the NPS Western Region Office, 450 Golden Gate Ave., Box 36063, San Francisco, CA 94102, or by calling Cunningham at FTS 8-556-3184 or (415) 556-3184.

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indicate that the B.P. Bishop Museum of Honolulu is planning a modern invertebrate survey for the next decade (stimulated, again, by the MacArthur Foundation grant). They note that, although extinction and endangerment rates are extremely high, the resilience of the surviving native species gives cause for optimism and for increased efforts in research and management on protected areas.

Scott and associates state that the diversity and abundance of seabirds are still impressive in Hawaii, and that forest bird densities are the highest documented anywhere. The percentage of extinct species (as high as 66 percent), of species with healthy populations (perhaps 10 percent of the species remaining), and the number of species confined to a small segment of historic range, provide sobering perspective, however. Recommended management measures for seabirds include control of alien plants and animals and monitoring. For waterbirds, acquisition, enhancement, and protection of habitat, together with control of alien species, are suggested. For land birds including the endemic honeycreepers, land acquisition and forest restoration in key locations above 1500 m elevation and reduction of ungulates are recommended. Captive propagation for many avian species is now, unfortunately, a necessity, and translocation will undoubtedly be used more in the future.

Sheila Conant notes that translocation of birds in Hawaii, inspired by the New Zealand experience with "marooning" rare birds on predator-free islands, can have unpredictable consequences. One effect may be harm to the new environment. For example, Laysan finches (*Telespyza cantans*), introduced to Pearl and Hermes Reef in 1967, may be reducing seabird nesting success by breaking and eating eggs. Another effect is rapid change in the translocated species in response to

the new environment. Such change seems to be the case in Laysan finches introduced to Pearl and Hermes Reef, and Conant speculates about "evolutionary tinkering" to the extent that new races or species are created by human action.

Wayne Gagné notes that 88 of 180 (or 49%) of native terrestrial ecosystems will soon be lost unless protected and managed. He recites a litany of threats to natural areas and native biota, including grazing, hunting, alien species of plants and animals, lack of awareness of conservation values in schools and society, lack of action by Federal and State agencies, tourists, the "powerful pet industry" (pit bulls maybe?), botanical gardens, the horticulture industry, the postal service, and (inadequate?) focus of some environmental groups. He is especially critical of the idea that sustained-yield management of ungulates, a well-known continental concept, can be applied where native biota are unadapted to ungulates. Managing of game species in general to "nondamaging" levels by hunting or other means is biologically meaningless. Hunters and their supporters have had considerable influence, but this should not extend to valuable natural areas.

Lloyd Loope and colleagues use the Galapagos Archipelago as a basis for comparison with Hawaii. Effects of alien predators, ungulates, arthropods, diseases, and plants are compared, and in most cases Hawaii is the loser. Even though Hawaii is more remote and has a shorter history of European visitation, logistics are more favorable for visitors and their introductions, human populations are higher and more dispersed, and – perhaps most importantly – the standard of living in Hawaii and the requirements of residents and visitors are incomparably higher. As oceanic islands, both areas are vulnerable, but the more rigorous climate of the Galapagos also works in its favor.

Despite the problems, the authors conclude that

oceanic islands may not prove any more difficult to protect and manage than many fragmented continental reserves. Hawaii's plants and animals, at least, are used to the economy of a smaller scale.

In summary, the Special Issue of *Bioscience* on Hawaii is worthwhile reading and will be the most up-to-date treatment available until *Conservation Biology in Hawaii* appears late in 1988. The cost of the issue is \$7.50, and reprints should be available from most authors.

In the April 1988 issue of *Bioscience*, Wayne Gagné, an entomologist and education specialist at the B.P. Bishop Museum in Honolulu, outlined conservation priorities for Hawaiian natural systems. He noted that "most youngsters pass through Hawaii's public and private education systems largely without exposure to fundamental biological processes and natural systems of insular environments." Decision-makers sensitive to the values of natural areas in Hawaii are not readily produced in such an environment.

Even though the situation may be similar to some mainland states in the U.S., so much environmental destruction is occurring so rapidly in the Islands that we have less time to prepare decision-makers to preserve natural areas. Pressures are more severe in many cases, because land is limited and in high demand. Gagné suggests, as has Dan Janzen elsewhere for the neotropics, that scientists and others most familiar with the conservation problems get actively involved in educating others to the values at risk and in fighting to preserve the natural areas that remain.

Peregrine Falcon Monitoring at Padre Island

By Jennifer Bjork

It is October. The threatened tundra population of the peregrine falcons (*Falco peregrinus tundruis*) will have reached Padre Island, Texas, by now, arriving via two flyways, one group from Greenland, the other from Arctic Alaska and Canada. They will rest and feed before continuing their migration to South America.

Where do the birds congregate? Hunt, Rogers and Slowe (1975) observed that the wind-tidal flats create ideal foraging opportunities for peregrines. This area is a flat expanse of fine-grained sand covered by an algal mat overwashed by a thin layer of seawater during extreme high tides. It provides no protective cover for birds chased by peregrines. The flats are studded with small vegetated sand dune mounds, the preferred perch for peregrines. The falcons lean into the wind and wait for their prey, predominantly migrating passerine and shorebirds. The falcon takes flight, stoops and hammers the prey with its feet, then flies in a circle to gain altitude and stoops again, eventually grabbing the prey.

The southern half of Padre Island National Seashore contains these extensive wind-tidal flats. Padre Island is a barrier island at the southern end of a chain of such islands along coastal Texas. It is the longest, continuous barrier island in North America; the National Seashore runs 68 miles along the length of the undeveloped section.

The peregrine researchers will arrive, also. They will use a rubber inflatable boat to transfer supplies and two 4-wheel off-road vehicles (ORVs) across the man-made cut through Padre Island at Mansfield Channel to the southern end of the National Seashore. Two tents will be set up behind the dune line so they won't be visible to park visitors. Access to and from the beach will be on natural washes through the dunes, so as not to damage the island's first line of protection from the sea.

In 1979, Hunt, Johnson and Ward radio-tagged 15 peregrines on South Padre Island and found that they remained in south Texas for from 3 to 28 days, concluding that Padre Island is an important resting and feeding or staging area for this migrant species. Data to date indicate that peregrines move into and out of the staging area at Padre Island with the arrival and passage of cold fronts. They remain for extended periods of time. It is important to understand that no assemblage of spring migrant peregrines has been noted elsewhere.

Researchers from the University of Texas Science Center, K.E. Riddle, D.C. Morizot and their graduate students, have been monitoring peregrine falcons at Padre Island for 10 years. Migrating peregrines are counted, observed, sexed and aged, if possible from feather coloration and size. Attempts are made to trap as many as possible in order to gather further information. Each captured peregrine is tagged in order to be able to track individuals and to monitor population trends through band recoveries and sightings. Two cubic cen-



A peregrine falcon is released during Fall 1987 migration monitoring at Padre Island NS.

timeters of blood is withdrawn for later analysis. Genetic markers in blood proteins are examined to determine natal origin and thus, geographic population. Feather condition, fullness of crop, and density of muscle also are examined to determine the general health of each individual.

Data on migratory falcons on Padre Island have been compiled from 1982 through 1987. Reports are missing from both the spring and fall of 1985 sampling seasons. These and data prior to 1982 will be added.

Since 1981, over 7,180 birds have been counted in the wind-tidal flats, an average of 1,026 per trapping season. An average of 15 percent (range 9.7-25.9 percent) of the birds seen are trapped. After an examination of trapping records, a disparity in adult to immature ratios has emerged. There are reduced numbers of adults in the fall and reduced numbers of immature birds in the

spring. Most birds sighted and trapped are females, an average of 85 percent. This may be due to different migratory habits of males, for example, following different prey species and/or taking longer flights over water.

Research has been funded from non-NPS sources. Through the Collecting Permit system, we have been able to work with researchers in directing the study to impact the resource as little as possible while gaining the maximum amount of information. Access behind the dune line is through storm breaks in the dunes. Off road vehicles are primarily driven on "roadways" established years ago by oil and gas seismic vehicles. The camp facility is situated in the back dune area where it has little impact. Drinking/wash water is brought by the researchers with the supplies. All garbage is taken out at the end of the field sampling effort. All captured falcons are released at the capture site after banding and blood sample collection. A good working relationship has developed. From the required research reports and interaction with the people working on the project, the park has learned much about the mud flat area of the park.

Padre Island provides a critical concentration point during lengthy migrations in the spring and fall. It provides an extensive land area with reduced human interference. Once this valuable habitat has been delineated, it has been and will be protected as a critical habitat in park planning documents. No recreational ORVs are allowed on these mudflats at any time. Oil and gas exploration mandated by the enabling legislation is not allowed during spring and fall migration periods. No oil or gas development will be allowed in this critical staging area.

Peregrine falcon populations began to decline in the late 1940s with the advent of widespread agricultural use of organochlorine pesticides, especially DDT. Eggshell thinning was the main cause. The peregrine falcon has made a substantial recovery, mostly due to reduction in pesticide use. Protection of critical habitats will be important in maintaining the current population levels of this species.

As a result of cooperation and understanding between research and park managers, this project has been conducted smoothly for many years providing informa-



Peregrine falcon (*Falco peregrinus*).

Biodiversity Interpretation

The NPS plan for interpretation of biological diversity, designated by NPS Director Mott as the Servicewide interpretive theme for 1989, is currently undergoing review by the Regional Directors and Superintendents. It should be ready for release some time in June or July at the latest, according to Western Region Interpretation Chief Dick Cunningham.

(An article describing the plan's formulation was carried on page 16 of the Spring issue of *Park Science*.)

Continued on page 8

Usefulness of Genetic Marker Studies to Resource Managers

The use of genetic studies to differentiate populations of a species is fairly new. The first extensive raptor genetic studies using bald eagles were conducted by Dr. Don Morizot, University of Texas Science Center. They successfully documented a pattern of small genetic difference among two widespread populations, Alaska and Arizona. Dr. Morizot decided to attempt similar research using the peregrine falcon (*Falco peregrinus tundrius*).

Padre Island was selected as a study site. Peregrines reach Padre Island by two flyways, one group from Greenland and the other from Arctic Alaska and Canada. The nesting area from which migrating falcons converge is expansive. Peregrines from the following areas have been captured at Padre Island:

Alaska – Western drainage of the Kuskokwin River, Western lower and upper Yukon River, Tanana River, Colville River.

Canada – Northern Northwest Territory, Ungava Bay, Alberta.

Greenland – Near Sondrestrom, Western coastal Greenland.

Capturing efforts are concentrated during spring and fall migrations. After receiving an approved Collecting Permit, in addition to the permit required by the U.S. Fish and Wildlife Service to work with a threatened species, researchers set up camp and begin trapping birds. One blood sample is withdrawn from the brachial vein of each bird. Two cubic centimeters are collected, centrifuged with buffers extracting blood proteins and frozen for later analysis.

Approximately 60 blood protein products are surveyed using electrophoresis. Vertical starch gel electrophoresis using an electrical charge in a gel medium orients the blood proteins in thin, vertical lines. Chromosomes can be differentiated. Loci, (positions on a chromosome of a particular gene or allele,) are identified. Alleles, (a group of genes that occurs alternately at a given locus), are compared.

Since raptors contain from 10,000-100,000 genes, identification of the few genes or alleles that are different between populations is necessary. Geographic differ-



Peregrine falcon band number is recorded.

entiation is identified from three genetic alleles or markers by introducing three different enzymes to the blood plasma during electrophoresis: lactate dehydrogenase-1 (LDH1), mannosephosphate isomerase (MPI) and nucleoside phosphorylase (NP). The genetic markers are identified with the enzymes.

Data to date indicate that the MPI allele has been observed only in peregrines from Colville River, Alaska, and in Padre Island migrants at very low frequencies. Therefore the usefulness of MPI as a genetic marker has been minimal.

The NP locus has four alleles identified with it. It differentiates European, North and South American and Australian populations.

Peregrine Falcon

Continued from page 7

tion valuable to the protection of the threatened bird and of park areas it uses.

Bjork is a Natural Resource Specialist at Padre Island National Seashore.

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Natal origin of Padre Island peregrine migrants from two different methods:

	Genetic marker		
	Band Recovery ¹	LDH1 Allele ²	NP Allele ²
Alaska	58%	70%	-
Greenland	10%	-	21%

¹Yates et al.

²Morizot, 1985.



Researcher Tom Maechtle attaching band on a restrained, hooded peregrine falcon at Mudflats, Padre Island.

mab notes

The LDH1 allele has been observed only in Alaskan birds. There are appreciable levels of this allele in the Padre Island population which presumably reflects a substantial proportion of Alaskan birds in the migrant flock utilizing this staging area. Band recovery data confirm the genetic data.

Discrepancies in the percentages of birds at Padre Island can be explained: 1. unsampled Greenland populations may have substantially higher NP frequencies, 2. the NP allele occurs at appreciable frequencies in unsampled North American populations, or 3. the Padre Island samples may have been taken in years with unusually large proportions of Greenland migrants.

From worldwide samples, common alleles at most, if not all, loci in peregrine falcons occur worldwide. This implies either a recent evolutionary origin of peregrine populations or extensive gene flow presently or in the recent past.

By trapping and taking blood samples from migratory species, changes in their environment can be detected. Animals high on the food chain such as raptors bioaccumulate toxins to levels that are easily measured. A small amount of blood can detect low levels of pesticides, heavy metals or other toxins. If it is not possible to collect and analyze a large number of grab samples of water, soil or vegetation, collection of a single blood sample from several resident raptors may identify an environmental problem area.

The use of techniques from other disciplines can be of valuable assistance to parks. Blood electrophoresis and genetic markers already are used to differentiate populations of peregrine falcons and could be of considerable use for avoiding inbreeding in captive breeding programs, in identifying natal origins of other migratory populations, in determining paternity and maternity and possibly in identifying and delineating endemic populations.

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The elation felt by the Crater Lake NP staff following successful hatching of three peregrine falcon chicks was dashed on May 3, when the adult female and her three chicks disappeared during the night.

A thorough investigation by NPS Natural Resource Specialist Jim Milestone and the U/Cal Predatory Bird Research Group representative Brent Hetzler turned up no information. Since no evidence of human disturbance was found, it is presumed the birds were lost to a natural predator.

Encouraging words for the international MAB program came from biochemist Federico Mayor of Spain, the new head of Unesco. At a reception in his honor at the National Academy of Sciences in Washington, D.C., he said that the MAB program would be his highest priority in the Science Sector of Unesco.

In June the U.S. MAB National Committee will decide on funding for research proposals. Recent MAB developments include the following:

Southern Appalachians Agreement. A draft inter-agency agreement for establishing and operating a Southern Appalachian Man and the Biosphere Cooperative (SAMAB) is in final review; signing is expected this summer. The agencies involved are the National Park Service, Fish and Wildlife Service, Forest Service, Tennessee Valley Authority, Economic Development Administration, U.S. Department of Energy, and the Appalachian Regional Commission. The purpose is to cooperate on a wide range of scientific, educational, and demonstration activities which foster better resource management and ecologically sound economic development in the Southern Appalachian region. At a meeting March 28-29 in Gatlinburg, Tenn., agency representatives discussed creation and funding of a MAB office, and recommended as the first research project development of a regionwide classification of ecosystems and a geographic information system. The proposal is awaiting action on funding by the U.S. MAB National Committee. Wilson Crumacker (University of Colorado) is the principal investigator and Peter White (University of North Carolina) the coinvestigator.

Ozark Highlands Biosphere Reserve. A managers' workshop held on March 30 considered creation of an Ozark Highlands BR centered on the watersheds of the Buffalo River in Arkansas and the Current-Jacks Fork rivers in Missouri, with possible satellite sites elsewhere. An important resource issue here is the relation between land use and water quality of the river systems, much of



Wings of the peregrine falcon are gently wrapped to prevent harming the bird.

which lies in NPS areas. A patchwork of national forests, state, and private land occupies the rest of the watersheds. Participants at the meeting, representing federal, state, and private landowners, agreed to seek funds for a MAB feasibility study to identify regional resource issues, determine interest in MAB, recommend coordination mechanisms, and provide a basis for a possible future biosphere reserve nomination.

Northern Science Network Plans New Action.

Meeting in Helsinki last March, representatives from member countries of the Northern Science Network decided on five topics to pursue, through symposia or in other ways, during the 1988-1991 period: (1) Protected Areas and Biosphere Reserves in Northern Regions; (2) Birch Forest Ecosystems and Ecotones/Treelines; (3) MAB and Sustainable Development in the North; (4) Geosphere-Biosphere Observatories; (5) Monitoring of Environmental and Social Change in Northern Regions.

The Northern Science Network was organized in 1982 under the aegis of Unesco's Man and the Biosphere Program. Member countries are Norway, Sweden, Finland, Iceland, the Soviet Union, Greenland (represented by Denmark), Canada, and the United States. Iceland and the Soviet Union were not represented at the March meeting. The Network has previously held four major symposia - on northern land use and grazing, subarctic birch forest ecosystems, monitoring in biosphere reserves, and Arctic science policy - and has published the proceedings.

Chihuahuan Desert Symposium. A session on the role of biosphere reserves in addressing desertification and resource depletion in the Chihuahuan Desert is planned for the Third Chihuahuan Desert Symposium, to be held at Sul Ross University in Alpine, Texas, November 10-13, 1988. A workshop is scheduled during the symposium to develop an agenda for cooperative research among biosphere reserves in the Chihuahuan Desert, which include Big Bend NP and Jornada Experimental Range in the U.S. and the Mapimi Biosphere Reserve in Mexico.

Biosphere Reserve Brochure. The U.S. MAB Secretariat will fill requests for up to 25 copies of the recently published international brochure on biosphere reserves, as long as the supply lasts. Write to: Executive Director, US-MAB Secretariat, Department of State OES/ENR (MAB), Washington, D.C. 20520. Or phone FTS 632-2786 or (202) 632-2786. A second printing, including French and Spanish versions, is planned for later this year.

MAB-8 Elects New Slate of Officers. In March the MAB-8 Directorate elected Paul Risser as Chairman, Peter White as Vice Chairman, and Bill Gregg as Secretary. These elections reflect some of MAB-8's current research priorities. Risser, Vice President for Research at the University of New Mexico, has been particularly involved with the issue of global climate change. White, formerly an NPS scientist and now head of the botanical garden at the University of North Carolina, has done much work related to biological diversity. Bill Gregg, the NPS MAB Coordinator, had held the co-chairmanship of MAB-8 since 1980, with Stanley Krugman of the Forest Service, who had served since the Directorate's inception in 1976. The NPS will continue to have a lead role in the establishment and functional development of U.S. biosphere reserves.

Napier Shelton
NPS Washington Office

superintendent's corner

Public Response to the Fee Program At Fort Clatsop National Memorial

Editor's Note: In 1986 and 1987, a sociological pulse was taken at Fort Clatsop National Memorial by Donald R. Field, NPS Sociologist, and Marty Lee, a Research Associate with the NPS/CPSU at Oregon State University. The project was a joint endeavor with the park staff. Here, Supt. Frank Walker reports on the study of public response to the initiation of entrance fees at his park.

Fort Clatsop National Memorial began collecting entrance fees in 1987 for the first time since its establishment in 1958. The U.S. Congress had legislated that 134 additional NPS sites would either begin collecting fees or raise existing fees.

Fort Clatsop is a small, rural historical site about 5 miles from Astoria, Ore. It commemorates the winter encampment of the Lewis and Clark Expedition of 1805-06 at the mouth of the Columbia River, and has about 170,000 visitors a year. The primary orientation is the interpretation of cultural history. Public response to the fee program was expected to be positive because:

- Fees would enhance interpretation by providing new programs.
- Fees would allow the staff to expand both interpretive offerings and the season when they were offered.
- Fees would allow expansion of other visitor services.
- Fees would add to our resource management capability and research initiative.
- Fees would enable the staff to measure public response to our programs, facilities and services.

1987 Action Plan

Our first step was a plan of action for fee collection and informing the public about it. A general press release went out in mid-December and was carried in three local area papers and in the statewide *Oregonian*. As superintendent, I was interviewed on two local radio stations. Our fee collection rationale focused on improving visitor services over a longer season, and the local newspaper printed an editorial supporting the park fee concept.

The second step was to insure that each staff member knew the fee issue and could explain it to visitors and local residents. Most early reactions were "Okay, if we have to . . . you do a good job out there . . . the fee might eliminate some of the frequent local visitors . . . we really support and parks and are happy to help . . ." Even many of the Golden Age Passport visitors contributed their dollar entrance fees to the Historical Association's donation box.

Our third step involved my public relations role as superintendent. I presented talks about the fees to the Astoria Kiwanis Club, the Seaside Chamber of Commerce, the Greater Astoria Area Chamber of Commerce's tourism promotion committee and the Fort Clatsop Historical Association. We also published information in the National Lewis and Clark Trail Heritage Foundation publication. All of this occurred at least three months before actual fee collection began in mid-April.

The fourth step was to assign the Chief Park Ranger responsibility for the fee program. A returning seasonal Park Ranger was hired one month early to establish the system. The information desk was modified to accommodate a cash register, necessary fee collec-

tion signs were constructed, the new fee collectors were sent to Mount Rainier NP to examine their operation, and fee information was included in the materials available at the 15 to 20 visitor information centers in the area and in the park's own summer interpretive schedules.

Fee Allocation

The daily fee at Fort Clatsop, \$1 per person, was collected at the visitor center. Visitors under 13, those 62 or older, and school groups on educational field trips were exempt. There was a \$3 maximum limit per family and a \$10 annual Fort Clatsop pass for area residents. In addition, the park sold federal Golden Eagle Passports and issued Golden Age and Golden Access passes.

The fees were deposited directly into the U.S. Treasury, but Congress appropriated special FY 1987 "fee enhancement funds" specifically for improvements in park interpretive programs, resource management, and research activities. At Fort Clatsop, the \$19,200 thus available was used as follows:

Interpretation

1. Initiated new spring and fall living history demonstrations April 1 - September 30, using two additional seasonal park rangers. \$7,300
2. Provided salary for 6 weeks of outreach interpretive "Ranger on the Road" living history programs in Oregon and Washington schools. Matched \$2,000 donation from Fort Clatsop Historical Association as support for this effective program. \$2,000
3. Hired one additional summer park ranger for additional special programs during the summer at Fort Clatsop and once-a-week evening programs at Fort Stevens State Park. \$3,500
4. Developed an off-site Bicentennial of the Constitution school exhibit, and new site bulletins on the Saltworks and the Fort Clatsop replica. \$2,400
5. Constructed and installed interpretive bulletin board at the Saltworks site in Seaside, Ore. \$1,000

Research

1. Conducted follow-up survey on 1986 Fort Clatsop visitor study by OSU/NPS Cooperative Park Studies Unit. \$1,000

Resource Protection

1. Hired seasonal landscape architect and developed Landscape Management Plan to guide historic scene development back to the 1805-1806 time period when Lewis and Clark were here. \$2,000
- Total \$19,200

Visitor Profile

In June 1987, a weekend visitor pulse was conducted to gain information about park visitors and their assessment of programs and services, including fee collection. A combination of on-site interviews and mailback questionnaires was used. Based on estimates of visitor numbers, a random sample of 200 groups leaving the visitor center was contacted over a 3-day weekend. The interview, conducted by a CPSU researcher or a Fort Clatsop park ranger, included a brief description of the purpose of the study,

and a request for cooperation and choice of a group spokesperson to facilitate completion of the postage-paid mailback questionnaire. The questionnaire asked visitors about their satisfaction with Park programs and facilities, their knowledge of the history surrounding Fort Clatsop, their travel patterns, and demographic characteristics, as well as their feelings about the collection of fees. Follow-up reminders were sent a week after the initial interview as needed. At the survey closing date, 80 percent had returned the questionnaires. Data on visitor characteristics have not been summarized at this writing.

Visitor Response to Fees

Three questions focused on visitors' opinions about collection of fees:

Fort Clatsop began charging an entrance fee in April 1987. A substantial portion of the money goes back into visitor services for the park. Did you know before you came that there was an entrance fee being charged at Fort Clatsop? (check one)

Yes 25% No 75%

Despite major public awareness efforts, a majority did not know about the entrance fee, probably because many came from out-of-region.

How do you feel about paying a fee to visit Fort Clatsop?

5% I shouldn't have to pay

88% I don't mind paying

7% I don't know how I feel about paying a fee

The need to pay a fee obviously is not a problem for almost 90 percent of those contacted. Whether the nominal fee amount was part of the reason visitors did not object is unknown.

How do you feel about being charged? (check one)

4% One dollar is too little

92% One dollar is just right

4% One dollar is too much

Summary

Overall, Fort Clatsop visitors did not object to having to pay a fee to enter the park. Very few visitors appeared upset and only a few left when asked to pay. Fee collection rangers made every effort to make people feel welcome and to explain the programs and visitor services available. It was time-consuming to explain repeatedly all the various fee options, although signs helped alleviate the problem. At times the visitor center lobby became congested, with visitors paying fees at one end of the information desk and buying books and historical items at the other end. Although fee collection rangers were rotated to other duties, some boredom did set in towards the end of the summer.

The park collected a total of \$31,116 from April 13 through September 30. It cost \$14,800 to set up and collect fees; \$19,200 in funds were used to enhance interpretive, research, and resource management programs. It is interesting to note that the donation box collections were down 18.5 percent compared to the same period the year before (FY86 = \$2,386, FY87 = \$1,944).

Strict accountability, well-followed operating procedures, and good internal controls helped give the operation credibility. The effort paid for itself and the Park gained from collection of the fees.

Our experience and visitor pulse survey results show the value of maintaining the on-going personal information effort with park visitors, even after an intensive media campaign.

New Cave Discovery Affords Perfect Baseline

By John Roth

About 13 years ago, a geology Master's thesis tried to explain how a mysterious boulder came to rest on a certain hill in central Pennsylvania. After completion of the thesis, it was discovered that the boulder had been hauled up to the hill with the aid of a large truck!

Ideally, scientific investigations should be undertaken without the complications and confusions caused by human disturbance of natural features. So it is not surprising that scientists are delighted with Lechuguilla Cave, perhaps the most significant new cave discovery in the West since Carlsbad Cavern was explored around the turn of the century.

Lechuguilla Cave is the perfect environment for gathering baseline data as over 99 percent of the entire cave was not entered by people until just three years ago. New passages are being found as fast as they can be surveyed.

The cave is now known to extend at least 1,412 feet deep and to contain more than 16 miles of passages. Yet, except for a narrow, taped trail, there has been virtually no human impact within the cave.

The cave contains a wide variety of speleothems. Lechuguilla is one of five caves in the United States and one of a handful in the world to have hydromagnesite balloons. Lechuguilla also appears to have the best display of gypsum speleothems in the world. These include a gypsum rim approximately one by two feet in diameter, blisters, flowers, crusts, needles, thick gypsum beds and large crystals oriented to wind directions. The cave may have the thickest gypsum beds of any cave in the world not formed within gypsum layers. Gypsum hair over 15 feet long may be the longest in the world. Gypsum stalactite clusters exceed in size and beauty those known anywhere in the world.

The cave also contains some of the best and largest examples of cave ice, cave pearls, "silticicles," red and orange velvet flowstone and boxwork known in the Guadalupe Mountains. Time and dryness has resulted in a variety of mineral forms not found in most caves in the world and include delicate aragonite anthodites, moonmilk, cave popcorn and rims, as well as speleothems so unique that apparently they have not yet been scientifically described, such as "helictites" growing underwater and immense gypsum "stalagmites." Rare cave minerals include sulfur, ranceite, todorokite, corundum, and endellite.

Exploration apparently has extended into the Capitan Limestone and Goat Seep, Yates, Seven Rivers and Queen Formations, making it possible for speleologists, paleoecologists and stratigraphers to study nearly continuous exposures of the transitions between upper Permian forereef, reef and backreef sequences and to relate this to the regional picture. The reef complex is one of the least altered in the world; many of the original depositional features still are visible. Etching by acidic condensation has revealed exquisite details of fossils, breccia, bedding planes, and other wall features that are not usually visible in surface outcrops. Nearly 100 percent exposure of wall rock in large parts of the cave gives geologists "windows" on large scale features, such as reef collapse, that cannot be studied with the usual methods of surface outcrop, thin section, or drilled core analysis.

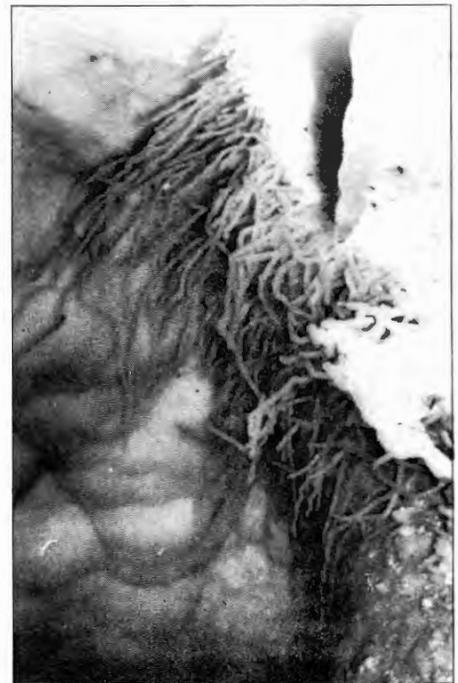
Bones tentatively identified as those of a woodrat (*Neotoma*) species, a ringtail (*Bassariscus astutus*), a weasel (*Mustela*), and bats have been found in the cave.

A leg bone larger than that of a mule deer (*Odocoileus hemionus*) has also been found. Some bones have been well preserved by a layer of calcite flowstone. The cave may have served as a natural trap for animals during the Pleistocene and Holocene.

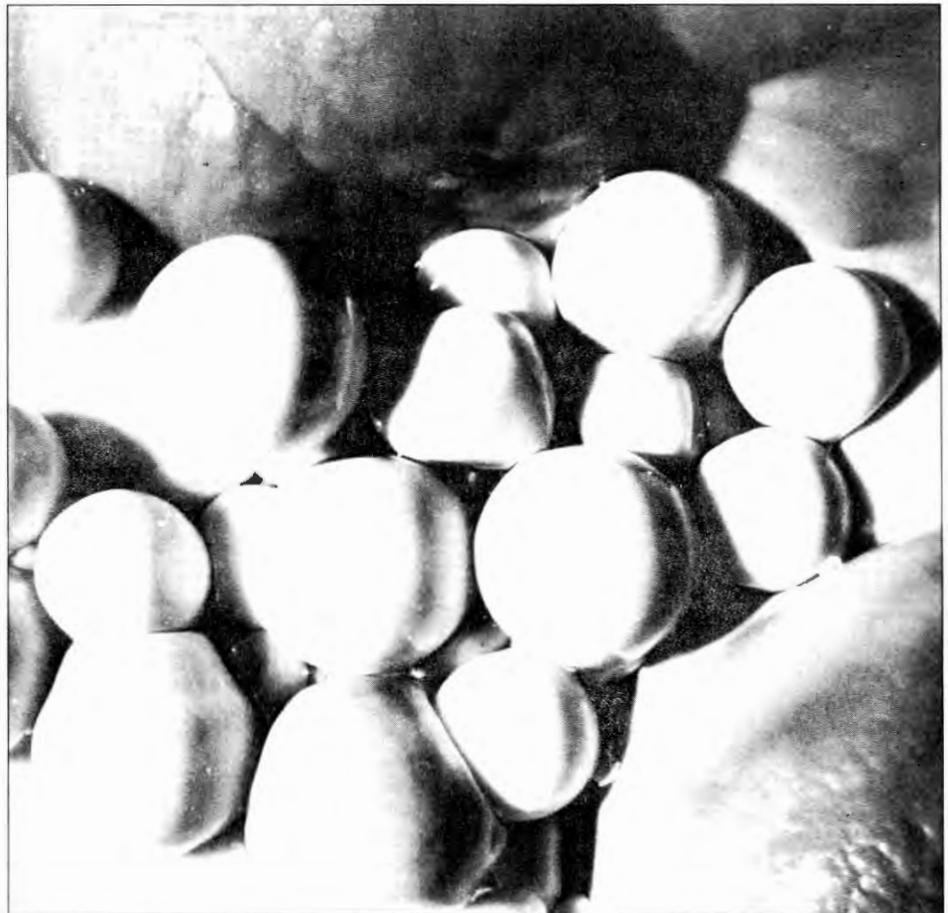
Lechuguilla Cave has a relatively simple system of insects and microbes that can be studied to shed light on more complex systems on the surface. Diplurans, flies, ringtails, tenebrionid and rhadine beetles and camel crickets have been found in the upper levels of the cave but a preliminary survey has not yet been made of the cave fauna. The cave offers a unique opportunity to study cave fauna in a large cave relatively uncontaminated by humans. Comparisons can be made with the tourist trail area of Carlsbad Cavern and with Lechuguilla Cave in the future. Air circulation in the cave appears sufficient to flush out the effects of human breathing within a few hours.

In summary, Lechuguilla Cave offers scientists outstanding views of undisturbed geological and biological processes rarely seen on the surface or in caves even moderately impacted by people.

Roth is a Resource Management Specialist at Carlsbad Caverns NP.



Helictites growing underwater were found growing out from the walls in a chamber deep in Lechuguilla Cave – a speleothem variety never before described.



Cave pearls two inches in diameter shine through the water in a pool in Lechuguilla Cave.

regional highlights

Midwest Region

Regional Chief Scientist Michael Ruggiero opened a three-year aquatic resource inventory of seven prairie parks by visiting Wilson's Creek National Battlefield with a representative from the Missouri Dept. of Conservation. Several sample sites were identified in the creek and a suite of chemical constituents was selected for measurements. The program was discussed with park management and staff in the light of their expected needs.

* * *

The Midwest Region will hold an Inventorying and Monitoring Workshop at Northland College and Apostle Islands National Lakeshore June 13-17, featuring planning exercises, problem-solving with monitoring data, and training sessions on monitoring design.

* * *

Plans are underway to present a symposium on national parks at the 32nd Conference of the International Association of Great Lakes Research, May 1989. We will be contacting researchers at other large lakes in the NP System for possible involvement.

* * *

For the second year Homestead National Monument of America will transplant native prairie sod to restore an area of the park where reseeding has not been successful. The sod is being transplanted from a local prairie which is threatened by agricultural development. The first year effort was labor intensive but highly successful.

Mid-Atlantic

Chief Scientist John Karish and Regional Biologist Jeff Marion recently met with The Nature Conservancy staff and State Heritage program representatives from the Mid-Atlantic states to discuss expansion of our current cooperative efforts regarding R,T&E (Rare, Threatened and Endangered species) programs. New efforts will include a Memorandum of Understanding and/or Cooperative Agreements to conduct additional R,T&E surveys and enable the updating and sharing of State Heritage database information.

* * *

A publication entitled "Inventory and Impact Monitoring for River Campsites within the Delaware Water Gap National Recreation Area" is now available from Jeff Marion, Star Route 38, Dingmans Ferry, PA 18337. The report is a case example of how such a program can be developed and information on inventory and impact parameter selection, well-documented measurement procedures field/computer data forms and coding, a DBASE III database with menu-driven programming, and management recommendations illustrating the usefulness of the monitoring data.

* * *

Two additional Regional publications, available from Chief Scientist John Karish, include "Identification and Mapping of Vegetation Communities in Shenandoah NP, Virginia, by Allison Teeter, and "Analysis of Secondary Products to Determine The Ecological Effects of the 1986 Black Fly Pest Management in the New River below Bluestone Dam" by J.R. Voshell, R.J. Layton, and S.W. Hiner.

New Head, New Look At UC/Davis CPSU

What's in a license plate? (Apologies to Will Shakespeare.)



Last fall Stephen Veirs was re-assigned from his job as Research Scientist at Redwood to the Unit Leader position for the Cooperative Park Studies Unit at the University of California, Davis. Now you see the connection between his new job and the new plate ... CPSU4CA. Maybe it's inside humor. Not many people guess the meaning.

On the other hand, the role of the Davis CPSU for the California NPS areas it serves is reflecting some broad changes in the Western Region Natural Resource and Research program. In his new role as Unit Leader, Veirs now supervises the eight Western Region research scientists located at Davis (2), YOSE (1), SEKI (2), PORE (1), and CHIS (2). Tom Stohlgren, an ecologist, is now stationed at the Unit and Silvia Hillyer, a University employee, is the Unit's Secretary/Administrative Assistant. Dr's. Charles van Riper III and Christine Schonewald-Cox, who formerly had administrative roles, have been freed for full time research.

The research carried out by the Western Region

research scientists supervised by Veirs is primarily based on the priority research needs of the parks, as identified in their resource management plans. Although duty stationed at Davis or in the parks, these scientists can respond to needs for their expertise throughout the region and elsewhere as NPS priorities dictate. The relationship with U/Cal allows research work to be carried out by University scientists and graduate students in close cooperation with NPS. Through the CPSU, NPS field areas, especially smaller units can obtain scientific assistance in the form of literature searches, research proposal reviews, study designs, and statistical consultation. The University/Service relationship fosters use of the parks as scientific resources for University students and faculty, providing benefits to both the scientific community and the NPS.

The CPSU staff, in cooperation with the Regional Office, assists field areas in reviews and upgrades of their resource management plans and performs an extension role in research and resource management topics as requested by the parks. The CPSU insures the quality of research and research results by obtaining scientific reviews of NPS research proposals and reports. It also facilitates training. Finally, the Unit hosts a biennial conference on research in California's National Parks, which brings together NPS and University scientists, park managers and resource managers, students and the interested public.

What's in a license plate? This one symbolizes a great job that helps integrate and improve research and resource management for the benefit and protection of the resources of the parks and for the visiting public.

Pacific Northwest

A bibliography entitled **Review of Paleontological Specimens and Related Records from the Vicinity of John Day Fossil Bed NM** has been completed by Jane Sikoryak. This comprehensive bibliography of John Day records and specimens which are found in major Washington, DC area collections has been reproduced for distribution by the park to interested researchers and institutions.

* * *

A Review of Scientific Research at Craters of the Moon NM by Jennifer A. Blakesly and R. Gerald Wright of the NPS/CPSU at University of Idaho has been received at PNR headquarters. The report is Bulletin #50, Wildlife and Range Experiment Station, U/ID.

* * *

The first field trip of the newly organized Revegetation Working team in the Pacific Northwest Region took place in early May at the Soleduck road project in Olympic NP. Ed Menning, PNR Resource Management Specialist, reports formation of the group (it held its first meeting on April 26) as a result of a September 1987 workshop at Mount Rainier NP.

"Our overall objective," he said, "was to share knowledge and understanding of revegetation with native plant materials. The primary thrust was to be forest and alpine ecosystems. Among the ideas generated was establishment of a team to develop future workshops, to prepare a revegetation workbook/manual, and to support revegetation efforts.

On the group's May trip to Olympic NP, members

urged Nancy Dunkle - the DSC representative who is in charge of the Soleduck revegetation project - to write up additional information on her project for **Park Science**.

* * *

Jim Thomson, Regional Archeologist and co-sponsor of the Highland Archaeology/Ethnography symposium held last year as part of the 40th Annual Northwest Anthropological Conference in Oregon, reports that the Symposium has been recognized as the first in the Conference's history to address prehistoric and historic Native American adaptations to subalpine and alpine landscapes.

Fourteen presentations were given; geographic coverage of topics spanned high mountain ranges from northern British Columbia to northern Idaho, from the North Cascades, and the Olympics of Washington to the southern Cascades of Oregon. Topical coverage included prehistoric archaeological surveys, management of archaeological sites in mountainous settings, modeling of resource uses and settlement locations, ethnohistoric accounts of Indian land uses, and ethnoarchaeological studies of mountain Indians.

Abstracts of the prepared papers were contained in the Conference program, which is available from Thomson at PNRO, 83 King St., Seattle, WA 98104.

Western Region

Research scientists, resource managers, planners, and landscape architects from throughout the Western Region, Washington Office, and Denver Service Center participated in a revegetation workshop in San Francisco April 11-15. The workshop included a review of

Golden Gate NRA's and Joshua Tree NM's nursery facilities and revegetation program and culminated in Regional comments on the recent draft NPS Management Policies regarding revegetation, genetic integrity, and landscaping; identification of issues not covered in the draft Policies; and development of guidelines for implementing the proposed Policies.

A multi-disciplinary team of NPS scientists, resource managers and planners met with university scientists at the University of Nevada, Las Vegas, Jan. 19-21 to scope out needs of a strong research and resource management program for Great Basin NP. A "step-down" planning process, which has been successfully applied to similar efforts for Organ Pipe Cactus NM and Channel Islands NP, was the vehicle for identifying and prioritizing needs and developing a new natural resources management plan for the park.

Several staff changes have occurred at two CPSUs in the Western Region. In October, Steven Veirs moved from Redwood NP to become Unit Leader at the U/Cal/Davis CPSU. Thomas Stohlgren, an Ecologist at Sequoia and Kings Canyon NPs, was transferred to Davis to assist Steve in that role. These moves allowed former Unit Leader Charles van Riper III to devote full-time to high priority research for Yosemite NP, Channel Islands NP, and Pinnacles NM. More recently - March 27 - Dennis Fenn returned to the Western Region to assume the Unit Leader position at the CPSU/U/AZ, Tucson. The transfer will allow R. Roy Johnson to devote more attention to high priority research for Arizona units of the NPS.

"Giant Sequoia Mortality in Burned and Unburned Stands," in the *Journal of Forestry* (86(2):44-46), by U/Cal Research Asst. Sherman Lambert and NPS Ecologist Thomas J. Stohlgren, finds that recently burned and long unburned giant sequoia stands have detectably different tree mortality rates, but the effect is almost entirely restricted to trees smaller than one foot in diameter.

A number of members of the new NPCA Commission on Science and Resource Management Policy will be participating in the Aug. 14-18 Ecological Society meetings at U/Cal/Davis. NPS Research Scientist Dave Parsons writes that the meetings point to dawning recognition on the part of leading professional societies of the value of the National Parks and notes that a number of the symposia and special sessions are of direct relevance to the NPS.

"Discovery of *Atoxoplasma* in Hawaii" is the title of a paper by Charles van Riper III and Sandra van Riper of the NPS/CPSU at A/Cal Davis, that appeared in the *Journal of Parasitology*, 73(5), 1987, pp. 1071-1073. This parasite, previously unreported from the Hawaiian Islands, was found in the nutmeg merrin, house finch, Japanese white-eye, and house sparrow.

Southwest Region

During the week of April 11, 1988, NPS Chief Scientists held a three-day meeting in Santa Fe. Dr. Eugene Hester and several of his division chiefs were present to discuss Water and Air Resources, GIS progress in the NPS, National Natural Landmark activities, and other topics. How to better utilize scientific personnel in the Service was a topic of great interest. The Chief Sci-

tists are preparing a position paper on CPSUs and their activities.

A report recently released by the NPS/CPSU at Texas A&M describes the results of a survey by three Southwest Regional permanent park employees and VIPs. The study, entitled "Relations Between National Park Service Employees and Volunteers in the Park" indicates that VIPs are greatly appreciated by NPS permanent employees. Those agreeing or strongly agreeing that "VIPs provide a great service to our Park" made up 87 percent of the sample. Eighty-three percent of the sample agreed that VIPs are dependable workers. Copies of the study may be obtained by contacting the CPSU Leader at Texas A&M University.

Peregrines have returned to Big Bend and Guadalupe Mountains NPs again. Big Bend believes they have seven or more active eyries even though Case Grande may have been abandoned. Guadalupe has an active eyrie at Peregrine Palace. Until young birds hatch and can be seen by monitors, a lot of speculation exists about eyrie status. This looks like another banner year for peregrines.

Ah, spring, when Padre Island National Seashore gears up for the annual Ridley Turtle watch. Supt. John Hunter, moving smoothly from managing burros at Bandelier NM to turtles at Padre Island, reports that an adult Ridley came ashore the week of April 25 and laid 103 eggs. The nestling, at Mustang Island just north of Padre Island, was not a tagged turtle from the Head Start program but she renewed interest of turtle scientists and the public as well. The Atlantic Ridley Turtle is the smallest and most endangered of sea turtles with a total adult population in the wild of approximately 600 animals. The eggs of the Ridley were recovered and are being incubated at the Padre Island hatching facility by NPS Resources Management personnel. Hatching will occur in approximately 58 days. The sex of the hatchlings will be determined by the incubation temperature - a phenomenon common among reptiles.

Rocky Mountain

The Department of State's US MAB Program is publishing a summary of Man and the Biosphere research funded through the Directorate on Temperate Forests. One chapter of this volume, entitled "Paleolimnological Reconstructions of Atmospheric Deposition Trends in Rocky Mountain NP/Biosphere Reserve, was written by Jill Baron, biologist with the NPS Water Resources Division in Fort Collins, Colo. Dr. Peter Ffolliott, former chairman of MAB 2, is editing the volume.

Water Resources Division

Nancy Hoefs, a graduate student assistant in the NPS Water Resources Division at Fort Collins, is coordinating application of an Index of Biological Integrity (IBI), which measures the health of an aquatic ecosystem in terms of its fish community. A test of the Index now underway involves the Missouri Department of Conservation, the NPS/WRD, and Ozark National River. The Index is seen as one potential tool that could be applied to NPS river systems on a Servicewide basis, allowing scientific rigor to the newly mandated Resource Inventory and Monitoring effort while at the same time being interpretable to resource management concerns. Results of the research will provide Ozarks NR with an evaluation of its fish community and will provide NPS with experience

and a protocol for application of the IBI in other park units.

North Atlantic

Acadia NP began releasing peregrine falcons in 1984 to assist in the restoration of the species in coastal New England (*Park Science*, Vol. 5, No. 3, pp. 7-8). Kyle Jones, biological technician, reports that 22 of the 23 birds released to date have successfully advanced to the stage where they care for themselves and disperse. In 1987, returning falcons were found exploring the release site, potential nesting areas, and exploiting seabird colonies nearby. Park employees and volunteers conducted falcon searches, combing cliff areas in the spring looking for prospecting adults. Although no signs of nesting or pairing were observed, hopes are high in Acadia for the upcoming season. New releases have been suspended in the park to avoid conflicts with returning falcons.

We have learned that our efforts on behalf of the peregrine falcon have been a success elsewhere as well. Rory, a peregrine falcon released in Acadia in 1986, is reported to have established her territory on Staten Island, NY near another NPS unit, Gateway NRA. Observers of the falcon were able to read the band numbers, which identified it as a bird released and raised in Acadia. Rory was hatched at the Raptor Research Center in Boise, ID and raised at Cornell University in Ithaca, NY supported by the Peregrine Fund. It is hoped that she will nest in the Staten Island area.

Jim Allen led a research team with participants from the Rutgers University CPSU, University of Southern California and Northern Ireland, UK, evaluating the effects of revetment construction adjacent to Canaveral National Seashore. A report is expected this fall.

The final report from a workshop of estuarine scientists and coastal resource managers, "Alternatives for Salt Marsh Restoration in the Fire Island National Seashore Wilderness," has been received from the CPSU at Rutgers University. It finds minimal stress to the system and recommends continuation of passive restoration of mosquito control ditches. It also suggests research to develop a more detailed study of the alternatives if increased stress to the system becomes apparent.

The North Atlantic Region would like to extend congratulations to the Pacific Northwest Region. Barbara Samora, formerly the resource management specialist at Cape Cod NS, has left to take a job as a backcountry resource manager at Mount Rainier.

Alaska

Patrick McClanahan, in his first NPS assignment, has started work as the Computer Systems Analyst for the Region's GIS. Pat comes from the Salt Lake City area where he spent the last seven years working as a computer systems programmer, first for the Army and then for UNISYS Computer Corporation. He has a Bachelor's degree in park management and is finishing a Master's degree in computer science. Pat's father is Les McClanahan, who worked for the NPS for almost 30 years before retiring from the superintendency of Wind Cave NP in 1983.

The long-awaited *Beach ridge archeology of Cape Krusenstern: Eskimo and Pre-Eskimo Settlement*

Continued on page 14

information crossfile

Discovery of a rare protein found in some wild beans but absent in common cultivated varieties is reported in **Science News** (Vol. 33, p. 246) and underlines, according to researchers, the importance of current efforts to preserve the genetic diversity of earth's plants.

The protein, which has been analyzed and cloned in a collaborative effort involving plant breeders, entomologists, and molecular biologists, can protect against an important bean pest. The protein is called arcelin and is closely related to the more common phytohemagglutinin, or PHA. Although PHA has some insecticidal qualities, it has tested as ineffective against two common varieties of bean-destroying weevils. Researchers report that arcelin, in contrast, is highly toxic to bean weevil larvae.

The discovery focuses attention on the problems that may result as modern agricultural practices and global development narrow the range of genetic variation. Thomas C. Osborn, a researcher at the University of Wisconsin, Madison, reported the discovery in the April 8 **Science**. He told **Science News** that the new protein, with its important implications for the world's food supply "is a good example of the need to preserve wild germ plasm."

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Researchers in Hawaii are trying to build "an acoustical phylogeny" of the islands' *Drosophila* flies, some species of which are unique to the islands. **Science News** (Vol. 133, p. 244) reports on the efforts of several scientists to relate the song style of a species to its place in evolution.

Four song types are reported: a click-song, a complex pattern of short pulses followed by a trill, a purr made up of steady-sound pulses, and a low hum. Ronald R. Hoy of Cornell University says the larger Hawaiian cousins are more flamboyant in both appearance and communication skills than their continental cousins. Some biologists estimate that more than 500 different *Drosophila* species have evolved on the islands, producing flies not

found anywhere else on earth. Evidence supports the one-original-fly idea, says Hoy — a fly blown in from the mainland whose offspring then island-hopped to start new colonies. "However it happened," says Hoy, "it is certainly the case that these *Drosophila* evolved from mainland species."

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The Committee for an International Wolf Center is proposing the creation of such a center in Ely, Minn., according to word from Mike Link, chairman. In a brochure subtitled "Wolves and Humans: Coexistence, Competition and Conflict," (available from the International Wolf Center, c/o Vermilion Community College, 1900 East Camp St., Ely, Minn. 55731; (218) 365-3256), Link traces the Committee's work since its formation in 1984. The 1988 legislative initiative in Minnesota would establish in Ely a home for the Science Museum of Minnesota's Wolves and Humans exhibit. The central mission of the International Wolf Center would be a public education program that would offer a wide variety of efforts and affiliated educational institutions.

"A multifaceted educational delivery system will be used by the Center to ensure broad public exposure to the wolf and related species both at the Center and through the Center's extension programs and speakers' bureaus."

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If global reforestation could be increased by the year 2000 by an area nearly twice the size of Texas, not only would the world's supply of wood for fuel and industry be sustainable, but watersheds and highly erodible, wind-prone areas would be stabilized. All this according to Sandra Postel and Lori Heise of Worldwatch Institute, whose report, **Reforesting the Earth**, was published in mid-April.

Rough calculations presented by Heise and Postel suggest that preserving tropical forests and planting new trees could significantly slow the CO₂ buildup that threatens to overheat the earth. Adding 120 million hectares of forest cover would store about 780 million tons of carbon annually. Simply by halving the deforestation going on in Brazil, Indonesia, Colombia and Cote d'Ivoire would cut net annual carbon releases from tropi-

slid approximately 500 feet down a very steep snow chute before hitting a rock outcrop and then continued his slide for an additional 200 feet before stopping. Undaunted, he placed a radio-collar on the darted wolf before being evacuated to the hospital in Fairbanks. Although he escaped major injuries, he was sore enough to direct the project from Anchorage for the next week.

Southeast

Jim Wood, NPS Science Publications Editor, has added Dr. Robert Stottmeyer of the NPS Great Lakes Resources Studies Unit to the science publications Editorial board, replacing Bill Lukens, who retired recently.

The Southeast Region has published five new reports in its Research/Resources Management Series:

SER-85: *Vegetation Changes on Bodie Island, Cape Hatteras National Seashore, North Carolina*, by Ian Firth. 42 pp.

SER-86: *Organic Pollution of the Water in the Black Creek Vicinity, Biscayne National Park*, by Eugene F.

cal forests by more than 20 percent, the report states, and could buy the world time to wean itself from an addiction to fossil fuels.

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The Historic Resources of the U.S. Virgin Islands is the title of a 58-page review and assessment prepared by the NPS Caribbean Strategy's Cultural Resource Group.

The working group, chaired by Ro Wauer, NPS resource specialist, identified the key cultural resource issues that fall under the purview of either the federal or territorial governments, assessed those issues to determine what must be done to mitigate or prevent further resource degradation, and laid plans to build a constituency so that useful followup action would be forthcoming.

The booklet consists of 19 cultural resource elements that incorporate brief descriptions of the issues, pertinent management objectives, proposed corrective measures, and the kind of funding required.

Also contained are tear-out pages so that readers may send their comments to the working group for input into the process. The document is available from Wauer, Cooperative Extension Service, College of the Virgin Islands, P.O. Box L, Kingshill, St. Croix, USVI 00850; (809) 778-0246.

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From William F. Loftus, fishery biologist at Everglades NP and Fort Jefferson NM, comes a 344-page Bulletin of the Florida State Museum, Biological Sciences (Vol. 31 No. 4), authored by himself and James A. Kushlan (former NPS research biologist), and entitled **Freshwater Fishes of Southern Florida**.

The monograph presents the results of the first systematic study of the distribution of fishes in southern Florida's fresh waters. The presence of 92 species is documented for extreme southern Florida and their status, distribution, and the ecological factors that affect them are discussed. The data were collected during a seven-year study supported by the South Florida Research Center of Everglades NP.

A limited number of reprints are available and may be had by writing Loftus at the park, P.O. Box 279, Homestead, FL 33003.

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Three new Technical Reports were reported by the NPS Cooperative Resources Studies Unit at U/Cal

Corcoran, Melvin S. Brown and Ana D. Freay. 19 pp.
SER-87: *Biological Investigations of the Black Creek Vicinity, Biscayne National Park*, by Aina M. Szmant. 64 pp.

SER-88: *South Biscayne Bay Water Quality: A Twelve Year Record for Biscayne National Park*, by Soronadi Nnaji. 79 pp.

SER-89: *Canal Discharge Impacts on Biscayne Bay Salinities, Biscayne National Park*, by Jocelyn Chinn Fatt and John D. Wang. 229 pp.

Copies of these publications are available through Jim Wood, NPS Southeast Regional Office, 75 Spring Street S.W., Atlanta, GA 30303.

The 1987 Annual Report of the Park Service's University of Georgia Cooperative Park Studies Unit is now available. Persons interested in obtaining a copy should write to Susan Bratton, Unit Coordinator, NPS Cooperative Park Studies Unit, Institute of Ecology, U/GA, Athens, GA 30602.

Regional Highlights, cont.

Around Kotzebue Sound, Alaska by J.L. Giddings and Douglas D. Anderson (Publications in Archeology 20, NPS, USDI, Washington, D.C. 1986) has been published. Copies are available from the Supt. of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (Stock Number 024005-01019-0. Price \$29.00). Questions about the publication can be directed to the Regional Archeologist, Alaska Region.

Mike Britten was selected as the Resource Management Specialist Trainee for Gates of the Arctic National Park and Preserve and Penny Knuckles was selected for a similar position at Yukon-Charley Rivers National Preserve. Both bring experience gained through assignments in other units of the NP System, including several in the Alaska Region.

Layne Adams, Wildlife Research Biologist (ARO), was injured while pursuing a darted wolf near the Arrigetch Peaks in Gates of the Arctic NP. He lost his footing and

Davis. No. 26, by Mark K. Sogge and Charles van Riper III, is titled "Breeding Biology and Population Dynamics of the San Miguel Island Song Sparrow"; No. 29, by Johnson C.S. Wang and Thomas P. Keegan, is "Assessment of an Oil Spill on Selected Fishes in Rodeo Lagoon and Muir Beach"; No. 30, by Margaret Cymerys and Brian J. Walton, is "Raptors of the Pinnacles National Monument: Past and Present Nesting and Possible Impacts of Rock Climbers."

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"Has the Greenhouse Taken Effect?" is the title of a Richard Monastersky article in April 30 *Science News* (Vol. 133 p. 282). Based on average global temperatures for land and ocean areas, 1987 was warmer than any year on record in the last hundred-odd years.

In addition, 1981 and 1983 tied for second place; 1980 was fourth and 1986 fifth highest. "It's pretty clear," says climatologist Thomas M.L. Wigley from the University of East Anglia in Norwich, England, "that the 1980s – in terms of the global mean record – are far and above the warmest collection of years ..."

According to Wigley's report in the April 28 issue of *Nature*, the warming trend is confirming several predictions of the greenhouse theory (such as the warming of the lower atmosphere and the cooling of the stratosphere), but the Southern Hemisphere's ocean is not exhibiting the inertial drag to temperature rise that theorists predicted.

"It means that there are other things going on ... It's just one of the factors that prevent the interpretation of this warming in the 1980s from being open-and-shut."

Natural variations in global climate records further complicate the picture. James Hansen of the NASA Goddard Institute of Space Studies in New York City, predicts global temperatures will accelerate their rise in the next decade. If the trend of the last 20 years continues for another 20, he said, "it will be warmer than it has been in the last 100,000 years."

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"Bird Buyer Beware" is the title of the cover story in the May 8, 1988 issue of *Parade* magazine. The story gives nationwide coverage to one facet of the illegal international trade in wildlife. For the NPS angle on this story, see this issue page 6.

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From David Peterson, USFS Research Ecologist with the Forest Fire Lab in Riverside, Cal., comes a reprint from *APCA Journal* (Vol. 37, No. 8, Sept. 1987, pp. 906-912) describing work in Sequoia/Kings Canyon NPs on ozone-injured Jeffrey pine. The evidence shows reduction in radial growth of these pines in the mixed conifer forests of the park. Mean annual radial increment for trees with symptoms of ozone injury was 11 percent less than for trees at sites without ozone injury; larger trees (more than 40 cm in diameter) and older trees (more than 100 years) showed greater decreases in growth than smaller, younger trees. Results corroborate surveys of visible ozone injury to foliage and are the first evidence of forest growth reduction associated with ozone injury in North America outside the Los Angeles basin.

Authors are Peterson, Michael J. Arbaugh, Victoria A. Wakefield, and Paul R. Miller, all of the Pac/SW Forest and Range Experiment Station in Riverside.

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Acid rain isn't off the hook by any means as the culprit in dying forests, but a new "villain" – or at least another villainous link in the chain of death, is reported in the

April 30, 1988 issue of *Science News* (Vol. 133, p. 285). University of Colorado geographer Lee Klingler, who works at the university's Institute for Arctic and Alpine Research, has looked at 100 regions in some 30 states experiencing forest dieback, and has found himself on the trail NOT of some deadly pollutant, but of mosses.

Mosses, says Klingler, are "terrestrial sponges" that can hold enough water to make the area right beneath them anaerobic. As tree feeder roots grow into this oxygen free zone, they die. In addition, mosses can kill mycorrhiza – the symbiotic fungi that help tree roots absorb nutrients.

Acid enters the picture again at this point. Mosses love acidic conditions – they acidify water passing through them. Once the water reaches a critical acidity, toxic aluminum in the soil becomes soluble and can be taken up by the trees. Working together, mosses and acid rain seem, according to Klingler, to accelerate this natural process of forest death.

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A new study released in late April by the New York City-based Environmental Defense Fund claims that acid deposition is second only to fertilizer runoff as a source of nitrogen pollution in Chesapeake Bay – the largest spawning ground for East Coast fisheries from Maine to North Carolina. Michael Oppenheimer, one of the study's authors, notes that acid rain's role in overloading the bay's waters has been largely overlooked. Diane Fisher, who led the study, says, "Our analyses show that acid rain is a significant problem in coastal waters up and down the entire eastern seaboard." Control of nitrogen oxides emissions – for electric power plant and for motor vehicles – is the primary recommendation. The report urges all governmental bodies to acknowledge acid rain's contribution to the deteriorating quality of East Coast waters and to work at reducing nitrogen from sources besides acid rain – especially from sewage treatment plants and fertilizer and manure storage.

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Someone out there may be throwing snowballs at us.

Two studies reported in mid-May at the American Geophysical Union meeting in Baltimore, together with studies in Europe and Canada, support a controversial theory proposed two years ago by U/Iowa physicist Louis A. Frank. The theory is that all of the earth's oceans were filled with water from blackened snowballs that fall from space – 100-ton comets of ice coming in at us at the rate of 10 million a year.

Frank studied ultraviolet images taken from 1981 to 1986 by the Dynamics Explorer I satellite and found that the air glow around the earth showed unexplained holes punched through the atmosphere. He concluded the holes could only be made by huge ice balls that vaporize and eventually fall as rain.

One skeptical physicist – Clayne Yeates from the Jet Propulsion Lab in California, calculated that the snowballs would be moving at about 22,000 mph and would break up about 1,000 miles above the earth. Using a powerful space search telescope at the Kitt Peak Observatory in Arizona, Yeates actually captured photo views of the speeding comets approaching earth.

Another doubting Thomas – Thomas Donahue – a space physicist at U/Mich, sought to disprove Frank's theory by measuring the level of hydrogen atoms that would be released by the water vapor in the space about the earth. Ultraviolet data collected by the Voyager 2 spacecraft showed the hydrogen was much denser than expected – enough so to support Frank's theory.

**

Score one more advance in the universe's effort to understand itself. Researchers at MIT have deciphered a second genetic code – that governing "transfer RNA" – thus promising important applications in genetic engineering.

The biology revolution began in 1953 when James Watson and Francis Crick worked out the basic structure and function of DNA, which contains the master plan for assembling amino acids into protein. The DNA passes this information along to a substance called "messenger RNA," which then gives it to another substance, "transfer RNA," which actually puts the protein together.

That there was a second genetic code – one governing this putting-together process – has been known for 20 years, but its deciphering was described in May in an article in the British science journal *Nature*. The paper's two authors, Paul Schimmel and Ya-Ming Hou of MIT, professed surprise at the elegantly simple logic of the code.

The *Los Angeles Times*, commenting editorially on this stunning discovery, wrote: "The key word is elegantly. As Albert Einstein said in a different context, 'Subtle is the Lord, but malicious he is not. Nature hides her secrets because of her essential loftiness, but not by means of ruse.' He was speaking of physics, but his insight applies to all of science."

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An article in *Wildlife's* Sept/Oct 1987 issue by J.A. Zak Ball describes the discovery and observation over a week of at least one peregrine falcon in Tehipite Valley in Sequoia/Kings Canyon NP. Zak writes about the five-person research team effort, "humbly titled The Kings Canyon Peregrine Expedition of 1987."

In 1970 only two peregrines were known to nest in California and no nests were known in the Sierra Nevada. About 400 birds have been reintroduced into the wild since 1977, and nearly 80 pairs are now known to nest in the state. Discovery of this falcon is the first evidence that reintroduction efforts have succeeded in that section of the Sierras.

Zak is raptor biologist for the Santa Cruz Predatory Bird Research Group, which has been responsible for the captive-breeding and reintroduction of this endangered species.

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Specific issues of the so-called Gaia hypothesis were discussed in a March conference in San Diego that brought 162 researchers together under the auspices of the American Geophysical Union – reports of which reached *Park Science* from Gary Davis, NPS Research Scientist at Channel Islands NP. Paul Ehrlich discounted the Gaia theory in a keynote address but recognized its importance in calling attention to the interconnectedness of the entire global environment. Others cited specific research that they claim contributes to the view of Earth as a living organism. The father of the Gaia theory, British scientist James Lovelock, writes: "Organisms do not just 'adapt' to a dead world determined by physics and chemistry alone. They live with a world that is the breath and bones of their ancestors and that they are now sustaining."

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NPCA Commission on Research and Resource Management Policy in the National Park System

By Carol Aten and David Jervis

For years the Service has sought to convene a panel of outside experts to review our research and resource management functions. Point Six of Director Mott's 12-Point Plan (Expand the Role and Involvement of Citizens and Citizen Groups at All Levels in the National Park Service) proposes the following action: "Establish a Blue Ribbon Panel to Examine NPS Policies About Natural and Cultural Resources and to Recommend How These Policies May be Improved." The Service had not yet been able to establish such a "Blue-Ribbon Panel" under the Federal Advisory Committee Act.

This spring, the National Parks and Conservation Association (NPCA) secured funding for such an effort, and sought the Service's cooperation in it. Director Mott has welcomed this initiative, and asked that courtesy and cooperation be extended to the NPCA group. At the same time, he emphasized that: "This effort is independent and I do not expect to be able to influence its conclusions. Conversely, we will not be bound to follow its recommendations. However, the quality of the appointees and the public interest in the subject leads me to conclude that we should provide information and support."

NPCA has selected 17 distinguished experts in the natural, cultural and social sciences to comprise the panel (Commission). The Commission members and their backgrounds are listed at the end of this article, along with the members of a counterpart NPS "coordination group," which is to provide information and assistance to the Commission. The Service's coordination group was chosen by discipline to parallel categories used to select the Commission. Director Mott instructed the NPS coordinators that they are to represent their peers and the Service, not just themselves.

The Commission held an organizational meeting in Washington, D.C., on April 19, 1988. At a get-acquainted dinner the previous evening, NPCA President Paul Pritchard emphasized the Commission's independence from both NPCA and the Service. In his opening remarks, Deputy Director Dennis Galvin underscored the need for the Commission, and the variety of issues they could face. Paul Schullery, Editor of *The Country Journal*, spoke on resource management challenges and reflections on discussions he had had with Starker Leopold.

In 1963 the "Leopold Report" reviewed the Service's wildlife management practices and launched us on the concept of ecosystem management. The NPCA Commission was likened to the Leopold group, but with a mandate to review and make recommendations on the full range of the Service's research and natural and cultural resource interests, plus the social science aspects of park visitation. In an attempt to accomplish this broad mandate in an interdisciplinary way, the Commission organized into three subcommittees as follows:

(1) Values and purposes of national parks, and of science and research in the parks.

(2) Resource management policies and comparison of the NPS research/science program to other research/science programs.

(3) Addressing the interface between research and resource management.

Personnel throughout the Service are strongly encouraged to contribute their thoughts and comments to this historic effort. You may do so in two ways - by contacting one or more of the NPS repre-

sentatives or by letter to the NPCA staff member providing primary support to the Commission:

Mr. David Simon

National Parks and Conservation Association

1015 Thirty-First Street, N.W.

Washington, D.C. 20009

(Telephone (202) 944-8530)

The NPCA staff will assure that information is forwarded to Commission members.

The Commission Chairman, Dr. John C. Gordon (Dean of Yale University's School of Forestry and Environmental Studies), believes that at least a draft copy

of Commission findings and recommendations should be completed by the time of the presidential election in November. This will require intensive effort over the summer months. Such efforts will involve individual investigation, subcommittee meetings, and meetings and investigations by ad hoc groups of Commission members. Meetings of the full Commission are tentatively scheduled for:

(1) Mid-August in California in connection with the meetings of the Ecological Society of America and the American Institute of Biological Sciences; and

Editor's Note: *The work of this Commission represents the kind of effort that happens only once in a generation, and members of both the Commission and the NPS Coordinating Group have expressed their earnest desire to "hear from the field" any thoughts or suggestions that should go into their deliberations. With the idea that field personnel may feel more effective or more comfortable communicating with some particular member of either group, Park Science presents this full list of Commission and Coordinating Group members.*

NPCA Commission on Research and Resource Management Policy in the National Park System

1. **Dr. John C. Gordon (Chairman)**, Professor of Forestry and Environmental Studies, and Dean of the Yale School of Forestry and Environmental Studies, New Haven, CT.

2. **Dr. Robert Dean**, Professor of Coastal Engineering, University of Florida, Gainesville, FL, Director of the Division of Beaches and Shores for the State of Florida, and a member of the National Academy of Sciences coastal advisory board.

3. **Dr. Barbara J. Howe**, Department of History, West Virginia University, Morgantown, WV; Vice-Chair, National Council on Public History.

4. **Dr. Ervin H. Zube**, Professor, School of Renewable Natural Resources, and Adjunct Professor of Geography and Regional Development, University of Arizona, Tucson, AZ, with degrees in landscape architecture from Harvard and geography from Clark University.

5. **Dr. Tim Clark**, Jackson, WY, Adjunct Professor of wildlife ecology at Idaho State University and Montana State University, a consulting biologist to the Wyoming Department of Game and Fish, and Director of the Northern Rockies Conservation Cooperative.

6. **Dr. Stephen P. Leatherman**, Laboratory for Coastal Research, University of Maryland, College Park, MD, Director of the laboratory, and Chairman of the Board of the Climate Institute.

7. **Mr. Robert Cahn**, Leesburg, VA, a Pulitzer Prize-winning journalist and author and a past member of the Council on Environmental Quality with 20 years of experience in writing about national parks and park policy.

8. **Dr. Sarah Bishop**, Washington, D.C., holder of a doctorate in education, President of the Cave Research Foundation, and founder of "Partners in Parks," devoted to enhancing cooperative research efforts between universities, the private sector, and the NPS.

9. **Dr. Douglas Latimer**, Gaia Associates, San Rafael, CA, a partner in a consulting firm that specializes in air quality work.

10. **Dr. George Gumerman**, Professor of Anthropology, University of Southern Illinois, Carbondale, IL, a leading archaeologist of the Southwest, currently on sabbatical at the School of American Research of the University of New Mexico and the Museum of New Mexico in Santa Fe and founder of SIU's Center for Archaeological Investigation.

11. **Dr. Benita Howell**, University of Tennessee, Knoxville, TN, professor in the Department of Anthropology, where she specializes in ethnography, cultural resources management, cultural conservation, and the role of public land management agencies in these topics.

12. **Dr. Jerry Franklin**, College of Forest Resources, University of Washington, Seattle, WA, on sabbatical from his position as the Chief Plant Ecologist, U.S. Forest Service.

13. **Dr. Russell Cahill**, Manager, Kings County Dept. of Recreation and Parks, Mercer Island, WA, former Director of the state park systems of both California and Alaska, has served with the Council on Environmental Quality, as Deputy Commissioner of the Washington Department of Natural Resources, and as superintendent of Haleakala National Park in Hawaii.

14. **Dr. Ralph W.E. Jones, Jr.**, Director, Department of Recreation and Parks, Baltimore, MD, directs the City of Baltimore's park and recreation programs and is Chairman of the Recreation Roundtable, a group of the top 35 park and recreation administrators from the major cities of the nation.

15. **Dr. William R. Burch, Jr.**, Professor of Forestry, Yale School of Forestry and Environmental Studies, New Haven, CT, Director of the School's Tropical Resources Institute.

16. **Dr. Harold Mooney**, Professor of Biology, Department of Biological Sciences, Stanford University, Stanford, CA, pioneered work on plant physiology and genetics, a member of the National Academy of Sciences, and President-elect of the Ecological Society of America.

17. **Dr. Victoria Wyatt**, Division of Art History, University of Washington, Seattle, WA, Assistant Professor of Art History at the University and Curator of Northwest Indian Art at the Burke Museum.

(2) Mid-November, in Tucson, in connection with the triennial meeting of the George Wright Society.

In letters to Dr. Gordon and other Commission members, Director Mott emphasized the importance and diversity of the policy issues the Commission will be considering, as the Service faces increasingly difficult challenges in our research and resource management functions. Dr. Gordon has challenged the Commission to produce a report with as much grace, philosophy and substantive guidance as the Leopold Report.

The Commission has taken on a sorely needed but daunting task.

Aten is Chief and Jervis is Assistant Chief and Supervisory Program Analyst in the NPS Washington Office of Policy.

NPCA Focuses on Protecting, Planning for Parks of the Future

The National Parks and Conservation Association (NPCA) used the occasion of its March 15-16 meeting in Washington, D.C. on Protecting and Planning for Parks of the Future to present its recently released National Park System Plan: A Blueprint for Tomorrow. The Plan, over 2,000 pages in length, recommends establishment of the NPS as an independent agency directly responsible to Congress and the President; enactment of specific legislative mandates and increased funding, for science, resources management and interpretation; establishment of an independent research arm within the Park

Service, and significant land acquisition and boundary adjustments . . . recommendations sure to create considerable discussion and debate in coming months.

NPCA President Paul Pritchard announced appointment of an interdisciplinary commission to review the NPS science and resource management program. Under the leadership of John Gordon, dean of the Yale School of Forestry, the Commission on Science and Resource Management Policy will assess resource policy and implementation strategies. (See story p. 16 this issue.) They will work closely with NPS professionals and other informed parties to assess current policy and program status and offer philosophical and technical guidance for improving the effectiveness of the NPS science program.

Congressman Bruce Vento, Chairman of the House Subcommittee on National Parks and Public Lands, challenged the meeting to better understand and protect park resources. He discussed his recently submitted legislation to establish the NPS as a separate agency with the Director appointed by and accountable to the President and the Senate. Vento expressed concern over what he sees as increased and inappropriate influence of political forces in the Interior Department on NPS matters. He also focused on the recent fee legislation, which was designed to supplement and enhance the Service efforts in science, resource management and interpretation, not, as is now being proposed, to supplant or replace base budget items. Other speakers in the introductory session included Deputy NPS Director Dennis Galvin and former Director George Hartzog.

Symposia and workshops included sessions on Providing Park Protection through Legal Measures, Innovative Financial Programs, Alternative Means of Providing Funding and Protection for Parks, Efforts to Protect Peripheries of Parks, Integrating Science and Resource Management (including Larry Belli and John Dennis of NPS-WASO), Concessions and Tourism (David Gackenbach, Chief of Concessions, WASO), Carrying Capacity: Current Applications (David Parsons, Sequoia and Kings Canyon), and Education and Interpretation (Rob Milne, International Affairs Office, WASO).

A closing session on Achieving Balance Between Preservation and Use made for lively discussion among George Fleharty (President of ARA Outdoor World, the concessioner at Denali) on the importance of concessioners working with the Park Service to assure long term resource preservation, writer Paul Schullery on his experiences in the Yellowstone ecosystem, and Alaska Regional Director Boyd Evison on a manager's view of the difficulties in balancing preservation and use.

The meeting, which also included presentations by Sen. John Chafee and Cong. Wayne Owens, was well attended by park professionals, including a smattering of NPS managers and resource professionals. Next year's NPCA meeting will focus on presenting the recommendations of the Gordon Blue Ribbon Commission on Science and Resource Management Policy, in effect updating the 1963 Leopold Report.

David J. Parsons
Research Scientist
Sequoia Kings Canyon NPs

National Park Service Coordination Group

LEAD LIAISON

Carol F. Aten, Chief, Office of Policy, National Park Service (022), P.O. Box 37127, Washington, DC, 20013-7127. 202-343-7468.

NATURAL RESOURCES

Forest Ecosystems: Susan P. Bratton, Institute of Ecology, University of Georgia, Athens, GA 30602. 404-542-2968.

Wildlife/Ecosystem Management: David M. Graber, Research Scientist, Sequoia and Kings Canyon NPs, Three Rivers, CA 93271. 209-565-3341.

Air Quality: Christine L. Shaver, Chief, Policy, Planning and Implementation Branch, Air Quality Division, National Park Service, P.O. Box 25287, Denver, CO 80225. 303-969-2071 (FTS 327-2071).

Coastal/Marine Environments: Gary E. Davis, Research Marine Biologist, Channel Islands NP, 1901 Spinnaker Drive, Ventura, CA 93001. 805-644-8157.

Earth Sciences: Dan B. Kimball, Chief, Policy, Planning and Evaluation Branch, NPS Water Resources Division, P.O. Box 25287, Denver, CO 80225. 303-969-2813 (FTS 327-2813).

CULTURAL RESOURCES

History: Barry Mackintosh, Bureau Historian, History Division, National Park Service (418), P.O. Box 37127, Washington, DC 20013-7127. 202-343-8169.

Curatorial Historic Preservation: Katherine H. Stevenson, Associate Regional Director, Cultural Resource Management, Mid-Atlantic Region, National Park Service, 143 South Third Street, Philadelphia, PA 19106. 215-597-0652.

Architecture Landscape: Hugh C. Miller, Chief, Park Historic Architecture Division (422), National Park Service, P.O. Box 37127, Washington, DC 20013-7127. 202-343-8146.

Archeology Anthropology: Douglas H. Scovill, Chief, Anthropology Division (434), National Park Service, P.O. Box 37127, Washington, DC 20013-7127. 202-343-8161.

SOCIAL SCIENCE

Socio-economics: Donald R. Field, Cooperative Park Studies Unit, College of Forestry, Oregon State University, Corvallis, OR 97331. 503-754-2056.

Recreation/Leisure: Robert W. McIntosh, Jr., Superintendent, Gateway NRA Headquarters, Building Number 69, Floyd Bennett Field, Brooklyn, NY 11234. 718-338-3338 (FTS 665-3575).

Education: William E. Brown, Research Historian, Denali National Park and Preserve, P.O. Box 9, Denali Park, AK 99755. 907-683-2294.

GENERAL

G. Bryan Harry, Pacific Area Director, National Park Service, P.O. Box 50165, Honolulu, HI 96850. 808-541-2693 (FTS 551-2693).

Ernest W. Ortega, Superintendent, Wind Cave NP, Hot Springs, SD 57747. 605-745-4600.

J.T. Reynolds, Chief, Resource Management and Visitor Protection, NPS North Atlantic Regional Office, 15 State Street, Boston, MA 02109-3572. 617-565-8850 (FTS 835-8850).

interpretation notes

The biological diversity interpretation program, designed to carry out NPS Director Mott's designation of biological diversity as the interpretive theme for 1989 in the National Park System, was presented to the NPS Regional Directors at their May 31 meeting in the Grand Tetons, according to Dick Cunningham, Western Region interpretation chief and author of the plan.

(Details of the program planning and make-up of the committee chaired by Cunningham were carried on page 16 of *Park Science*, Spring issue.)

Following approval by the RDs, the plan will be dis-

tributed Servicewide and will be discussed in the Fall issue of *Park Science*.

. . .

Fossil Area Parks will be the subject of the Sept. 13-16 Interregional Resources Management/Interpretation Workshop to be held in Holbrook, AZ, near the Petrified Forest National Park. As with preceding workshops in other subject areas, this workshop will be led by Dick Cunningham and will be aimed at interpreters, scientists, and resource managers.

Cunningham, the Western Regional Chief of Interpretation, has had great success in closing the gaps between interpretation and scientific research (which furnishes much material of interest for interpretation) and between interpreters and resource managers (who often need their messages heard by the visiting public).

meetings of interest

1988

- July 5-8, INTERNATIONAL ASSN. FOR IMPACT ASSESSMENT (IAIA) ANNUAL MEETING**, at Griffith University, Brisbane, Australia. Meeting theme: "Integrating Impact Assessment in the Planning Process." Contact: Rabel J. Burdge, Institute for Environmental Studies, University of Illinois, 408 S. Goodwin Ave., Urbana, IL 61801; (217) 333-2916.
- August 7-11, ELEVENTH NORTH AMERICAN PRAIRIE CONFERENCE**, on "Prairie Pioneers: Ecology, History & Culture": at the University of Nebraska-Lincoln. Abstracts due March 1. Contact: Thomas B. Bragg, 11th NA Prairie Conf., Dept. of Biology, University of Nebraska at Omaha, Omaha, NE 68182-0040; (402) 554-3378.
- August 14-18, SOCIETY FOR CONSERVATION BIOLOGY**, Second Annual Meeting, to be held jointly with the American Institute of Biological Sciences and the Ecological Society, at the University of California, Davis. Contact Christine Schonewald-Cox, Institute of Ecology, Wickson Hall, U/Cal, Davis, CA 95616; (916) 752-2088.
- August 30-September 4, SECOND WORLD CONGRESS ON HERITAGE PRESENTATION AND INTERPRETATION**, at University of Warwick, near Coventry England; theme, "Preparing for the 90s." Sponsored by the Centre for Environmental Interpretation (CEI), the Society for the Interpretation of Britain's Heritage (SIBH), and in association with the University of Surrey. A Provisional Programme and Registration Form will be available from the Congress Office, Aldine House, 9-15 Aldine St., London W12 8AW. Approximate cost will be 300 pounds, for accommodations and registration.
- September 11-14, 9TH NATIONAL TRAILS SYMPOSIUM**, at Unicoi State Park in Helen, GA, co-sponsored by the National Park Service and the U.S. Forest Service. Contact: Helen Freilich, FTS 8-250-2451, (404) 546-2451.
- September 13-15, RESEARCH IN CALIFORNIA'S NATIONAL PARKS**, Third Biennial Conference, at U/Cal Davis, for presentation and discussion of research related to the biological, physical, and sociological resources of California's National Parks. Contact: CPSU/Institute of Ecology, U/Cal/Davis, CA 95616; (916) 752-6086.
- September 13-16, INTERREGIONAL RESOURCES MANAGEMENT/INTERPRETATION WORKSHOP ON FOSSIL AREA PARKS**; at Holbrook, Ariz. Contact Dick Cunningham, NPS Western Regional Office, or Superintendent, Petrified Forest NP.
- September 19-22, SECOND GLACIER BAY SCIENCE SYMPOSIUM**, at Glacier Bay Lodge, Gustavus, AK, sponsored by Glacier Bay NP&P, Friends of Glacier Bay, and the Glacier Bay Science Board. Contact: Gary Vequist at Glacier Bay or Alexander Milner, P.O. Box 90316, Anchorage, AK 99509; (907) 561-1020.
- September 22-24, SECOND CALIFORNIA RIPARIAN SYSTEMS CONFERENCE**, at U/Cal Davis, to report on issues surrounding destruction of streamside lands and progress in learning to manage these resources since the first conference in 1981. Contact: Dana Abell, (916) 752-3098.
- September 30-October 2, ANNUAL SYMPOSIUM OF THE AMERICAN ACADEMY OF UNDERWATER SCIENCES**; theme, "Advances in Underwater Science"; at Scripps Institution of Oceanography, La Jolla, Cal. Contact: Mike Lang, San Diego State Univ. Biology Dept., San Diego, CA 92182. (619) 265-4676.
- October 11-13, SAGIS/GRASS USERS CONFERENCE FOR NPS PERSONNEL**, at Shenandoah NP. Contact: Allison Teeter, Shenandoah NP; (707) 999-2243.
- November 10-13, THIRD CHIHUAHUA DESERT SYMPOSIUM**, at Sul Ross University in Alpine, Tex. Contact: John Bissonnette, professor of wildlife research, Utah State Univ., Logan, UT 84322-5210.
- November 14-18, CONFERENCE ON SCIENCE IN THE PARKS**, sponsored by the George Wright Society with the National Park Service and co-chaired by R. Roy Johnson, Leader of the NPS/CPSU at University of Arizona, Tucson, AZ 85721, (602) 762-6501 and James Judge, Director, Fort Burgwin Research Center, P.O. Box 300, Ranchos de Taos, NM 87557, (505) 758-8322.

Biodiversity Workshop Leads to NPS Strategy

By John McCrone

An intensive workshop on biological diversity, involving selected university scientists, NPS managers, scientists and Washington office personnel, and representatives from the National Science Foundation, the Office of Technology Assessment, USFS, the USFWS, and the Park Service-Environment Canada, was held in Gatlinburg, Tenn. on May 3-5, 1988.

The workshop was sponsored by the National Science Foundation, the National Park Service, and the Society for Conservation Biology and hosted by Great Smoky Mountains NP.

Six focus groups were organized around these topics: (1) management, (2) inventory and monitoring, (3) viable populations, (4) dynamic processes, (5) human disturbance, and (6) integration into larger units. The hard-working, product-oriented groups, after spirited discussions, turned in reports containing a wealth of material for further evaluation and action. The reports were delivered by group leaders or their designees to NPS Assoc. Director for Natural Resources Eugene Hester, SE Regional Director Bob Baker, Alaska Regional Director Boyd Evison, Timothy Lawlor (representing the NSF Directorate), and Peter Brussard (representing the Society for Conservation Biology).

The day after the workshop, at the request of NPS Director Mott, most of the NPS participants met to discuss an NPS strategy for developing a plan in biodiversity that would respond to the issues and challenges raised at the workshop. Three groups were formed: two reviewed the reports produced by the focus groups, the third considered questions of missions, goals, and objectives.

Reports from these three groups were used to draft a letter to Director Mott, outlining the recommendations of the NPS participants in the workshop and will be used as a basis for development of a more detailed and comprehensive biodiversity program for the NPS.

Organizers of the biodiversity workshop (Brussard, SE Regional Chief Scientist Dominic Dottavio, and John McCrone of the Clemson University NPS-CPSU) are presently compiling all the material presented at these sessions and are preparing a series of articles that will be published in *Park Science* and other appropriate outlets.

Summer Workshops Set

The two summer wilderness work skills programs remaining in the 1988 series sponsored by the Student Conservation Association, Inc. (PO Box 31989, Seattle, WA 98103) will feature Revegetation and Rock Structures.

The revegetation sessions will take place August 26-28 at North Cascades NP Mt. Baker-Snoqualmie NF and will deal with sub-alpine site restoration, revegetation, and greenhouse culture of native plants. The rock structures session, September 1-3, will be held at Mt. Baker-Snoqualmie NF and will focus on backcountry use of rock as a building material - drywalls and steps, stone structures to carry trails across boulder fields, perfect switchback turns, rigging systems for hauling materials to work sites, and emphasis on tools of the trade such as stone hammers, rock bars, and gasoline-powered drills.

Tuition for both programs is \$200, which includes room and board.

Oops!

A rose is a rose is a rose ...

And a butterfly is not a moth.

Eagle-eyed Gerald McCrea, assistant IPM coordinator in the NPS Washington Office, called editorial attention to the "buckeye moth" on page 19 of the Spring issue of *Park Science*. Butterflies, he pointed out, have the knobbed antennae so nicely shown in the picture. Moths, on the other hand, have feathery antennae.

This information reached us, appropriately, just before Mother's Day, and we are happy to set the record straight.

Divers to Meet

The American Academy of Underwater Sciences (see Calendar for meeting dates), dedicated to the advancement and practice of scientific diving, has organized the 1988 Symposium to bring together diving scientists on a national scale and to provide the opportunity to share information on a variety of aspects of underwater science.

In addition to the symposium, diving workshops and local diving excursions have been scheduled before and after the symposium.

Managers and Researchers Examine Vandalism and its Prevention

By Cynthia Miner, Editor

Pacific Northwest Research Station, USDA Forest Service

How are practitioners and researchers tackling the problem of vandalism? This question was answered by the participants of the International Symposium on Vandalism: Research, Prevention and Social Policy held in April in Seattle. Park, forest, and city managers; archaeologists; sociologists; psychologists; law enforcement experts; and others shared their approaches to the problem.

One approach is to examine the ingredients of anti-vandalism programs. Willhem van Vliet, associate professor, University of Colorado, identified six main efforts of the programs presented at the symposium: 1) increase awareness of the community (including the employees of the park, forest, or city) that vandalism is a problem, 2) increase communication between groups involved, 3) obtain funding, 4) recruit volunteers, 5) get law enforcement support, and 6) make the targets of vandalism difficult to harm.

After a sudden increase in crime in the Caribbean National Forest, Puerto Rico, all these efforts were made. The result – a drop in criminal incidence from 86 in 1986 to 32 in 1987, as reported by District Ranger of the Forest, Daniel Nolan. Regarding projects to reduce vandalism of archaeological sites in the Coconino NF in Arizona, Peter Pilles Jr., archaeologist, said in addition to strong law enforcement and agency presence, "public involvement and the development of partnerships are the final key for promoting public responsibility and help in the protection of public resources." The project in-

cluded children, ages 9 to 12, helping to excavate and develop interpretive sites and to clean graffiti from pictographs.

Another related approach to vandalism is to find out who the vandals are and why they vandalize property. Devon Brewer, student, University of Washington, closely observed one type of vandal, nongang graffiti writers. As in other papers presented about vandals at the symposium, Brewer and coauthors Harriet Christensen, social scientist, USDA Forest Service, and Mark Miller, associate professor, University of Washington, found that graffiti is a group activity of mostly 12- to 20-year-old males.

Researchers at the symposium presented papers analyzing a variety of management issues. Darryll Johnson, NPS rural sociologist, and Thomas Swearingen, research assistant, University of Washington, found signs near problem sites deter off-trail hikers, particularly signs warning "off-trail hikers may be fined," which reduced off-trail hiking by 75 percent in the study.

Two hundred and fifty participants attended the symposium sponsored by the USDA Forest Service, University of Washington, and Vandalism Alert, Inc. and co-sponsored by NPS. Another symposium is planned for spring 1990 in Calgary, Alberta, Canada. The proceedings from the 1988 symposium are being prepared jointly by the Park Service and Forest Service and will be available in 1989.

Clearing the Air Program Update

Training and materials to help interpreters launch the NPS Clearing the Air program are on the way. Training teams from nine Regions sharpened their knowledge, reviewed interpretive media, and developed lesson plans on air quality and acid rain at a workshop held at the Albright Training Center Feb. 22-26, 1988. Discussion of scientific and political constraints was particularly lively, as it is likely to be when these teams conduct training in their Regions. Regional training, assisted by seed money from WASO Interpretation and Natural Resources, is scheduled for various times during 1988. Contact your Regional Training Officer for further details.

A Servicewide slide-script program on visibility, ozone, and acid rain, and a slide collection on acid rain, were nearing completion in May, as was the videotape on NPS acid rain research. Barring unexpected delays, these materials should be available this summer. Ten copies of the slide-script program, 10 of the slide collection, and 2 or 3 of the videotape will be distributed to each Regional Chief of Interpretation.

The contract for a computerized encyclopedia on air quality acidic deposition has been awarded. Carefully reviewed information on air pollutants, their effects on cultural and natural resources, and control and mitigation strategies, at the global and North American level, and in three pilot biogeographical cultural regions should be available next year. During the succeeding two years, modules for the other biogeographical-cultural regions, and for parks, will be developed. This project, which will provide information in both textual and graphic forms, promises to have long-term value for both interpretation and management.

Last October an information packet on air quality acidic deposition was mailed to 258 Chief Park Interpreters. Most of the items in this packet, plus an article – "Trouble with the Rainbow: Acid Deposition in the National Parks" – and conclusion sections from the Interim Assessment of the National Acid Precipitation Assessment Program are still available from the Washington Office. Contact Napier Shelton, National Park Service (490), Department of the Interior, P.O. Box 37127, Washington, D.C. 20013-7127. Phone: FTS 343-8136 or (202) 343-8136.

Napier Shelton
NPS Washington Office

Biological Controls Feed 'Em or Lose 'Em

"Tansy Flea Beetle Wins Ragwort Sweepstakes at Redwood NP"

This headline article by Lorraine J. Holden, a Redwood NP biological technician, told the story (*Park Science*, Vol. 5 No. 4, pp. 10-11) of how 225,000 "tiny, golden, and deadly" beetles were quietly chewing to death the tansy ragwort that was then rampant in and around the park.

"We hope a few beetles survive," Holden wrote. The problem, like most fine-tuning, ecosystem problems, is a close call. The beetles work more slowly than do chemicals. They eat the problem up, but eventually their cupboard is bare.

Now comes a story in the Oregon State University agricultural experiment station's *Progress* (Winter/Spring 1988), suggesting that the flea beetle may have been all too successful. While the cinnabar moth and the flea beetle are munching their way to extinction, the tansy ragwort's sturdy seeds lurk in the soil. Peter McEvoy, an OSU entomology professor, reports finding 6,000 viable seeds buried in the top soil of a one-square-meter area. "And they just seemed to stay at that level," he said. "Their decline and decay is immeasurably slow." Any soil disturbance could start another epidemic.

So what is Oregon doing about it? Can you believe a tansy ragwort nursery? A field of tansy near Salem, Ore., is being used to nurture a good

population of beetles for spot inoculations in problem areas.

Eric Coombs, a biological control entomologist with the Oregon Department of Agriculture, gives the lion's share of credit for tansy control to the flea beetle. It's almost invisible unless you know what you're looking for, and gets far less attention than its larger, more colorful partner, the cinnabar moth. But "at this point," Coombs said, "the flea beetle is the real workhorse and the moth just gets most of the credit."

Meanwhile, back at the Redwoods, the tansy population within the park is at "very low level," according to Mary Hektner, the park's supervisory botanist. She reports that Del Norte County control officer Ken Collins has set out some plants as food for the beetles. The park is experimenting with its small remaining tansy population by clipping the seed heads, thus leaving some food for the beetles while denying them their former banquet.

As Holden wrote four years ago: "Biological control operates within the parameters of the environment – at nature's pace. Faith and patience are prerequisites for a successful management program. Biological control can offer a cost effective, ecologically sound, self-sustaining method for exotic plant control... It's a methodology well worth looking into."

GIS Notes

SAGIS/GRASS Users To Meet

The first GIS Users conference for National Park Service users of the GIS family of software will be held Oct. 11-13, 1988, at Shenandoah NP. The conference will bring together for the first time as many NPS users of GIS as possible to exchange information and ideas about their use of GIS technology.

Short, delivered papers will describe applications and activities. Conferees will discuss and set general directions for the NPS GIS program, including such issues as data base construction, software, hardware, and staffing.

More GIS Notes will appear in the Fall issue of *Park Science*.

Subalpine and Montane Revegetation in Yosemite

By Richard L. Hadley and Barbara J. Moritsch

The Tuolumne Meadows region of Yosemite National Park is a scenic and fragile subalpine region easily reached by California State Highway 120. As a result it has experienced extensive damage from high levels of human use. In the summer of 1987, a revegetation program was begun, designed to restore heavily impacted wilderness campsites and trail segments currently closed to use. Methods that prove effective will be incorporated into the park's Comprehensive Wilderness Restoration Plan, now under development.

Subalpine Vegetation

Twenty-seven subalpine sites received a variety of soil and plant restoration treatments. Within these sites, experiments were conducted on 37 subalpine plant species. Field tests included direct transplants, seeds and the use of cuttings. Following treatments, interpretive signs were installed for site protection.

In addition to site rehabilitation, a controlled trampling study was set up to evaluate individual species and plant communities for their relative resistance to trampling. Data were collected on three species and two different plant communities.

To assess accurately the nursery propagation potential of subalpine plant species, the park established an interagency agreement with the Soil Conservation Service (SCS). Stock plants and seeds from seven different species were collected and transported to the SCS plant materials center in Lockeford, Calif., where they are being propagated by seed and division.

Several years will be required for accurate assessment of the program's effectiveness, but preliminary results are encouraging. Six of the seven species under propagation by SCS exhibited good top growth and root growth and were divided in mid-March. *Carex exserta* has responded poorly to treatments with a 30 percent mortality rate. Of the seeds tested, *Calamagrostis breweri* has shown the most promise with a 90

percent germination rate. Other species being tested are *Juncus parryi*, *Carex rossii*, *Oryzopsis kingii*, *Deschampsia caespitosa* and *Antennaria* species.

Visually, direct transplanting has been immediately successful at mitigating camping impacts on many sites. Monitoring of these sites in 1988 will determine mortality, survival and seed germination rates. Field trials will be expanded to include an extensive portion of the John Muir Trail that has been closed and rerouted. Controlled trampling plots will be monitored to determine long and short term effects, and treatments will be replicated to verify results.

Montane Meadow Revegetation

In addition to the subalpine work, a montane meadow restoration project was undertaken in Yosemite Valley. Stoneman Meadow is the most abused and least pristine of Yosemite's meadows. Aerial photographs taken in July 1987 revealed the extent of the damage. Less than 25 acres in size, the meadow was bisected by 27 substantial trails that totaled 1.5 miles of tread. Trails ranged in width from 1 to 5 feet.

A restoration plan was implemented in October 1987 with funding provided by Chevron USA, through a grant of \$104,000 to the Yosemite Association. The revegetation work was completed by the San Francisco Conservation Corps under direction of NPS resources management and trail maintenance personnel.

To protect the restored treads, use was diverted out of Stoneman meadow by installation of interpretive signs. A temporary redwood post and rope fence was constructed around the meadow and along one major trail, which bisects the meadow's eastern margin. This trail was selected as a compromise to allow concentrated access across the meadow. The trail's condition will be monitored and the data collected will guide management decisions as to what type of trails should be maintained in montane meadows. Other options and types of surfaces under consideration include:

complete removal of the trail or construction of an elevated boardwalk, rock causeway and asphalt.

Meadow trails selected for restoration were scarified, planted with direct transplants, sown with native seed and temporarily irrigated. Unfortunately alien grass species dominate in what was once a meadow of native wildflowers, grasses, sedges and rushes. In light of this, revegetation efforts attempted to match the existing vegetation mosaic and not the mosaic that existed prior to European influences. However, native species were utilized whenever possible.

Where a trail bisected a relatively pristine stand of native plants, natives were targeted. At the mouth of the largest trails western raspberry (*Rubus leucodermis*) was transplanted to form thickets as an additional deterrent to human use. The result of matching planting prescriptions with adjacent vegetation is a blending effect, which softens the abrupt edges of trail scars. Camouflaging the site in this manner also helps protect the site from visitors.

As with the subalpine restoration project, the results are encouraging but not yet conclusive. Prior to winter snows, transplants exhibited several inches of new growth. By February, 1988 raspberries still above the snow appeared healthy and survival rates are expected to be high. The ultimate success of any revegetation program depends on the effectiveness of restoration techniques and the continued protection of sites from additional use. The subalpine sites and Stoneman Meadow have been given a chance to recover. The final ingredient in this process is time. Given sufficient time and protection, these areas will heal.

Project summaries and preliminary results are available from the Resources Management Division. For additional information, contact Richard Hadley, Yosemite National Park, P.O. Box 577, Yosemite, CA 95389 (FTS 448-4318, Comm 206-452-4501).

Hadley is a year-round seasonal Biological Technician who has designed and implemented Yosemite's Revegetation Program, working with the North Cascades and Olympic NPs revegetation programs.

Moritsch is a seasonal Biological Aid with the Yosemite Revegetation project in the summer. She was a seasonal interpreter at Death Valley National Monument.



After careful preparation and treatment (Jerome Shaw waters *Trisetum spicatum* (left), the camp site at Budd Lake looked like this (right). Budd Lake is 10,000 feet up in the Cathedral Range, Yosemite NP.

Shenandoah Science Symposium Features Air Pollution and Gypsy Moths

"Clearing the Air," appropriately, was the theme of the 11th Shenandoah Research and Resource Management Symposium, held in the park May 5-6. It was appropriate not only because this is the kick-off year for increased interpretive focus on air quality/acid rain, but also because Shenandoah NP is the focus of some of the Service's most important research on air pollution effects.

Some 70 attendees, including university scientists, members of state agencies, NPS staff, and assorted friends of the park, heard talks on the air quality monitoring program, the University of Virginia's mountain cloud study, the Virginia trout stream survey, and the legal side of air pollution, as well as an interesting mix of reports on gypsy moths and other important work underway in the park.

The messages on air pollution were not encouraging. Jim Watkins, a park staff resource management specialist, said that average hourly ppm for ozone and sulfur dioxide has remained stable over the past 5 years, but ozone measurements have twice reached .12 ppm, the maximum allowable under federal law, and ozone damage is evident on milkweed and white pine. Fifty percent of the time the visual range is under

39 km — a sad state in a park where long-distance views from Skyline Drive have been one of the most inspiring features.

John Sigmon, director of the Mountain Cloud Water Chemistry/Forest Response Study in Shaver Hollow, reported cloud moisture pH values averaging about 3.8 and reaching as low as 2.9. This ambitious project, one of several mountain cloud studies sponsored by EPA along the Appalachian chain, aims ultimately at an understanding of cloud water and precipitation chemistry and its effects on the forest.

The Virginia trout stream survey, managed by Rick Webb of the University of Virginia, sampled some 360 streams in April 1987 and found 11 percent of them acidic (zero or less acid neutralizing capacity). Modeling predicts a sizable increase in this percentage and pH levels in many streams below the tolerance of brook trout before a steady state is reached. Seventy streams, 10 of which are in Shenandoah NP, will continue to be monitored on a quarterly basis.

How can the Park Service deal with such problems? Banquet speaker Molly Ross from the WASO Air Quality Division counseled additional scientific evidence, better use of the many existing federal, state,

and local laws, and expanded education of the public, which is the ultimate base of action.

Gypsy moths, steadily eating their way south, are another major park concern. Alison Teetor of the Shenandoah staff described the park's gypsy moth risk assessment. A map showing four forest susceptibility classes was created by combining map overlays of forest cover types, which indicates distribution of preferred food species, and elevation classes, which roughly correlate with environmental stress on trees (see **Park Science**, Winter 1988). Corrections in the susceptibility map will be made as the mapping of actual defoliation proceeds. Thus far, more defoliation than expected has occurred in the lower susceptibility classes. Since oaks, a preferred gypsy moth food, dominate in the park, it appears there will be significant changes in forest composition and ecology. Defoliation, which amounted to 1300 acres in 1986 and 6800 acres in 1987, is expected to continue to increase.

Among probable effects of this defoliation is a decrease in mast production. Researchers from Virginia Polytechnic Institute (VPI), who have been studying Shenandoah's black bears since 1982, will assess the short-term and likely long-term effects of gypsy moth infestation on bears. At this symposium, John Kasbohm described the dens selected by 13 radio-collared bears. The majority were in tree cavities. VPI estimates a population of 400-700 bears in the 300-square-mile park.

In a totally different vein, Michael Fies of the Virginia Department of Game and Inland Fisheries reported on a study of northern flying squirrels (*Glaucomys sabrinus*) in Virginia. The two Southern Appalachian subspecies are both federally listed as endangered, and in Virginia the species had previously been recorded at only one location. Two hundred ninety-two nest boxes installed at 22 high elevation sites in western Virginia, which included Shenandoah NP, yielded 19 northern flying squirrels. None have yet been found in the park, but favorable habitat exists there.

The condition and trends of Shenandoah's natural resources will be much better known when the Long-Term Ecological Monitoring System (LTEMS) designed by VPI is established and operating. Several of those involved described gypsy moth, terrestrial, and aquatic components of the system. The gypsy moth component is based on pheromone traps in each 2 square kilometers. The terrestrial component calls for 24x24m permanent plots within seven forest cover types, three elevational classes and two slope aspect categories, in each of three administrative districts, with three plots at each site. This could give a total of 378 plots, depending on distribution of the cover types. The aquatic component consists of 17 100-meter-long stream plots distributed according to district, geological formation/alkalinity, and elevation. Thus, the LTEMS represents a high percentage of the ecological situations that exist in the park.

The symposium reports demonstrated the truth of Supt. William Wade's opening statement: "Shenandoah has one of the National Park System's strongest resource management programs." The 11th biannual science symposium was organized by Chief Resource Manager Dave Haskell and his crew.

Napier Shelton
NPS Washington Office



Revegetation site at Budd Lake in Yosemite NP is prepared by Jerome Shaw (left) and Russ Tenka.

Glacier Bay: What Can Be Learned Here?

Researchers from around the country will meet in Glacier Bay National Park and Preserve Sept. 19-22, 1988, for the Second Glacier Bay Science Symposium. It is rare in today's specialized society to find an interdisciplinary conference planned where papers covering lake ontogeny, bryophyte succession, plate tectonics, and marine mammal biology can all be presented and discussed. That is exactly what marked the success of the last symposium. This year's gallery of scientists again will seek to provide a better understanding of the total interrelationships of the natural systems that shape the park environment.

The five years since the last symposium seems only an "eye wink." But five years in Glacier Bay could equal a century of change elsewhere. For example in five years an open stand of 3-5 foot alder in Wachusett Inlet is now an impenetrable tangle of alder trunks and branches 12 feet high. The site is no longer devoid of large mammals. Alaska willows on the fringe of the alder thicket now support a healthy moose population. And although nearby Carroll Glacier has retreated 2 miles onto the land, glacier sediments are rapidly building an outwash delta, filling in Wachusett Inlet at an incredible rate of 8 meters per year. Recent glacier photographs indicate that the glacier is beginning to surge forward, so another 5 years of advancing ice may erase all these changes.

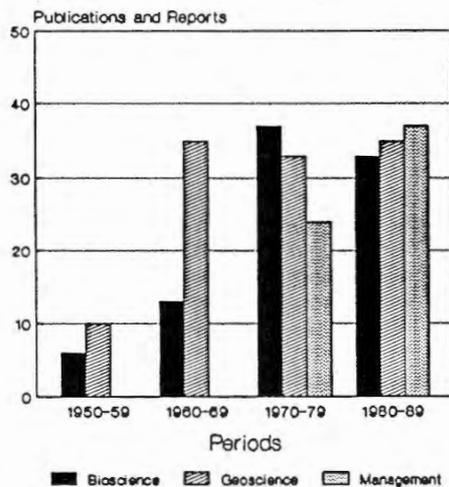
For the past 5 years, Glacier Bay NP has served as a field laboratory for more than 80 separate scientific investigations. In the *Proceedings* for the past Science Symposium, Garry McKenzie wrote a paper on "Research Trends in Glacier Bay Since 1890." He used the titles from the park's bibliography as an indicator of research emphasis in bioscience, geoscience, and resource management.

Early theories relating to plant succession were derived in Glacier Bay and it was this type of research that led the Ecological Society of America to lobby for the park's creation. But geoscience research predominated until the decade of the 70s, probably because of spectacular geomorphic changes that could be studied here. Bioscience research began to increase in the 1960s along with the emergence of ecology as a science. What direction will research take in the next decade? Will the recent increase in resource management directed research mean that we may truly begin to use science as the basis upon which most decisions affecting the park are made?

Stay tuned to this and other NPS stations for the next exciting episodes.

Gary Vequist
Resource Management Specialist
Glacier Bay National Park & Preserve

Research Trends Glacier Bay



Some of the continuing research from the past includes this Institute of Polar Studies weather station at Casement Glacier's 3,500 foot level, operating in August 1965, when Glacier Bay was still a National Monument.

Every Three Years We Meet To Look At Science in Parks

The Third Triennial George Wright Society Conference on science in the national parks will be held Nov. 14-18, 1988, at the Holiday Inn Broadway in Tucson, Ariz. The focus is on international, interagency, interdisciplinary involvement in science, resource management, and education, according to conference co-chairman R. Roy Johnson.

The conference theme is tentatively titled "National Parks, Eco-systems, and Neighbors: Maintaining Diversity Across Political Boundaries," and sessions will deal with biological, cultural, social, and physical aspects as well as management, interpretation, and legal considerations.

A conference highlight will be the involvement of the National Parks and Conservation Association's Commission on Science and Resource Management Policy in the NPS. (See story pages 16, 17 this issue). At the request of NPCA, the Commission will present a status report at a plenary session, to be followed by a workshop that will involve conference participants in a discussion of the Commission's progress.

A call for papers is carried in the current issue of the George Wright Society *FORUM*.

Plenary and keynote speakers will be drawn from within as well as outside the Service. Workshops and mini symposia are being scheduled for 2-3 hour long sessions. Contributed papers will be given as poster sessions; an official call for papers was mailed following the final Steering Committee meeting in May.

Further information and technical questions may be sent to Jim Judge, co-chairperson for cultural sciences, or to Johnson. (See Meetings of Interest for addresses.)

Landscapes Linked To Ecological Processes

"Linking Landscape Structure to Ecosystem Processes" is the title of the Fourth Annual Landscape Ecology Symposium, to be held March 15-18, 1989, at Colorado State University in Fort Collins.

Contributed and invited presentations will address theory, methodology, empirical results, and implications for landscape management.

Abstracts for contributed posters and 15-minute papers should be less than 300 words, double-spaced on a single page. They must be submitted by Nov. 15, 1988, to Dr. Monica G. Turner, Environmental Sciences Division, Bldg. 1505 MS-038, Oak Ridge National Lab, Oak Ridge, TN 37831-6038; (615) 574-8282.

Gagné Will Be Missed

Wayne Gagné, 46, a leader in Hawaiian conservation biology, died suddenly on May 24 in Honolulu. He was an entomologist and an important educator and activist. "His helpfulness, humor, and involvement in Hawaiian conservation circles will be sorely missed by all of us," said Chuck Stone, Research Scientist with Hawaii Volcanoes NP.

Second Glacier Bay Science Symposium – 1988

The principal objectives are:

- 1) Provide bridges for communication among disciplines.
- 2) Present results of research conducted in GLBA during the past five years.
- 3) Examine the relationship between science and management in GLBA.
- 4) Discuss the future direction and role of science in GLBA.

The proposed sessions are:

- 1) Ecosystem development – (Colonization, succession and community development of plants and animals in terrestrial and aquatic ecosystems, etc.)
- 2) Physico-chemical processes (glaciology, geology, oceanography, hydrology, etc.)
- 3) Research related to resource management and human influence (humpback whales, seals, spruce bark beetle, other mammal studies, commercial fisheries, salmon spawners surveys, carrying capacity, anthropology and historical surveys, etc.)
- 4) Science and management: history of science in the park, funding, management utilization and needs of science, implications of biosphere status, direction and role of science in Glacier Bay.

The idea is to move away somewhat from the discipline to the interdisciplinary approach and thus make the sessions more widely ranging in topics

Geologic and Glacial Influences on Surface Water Chemistry, Lake Clark National Park and Preserve, Alaska

By Robert Stottlemeyer and Daniel Chamberlain

The primary objective of our ongoing studies of surface water quality in Alaska's national parks is the establishment of baseline data. The initial phase of each study attempts to relate variation in surface water chemistry to regional geomorphology, while the second phase examines biological factors that may be responsible for observed seasonal variation. Most of the characteristics within a watershed or lake ecosystem cannot be sampled with true replication. Non-parametric statistical means must be employed to distinguish among sampling stations. Comparisons among watershed/lake ecosystems generally are done with co-variance analyses. The end result of such analyses permits us to locate the stations that are representative of the natural variation within the park and, perhaps, some of the ecosystem components or processes likely to be sensitive to natural or human-imposed ecosystem stress.

Lake Clark National Park and Preserve (LACL), (about 1.46 million ha.), is located about 340 km southwest of Anchorage. Geologically it lies at the southernmost end of the Alaska Range and the northernmost portion of the Aleutian Range. Lake Clark, 65 km long and up to 6 km wide, is the largest body of water in the park. LACL makes up a significant fraction of the watershed feeding Bristol Bay, one of the world's most valuable fisheries. The Tazimina River, which drains into the southeastern end of Lake Clark, is the largest spawning area for salmon in LACL. For some time it has been thought that migrating salmon might be a major nutrient source for Lake Clark. The relative proximity of LACL to the Anchorage area via small plane and the considerable private inholdings within the park and adjacent Lake Clark make the park subject to development in the very near future. A major concern is whether this will accelerate eutrophication of this largely oligotrophic lake and watershed system.

Runoff into Lake Clark is dominated by glacial meltwater and "flour" from the Tlikakila River and Current Creek located near the northeastern (NE) end of the lake (Fig.

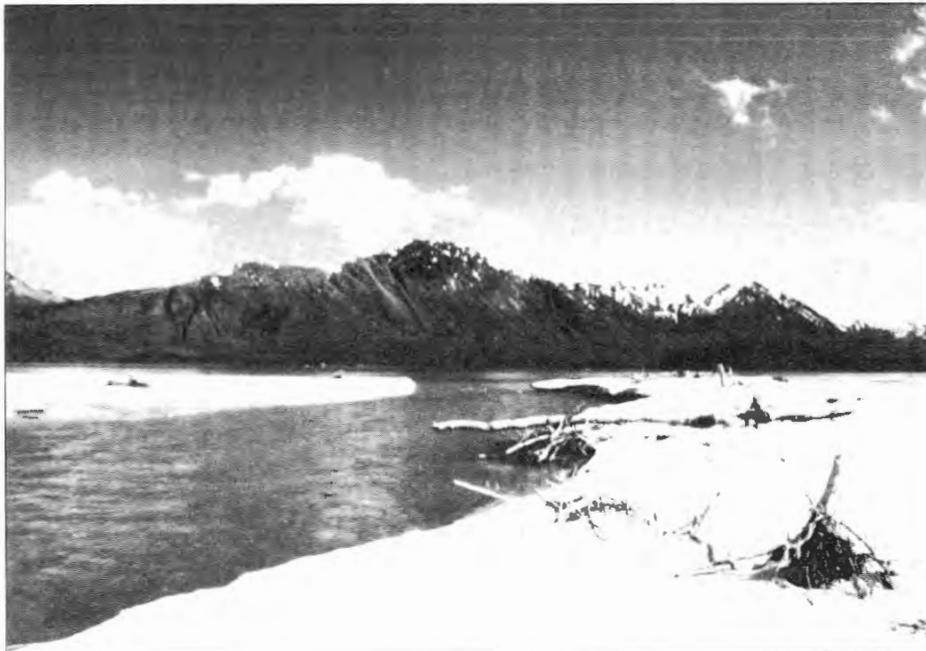


Fig. 1. Current Creek, one of the major sources of suspended and dissolved solids into Lake Clark.



Fig. 2. Eastern end of Turquoise Lake, one of the more northern lakes in Lake Clark National Park and Preserve.

1). These inputs generally peak in late July, resulting in a reduction of compensation depth (depth to which lake primary production by phytoplankton can occur) to 2 m while it remains at its pre-runoff value of 20 m at the southeastern (SE) end of the lake. During August and September, glacial flour input moves down the lake, resulting in decreasing compensation depths throughout.

This glacial flour and associated filterable solids could be a major source of phosphate. It's been hypothesized

that phosphate is the nutrient limiting primary productivity in this lake, thus the concern over cultural eutrophication. Our objective was to quantify some of these potential sources of natural variation in critical nutrients and primary production to better qualify our parkwide baseline data set.

We began our study in 1985. Lake Clark had 15 permanent stations located in it along with 7 additional stations periodically sampled. All major tributaries to the lake were sampled. Ten additional lakes along a 135 km north-south gradient which included Lake Clark also were monitored. Sampling was conducted monthly from June to September with an index station sampled more frequently. Data collected include complete chemical analyses of inorganics; dissolved carbon; total nitrogen; turbidity, filterable and non-filterable solids (suspended and non-suspended sediments); light, temperature, and dissolved oxygen profiles. Several carefully selected stations within Lake Clark also were measured for primary production rates and the effect on production of adding varying levels of phosphate and nitrate to the incubation bottles.

The lakes throughout the park show a pronounced trend in surface water chemistry that reflects change in bedrock mineralogy. Most evident is the ecologically important nutrient potassium, which sharply increases in lake concentration as one goes north in the park (Fig. 2). Conversely, nitrate input, which is mostly from biological fixation in this region of low atmospheric contamination, shows an opposite trend with the highest levels in the southern lakes and tributaries. This reflects differences in biological fixation especially the presence of alders in the lower elevation portions of the park. Inputs into Lake Clark proper also demonstrate this. For example, nitrate input is highest from those tributaries which have alders present. The tributary with the highest carbon input, the Chulitna River, has the lowest nitrate input

In the Next Issue:

Spot news crowded out some great features scheduled for this issue. **Sooo**, the Fall issue will contain "A Cooperative Approach to Water Quality Management: The Delaware River Experience," by Richard C. Albert and Elizabeth A. Johnson; "IPM Notes on Pesticide Use Tracking System (PUTS)" by Christine Cassidy; "The NPS Inventory and Monitoring Initiative – A Hierarchical Strategy (by Ray Herrmann) and An Ecological Imperative," by Herrmann and Terence Boyle; and "Lake Powell Carrying Capacity Study" by Charles W. Wood and Mike Snyder; and extended GIS Notes.

Geologic and Glacial Influences

Continued from page 23

as a result of little or no alders and likely denitrification in its extensive wetland areas.

In Lake Clark most chemical species had their highest concentrations early in the season and in the uppermost NE section of the lake. This was especially true for nitrate. Nitrate declined throughout the season and also down lake on each sampling date except in late summer, suggesting that nitrate was becoming more limiting throughout the season, especially in the lower SE section. Such a situation increases the advantage nitrogen-fixing aquatic species, such as blue-green algae, would have.

What about phosphate? Phosphate levels were always below the level of detection, which limits their direct measurement. However, one can get a relative idea of which nutrients are limiting over the season by inoculating the primary production incubation chambers with varying concentrations of phosphate and nitrate, both individually and in combination.

Most of the phosphate added to an aquatic ecosystem comes from weathering of minerals or possibly recycling from the lake bottom. However, Lake Clark's considerable depth (280m) makes recycling from deep sources unlikely. We hypothesized the following. The very high inputs of glacial flour early in the season would make phosphate relatively abundant in the NE section of the lake, and nitrate could then become limiting. Later in the season with the continued increase and spread of this glacial input of filterable solids throughout the lake, (which we quantified), nitrate would there, also, become more limiting. This might then result in a biological shift in species toward more planktonic nitrogen fixers. And that is essentially what happened.

In June at the most NE station the addition of high nitrate concentrations to the incubating bottles stimulated primary production 50 percent while the addition

of phosphate had no effect or slightly lowered productivity. Conversely, at the lower stations both nitrate and phosphate increased primary production by about 15 percent. By late summer (August), the period of maximum primary productivity (2 - 2.5x the rate observed in July and September), the only station that showed response to nutrient addition was the most NE station, which responded to nitrate. Interestingly, in August the nitrate concentration in Lake Clark shows no NE - SW decline in concentration. In fact it begins to increase in concentration south of mid-lake, suggesting the presence of aquatic nitrogen fixers. By September this lake nitrate concentration trend is gone and the most limiting nutrient generally was nitrate. However, here for the first time the addition of high concentration phosphate had a significant positive effect on primary productivity rates. By September, the filterable solid load had decreased and with it the likely phosphate load to the lake.

In sum, this two-phased approach has given us the following evidence regarding the character and variation of surface water chemistry in LACL. 1) Regional variation in geology is strongly reflected in surface water chemistry, and if one wanted to invest in the monitoring of "representative" ecosystems several would have to be selected. 2) Within Lake Clark proper the nutrients limiting primary productivity vary both spatially and seasonally. 3) Phosphate inputs appear dominated by glacial flour and not migrating salmon. 4) The high productivity response to nitrate addition means that significant portions of the lake's biota would likely respond to nitrate inputs, as from atmospheric contamination. 5) Overall, our evidence suggests that on a seasonal basis phosphate is not the limiting nutrient over much of Lake Clark.

Stottliemyer is a Research Scientist and Chamberlain is a Research Assistant at the NPS Great Lakes Area Research Studies Unit.