PARK SCIENCE

A RESOURCE MANAGEMENT BULLETIN

NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR

VOLUME 2 – NUMBER 2 WINTER 1982

PARK SCIENCE

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WINTER 1982

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

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Cover photo: *Atlantic Ridley turtles tumble out of their shells and into Padre Island sand. (See story page 3).*

In The Next Issue:

"Channel Island Monitoring of Living Marine Resources," Gary Davis; "Gambusia Hang On at Big Ben," Gerard Hoddenbach; "Tree Survivability and the Urban Landscape, Philadelphia," Paul Meyer and Ann Rhoads.

From the Editor,

In the interests of shortening, sharpening, causing words to conform to editorial policies regarding length, relevancy, etc., Ray Herrmann's Letter to the Editor (p. 5) now reads briskly to the point made by James B. Thompson in the prior issue – the need for a science/management dialogue that will work toward synthesis of these two essential efforts on behalf of the National Park System.

What fell under the editorial pencil were three paragraphs from the letter – paragraphs that seemed peripheral at the time of editing, but that in retrospect seem absolutely essential to the whole rationale for holding a dialogue in the first place. They are three paragraphs that deal with "information."

Almost no one argues with the idea that decisions are best when they are **informed.** Take apart the word "information" and you find it has to do with the meaning – the relevance – of something the observer discerns "in form." Thus, the scientist discovers in the form of his subject matter certain meaningful in-form-ation that is relevant to management. The dialogue therefore, consists of communicating and agreeing upon that relevancy.

The shortest way to remedy what probably was an ill-advised excision of Herrmann's letter is simply to restore those paragraphs, and here they are:

"One might attempt, using modern principles, to answer the questions pertaining to the requirements for survival of the black bear in the Great Smoky Mountains; but who can identify the larger requirements for the survival and natural succession of the diverse fauna and flora of the Great Smoky Mountains?

"Preservation of the 'natural area' requires active management of the total resource. Under some pristine conditions, it is best that an area be left completely alone, but when protective management is required, it will be to a lesser degree than that practiced on lands dedicated to commercial enterprises. The problems of today are determining what management practices are actually necessary, what management tools should be utilized, what degree of management control should be exerted, and what timing is proper for management actions.

"We lack up-to-date research. As managers begin to employ ecosystem concepts, which involve entire arenas of hypotheses, research priorities must be set to encompass these new dimensions. Our new perceptions have given us the ability to set priorities and the direction to attempt to obtain answers."

Even in days of shrinking budgets – perhaps especially in such days – these paragraphs suggest alternative ways-to-go that deserve careful attention.

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Atlantic Ridley Turtle Reintroduced At Padre Island

By Milford R. Fletcher

The Atlantic Ridley Turtle *(Lepidochelys kempi)* has long been recognized as an endangered species, possibly the most endangered of all sea turtles. It was formally listed by the U.S. Fish and Wildlife Service (USFWS) in 1970 as evidence accumulated showing an alarming population decline. A 1947 film made from aircraft showed a nesting aggregation of approximately 40,000 females on an isolated Mexican beach. Estimates in the 1970s were considerably less than this number, and by 1981 indications were that there may be no more than 1,000 individuals of this species on the planet earth.

In 1977, a joint effort between the Audubon Society, the State of Texas, the National Marine Fisheries Service, the USFWS, the U.S. Coast Guard and a number of other private, State and Federal agencies, including the National Park Service and the Republic of Mexico, met to explore avenues to help this animal make a comeback.

In meetings with the world's leading turtle authorities it soon became evident that little was known about the biology of the Atlantic Ridley; obviously we were exploring new ground. However, officials of Mexico were eager to assist the turtle in its plight as were all contacted in the U.S.A. Thus, the Atlantic Ridley turtle restoration project began.

We began with several assumptions that are yet to be tested in a satisfactory manner. Some of these were:

1. It would be desirable to have a breeding population of the turtle in an area in the United States where they had been known to nest in historic times. The logical area was Padre Island National Seashore (NS) in south Texas where the animal was known to nest in the past, although infrequently. In addition, the NPS would be able to afford some protection in the event that a new breeding population became established. The animal is particularly susceptible to predation by humans since it is one of the few turtles to lay its eggs during the daytime.

2. Although the mechanism is unknown to us, even after four years of research, we believe that the turtles, in some way, imprint to the beach where they hatch and to which they return as adults to lay their eggs. We feel that this imprinting may be olfactory, as in salmon, which return to spawn in the stream where they hatched.

3. Mortality of hatchling turtles is quite high in other species studied. We assumed this would be so for the Atlantic Ridleys as well. It appeared that mortality would be greatly decreased if we could release turtles somewhat larger than hatchlings (which are about 1½ inches in diameter.) Hatchling turtles are avidly sought by predators such as crabs and sea birds; mortality of yearling turtles appears to be primarily by sharks. Also, the eggs are highly prized; adult turtles are used as meat and their shells for jewelry.

With these things in mind, we began the project. Rather than enumerate the frustrations, lost tempers, late permits, and other problems we faced and solved, I will outline the steps we now go through to raise a turtle to approximately one year of age.

First, Styrofoam boxes are filled with sand from Padre Island and relocated to the only known nesting beach which, in the Mexican State of Tamualipas, is called Rancho Nuevo. We felt that if the imprinting process is olfactory, then the eggs should not be exposed to sand other than that from Padre Island. The turtle eggs are gathered in plastic bags from a laying turtle. The eggs are then transferred to the boxes of Padre Island sand and flown to Padre Island where they are placed in an insect- and predator-proof hatching facility. They are incubated in the Styrofoam boxes for approximately 50 days until they hatch.

The hatchlings then are transported a short distance to an isolated beach where they are released and allowed to make their way down the beach and a short distance into the surf. This is done to approximate the conditions that would exist if the animals actually had hatched on the Padre Island beach. As soon as they enter the surf, the young turtles are caught, placed in boxes, and flown to the National Marine Fisheries Service in Galveston, Texas. The U.S. Coast Guard has been most helpful in the transportation phase of this operation. The catching of the turtles in the surf is always attended by the news media and a host of visitors who appear to enjoy the activities immensely. The publicity has been favorable and the visiting public has been very supportive. The turtles are held at the laboratory in Galveston for approximately one year, during which time they reach dinner plate size.

Because of a conflict between the turtles and theTexas shrimping industry, the first two releases of yearling turtles were made off the west coast of Florida. Shrimp trawlers operating off the Texas coast had frequently caught adult sea turtles, which substantially interfered with their operations. Recently, the National Marine Fisheries Service and the Texas Department of Parks and Wildlife, working with shrimping industry, has tested "excluder nets" that allow shrimp but not sea turtles to enter. Because of the progress and the good faith evidenced in this effort, yearling turtles were released in the spring of 1981 off Padre Island. The University of Texas Marine Station at Port Aransas provided use of its research vessel for this release.

To date, nearly 5,000 yearling turtles have been released in the Gulf of Mexico. Each turtle is tagged for identification purposes, in the event of future recovery. Numerous turtles have been re-caught, from the east coast of Florida to Chesapeake Bay. The following table indicates the number of eggs received and hatching success:

***Hatchling turtles** being released on Padre Island beach to make their way to the surf.*

***Surf imprint** is made on this tiny hatchling, under careful human supervision.*

SUMMARY OF ATLANTIC RIDLEY TURTLE PROJECT

Year	Number of Eggs Received from Mexico	Hatching Percent at Padre Island	Number of Hatchlings Released
1978	2191	88.1	2019
1979	2053	85.7	1439
1980	2976	84.1	1530
1981	2284	83.3	

The many unknowns that still exist in this project may influence our actions in the future. For example, we are still not sure at what age these turtles reach sexual maturity. Speculations range from 8 to 14 years. We are far from sure that the animals will return to Padre Island NS to nest and, if they do, whether we will be able to protect them. The State of Texas has an open beach law, and one very popular pastime is driving 4-wheel drive vehicles on the beach at Padre Island. It is conceivable that we may have to close the beach to vehicles for a period of two or three months, which is certain to cause some controversy, although the public has been very supportive of the project to date.

Research on Green and Pacific Ridley turtles indicates that the temperature at which the eggs are incubated greatly influences the sex of the hatchlings. It appears that the early part of the middle third of the incubation period is critical in determining the hatchlings' sex. If the temperature at this critical time exceeds 29.5 degrees Celsius (85 degrees F.), there seems to be a preponderance of females hatched. If the temperature is less than 29.5 degrees Celsius during this critical period, the preponderance of hatchlings will be males. Sometime in the future, if this proves true of Atlantic Ridleys, we may decide to take advantage of this phenomenon. On the surface, it seems that adding females to the wild population would be advantageous, but this must be approached with great care since so little is known about the breeding biology of Atlantic Ridleys. In the wild, females seem to nest twice each season with an average of about 100 eggs per clutch. Males do not come ashore during the breeding season, so little is known about their behavioral role in the breeding process.

Outstanding cooperation and support of numerous agencies and individuals has spelled the success so far of this project. Four National Park Service regional directors and three Padre Island superintendents have staunchly supported the reintroduction. Republic of Mexico officials and U.S. Federal, State and private organizations have shown a spirit of cooperation that is astonishing, with so many agencies involved. The Southwest Parks and Monuments Association has generously donated funds to support travel of officials from Mexico to the U.S. for strategy meetings. Without the continuing support of all these organizations, the project would have failed.

Numerous agencies are committed to continue this project but funding is always uncertain. Indications are that the National Marine Fisheries Service may undergo budget cuts which could reduce the "head start" program. The USFWS and NPS are under tight budget constraints which also could affect the program. Ultimately, our objective is to reintroduce enough turtles to establish another breeding population of the animals and provide another habitat in which they can breed and reproduce.

That's enough *for now, say these NPS employees as they catch the hatchling and transfer it to the Galveston-bound box.*

After their taste *of ocean, these hatchlings are on their way to the Galveston laboratory for a year of growing up.*

Dinner plate size, *these year-old Atlantic Ridley turtles are now big enough, it is hoped, to keep from winding up as the main course on some larger critter's dinner plate. Here they are released in the wild.*

feedback

(Letters may be slightly edited to fit space requirements.)

To the Editor:

I very much enjoyed the article by Jim Thompson in the Fall issue of *Park Science*, and it stirred me to rummage around for some thoughts I had been moved to write on the same subject. I began to set down these thoughts about the time the National Environmental Policy Act (NEPA) presented science and management with a whole new set of demands. My ideas may be encapsulated by the title "From Wildlife to Ecosystem Management."

New interests and new knowledge require that managers respond to new pressures and new kinds of problems, previously unsuspected and not readily solvable by old methods (viz., encroaching exotic species, changing habitats due to low level pollutants, the effects of global pollutants, the need to better understand the processes of natural change, natural succession, and so forth.) In the interests of continuing Jim Thompson's proposal that we maintain a science/management dialogue, here are my observations.

Five subject areas bear directly upon our understanding of preserved land management. They are 1) parks as preserves, with the attendant question as to whether a park can be treated as an isolated preserve; 2) the maintenance of species diversity; 3) the required representation and classification of preserve lands; 4) the protection of humankind and its environment (What is the acceptable management blend of socio-economic and biological concerns?); and 5) the employment of ecosystem management – the integrated approach to management or non-management of the total park environment.

Many of the crucial issues are only partially understood, given today's state of knowledge. Such questions as habitat requirements for rare and endangered or unique species, control of nuisance and destructive exotics, indicator species, habitat degradation or modification, the effects of air and water pollution (both short- and long-term), resources carrying capacity, boundary pressures, visitor pressures – the fact that we are even aware of these **questions** is due to research. If we want **answers,** then we must do **more** research.

The performance of resource management functions requires some minimal data base, usually acquired with very limited funding and on extremely short notice. A helter skelter response to unheeded problems that are suddenly presenting overdue bills does not meet the requirements placed upon us as a Service to protect the System with which we have been entrusted. Constraints placed on researchers by time, budget and an emphasis that urgency dictates shall be mostly management-oriented, is not conducive to the kind of professional research that our mission requires. Solutions that are predetermined by the hurry-up nature of the research are too-often the outcome.

The independence needed by research personnel is not well understood by management, probably because managers and scientists have such inherently different functions, operations, and goals. The qualities that go into making for excellence in an inquiring scientist are almost diametrically opposed to those that make for a successful manager. The association of these two fields could almost be viewed as a pre-ordained arena for conflict. The scientist, doggedly determined to do his job, often comes through as uncompromising, arrogant, apolitical, dogmatic – attributes not generally admired by management.

So what can we do to solve this dilemma? Probably facing up to it is the most important first step. Beyond that, there are a number of solutions we might try. I agree with Jim Thompson that regular communication between research and management is a must. I suggest regularly scheduled meetings for the presentation of research results, discussion of current problems, and the developing and planning of cooperative efforts for acquiring the information that both management and science can agree is needed.

Out of such meetings should come 1) a management commitment to acquiring the best quality data, through research, to serve operational and planning needs; 2) the development of a research program commitment to provide timely management alternatives and the data for solution of chronic problems; 3) the capability to respond to emergency requests; 4) the development of a long-term research program aimed at solving future problematic needs before they become present crises; and 5) a mutually acceptable process for evaluating and updating ongoing resources management activities relative to data supplied by the research program.

Today's ecosystem managers are called upon to deal with complex and esoteric questions, the answers to which, in truth, may not be available. We have just begun to work on the Gordian Knot. Ambiguities resulting from natural systems studies often contribute to complicated problems for managers of preserved lands. Social, technological, physical, and biological variables, when viewed as interacting, have cause and effect relationships which influence the rationale of natural resource studies, and which have ramifications for new possibilities for planning and programming. Complicated solutions often are indicated, and the preserve manager is the integrator.

I hope that what I am saying is a recognition that management's job is not an easy one. I have admitted to the qualities of scientists that tend to make it an even more prickly affair. But I see great benefits if we can come to recognize each other's necessary input into the preservation of our resource base, and I see great hope that such recognition is dawning – on both sides.

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research notes

NPS managers and scientists, as well as planners and interpreters, may be interested in obtaining a copy of **Testimony on Acid Rain: Its Causes and Consequences in the Environment,** presented to the House of Representatives' Subcommittee on Health and the Environment in Washington, D.C., during an October 2, 1981 hearing on Congressional reauthorization of the Clean Air Act. Its author, Ellis B. Cowling, is chairman of the National Atmospheric Deposition Program. This mimeographed document contains background descriptions of the acid rain phenomenon and references on the changing chemistry of atmospheric deposition and its effects on terrestrial and aquatic ecosystems, human health, and materials. It also includes Dr. Cowling's recommendations to the Congress on a proposed national acid deposition management plan. Copies of this memo are available from Jim Wood, Natural Science and Research Division, SERO, 75 Spring St., S.W., Atlanta, GA 30303.

NPS-SER Research/Resources Management Report No. 33, **Reports on Rare, Threatened, and Endangered Vascular Plants: Discussion and Guidelines,** authored by botanist Peter S. White at Great Smoky Mountains National Park, is now available. White's publication discusses problems associated with the determination of species rarity and endangerment, and proposes guidelines to assist NPS field personnel in their efforts to classify the rare or endangered plant in a systematic way. Copies may be had from White at Uplands Field Research Laboratory, Great Smoky Mountains National Park, Twin Creeks Area, Gatlingburg, TN 37738.

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Black Bear-Human Interactions in Yosemite National Park, 1978-1980, by Bruce C. Hastings and Barrie K. Gilbert of the Wildlife Science Department, Utah State University, Logan, UT 84322, is available from the NPS Western Regional Office in San Francisco. The two major problem areas studied were (1) human-bear interactions examined largely through observational and interviewing approaches, and (2) aversive conditioning, studied experimentally. More than 35,000 responses of bears and humans to 2,800 encounters were recorded, and detailed results are presented in Hastings' 1981 Master of Science thesis.

Biomass of Coniferous Understory Trees in Crater Lake National Park, Oregon is the title of Cooperative Park Studies Unit/University of Washington Bulletin No. 82-1, published Fall 1981 and written by James K. Agee. The 29-page report investigates the biomass of five common understory trees in southern Oregon, with two study objectives: to determine biomass of several species by diameter size classes, and to relate the measured biomass values to easily measured tree characteristics.

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Impacts of Backcountry Recreation: Site Management and Rehabilitation – An Annotated Bibliography is the title of General Technical Report INT-121, compiled by David N. Cole, U.S. Forest Service, and Edward G.S. Schreiner, biologist, Olympic NP, published September 1981 by the Intermountain Forest and Range Experiment Station, USFS.

Over 300 references on recreational impacts, impact management, and rehabilitation of impacted sites are briefly reviewed and their implications for backcountry management are assessed. About 75 percent of the referenced materials are on file in the park. Schreiner can be contacted at (FTS) 396-4244 or (Comm) (206) 452-4501.

Digital Cartography at the Denver Service Center

Editor's Note: *In the May issue of Park Science Maury Nyquist introduced readers to the Natural Resources Information System (NRIS) that he and his colleague, Harvey Fleet, are building at the Denver Service Center. In response to requests for additional details Dr. Fleet has provided the following description of his activity in digital cartographic information management, work that forms an integral half of the NRIS. Fleet is Chief, Branch of Science, at the Denver Service Center.*

By Harvey Fleet

I have long been convinced of the immense value of maps as communicators of information. They are the only medium I know that at once conveys both spatial (= geographic) and thematic (= substantive) information. To the investigator interested in relationships and synthesis, their immense utility is severely hampered, however, by their static nature: the data they contain are neither manipulable, analyzable, nor synthesizable; they may not be readily available or reproducible; and they are almost never easy to revise (with more current or correct information), particularly where propagation of the revised data is desired. The techniques – or more properly, the **technology** – of digital cartography and digital cartographic information management overcome these deficiencies, although I would be the first to acknowledge that they introduce a new, unique set of their own. But as I will describe here, these shortcomings are being overcome.

Digital cartography is not new to the Park Service. Activities during the '70s involved efforts in the Great Smokies, Yosemite, Delaware Water Gap, and John D. Rockefeller Parkway to build and use digital cartographic data bases. For a variety of reasons I described in a paper in the *Proceedings of the Second Conference of Research in National Parks* these efforts were not very successful. My own work started about three years ago when I learned of the system and capabilities being developed by the U.S. Fish and Wildlife Service's Western Energy and Land Use Team (WELUT) in Fort Collins, Colorado. Since the early '70s WELUT has had a full-scale commitment (as has the Forest Service and Bureau of Land Management) to the development and utilization of contemporary techniques for managing and analyzing information. It is principally these techniques that I have adopted and adapted for use as part of the NRIS.

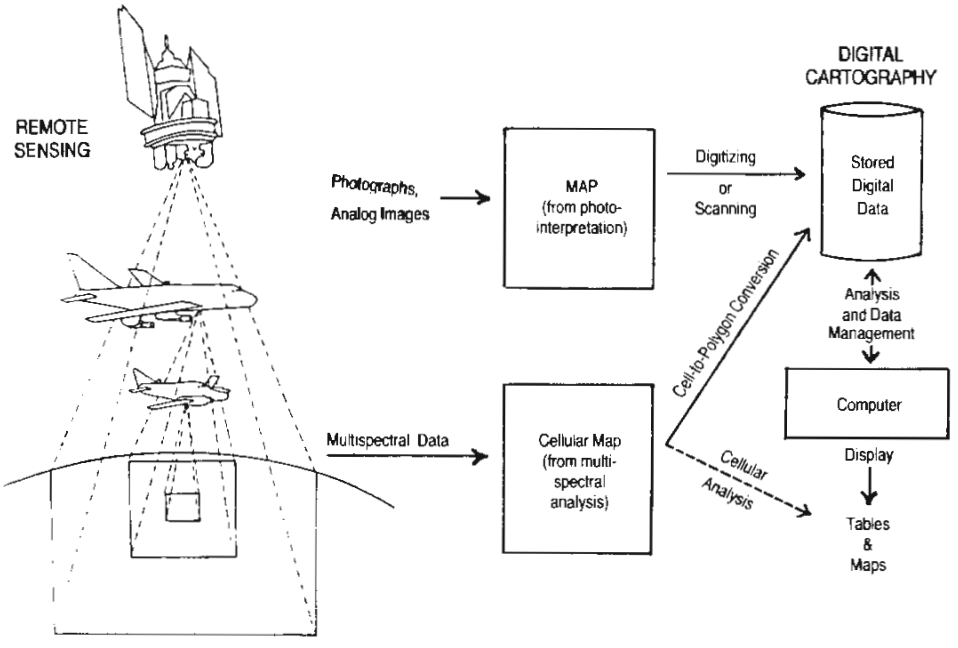
Digital Cartography Not Remote Sensing

Digital cartography is **not** remote sensing. As in the bassoon and oboe, both of which use double reeds, there is a familial relationship, but each produces quite different results (sounds) from the other. Similarly, remote sensing and digital cartography both handle digital data, but, like the bassoon and the oboe, each produces quite different results: remote sensing **gathers** information, while digital cartography **manages** and **manipulates** it (and not all – or any – of it necessarily from remotely sensed sources). Although both deal with digital data, remote sensing handles digital **multispectral** data; digital cartography handles digital **cartographic** data. In the NRIS we are attempting to exploit the common blood between these two technologies.

I conceive of digital cartography as consisting of three distinct but essential components: data entry, data analysis and management, and production of output.

Each component has its own hardware and software requirements. The old tools and techniques, with which so many people are comfortable, have very little place in digital cartography. Felt tip pens, drafting tools, lettering sets, and writing implements are out; CRT's (cathode ray tubes),* digitizing tablets, computers, computer program (= software), disc and tape storage devices, and plotters are in. Before a functioning digital cartographic information management system can be established, the front end commitment is heavy: each of the three components – entry, analysis and management, and output – must be carefully and accurately installed. Failure of any one will cause failure of all.

REMOTE SENSING GATHERS INFORMATION, DIGITAL CARTOGRAPHY MANAGES, ANALYZES AND DISPLAYS IT



Data Entry Capability

Our data entry capability consists of Talos and Tektronix digitizing tablets, a Tektronix 4054 Graphics Display Computer, and MAPDRAW, a sophisticated package for compiling line segments, or "arcs," into finished mapfiles. (An arc is a node-to-node line.) The digitizing tablets transform the mapped information into digital form, lists of X,Y points in an X,Y plane. Using homemade software, we capture these data on the tape cartridge in the 4054 and then ship them over to a powerful mainframe machine (a CDC CYBER 730) that we timeshare at the Bureau of Reclamation.

After an appropriate format transformation we use MAPDRAW to compile each line segment, or arc, one by one, into meaningful polygons or lines. The resulting "draft" mapfile is checked for digitizing errors and corrected. The finished mapfile is then ready for analysis.

"How long does this process take?" The task time is dependent on the complexity of the map to be digitized. The number of line segments, or arcs, determines the labor involved. The relationship is curvilinear or even logarithmic: as the number of arcs to be digitized goes up, the time-to-digitize each arc also increases. The following rule-of-thumb can serve as a general guide to the total time required for this process: 30 to 40 seconds of digitizing per arc for a map containing several hundred arcs to 2 to 3 minutes per arc for a map containing several thousands of arcs.

Other Data Input Considerations.

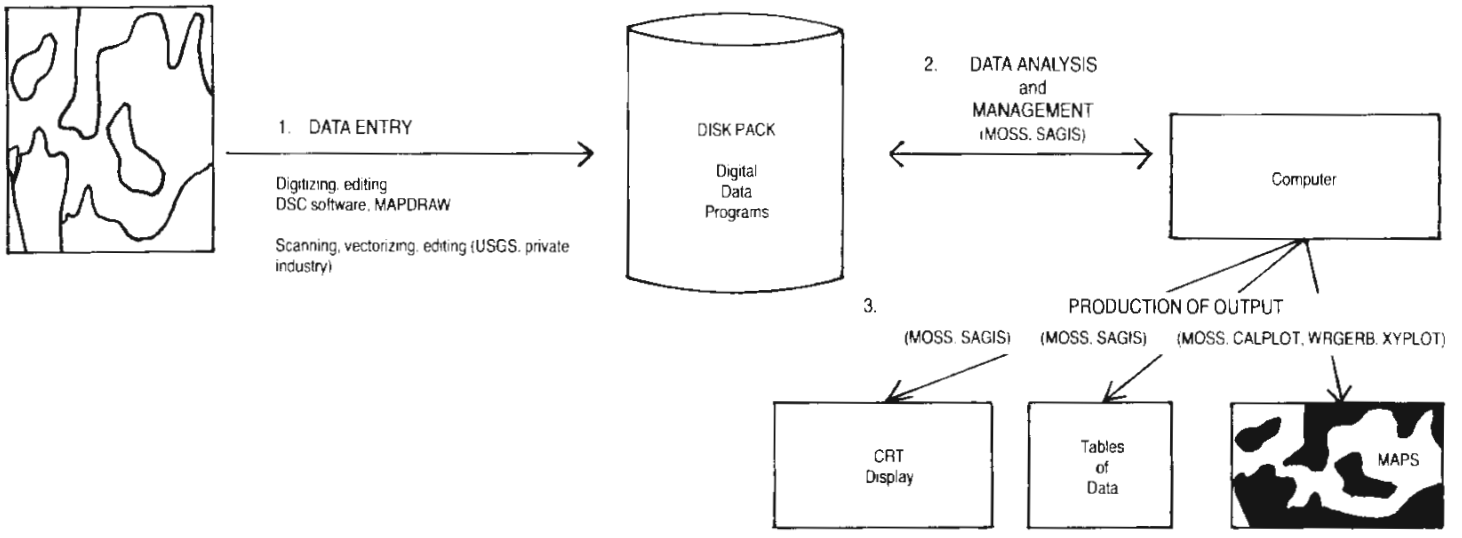
No single issue in the whole of the process of digital cartographic information management is more important than quality of the data base. Should the data be inaccurate, imprecise, misregistered, inadequate in resolution, or simply irrelevant to the questions at hand, the entire process will fail. Investigators will quickly discard a system which yields unfruitful results.

So no effort must be spared in deciding which data themes to enter into the system, the precise content of those themes, the resolution of the data elements, the digital data density desired, the organization of themes into mapfiles, subjects, and categories, and the geographic registration of the map components, if any. The computer is utterly indifferent to deficiencies in any of these items, and, unlike a human analyst or draftsperson, will not make "adjustments" for deviations in registration, duplication of data, or data voids. Beware: what you put in is what you get out!

Analysis Described

Having built the mapfile, the investigator can begin to use it to answer questions and discover relationships. The questions one can ask and the answers one can obtain depend on three critical factors: the

THE THREE PRINCIPAL COMPONENTS OF DIGITAL CARTOGRAPHY



quality of the data base (as discussed above), the capability of the software used in analyzing it, and the capabilities of the hardware on which the software will run. In Denver we have two very powerful, analytical software packages available. They are MOSS (Map Overlay and Statistical System) and SAGIS (Systems Application Group Information System). Important capabilities of these systems include: displaying plots on the graphics screen; shading plots; merging maps; overlaying polygon sets (i.e., finding polygon intersections); performing proximity searches; generating buffers around lines, points, or polygons; finding contiguous edges; calculating distances and lengths of lines; windowing and blowing up; compositing (arithmetic and logical); searching by size criteria; polygon-to-cell conversion; calculating areas and other statistics; generating a contour map from a grid surface; and locating UTM coordinates of any point on the display screen.

Feel free to write or phone me for a complete list of capabilities. MOSS and SAGIS are products of the Fish and Wildlife Service's WELUT group and are still under development. I estimate the packages represent between $1 and $2 million dollars worth of effort.

Like many of you, I am aware of the many powerful geographic information systems in addition to MOSS and SAGIS. Why did we choose these? Because: (1) acquiring them involved no front-end expenditures (up to tens of thousands of dollars; the packages are in the public domain); (2) the systems are operating on hardware accessible to us (a Control Data Corporation CYBER-730, operated by the Bureau of Reclamation); and (3) they work.

MOSS and SAGIS are Polygonal.

One more important point: MOSS and SAGIS, unlike many packages for analyzing geographic information, can perform their analyses on polygons or lines, not just on cells. The chief benefit of this method is precision: calculations are performed on data sets that most faithfully conform to reality. A line will be a line, a polygon a polygon, rather than an approximate collection of like cells. Of course, one must pay the price for such power. Compared to cellular computations, the calculations for polygonal data are more complex, require more computer processing, and, if one is time-sharing, they cost more. The benefits of this method, however, make the price well worth paying.

Output Hardware.

Of course, all these good things going on in the machine are of no use unless one can view the results. The workhorse of the output end is the graphics display screen – in our case either a Tektronix 4054 Graphics Desktop Computer or a Tektronix 4014 Graphics Display Terminal. These relatively large-screen monochrome devices (19" diagonal) have very high resolution display screens (4096 x 4096 addressable points). For complex cartographic data, this resolution is essential. Any Plot-10 compatible device can be driven by MOSS or SAGIS.

Instructions are issued from the keyboard of the 4054 or 4014 to the host computer, and results (various kinds of plots, with shading and labeling, if desired) are drawn on the screen for inspection. A working copy of the screen contents can be made, if desired.

For more formal purposes, we have three available plotters: a Tektronix, a Xynetics, and a Gerber. We are just now bringing our own Tektronix into full production as our primary plotting device. We are using it to produce high quality plots of the material generated by MOSS and SAGIS. Various line thicknesses, line styles, and ink colors, coupled with the 4054's capability to store MOSS plots off-line, yields enormous flexibility in the scale, style, format, and content of maps. The Tektronix is restricted to a plotting surface no larger than 22.75 in. x 17.5 in. (one USGS quad sheet), so for larger plots we either piece together the smaller sections or use the Xynetics or Gerber flatbed plotters.

The Xynetics is compatible with SAGIS mapfiles; so far we have used this device only for proofing MAPDRAW mapfiles (MAPDRAW is a SAGIS package).

The Gerber plotter is operated by the USGS's Rocky Mountain Mapping Center. This very high speed, high precision machine produces plots up to almost five feet wide by ten feet long! Using our own conversion software, we drive it with output from MOSS.

Its principal use for us now is producing single-piece plots of large maps. In the future we would like to use it to produce, with its light pen or scribing point capabilities, color separation plates for four-color printing. For now we are concentrating on exploiting the full range of capabilities of our Tektronix plotter, which is much cheaper and easier for us to run.

Exciting Developments.

Several exciting developments have recently appeared on our horizon. We are exploring the possibilities of automated digitizing with the Geological Survey. Using an elaborate, and expensive, instrument (originally designed for scanning wallpaper designs), the Survey will try digitizing some of our maps as part of its research program into this technique. If we can use the Survey's software for automatically compiling the digitized arcs into polygons, the technique will eliminate perhaps as much as 80 percent of the time and expense of our current data entry procedure.

Also, NASA is loaning us use of a Varian minicomputer system, principally for multispectral analysis. Putting MOSS up on this machine, if possible, would eliminate our complete dependence on the CYBER mainframe for digital cartography. In addition, if we are able to blend its ELAS software (for classifying and manipulating multispectral data) with MOSS's polygonal capabilities, we could have one of the most powerful packages for collecting, managing, analyzing, and displaying geographic information in the nation. This will not be an easy task, and we do not expect immediate success.

Lastly, I am attempting to wire a very powerful interactive graphics library into MOSS (and, possibly, SAGIS). This revision should vastly expand the capabilities of our Tektronix plotter.

We are just beginning to show applications of the capabilities I have described. For most, if not all of you, this is what it's all about – and rightfully so. The Park Service has no place for technology **for technology's sake alone.** Unless these tools can be shown to help us manage our resources better, we do not need them.

Developing this program has been an immensely challenging, frustrating, exhausting, and rewarding activity, and it is with great excitement that I look forward to harnessing for management the tremendous potential of this technology.

**CRT's = TV viewing screens.*

Management of Gray Squirrels and People In a Downtown National Park

By David A. Manski

Wildlife in urban areas are often mixed blessings to park management. On the one hand, they present many educational and recreational opportunities because of their high visibility and habituation to man. Yet these same species also can damage park vegetation and structures and may even be health hazards to the visitor. Unfortunately, practical strategies to encourage or discourage wildlife in cities are not widely available. Additionally, the factors that can affect downtown wildlife programs and policies are not well known to urban land managers.

This lack of information became apparent to the managers of Lafayette Park, a national park in downtown Washington, D.C., after unsuccessful attempts had been made to resolve a gray squirrel problem. For a number of years gray squirrels at the park had damaged vegetation. While economic losses were important, the aesthetic decline of the park vegetation was of utmost concern, since many people visit the park for its historical significance and proximity to the White House. In the past, squirrels were relocated to areas outside the city with the goal of reducing the damage. However this relocation program eventually was halted because of adverse criticism from local citizens and animal protection groups and the subsequent news coverage.

In an effort to help resolve this problem, the University of Maryland and State University of New York, Syracuse, joined forces with the NPS Ecological Services Lab in D.C. to investigate the activities and population dynamics of the park squirrels. This article summarizes our initial results from March-November 1980, and discusses some of the social and biological constraints governing urban squirrel management.

Lafayette Park is an 8.2 acre park across Pennsylvania Avenue from the White House. Sidewalks around the perimeter and in the park comprise 34 percent of the area, while nearly 50 percent of the park is manicured turf and a few flower beds. The 191 trees and shrubs in the park consist of 30 native and exotic species such as willow oak, American elm, magnolia, gingko and horsechestnut.

Using the largest number of squirrels seen and recorded during counts within a month, the squirrel density at Lafayette Park ranged from 9 squirrels/acre in March to 20 squirrels/acre in November. These gray squirrel densities are the highest reported in the literature, probably as a result of the tremendous quantity of food distributed to the squirrels by the public and the large number of artificial squirrel nest boxes in the park.

Despite diverse types of human activity in and around Lafayette Park (joggers, police sirens, demonstrations, etc.) there was no apparent difference in the squirrels' activity patterns from those reported in more natural areas. During spring and summer, squirrels were most active in the early morning and late afternoon, resting during midday. In the fall, peaks of activity were increasingly moved toward midday.

No previous studies of gray squirrel food habits revealed a population as dependent on foods obtained from the public, referred to as supplemental food, as the Lafayette Park squirrels. Peanuts, a supplemental food, were the most important food between March and November, comprising 35 percent of all items eaten. Other supplemental foods included English walnuts, chicken bones, oak acorns, and peach pits. However, none of these and the other 26 different items eaten by the squirrels during this period accounted for more than 4 percent of the diet.

Peanuts please *urban squirrels and the public is always more than glad to oblige.*

All four streets bordering Lafayette Park were crossed by gray squirrels. Movements to and from the park appeared to be of two types. Most commonly squirrels living adjacent to Lafayette Park entered the park for daily use of its resources, such as to obtain peanuts. The other kind of movement seemed related to the dispersal or emigration of squirrels from surrounding areas.

Squirrels were responsible for some of the damage to park vegetation between April and November. After leaf emergence, squirrels constantly pruned trees in order to construct and maintain the large number of leaf nests in the park. Consequently, many park trees showed visible signs of stress, such as defoliated crowns and sparse canopies. Squirrels also damaged trees by gnawing on bark. Damage to tulips and geraniums was not as severe as reported in past years.

One of the most important interactions between park visitors and the squirrels, was public feeding. We differentiated between two types of people that fed squirrels, using the analogy of "zoo visitor" and "zoo keeper" to describe them. "Zoo visitors" were commuters or tourists who fortuitously fed squirrels. They usually only fed squirrels that moved near them and typically watched the squirrels eat the food thrown to them. Contrastingly, the "zoo keepers" routinely visited the park specifically to feed the squirrels. They placed food throughout the park, whether or not squirrels were visible and usually did not watch the squirrels eat. We documented at least six individuals who fit the "zoo keeper" category. Approximately 90 percent of the squirrels' supplemental food was attributed to these six people.

Two "zoo keepers" activities merit description, to illustrate the tremendous commitment of these people toward the park squirrels. These two distributed food at least six days a week in the winter and five days a week during other seasons. During warmer months they placed a total of nearly eight pounds of raw peanuts in the park each visit, and during the winter, they doubled this amount. Thus over a year, these two "zoo keepers" together distributed nearly 3000 pounds of peanuts for the squirrels. At the July 1980, wholesale cost of peanuts, each "zoo keeper" spent $855.00 on the park squirrels.

Peanuts distributed in the park for squirrels were generally in surplus and were consumed by other park wildlife. For example, in July and August, pigeons and common grackles ate approximately 20 percent of the peanuts intended for squirrels. Rats also have been observed eating peanuts put out for squirrels. Thus park "zoo keepers" not only supported squirrels but also some species considered pests in urban areas.

Most people using the park did not come specifically to see the squirrels. Nevertheless, after arriving, many of these people photographed the squirrels and enjoyed their presence. It was our impression that when squirrels were active and visible in the park they were the third most popular sight after the White House and park statues.

Management Implications

Based on these and other results, we can assume several factors that can influence management efforts to maintain a healthy park. Reducing the number of park squirrels is one strategy that may help minimize damage to vegetation. However, removal of park squirrels will have no lasting effect on lowering the high squirrel density. Continual reproduction by the remaining squirrels and movement of squirrels into the park from adjacent areas, eventually will increase the population to the carrying capacity of the park. The carrying capacity at Lafayette Park is higher for gray squirrels than in other similar sized areas because of the large quantity of supplemental foods. For removal alone to be effective, a continuing effort would have to be carried out at least twice a year. A more efficient and long lasting method would be simultaneous removal of squirrels and reduction of supplemental foods.

Prohibition of public feeding in the park would lower the park carrying capacity for squirrels, rats and pigeons, but also probably would cause an initial increase in squirrel damage to park vegetation. Sudden elimination of peanuts might cause squirrels to compensate for the absence of this food by feeding on trees, shrubs and flowers. Park visitors who feed

squirrels for enjoyment would be denied an important component of their park experience. This policy also would be very difficult to enforce.

The keen interest and concern for the squirrels by some of the public may at times interfere with other interests in the park. Programs perceived as harmful to squirrels, such as relocation and prohibition of public feeding, would be intensely opposed if not legally challenged. Thus park management should be aware that strategies to reduce squirrel-park conflicts will be continually scrutinized by the public and may prove difficult to implement.

At this point in our study, the following management approaches seem to hold the most promise for reducing future damage to park vegetation, improving relationships between park management and the public, and enhancing a healthy park ecosystem:

1. Since damage to park vegetation rather than the presence of squirrels is the major concern, the greatest effort should be directed at minimizing damage. This may be accomplished by not planting certain flowers, such as geraniums, known to be damaged by squirrels. Efforts also can be made to spray repellents on flowers to discourage their use by squirrels. Preliminary results at the park suggest that a mixture of hot chili sauce, water and a sticking agent is sometimes effective in reducing flower damage. Metal guards can be placed around the trunks of the isolated trees to prevent squirrel movements into the branches where most bark and twig damage occurs.

2. Efforts should be initiated to reduce the surplus peanuts in the park. This might be accomplished by meeting with those zoo keepers who daily feed squirrels large quantities of peanuts and informing them that distribution of peanuts only when squirrels are visible and at least one hour before sunset will increase the probability that they will be eaten by squirrels and not by other animals. Waste also would be reduced if squirrels were fed individually, rather than by placing food at the base of trees. These efforts not only could reduce the amount of food available to rats and pigeons, but also would save the squirrel benefactors' money.

3. **A long range management goal** of the park could be to enhance wildlife habitat. Trees that are valuable to squirrels as well as park aesthetics should be planted, so that in the future they could possibly replace peanuts as important squirrel food. A smaller number of squirrel nest boxes would be required in the park, if dead tree limbs that contain cavities were routinely cut or pruned only if dangerous to the public.

4. If vegetation damage continues and management decides to reduce squirrel numbers, euthanizing the removed animals should be considered. This would be more humane than releasing them into areas, where they may have little chance for survival. However, regardless of how "humane" this may be, squirrel benefactors and others may criticize the Service severely for killing squirrels. Whenever squirrels are removed, there must be a concurrent reduction of supplemental foods.

5. Because squirrels are of great interest and concern to the public and park management, the development of an interpretive program at the park would be of value. Brochures and/or bulletin boards could present information on the park squirrels' habits and how they compare to squirrels in more natural areas. The best time of the day in each season in which to observe, photograph and feed the squirrels could be discussed. People also could be informed of the safe, proper ways of feeding squirrels, and the role of public feeding in the park ecosystem. Park managers could voice their concerns about past and future squirrel problems, as well as promote their efforts to improve park conditions for the squirrels. These actions would help demonstrate to the public that the park management is concerned with squirrels not only as pests, but as a valuable park resource.

Manski is a Park Technician/Urban Wildlife at the Ecological Services Lab, National Capital Region. This article is taken from a paper by Manski, L.W. Van Druff, and V. Flyger, presented at the 46th North American Wildlife and Natural Resources Conference in March 1981 and now available in Transactions of the Conference, Vol. 46, pp. 439-454, 1981.

***Bark damage** on beech tree in Lafayette Park, caused by squirrels gnawing and sometimes eating the moist, spongy, loosely cellular cambium on both the inner bark and exposed wood of stripped trees.*

Apostle Islands Conference Held

By Merryll Bailey

On November 6, 1981, the Apostle Islands National Lakeshore hosted its Third Annual Research Conference at Park Headquarters in Bayfield, Wisconsin. The general areas of research investigations covered by this year's reports were: environmental history and ecological surveys; water resources; archeological and historical research; background studies for park planning and development.

The meeting gave professionals as diverse as soil scientists, fisheries biologists, plant ecologists and cultural geographers the chance to exchange information on their Apostle Islands research projects. It also afforded an opportunity for interested area residents to learn what the current and future research and development plans are for the park.

From a total of 16 research papers presented at the conference, such varied subjects as "Forest History of the Apostle Islands National Lakeshore based on Pollen and Charcoal Analysis," "Electro-fishing Survey of Several Apostle Islands Shorelines, 1981," "Context and Background for Early Agriculture on the Apostle Islands" and "Social Carrying Capacity at Apostle Islands National Lakeshore" generated particular interest.

Some 63 registrants represented a cross section of academia and the general public. Press and television coverage was provided by local papers and Station WDIO, Duluth. Supt. Pat H. Miller, Regional Chief Scientist Gary Larson and Regional Chief Historian Andy Ketterson welcomed conferees.

Plans are to abstract and publish the conference papers. The publication will be available through the park and the Midwest Regional Office.

Mr. Bailey is an Ecologist at Apostle Island National Lakeshore.

Science and Management Work Together In Controlling Dutch Elm Disease in NCR

By James L. Sherald and Richard S. Hammerschlag

More than 3000 elms have long played a significant role in lending grace and continuity to the federal core of our Nation's Capital. The American elm *Ulmus americana*, the predominant species, was selected undoubtedly because of its unique arching habit, its rapid growth, and its tolerance of urban stress. Unfortunately, in addition to its many good qualities, the elm is susceptible to Dutch elm disease (DED), a vascular wilt disorder caused by the fungus *Ceratocystis ulmi*.

The first case of DED in Washington, D.C. was recorded on the grounds of the Lincoln Memorial in 1947 by Horace V. Wester of the National Capital Region (NCR). Although many elms have succumbed to the disease since then, yearly losses have been kept below 3 percent which indicates a good management program. In communities where little or no DED control has been exercised, elm populations were decimated shortly after the onset of the disease.

Successful DED management in NCR is credited to an evolving integrated management program coordinated by NCR's Ecological Services Laboratory (ESL). The ESL provides a link between technology and management through literature review, contact and cooperation with researchers and other professionals, resource monitoring, training, and applied research. All of these avenues are being used by the ESL in directing DED management in NCR.

In Washington, D.C., DED is spread almost exclusively by the European elm bark beetle, *Scolytus multistratus*. The beetle is attracted to stressed and dying elms where it lays its eggs beneath the bark. Since dying elms are often infected with DED, beetles emerging from these trees are covered with fungal spores. In the process of feeding in twig crotches of healthy elms, beetles introduce these spores into the tree's water conducting tissues initiating new infections. Disease control relies primarily on reducing the beetle population through sanitation, which involves scouting, detection, and rapid destruction of brood trees.

***American elm tree branches** are lopped off near the Jefferson Memorial in Washington, D.C. as the first step in destroying the tree, infected with Dutch elm disease. USDA Photo*

Monitoring trees for DED symptoms and beetle broods is a joint responsibility of tree maintenance workers and the ESL pathologist. Tree workers, who are trained by ESL staff in disease detection and management, scout the elm population throughout the summer for symptoms. Twig samples are collected from suspected trees and brought to the ESL for culture of the pathogen to confirm infection. Laboratory confirmation is particularly important for trees exhibiting questionable symptoms and for documenting the disease incidence.

Most infected trees are removed immediately; however, some trees with early, localized infections may be treated. A three-year cooperative research project between the USDA Forest Service and the ESL demonstrated that the combination of radical pruning coupled with fungicide injections into the trunk and infected limb will save about 50 percent of the trees treated. Such therapy is extremely important when elms of historic or significant landscape importance are infected.

Although sanitation has been practiced rigorously in cultivated elm populations, naturalized elms along Rock Creek as well as the Potomac and Anacostia estuaries have generally gone unmanaged. These natural stands are adjacent to cultivated plantings, and serve as beetle reservoirs. Since natural elms cannot be removed without considerable disruption of surrounding vegetation, other measures must be explored.

A pilot project is being conducted to evaluate the arboricide (tree killing) cacodylic acid as a treatment for trees infected with DED. These trees, upon being injected with the chemical, dry out rapidly, killing the tree and all beetles developing beneath the bark. The technique is effective, inexpensive, and can be applied in areas where tree removal is not possible or in cultivated plantings where constraints prohibit tree removal before beetle emergency. Cacodylic acid injections may soon become part of the DED management program. The pilot project is being conducted by Dr. Jerry Lanier of the College of Forestry and Environmental Sciences at the State University of New York – Syracuse, in cooperation with the ESL and maintenance staff in several NCR parks.

Another tactic used in DED management is the spraying of elms with the insecticide methoxychlor to protect twig crotches from beetle feeding. The ESL has cooperated with the USDA Forest Service in collecting twigs from sprayed trees for beetle feeding studies.

Tree workers were interested to learn from the study that only the lower limbs were being adequately protected and that coverage would have to be improved. Previously, two applications of methoxychlor were made, one in the early spring and the other in late June. Beetle feeding studies showed that the spring application remained effective throughout the period when the beetles were active. Because of the long residual effectiveness of methoxychlor the summer spray has been eliminated. As sanitation improves in the natural areas and the surrounding urban commu-

nity, beetle populations will decline and methoxychlor may no longer be necessary. Consideration is currently being given to limiting methoxychlor treatment to the most highly valued historic elms.

A biological approach to beetle population reduction that has been explored is the use of sticky traps baited with the elm bark beetle pheromone "multilure" – an aggregating phenerome that attracts both male and female beetles. Multilure is composed of three chemicals – one produced by the host (the tree) and two produced by the virgin female beetle. Although research has not shown trapping to be effective in reducing the incidence of DED, the ESL has used "multilure" baited traps in monitoring the timing and number of beetle emergence periods.

Biological control of the fungal pathogen is also being investigated. Isolates of the bacterium *Pseudomonas syringae* are known to kill the DED fungus in laboratory cultures. Injections of these isolates into the water conducting tissues of elms may establish the bacterial antagonists as permanent residents in the tree's vascular tissue and provide "immunity" to DED infections. Unfortunately, initial studies at the ESL nursery have not shown the treatment to be effective. This approach is new and more research is required for full evaluation of its efficacy.

The most promising approach to long term management of DED is through the use of DED resistant elm species and cultivars. American, Asiatic, and European elms from many sources have been screened and evaluated for resistance in NCR parks and at the ESL nursery. Some of the best selections are being propagated and grown for NCR by the ESL and several commercial nurseries. The elm is still the predominant landscape tree within NCR urban parks and in some areas, such as the Mall where most of the original planting remains, the elm population will be perpetuated. In other areas where the elm does not play as significant a role it will be replaced with other tree species. The ESL is working with the Regional Tree Advisory Committee to determine those areas where elms should continue to be the dominant tree and those areas where other species can be introduced.

By reducing the size and increasing the resistance of the elm population, DED will become less of a threat to the NCR urban forest.

For the first few years following the outbreak of DED in Washington, D.C., a cooperative sanitation program existed throughout the city. In recent years controls have slackened in surrounding areas and the disease incidence is beginning to rise. Since the NCR elm resource depends on effective DED management in the surrounding community, the ESL has initiated a Save the Elms Task Force to coordinate and encourage a community approach to DED management. The Task Force is under the auspices of the National Capital Planning Commission. A comprehensive DED management strategy stressing sanitation practices for all elms within the District of Columbia is being developed. Soon the Task Force will seek a commitment from city jurisdictions to adhere to the program. The ESL will continue to participate in the Task Force by monitoring the effectiveness of the program and by providing recommendations as new weapons and techniques are developed for dealing with the disease and its carriers.

Like so many other resource management problems, Dutch Elm disease requires continual technical direction from a scientific staff closely allied with the resource and with those who manage it.

Hammerschag is chief of the MCR Ecological Services Lab. Sherald is the lab's plant pathologist.

Editor's Note: On pages 56-66 of the August 1981 issue of Scientific American, *"Dutch Elm Disease" by Gary A. Strobel and Gerald N. Lanier describes in scientific detail the techniques discussed here. The article is illustrated with maps, drawings, and scanning electron micrography, showing the beetle (two species), the characteristic patterns that the disease etches on elm sapwood, and the molecular structure of the toxic substance from cultures of the Dutch elm disease fungus.*

☆☆☆

The December 29, 1981 issue of *Wall Street Journal* carries on page 1 a story about an incurable disease that has killed 8,288 palm trees – more than one out of five – in the Palm Beach, Florida, area. The disease is called "lethal yellowing" and it was first reported in Jamaica at the turn of the last century. The malady struck Miami's palms in 1971, then moved north, having killed so far an estimated 1.5 million South Florida palms, or about 80 percent of those trees.

The *Journal* describes the controversy that has erupted over treatment. A Miami nurseryman asserts that the spray he developed – a mixture of fertilizer and insecticide – controls the disease 98 percent of the time. Scientists have been unable to duplicate his success with the mixture.

One Californian, according to the *Wall Street Journal*, "confided that he knew of the three remaining locations of 'earth dust' – the dust from which God created man. For plane fare, he said, he would deliver the healing substance. Sprinkling the palm trees with it, he said, would rid them of what he called their leprosy virus. His offer was spurned."

Investigators are blaming spread of the disease on a mycoplasma – a microorganism smaller than a bacterium and larger than a virus and spread by the quarter-inch leaf hopper – a tiny green insect that feeds on the trees' circulatory systems. In this respect, lethal yellowing follows the pattern of Dutch elm disease with its bark beetle vectors.

University of Florida scientists have devised a counterattack, their main weapon being tetracycline, an antibiotic. Healthy trees injected with it seem to show diminished chances of catching the disease.

Elm limb prepared *for a therapeutic fungicide injection.*

Injection of a nursery elm *with a suspension of an isolate of* Pseudomonas syringae, *which is antagonistic to the Dutch elm disease fungus.*

Research Helps Pinpoint Interpretation Needs

Sociological research does pay off!

Ron Wartield, chief interpreter at Crater Lake National Park, took note of the research on visitor traffic flows at Crater Lake done by Oregon State University sociologist Bo Shelby in conjunction with the OSU/CPSU. Warfield began having his people stop by at a lake view turnout that Shelby's research showed was a "natural" gathering place for visitors, and he soon found his staff was giving impromptu talks to 20 to 30 people at a time.

As a result, a proposed development will increase the safety of the stop and will provide the kind of orientation there that the research study showed was needed and appreciated by visitors.

Parks as Islands

There is growing awareness that the units of the National Park System are becoming more island-like, as landscape alteration progresses outside their boundaries. This process, caused by human activity, is proceeding for many types of natural areas in this country and abroad. What the long-term impacts of insularization will be on the resident biota of these natural sites is poorly understood.

The WASO Natural Science Division is in the process of formulating a research program to study this situation. Such research is needed to provide a better predictive ability as to the future of parks and reserves biota, as well as what management options may be available to reduce any negative short or long term impacts. Coordinator of this activity is Craig Shafer, Natural Science Division, WASO, 523-5139.

Information Crossfile

***Miami Herald* Science Writer** Mike Toner did a January round-up story detailing the economic benefits that have accrued and that yet may accrue from successful efforts to save endangered plant species. He described "stunted, misshapen stalks of something that vaguely resembled corn plants, growing on an inconspicuous hillside in Mexico" that turned out to be the last few thousand stalks of one of the most ancient and remarkable ancestors of the modern corn plant. This newly discovered plant, unlike modern varieties of corn, is a perennial. It can survive high altitude and resist at least eight different diseases that regularly decimate modern varieties of corn. Eventually, the benefits of hybridization and cross breeding may save U.S. farmers as much as $4 billion in plowing costs alone.

Dr. Norman Farnsworth, University of Illinois pharmacologist, is quoted: "Few people realize that 25 percent of all prescription drugs dispensed in the U.S. contain active ingredients that are extracted from higher plants. And since less than 5,000 plant species have been thoroughly investigated for the presence of useful drugs, we ought to ask ourselves how many new drugs remain to be discovered."

The guyaule plant, considered little more than a weed in the Southwest, may someday provide such a rich source of natural rubber. The Toner article says "that the U.S. could be significantly less dependent on the oil it now uses to make synthetic rubber."

Undersecretary of State James Buckley's November 1981 address to a Washington, D.C. conference is quoted too: "Based on what we know, the needless extinction of a single species is an act of recklessness. The process is tantamount to book burning, but it is worse in that it involves books yet to be deciphered and read."

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A new book, published jointly by the Pacific Northwest Forest and Range Experiment Station in Portland, Oregon, and the Bureau of Land Management, entitled "Natural History of Oregon Coast Mammals," presents detailed information on the 96 species of mammals found along Oregon's coast. In addition to identifying and describing the 65 terrestrial and 31 marine species, their habits and habitats, the book includes personal observations and anecdotes by the authors and an extensive bibliography. Wildlife Biologist Chris Maser of BLM wrote the section on terrestrial animals; Bruce Mate, marine mammalogist at the Marine Sciences Center of Oregon State University wrote the section on marine mammals; Jerry Franklin and Ted Dyrness wrote the sections on vegetation and habitats, and geology and soils. Single copies are available from Publications, PNW Station, 809 N.E. Sixth Ave., Portland, OR 97232.

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Donald R. Field, Pacific Northwest Regional Associate Director for Science and Technology, is the guest editor of *Leisure Sciences* 1981 Vol. 4, No. 3 – a thematic issue devoted to Social Relations in Park Settings. A majority of the papers for this issue of the inter-disciplinary journal were presented at the Second Annual Conference on Scientific Research in the National Parks, San Francisco, 1979.

An introduction by Field, Gary E. Machlis of the University of Idaho CPSU, and Fred L. Campbell, University of Washington, explores a human ecological approach to the study of people and parks. A human ecological perspective is outlined, a theoretical framework is developed, and several ecological processes are discussed, including adaptation, competition, and succession. The introduction concludes with an outline of important research questions stemming from the concept.

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A Dec. 7, 1981 editorial in the *Washington Post* comments on the reported scientific "creation – there is no better word" of a new bacterium capable of metabolizing the toxic herbicide 2,4,5-T. Possibly this organism will be able to decontaminate waste dumps and agricultural areas where the herbicide has been heavily sprayed. "It should be possible," the *Post* notes, "to use this new organism together with the herbicide to gain the weed killer's useful impact without its harmful side effects. And the method for creating the bacterium should be usable in creating any number of others with equally unique appetites." The achievement, the *Post* notes, illustrates why it is so important to stop the world's accelerating loss of species. "Scientists can find genes in nature's extraordinary diversity that are capable of doing almost anything," says the editorial. "Using the techniques of genetic engineering, these can be selected and combined into useful new organisms. But scientists cannot design the genes themselves: for this they have to rely on nature. Nature's raw material – the 5 million to 10 million plant, animal and microbial species that inhabit the earth – is being lost at a ruinous rate."

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***Synthesis*, the Forestry Wildlife,** and Range Sciences Newsletter at the University of Idaho, Moscow, carries in its October 1981 issue news of a new book, *Public Relations and Communications for Natural Resource Managers,* by James R. Fazio, head of the UI Wildland Recreation Management Department, and the late Douglas L. Gilbert, who headed the Department of Fishery and Wildlife Biology at Colorado State University. The 375-page book, published by the Kendall-Hunt Publishing Company of Dubuque, Iowa, and Toronto, Ontario, presents examples of natural resources public relations activities, delineates guidelines to public relations planning, and includes a chapter of "biopolitics," covering the political aspects of public relations.

A 161-page Station Bulletin, "Vascular Plant Species of Concern in Idaho," has been published by the Forest, Wildlife, and Range Experiment Station, University of Idaho, Moscow, ID 83843. This Station Bulletin 34 replaces and updates Bulletin 27, "Endangered and Threatened Plants of Idaho," and is available from the Station editor for $7.50. Included are scientific nomenclature, location, land ownership, vegetation type, habitat, hazards, herbarium data, and recommendations for keeping or changing status.

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The February 1981 *Journal of Forestry* contains an article by David N. Cole entitled "Managing Ecological Impacts at Wilderness Campsites: An Evaluation of Techniques." As Jim Larson pointed out when he distributed copies to Pacific Northwest Region scientists, "the article challenges some of our established campsite and campground management beliefs and practices, and also includes recommendations to reduce impacts. The author notes that this review is largely confined to the ecological consequences of wilderness campsite management with a primary goal to provoke discussion."

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"Ecosystem Responses to Acid Precipitation" at Isle Royale National Park is the title of an article by J. Robert Stottlemyer, in the Autumn 1981 issue of the George Wright *Forum.* Stottlemyer, a research scientist with the NPS Great Lakes Area Research Studies Unit based at Michigan Technological University, writes that "Despite past information limitations, as new data are obtained scientists are in general agreement that the problem (of acid rain) is worsening, that man is responsible for putting up some of the precursors to acid precipitation, and that the effects of these increased atmospheric depositions will be very difficult to define due to the lack of baseline data."

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Three comprehensive summaries, couched in non-technical language, describe old-growth forests, Great Basin desert research, and southwestern riparian ecosystems – all from the point of view of management – in the September 1981 issue of *Forestry Research West.* The publication is available without charge by writing to Forestry Research West, 240 West Prospect Street, Fort Collins, CO 80526.

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Two new reports now available from the Intermountain Forest and Range Experiment Station (UT), 507 25th St., Ogden, UT 84401, are "Growing Colorado Plants from Seed: A State of the Art," General Technical Report INT-93-FR27, and "Measuring and Interpreting Fire Behavior for Correlation with Fire Effects," General Technical Report INT-93-FR27. Although the former report emphasizes plants in Colorado, many of the species discussed occur also in the Intermountain and Rocky Mountain regions and in parts of the Pacific Northwest. In the latter, two Forest Service scientists have proposed a way to describe fire behavior in measurable, standardized terms. The description is written for scientists not usually involved in fire studies, who will be designing and conducting experiments, and for researchers who need a system for predicting fire effects.

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The December 1981 issue of *Smithsonian* magazine carries an account of the establishment of West Africa's first national park, with the blessing of the local chiefs, the government of Northern Sierra Leone, and a $213,000 pledge from World Wildlife Fund-U.S. The article describes "a mosaic of savannahs, woodlands and riverine forests" that rise from the Guinea plateaus and house forest elephants, leopards, common and pygmy hippopotamuses, zebra duikers, colobus monkeys, and the largest single population of the West African sub-species of chimpanzees – *Pan troglodytes verus.* Up to 100 jobs will be created by establishment of the park, in an area where "local people don't often see any return on their resources or their wildlife." The park will make possible establishment of a graduate program with specializations in wildlife biology and applied ecology at Njala University College, according to the Smithsonian piece.

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Two articles dealing with monitoring and management of natural areas – one specific to Great Smoky Mountains NP (GRSM) and the other a generalized treatment of the subject – appear in Vol. 1. No. 2 (April 1981) of the new **Journal of the Natural Areas Association.**

Published quarterly by The Natural Areas Association, 320 S. Third St., Rockford, IL 61108, the Journal comes with membership (individual dues, $10) and speaks for this national non-profit organization of "individuals actively involved in identification, preservation, protection and management of natural areas and elements of our natural diversity."

"Standardized Ecological Measurements in Natural Areas," by Thomas V. Armentano of the Institute of Ecology, Indianapolis, IN 46208, sets forth in precise tabular form the basic functions central to ecosystem activity (the capture, transfer and expenditure of energy, the interception, cycling and loss of nutrients, and the life cycle activities of the biota), and the set of "core" measurements that, if monitored, would provide a moving picture of the integrated response of biotic processes.

The latter table is, in effect, a blueprint for a stringently cost-effective monitoring system that would allow resource managers to detect even gradual, subvisible deterioration effects. An example of such an effect is drawn from GRSM, where it was found that white pine in an apparently "clean" area was suffering growth reduction and increased mortality (from a 1980 study by J.M. Skelly of the Pacific Southwest Forest and Range Experiment Station, Gen. Tech. Rpt. PSW-43). The losses are attributed to air toxicities, especially ozone.

In addition to detailing the biotic data necessary for minimum monitoring, Armentano recommends sampling frequency intervals and considers methods and reasons for achieving standardization of sampling and analytical methods, documentation (for retrievability and management usefulness), sample archiving, and collection continuity over the years.

The companion article, "How Do We Insure Our Natural Area Parks Function to Provide Species and Natural Systems?", is by Peter S. White, stationed at the NPS Uplands Field Research Laboratory at GRSM. White describes briefly the major changes that have continued to occur "even after legal protection of habitat," and pinpoints "the single most important obstacle to assessing change: that baseline data is either lacking or ambiguous." Successional change and loss of rare species (in this case, loss of grassy balds and many rare plants) are cited as examples familiar to natural area managers everywhere.

White then takes his own cut at outlining a monitoring program, listing six stages applicable to any preserve and giving with these listings his assessment of the current state of the work within that item at GRSM.

White concludes with a paragraph on the future. "We cannot, of course, ever predict all the information needs of the future. We cannot afford to collect baseline data at every biological or physical parameter of interest. But clearly, good stewardship of conserved land requires more than passive guardianship. Data gathering, storage, and retrieval are essential to judge our effectiveness and the results of our decisions on management, whether active or passive, budget-limited or not."

Isle Royale Wolf Study

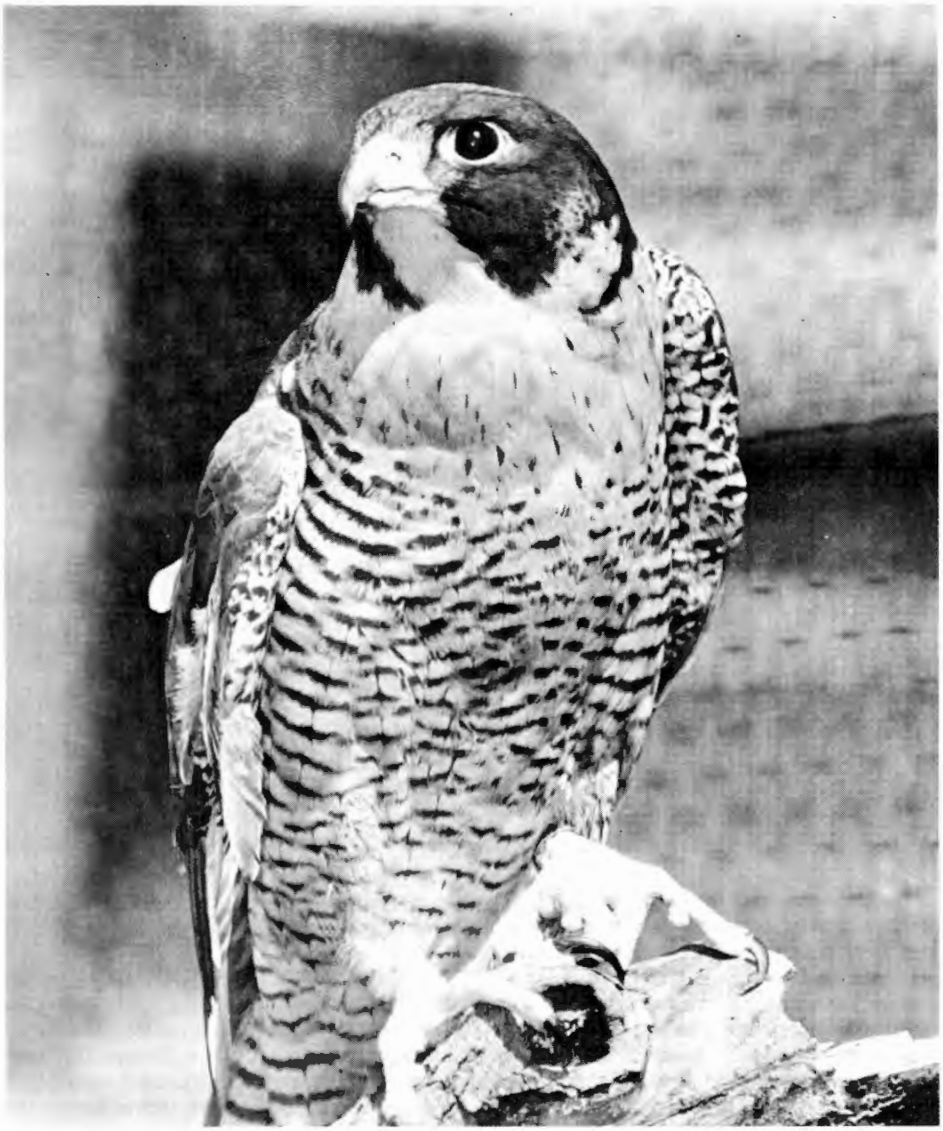
The accompanying chart on population fluctuations of wolves and moose at Isle Royale National Park over the last 23 years is a graphic illustration (literally) of the need to continue research until meaningful time frames for the particular research have been established.

In an article entitled "Long-Term Research: An Answer to 'When Are You Going To Quit?'," Rolf Peterson describes in the Autumn 1981 issue of the George Wright Society FORUM, the totally different understandings (and their attendant implications for wise management) that have emerged in the latter years of research into wolf-moose relationships at Isle Royale. Whereas the early research showed a wolf population of remarkable stability, the 1970s research was, in Peterson's words, "a real eye-opener." The apparent stability of wolf and moose populations was replaced by drastic fluctuations, dramatically underlining the essentiality of long-term research for true scientific understanding of wolf-prey interaction and population regulation.

In addition to describing the long-term research, Peterson's article makes a strong case for the preservation of pristine areas such as national parks and for the use of these areas "to improve our imperfect knowledge" of how best to manage these trusts.

Peterson, who succeeded Dr. Durward Allen as the project director in 1975, is assistant professor in the biological sciences department of Michigan Technological University, Houghton, MI 49931.

Figure 1. Population fluctuations of wolves and moose at Isle Royale National Park over the past 23 years.



Female falcon, *photographed at the USFWS Wildlife Research Center, Patuxent, Maryland, displays the aerodynamically perfect physique for her lightning mid-air captures, and the formidable talons that close into a "fist" for striking her prey on the wing.*

Crater Lake Peregrines Story in NPS Courier

The story of the daring and successful transplant of two fledgling peregrine falcons at a Crater Lake NP nest site in 1981, complete with details about the removal of three eggs and subsequent hatching of two, (one embryo was already dead) at the University of California, Santa Cruz, Predatory Bird Research Group laboratory, is carried in the February issue of the NPS *Courier.* Supt. Jim Rouse and his resource management specialist, Mark Forbes, made the decision to carry out the operation after it was discovered that the only known nesting pair of peregrines in Oregon had failed to hatch any young in 1980.

The rescue effort, which eventually involved 14 persons, including two pilots, plus one small private plane, one helicopter, snowmobiles, motorcycles, skis and mountaineering gear and expertise, was a joint operation of the NPS, the U.S. Fish and Wildlife Service, the Oregon Department of Fish and Wildlife, and the Predatory Bird Group at Santa Cruz.

Supt. Rouse has indicated his intention to continue this resource management operation this year if the pair returns to the site and produces eggs.

superintendent's corner

From William M. Lukens, Superintendent of Padre Island NS (and a member of *Park Science* editorial board), comes the suggestion that we ask, in these columns, for readers to write in and tell us what they would like to see.

"For instance," says Supt. Lukens, "I have a problem with tamarisk – does anyone know how to control or eradicate it?"

So if you have an answer to Lukens question, write him; if you have suggestions about stories *Park Science* might carry, write the editor.

regional highlights

Southeast Region

A Survey of Ecological Inventory, Monitoring and Research in U.S. National Park Service Biosphere Reserves (NPS-SER Research/Resources Management Report No. 49), by Alison Mack, William P. Gregg, Jr., Susan Bratton and Peter White was published by the Southeast Regional Office in August, 1981. It deals with a systemwide survey of all 14 Biosphere Reserve units of the National Park System and discusses the strengths and weaknesses of the reserves' baseline resource inventories and long-term ecological monitoring and research programs. Persons interested in obtaining copies should contact Jim Wood, SERO, 75 Spring St., S.W., Atlanta, GA 30303.

Interpreting Dynamics of Aquatic Resources: A Perspective for Resource Managers (NPS-SER Research/Resources Management Report No. 34), by Gary L. Larson, is an 18-page publication expressly written to help park managers understand complex aquatic ecosytems. The report points out the need for managing park resources on the ecosystem level (as recommended by the 1963 Leopold Report). In many instances, however, management programs have continued to focus on individual resource problems without apparent concern for the ecological consequences on ecosystems. Without knowledge of the interrelationships of ecosystem components, solving one problem may result in other resource problems. Larson's report takes the aquatic ecosystem as an example and presents graphic approaches designed to help the resource manager view these complex relationships. Copies are available from Jim Wood, SERO, 75 Spring St., S.W., Atlanta, GA 30303.

Southwest Region

Biologist Robert A. King is replacing Biologist Jim Woods at Padre Island National Seashore (PAIS), as Jim transfers to Big Thicket. King comes from the U.S. Fish and Wildlife Service's National Fishery Research Center in Seattle, Wash. He formerly served four years with the National Oceanographic and Atmospheric Administration, on east coast oceanographic surveys aboard the ship Ferrel. King's main responsibilities at PAIS will be "enhancement and restoration of Kemp's Ridley sea turtle population, Rancho Nuevo, Mexico and Padre Island, Texas, and environmental management of oil and gas development within the national seashore."

Jane Tate also is leaving her PAIS position, to be replaced by park technician (resources management) Anne Anderson, formerly stationed at Great Smoky Mountains NP. Tate is transferring to White Sands NM in New Mexico. Anderson will be involved in law enforcement from October to March, and will assist biologists on resources management projects from May to September.

A fire symposium, jointly sponsored by the NPS and the SW Fire Council at the Los Alamos National Laboratory in October 1981, explored four years of data col-

lected following the man-caused wildfire that ignited in the Santa Fe National Forest near Los Alamos, N.M. on June 16, 1977. The fire ultimately burned about 15,000 acres of Bandelier NM, Santa Fe NF and Los Alamos laboratory land. Before the fire, much of this area had been subject to ecological studies, which provided baseline data for post-fire studies, related to the effects of wildfire on vegetation and animal life. Other studies after the fire investigated its effects on soils, water quality, archeology, and geomorphism.

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

Mid-Atlantic Region

John Karish, Regional Chief Scientist for the Mid-Atlantic Region, sends word of a one-day symposium on research at Assateague Island National Seashore, to be held March 20 at the Pennsylvania State University's Mont Alto campus. The symposium leader is Dr. Ronald Keiper, PSU associate professor of zoology, a contract researcher for NPS and conductor of the last five years of pony research on Assateague Island.

North Atlantic Region

P.A. Buckley, North Atlantic Chief Scientist and outgoing president of the Colonial Waterbird Group, calls attention to the new journal of the CWB entitled *Colonial Waterbirds.* Its first issue as a refereed journal, Vol. 4, appeared in December 1980 and continues the previous three years' *Proceedings* of CWG annual meetings (hence Vol. 4).

The journal contains paper on management as well as the basic biology of those waterbirds that prefer to nest communally. Buckley also calls attention to a state-of-the-art publication, again the result of a conference, entitled *The Use of Multivariate Statistics in Studies of Wildlife Habitat,* published as General Technical Report RM-87 of the Rocky Mountain Forest and Range Experiment Station, U.S. Forest Service. It is obtainable from them at 240 W. Prospect St., Fort Collins, CO 80526.

Finally, Buckley notes that for nonpareil statistical assistance, the second edition of Sokal and Rohlf's *Biometry* is now available.

The Effects of Off-Road Vehicles on Beach and Dune Systems, Fire Island National Seashore is the title of the Final Report (No. 50) by Fred J. Anders and Stephen P. Leatherman for the NPS/CPSU at the University of Massachusetts, Amherst, MA 01003, published November 1981.

The 176-page document is the result of three years of investigation, using an experimental approach and specially developed instrumentation to measure the direct displacement of sand by vehicles on a daily basis. The changes described included "increased (beach sand) mobility (that) could lead to accelerated erosion," and rapid destruction of foredune vegetation by low level ORV impacts, which resulted in "a marked alteration in the cross-sectional profile in the dune zone." The changes noted "signal increased dune instability during storm attack," the report states.

Rocky Mountain Region

Dick Knight, team leader of the Interagency Grizzly Bear Study; Cliff Martinka, research biologist at Glacier NP, and Gary Brown, who heads the Yellowstone NP grizzly bear program, all made the front page of the *Wall Street Journal* on January 8, 1982, as part of an Eric Morgenthaler story, "Grizzly, Monarch of the Wild, Rules a Waning Kingdom." A subhead reads "Bear's Natural Fury Provess No Match for Civilization; Only 1,000 Remain in West." Martinka is quoted as saying: "The grizzly is the type of animal that just can't take human pressure. And its problems are an indication of excessive human pressure – not just on the animal, but on its entire ecosystem."

Pacific Northwest Region

Carl Key, research technician stationed at Glacier NP, is mapping the riparian plant communities and different land uses along the North Fork and mainstem of the Flathead River. The effort involves production of mylar maps – five different nested overlays for each of the 1:24,000 topographic maps. The information includes: 1) river and floodplain boundaries; 2) forest and natural non-forest areas; 3) roads, cabins, tributary streams and water bodies; 4) forest clearings, clearcuts, select cuts, agricultural areas, residential areas and mines; and 5) a differentiation of forest and non-forest habitat.

The entire program, covering four topographic maps of the North Fork and six covering the mainstem were slated for January 1982 completion. Information is available from R. Gerald Wright, NPS research biologist with the University of Idaho NPS/CPSU, Moscow, ID 83843.

A final report dealing with pocket gopher activity at Whitman Mission National Historic Site and potential measures to control them is now available as CPSU B-81-6. Authors are R. Gerald Wright and Phil Grabmiller.

Wildlife Biologist Leonard Ruggiero has been named manager for the new research and development program, Old-Growth Forest Wildlife Habitats, headquartered at the U.S. Forest Service's Pacific Northwest Olympia Lab in Washington. The new progam will coordinate research and administrative studies on old-growth ecology and wildlife habitat west of the Cascades in Washington, Oregon, and northern California. Other federal and state agencies, universities, private conservation groups and forestry associations and companies will participate through cooperative agreements.

Western Region

Gary Davis, research scientist at Channel Islands NP, spent the fall of 1981 in Egypt and Sudan doing a feasibility study for a marine national park at Sanganeb Atoll in the Red Sea. The project was funded by the World Wildlife Fund and the International Union for the Conservation of Nature and Natural Resources. All this followed a strenuous summer season at Channel Islands, the research effort of which will be featured in the Spring issue of *Park Science.*

Bruce Kilgore, former NPS Western Region Associate Regional Director for Resources Management, is now project leader for a fire application program at the Northern Forest Fire Laboratory, U.S. Forest Service Forest and Range Experiment Station, Missoula, MT.

National Capital Region

The Urban Forest Soils Workshop announced on page 11 of the Fall 1981 issue of *Park Science* was postponed at the last minute and will now be held April 26 through 28, 1982. The format will be the same as outlined in the previous issue. Co-sponsors, with the NPS National Capital Region, are the U.S. Forest Service and the College of Environmental Sciences and Forestry at Syracuse University. A 7-chapter workbook is being distributed to attendants prior to the workshop. The focus is on urban soils, their characteristics, management techniques, and specific applications toward effective long term management. All inquiries should be directed to Dean, School of Continuing Education; SUNY College of Environmental Science and Forestry, Syracuse, NY 13210.

WASO

The Washington, D.C. chapter of the George Wright Society met on Dec. 8, 1981, and elected Ro Wauer, president; Destry Jarvis, vice-president; Clay Peters, secretary, and Diane Gelbrud, treasurer. Members were unanimous in their praise of the program – a film entitled "Land of Lost Borders," produced by the Chihuahuan Desert Research Institute at Alpine, TX, and available for rental or purchase through Adams and Adams Films, 706 Wayside Drive, Austin, TX 78703. The film, narrated by Burgess Meredith, is a general overview of the Chihuahuan Desert. A sequel, focusing on water and the desert, already is in production; a third film, built around man and the desert, is still in the scripting stage.

mab notes

The Man and the Biosphere Program completed its 10th year in the summer of 1981, and a special Scientific Conference/Exhibit and International Coordinating Council (ICC) meeting were held in Paris in September to mark the occasion. Attendees from U.S. MAB were Bill Gregg, Frank Golley, Ariel Lugo, Paul Baker, Ed Fernald, Bill Roseborough, Don King and Jay Blowers.

At the same time, an informal meeting was held on preparation for the 1983 Biosphere Reserve Congress, to be convened by UNESCO and jointly sponsored by UNEP and UNESCO in Minsk, in the Soviet Union. The main theme will be the conservation of natural areas and the genetic material they contain (MAB Project 8). Major emphasis will be given to ecosystem conservation, baseline research, and their implementation in the international network of biosphere reserves. More detailed information can be had from Bill Gregg, MAB Program Coordinator for NPS, Office of Science and Technology/498, National Park Service, Department of the Interior, Washington, D.C. 20240.

MAB 8 Paper Delivered

At the 32nd Annual Meeting of the American Institute of Biological Sciences at Bloomington, Indiana, in August 1981, Gregg and Vernon C. Gilbert presented a paper on "Development of the Biosphere Reserve Network Under the UNESCO Man and the Biosphere Program." The paper describes the purpose of MAB Project 8 – to promote the conservation of the world's biological and genetic diversity by providing the scientific basis for establishing and managing protected natural areas . . . "a key part of which is the establishment of a global network of biosphere reserves, to provide secure protection for self-sustaining ecosystems representative of each of the world's biomes and equally secure sites for long-term ecosystem research and related education, demonstration, and training activities." The network presently consists of 193 areas in 50 countries.

Photo Librarian Comes Up With Missing Names

The George Wright Society story in the last issue (p. 14) was accompanied by a photograph of the U.S.-Mexican Border Commission, three of whose members were unnamed. The caption asked "Does anyone know the names of the other three men in the picture?"

To the rescue rode Tom Durant, picture librarian for the Branch of Graphics Research, Harpers Ferry Interpretive Design Center, Springfield, VA. Durant has been sifting through 80,000 nitrate-based negatives – part of the historic photograph collection in his care at the Springfield facility, and when he saw the *Park Science* story he recognized the picture as one he had recently seen.

The original nitrate negative, in his files, lists the three "missing men" (left to right in the photo) as Daniel Galicia, Santos Ibarra, and Juan Trevino. All three were Mexican members of the Border Commission.

The photo is listed as part of the Roger Toll collection, but since Toll is in the picture, Durant opined that the photograph probably was taken by George Grant, official NPS photographer at Big Bend when the group was there. Big Bend was authorized as a National Park on June 20, 1935; the photo was snapped on Feb. 18, 1936.

Grant became one of the first official NPS photographers in the 1920s. With stout backing from then Director Horace Albright, the idea of making a photographic record of the System finally received an appropriation, and Grant worked until his retirement in 1954 as a tireless recorder of the System's back country.

Durant reports that 1,000 of the 80,000 nitrate negatives have been selected for conversion to safety film and will form the basis of a permanent pictorial record of much of the National Park Service's history.

Park Animal Study Available Through Geo. Wright Forum

The George Wright FORUM, in its Autumn 1981 issue, carries in its entirety the Report to Secretary of the Interior James G. Watt -- A Review and Recommendations on Animal Problems and Related Management Needs in Units of the National Park System, prepared by Durward L. Allen, Larry Erickson, E. Raymond Hall, and Walter M. Schirra.

The report consists of summary and recommendations on five selected management problems (wild boars in Great Smoky Mountains NP, protection of grizzly bears in the Yellowstone ecosystem, feral burros in three areas of the National Park System, interpretation of the National Environmental Policy Act, and protection and restoration of the gray wolf), and complete scientific updates on all five problem areas.

In addition, there is a section on wildlife futures in the parks, and a chronology of landmark documents concerning wildlife resources in U.S. National Parks.

Reprints of the illustrated report may be purchased from The George Wright Society, P.O. Box 65, Hancock, MI 49930-0065 for $1 each, postpaid, or two or more for 50 cents each plus postage.

Wilderness Research in Yosemite

By Jan Van Wagtendonk

When Yosemite NP was established, few people visited it. Fewer still ventured into the trackless backcountry. Since that time use has increased dramatically and by 1972, it was not unusual to find 200 people camping around one of Yosemite's high country lakes. Such high levels of use caused resource damage and degraded the wilderness experience.

Recognizing the problem, the Park staff initiated a research and management program to provide a system for keeping use within acceptable limits. The program consisted of four steps. The first step was to get a handle on current conditions. What is current use? What problems result from it? Next it was necessary to determine what the optimum level of use should be, based on managerial as well as ecological and sociological constraints. How many should use it? The third step was to develop, test, and select a management strategy that would achieve the acceptable level of use. How do we go about it? Finally, the management strategy was implemented and monitored to see whether or not the objectives had been met. How will we do?

Determining Current Use

Wilderness permits provided the data base for determining use levels. Since permits were first issued in Yosemite in 1972, several years of data were available for establishing trends and patterns (Van Wagtendonk 1980). Actual counts by back country personnel provided good information for specific areas on a limited number of days. This information was essential for verifying permit data. In addition, exit interviews were used to determine travel behavior for backcountry users who did not get permits and to determine the validity of the data for users who had permits (Van Wagtendonk and Benedict 1980a). Questionnaires were used to develop visitor profiles of summer and winter backcountry users (Lee 1975, Gilbert 1980). From these data sources, visitor characteristics and temporal and spatial peaking problems were identified.

Determining Optimum Use

The determination of optimum use, also called carrying capacity, is often the hardest nut to crack. It is defined as the character of use that can be supported over a specified time by an area developed at a certain level without causing excessive damage to either the environment or the experience of the visitor. Since any use causes some damage, the problem becomes one of defining excessive use. What is acceptable change to either the resource or the experience is a management decision.

A conceptual model for making carrying capacity determinations was developed by Van Wagtendonk (1979a). Figure 1 depicts a simplified version of the model, which is currently being computerized. The model shows that as the number of users goes up, resource condition and satisfaction go down. By monitoring the number of users, user satisfaction, and resource conditioning, and comparing them to acceptable levels, management can decide to expend efforts to directly control the number of users, increase satisfaction through education and information, or mitigate resource impacts.

Many of the relationships between users, satisfaction and resource condition were studied in the park in order to quantify the model. Lee (1975, 1977) and Absher and Lee (1978) gathered data on the effects on visitor satisfaction levels of the numbers of users and resource condition. Foin (1977) and Foin *et al* (1977) studied visitor impacts on numerous ecological variables while Lemons (1979, 1980) focused his attention on meadow impacts. Other vegetation studies included cultural influences (Holmes 1979a, 1979b) and trampling and urine (Holmes and Dobson 1976, Holmes 1979b).

The effect of human use on microclimates was studied by Hecht (1976), on subalpine soils by Malin and Parker (1976), and on bacteria in subalpine and alpine waters by Holmes (1976). Palmer (1979) experimented with various methods to revegetate impacted trails. Studies concerning impacts on animal populations were fewer in number. Keay and Van Wagtendonk (1981) related visitor use levels with incidents with black bears, and Weston and Weston (1979) studied the role of vertebrates in reducing backcountry garbage.

Once the various relationships were graphed, a point on each curve was identified which signified the limit to acceptable change. Again, this was a management decision based on the consequences of that decision. For instance, in figure 2, which relates use to bear incidents, it could be decided that 20 incidents per year in a zone was the maximum number acceptable. That decision might be based on public safety concerns, impacts on the bear population at higher incident levels, or (we hope not) the number of complaint letters which would be received if more incidents occurred. In any event, based on bear incidents alone, a capacity of 60 people per night would be acceptable. The use of such deliberations for all data sets permitted the settling of a maximum use limit for each zone in the backcountry.

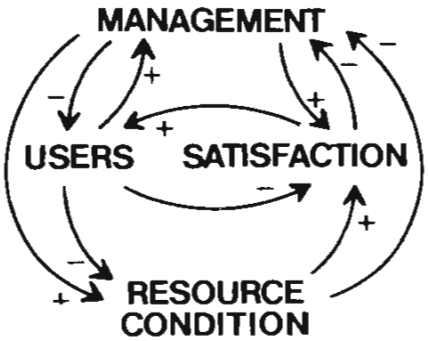


Figure 1. Simplified Carrying Capacity Model.

Developing and Testing Management Strategies

If current use levels are greater than optimum levels, a decision must be made to solve the conflict. Numerous indirect methods for rationing use are available but eventually there comes a time when use limits must be imposed. The manager must then have a means to distribute use in accordance with the desired capacities. Several methods are available, from designating fixed itineraries and campsites to allowing a set number of parties to enter each day.

The effectiveness of each method should be tested. This testing could be done by implementing a different

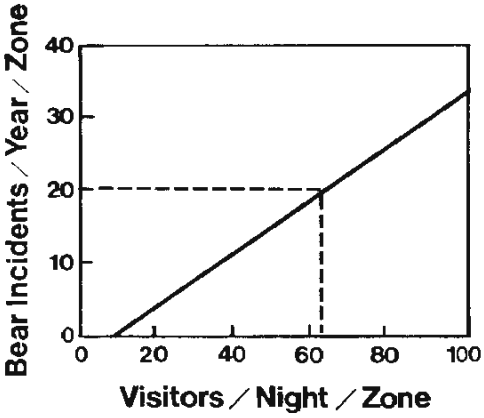


Figure 2. Relationship of Bear Incidents to Visitor Use.

method each year and comparing the results. This approach, of course, would take too much time and the results, such as long-lasting resource damage might not be desirable. As an alternative, computer simulation of backcountry use could be conducted with considerable time savings (Van Wagtendonk 1979b).

A simulation model developed for the Forest Service was applied to the Yosemite data to estimate use patterns in the future under alternative management strategies. Input to the model included trail network descriptions, user characteristics, and user-trail interactions. Maps, wilderness permits, and special studies were used to derive the input data (Van Wagtendonk 1978, Van Wagtendonk and Benedict 1980b).

Output from the simulator listed visitor use and encounter levels for each trail segment and camp area by day of the simulation. By changing the input variables the effect of varying trailhead entry volumes was tested to determine a distribution of use which would not exceed the capacities set for the internal zones. These were then translated into trailhead quotas through another computer program.

Implementing and Monitoring The System

The trailhead quota figures derived from the research program were presented to the backcountry management team. This group made adjustments to the quotas based on experience, judgment, and other management considerations. Following these adjustments, trailhead quotas were instituted in the Yosemite backcountry in 1976. Now that the system has been implemented, visitors no longer are required to tell the park where they are going to hike and camp, nor how long they plan to stay.

Another part of the program that has been implemented is increased visitor information. One of Lee's (1975) major conclusions was that visitor expectations played an important role in satisfaction. For instance, on a trail with many users, a person expected to encounter a lot of people probably would not be as disappointed as one who expected to see no one. To insure accurate expectations, maps are available at permit issuing points to show visitors where they might expect high use levels, stock on the trail, and incidents with black bears. With these expectations, visitors can plan their trips accordingly. Additional information also is available on trail distances and travel times (Benedict 1980), and on planning trips using various guide books.

The program has been monitored continually since its inception. Each year the quotas are adjusted in response to the past year's experience. The effect of quotas on overall use trends also has been critically reviewed (Van Wagtendonk 1981). In addition, the park has recognized that the effect of backcountry use on the wilderness resource must be monitored and has proposed several methods of accomplishing that end (Holmes 1981).

Successful implementation of the backcountry management system was dependent on sound scientific research in cooperation with park operational personnel. The major beneficiary of the system is the backcountry user who now has the maximum freedom possible consistent with management's responsibilities to resources and experiences.

An extensive Literature Cited for this paper is available from the author, a research scientist at Yosemite NP.

People Pressures Threaten Values Of Wilderness

NPS Director Russell E. Dickenson, in a November 1981 Distinguished Lecture at the University of Idaho Wilderness Center, described the wilderness management dilemma, laying particular emphasis on the management of human beings. "The regulation of human use," he said, depends in the long run on "informed public support".

Dickenson described wilderness parks, once protected by their solitude, as now locked into a struggle not only against the encroachments of the spoilers but against the embraces of would-be worshippers. The U.S. population in Thoreau's 1850 America was only 23 million, he said. In 1900, Muir's America had but 76 million. "For every Muir, we now have three; for every Thoreau, ten. Is it any wonder," he asked, "that there is more pressure for use of our wild lands?"

Dickenson made a strong case for the role of wilderness areas in the preservation of genetic diversity. He noted the disappearance of the lush resources that were in place when the first European settlers arrived – the forests and prairies, the passenger pigeon, the Carolina parakeet and the ivory-billed woodpecker. "The variety of animal life and plants that have become history are uncounted," he said.

At the same time, he noted there is still wealth to be hoarded and preserved . . . "rare and unique species (that) can be vital to our future. It is our charge," he told his listeners, "to protect what we have. In the perpetuation of the strange, the unusual, the little understood, we may hold the key to the perpetuation of our own kind. For all that we have managed to control, our destiny is still tied to the land and the sea of this planet."

Dickenson cautioned that "We should not casually throw away any life form. We should study it, protect it, find its usefulness, or failing that, leave it for our descendents to assess anew."

Of the approximately 80,000 edible varieties of plants on earth, only 150 varieties have ever been cultivated on a large scale, with fewer than 20 producing 90 percent of the world's food. Dickenson described the relatively recent development of such modern staples as corn, peanuts and soy beans and related these improvements to the wild strains that make hybridized plants possible. A recent discovery in the foothills of Central Mexico "holds great promise for improved food supplies the world over," he said. This native evergreen corn plant could easily have been lost forever to the world, had not a Texas botanist found it in a forest destined for clearcutting to make way for cattle to graze.

Quoted by Director Dickenson in his Nov. 12, 1981 Wilderness Lecture: "Protection and preservation of the physical memorials of our natural and historic origins is primary, of course. And I suppose a good case could be made for the mere locking-up of our most important treasures – the fragile and the irreplaceable and the 'bank deposits' of study in future years – because they are arks of our covenant and even when not seen are an inspiration through the feeling that they exist and are safe.

But fortunately, save in rare instances, this is not at all required. We can use these precious resources, so long as we do not use them up. Put it this way: We should not dissipate our capital, but we should zealously dispense the interest."

Freeman Tilden, in "Interpreting Our Heritage"

"The natural storehouses of parks may someday prove invaluable," Dickenson said. "We must remember that the purple foxglove of Europe is the source for digitalis, a common heart compound to which millions can credit their lives. And who would care to go back to a time when the infamous bread mold, penicillin, was just a common nuisance?"

Dickenson stressed the need for acquisition of baseline information. "Few parks," he said "have an adequate inventory of their natural resources. Few parks possess adequate information to implement enlightened management strategies. Good knowledge of the identity and location of park resources is prerequisite to wise stewardship. Improving the park's database will require that priority be given to conducting field studies on all types of physical and biological resources."

Acid Rain Manual Readied

A working manual on the status of acid rain work throughout the National Park System is being prepared by Jill Baron, biologist with the NPS Water Resources Laboratory, NREL-105 Grassland Lab, Colorado State University, Fort Collins, CO 80523.

The report, which will be the first in a Management Series out of the Water Resources Lab, will contain site information and a list of site operators, regional coordinators, and national information sources. Baron plans to have the manual ready for publication in June.

Exotic Plants in Hawaii's National Parks: A Major Challenge

By Donald E. Gardner

Exotic plants and the problems they cause are a familiar concern for managers of native areas. Such plants, however, are of particular importance in native ecosystems of islands. In such habitats some exotic species, isolated from those of continental landmasses, released from natural population controls and finding an "empty" niche, may become aggressive weeds. This is a common situation in the characteristically "depauperate" island communities. Because the Hawaiian Islands are regarded as a popular vacationland and have become easily accessible to visitors from all over the world, it is hard to realize that these islands are the most geographically remote of the world's major island groups.

The species of flora and fauna now found in Hawaii can be categorized into three rather clearly defined groups:

1. Endemic – those species that evolved in Hawaii from naturally introduced (without human intervention) ancestral forms and which are now distinct from those forms. It has been said that had Charles Darwin's voyage on H.M.S. Beagle brought him to the Hawaiian Islands rather than the Galapagos, he would have found even more supportive evidence for his work *On the Origin of Species*.

2. Indigenous – those species naturally occurring in Hawaii as well as elsewhere, having arrived in Hawaii by means other than human introduction.

3. Exotic – those species brought by European civilization beginning with the discovery of the Hawaiian Islands by Captain Cook in 1778. Species brought prior to this date from other Pacific islands by early Polynesian colonizers may also be considered exotic in a strict sense, although these usually are acceptable in practice due to their association with aboriginal cultures.

In general, endemic species are those that originated from life forms adapted for long distance travel or dispersal, whereas it is likely that only a very few of the exotic plants and animals now in Hawaii would have become naturally established there without purposeful or accidental introduction by recent human activity. For example, insect species whose ancestors, while in flight, could have been carried long distances by high altitude winds comprise a major portion of Hawaii's endemic fauna. The only endemic mammals are a fur seal and a bat, both now rare, whose predecessors' means of reaching the islands are apparent. In comparison, the probability that strictly terrestrial mammals could have come without the aid of humans is slight. Likewise, plants that colonized Hawaii were those whose propagules were carried long distances by birds or wind, or whose seeds were capable of withstanding long exposures to sea water.

During the process of evolution, many endemic Hawaiian species lost the ability, by nonselection, to ward off or avoid the natural predators or other enemies they left behind in their locality of origin. Although insular ecosystems may be noted for their resilient internal stability, they are particularly vulnerable to deleterious outside influences, such as the introduction of aggressive plants and animals.

Public awareness of these effects was lacking in the early days of colonization, when many species were freely brought to Hawaii. European immigrants, homesick for their former surroundings, brought favorite plants and animals. Other species were introduced inadvertently due to a lack of proper quarantine inspection procedures. Restrictions on importation of nonnative species have been imposed only relatively recently and are still not completely effective.

Certain exotic plant species in Hawaii (such as the firetree which is an important forest tree in its native environment, the Azores, Madiera, and the Canary Islands), are aggressive and unwelcome encroachers into native Hawaiian habitats. Firetree currently occupies extensive forest and other land use areas throughout the state. In Hawaii Volcanoes NP it occurs on hundreds of acres and is spreading at an alarming rate. Differences of professional opinion exist regarding the extent to which this species is capable of actually invading undisturbed native ecosystems and replacing component species. However, its explosive population growth in areas disturbed by fire or volcanic eruptions has led managers to consider this tree one of the greatest overall threats to the park's integrity.

Several other species of small trees or shrubs, grasses, and vine-like plants also are regarded as equal or more serious threats in both Hawaii Volcanoes and Haleakala NPs. Although it is difficult to reach a consensus regarding the relative dangers posed by each exotic plant species when the "top" 10 to 15 species are considered, managers and researchers generally agree as to the problems created by the "super exotics" in this category.

Control efforts have involved wide scale mechanical removal of young plants and chemical treatment of older plants. However, in the case of well-established grasses, the general disturbance that would result from such efforts tends actually to encourage further establishment of exotics. Managers are increasingly aware that in many instances there is insufficient manpower to keep up with control of exotics, some of which become reestablished faster than they can be eliminated. Prolific seed production and successful dispersal mechanisms, often not yet fully understood but suspected in some cases to involve exotic birds, are characteristic of many of the species. The ability of exotic grasses, such as broomsedge to become rapidly and densely established on burned sites disrupts the native successional sequence and creates an abnormally great fire hazard.

Although the use of chemical pesticides is discour-

Exotic firetree *(large arrow) growing in close proximity to a young native ohia tree (small arrow) in Hawaii Volcanoes National Park.*

aged in NPS areas if other means of control are available, herbicides continue to represent the only realistic approach, aside from mechanical removal. Herbicidal treatment has resulted in some partial successes, and managers have no apparent alternative at present. No single approach currently shows promise of controlling the problem or even of keeping up with it.

In view of this reality, resources managers have been compelled to set priorities, based on the probability of success, concentrating first on eradication of new invaders, next on containment of recently established populations, and finally on control of existing exotics in small, well defined sites designated for the natural regeneration of endangered species. Except for "cosmetic" removal of exotic plants, such as along roadsides or in campgrounds, well-established populations cannot be contained through present methods and are therefore placed near the bottom of the priority list.

Public awareness and opinion also play a role. The general public is not yet fully sensitive to the NPS mission of preserving environmental processes and features in their native condition. Thus, visitors to Hawaii's national parks expect to see an abundance of "tropical" plant life, a proliferation of fragrant and showy flowers, colorful birds, and similar amenities commonly associated with Hawaii.

While all of these can readily be found in Hawaii, frequently they do not represent Hawaii's endemic flora and fauna, a fact rarely of much consequence to the average visitor. Unlike plants such as the nonnative species of ginger, which grow in thick patches in rainforest areas and produce attractive, aromatic flowers, few truly native Hawaiian plants have the expected large, showy or fragrant blooms. Native birds may be colorful, but they are small and not readily seen. Too often, visitors fail to appreciate the true "inner beauty" of endemic species, which is the uniqueness of their origins, their adaptation to the environment in which they evolved, and their rarity among the world's flora.

Fuschia *sp. bushes (arrow) in a native ohia-tree fern forest in Hawaii Volcanoes National Park.*

Broomsedge *and other exotic grasses covering extensive acreages of Hawaii Volcanoes National Park.*

With the well-intentioned but misguided idea of "beautifying" Hawaii Volcanoes NP, several decades ago a number of colorful South American *Fuschia* sp. bushes were planted in the rain forest among the native tree ferns near a prominent visitor attraction. It is obvious from visitor comments and their photographic activities that *Fuchsia* now represent one of the most memorable "Hawaiian" flowers in the Park. Little regard is given to their exotic origin and great consternation would be expressed if the bushes were removed. Other flowering shrubs, such as glorybush *(Tibouchina urvilleana),* with large, bright purple flowers, may be included in the same category.

Visitors sometimes express surprise or concern at exotic plant eradication efforts and may leave the Park still wondering why the "forest rangers" found it necessary to remove a certain tree or shrub. In response to this problem, the visitor center at Hawaii Volcanoes NP now includes a display explaining NPS policy with regard to exotic species. Public information leading to public awareness of the NPS mission is essential to provide support for NPS management in carrying out its increasingly complex functions.

Insect predators and plant diseases have been and are being used in noxious weed control programs with varying degrees of success. Ideally, such biological control approaches may provide good cost effective control without the disadvantages of polluting residues or byproducts and other side effects.

A biocontrol program may in theory integrate the effects of several beneficial predators and/or parasites which, once established in the region where control is desired, make contact with the target species and continue to provide control indefinitely. In actual practice, several potential limitations must be considered. Complete eradication is not usually achievable through a biocontrol program. The expected result is a reduction of the problem population to a manageable level at which its aggressiveness is significantly mitigated.

For biocontrol programs to be effective, the insect predators or disease agents must possess two important qualities: A high degree of virulence, sufficient to kill or severely affect the host plant, and host specificity – that is, their destructive capability must be limited to the target species. Effective agents must display consistency and stability in both these qualities under the actual environmental conditions in which they will be used, not only in laboratory or greenhouse tests.

In addition, once biocontrol agents have been released into the environment, they cannot be recalled; they are free to cross political boundaries, such as those of a national park, and may spread to the limits of their potential ecological range. Their probable effect on target, as well as nontarget species throughout this range should therefore be ascertained as accurately as possible prior to their release.

In an effort to prevent further problems such as those created in the past by indiscriminate introduction of exotic species into Hawaii, the State of Hawaii has imposed stringent regulations for importation of insects or plant disease agents for any purpose, including testing for possible use in biocontrol programs. This cautious approach is understandable in view of the number of varying interests that must be considered and the prevailing element of uncertainty regarding unforeseen predatory or parasitic relationships inherent in any such research program.

In Hawaii other prominent interests, most notably those of agriculture, receive prime consideration in conficts which may arise from native ecosystem preservation efforts. Some exotic plant species which constitute problems and are not at all desirable in NPS areas are widely cultivated or otherwise encouraged outside park boundaries for their ornamental value or their fruit, effectively ruling out biocontrol efforts. Other troublesome exotic species are so closely related to agricultural crops as to severely restrict biocontrol methods. For example, certain aggressive exotic grasses in Hawaii Volcanoes National Park are closely related to sugar cane, Hawaii's most important crop.

Notwithstanding these difficulties, some exotic species appear to be equally undesirable, outside, as well as within NPS areas, presenting no serious conflicts. It is the hope of Hawaiian NPS managers and scientists that these species may serve as the basis for a pilot biocontrol program supported by state as well as NPS concerns, and that such efforts, if successful, may eventually make available more time and manpower to concentrate on the control of other exotics through more direct methods.

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Park Management Workshops Slated as Annual Events

From Washington, D.C. comes word that the recently instituted series of park management workshops will henceforth be held on an annual basis – the next session slated for early November, 1982.

According to George Gowans, NPS chief of maintenance, the primary objectives of the workshops are to acquaint park superintendents and facility managers with 1) responsibilities regarding facility management, 2) inventory and inspection information available, 3) source and kinds of professional and technical assistance available, 4) programming, scheduling, planning, and budgeting procedures, and 5) participation needed by park maintenance, ranger activities, interpretation, and resource management.

"Increased code and regulatory requirements in recent years, and increased awareness of safety and health factors," Gowans explained, "have expanded the responsibilities of park managers. It is increasingly important that park managers use the team approach to stay ahead of problems and to wisely utilize limited funds and staff. New inventory and inspection tools are available and can be used to determine needs and to support justifications."

The first park management workshop was held in September 1981 at Harpers Ferry, for superintendents and chiefs of maintenance from 30 parks. The course covered 10 working days. The second such workshop, for similar personnel from 20 parks, met for only five working days in Phoenix in November, and according to Gowans some of the benefits of the longer workshop had to be sacrificed. "At the Phoenix workshop we fine-tuned a project evaluation program," Gowans said. "This system is being incorporated into the 1984 budget call. The Fall 1982 workshop will focus on another segment of the process – the development and application of performance guidelines for maintenance management."

Buckley Addresses Genetics Conference

"Extinction is an act of awesome finality. Man cannot restore a species. He can only exterminate."

This was the message delivered in his opening remarks by Under Secretary of State James Buckley to delegates to the U.S. Strategy Conference on Biological Diversity, held Nov. 16-18, 1981, in Washington, D.C.

Buckley decried the "accelerating impoverishment of global genetic diversity" and the resulting damage to the safety net these resources represent for all life on earth. These are resources that "we are still too ignorant to understand," Buckley told the delegates. They represent "books yet to be deciphered and read."

Final recommendations emerged on the third day from five working groups: terrestrial plant species, terrestrial animal species, aquatic species, microbial resources, and ecosystems maintenance. Conference Proceedings will be available free of charge after mid-February from Bill Long, Director, Office of Food and Natural Resources, Bureau of Oceans and International Environment and Science, Department of State, Washington, D.C. 20520.

Practical Protection

In a related follow-up to the news reported in the Fall 1981 issue of *Park Science* about the discovery of a monobactam that resulted in a new class of antibiotics, the Squibb Institute's chief microbiologist, in Princeton, NJ, spoke out on the subject of protected lands. "Our discoveries," he said, "have always come from soil samples taken from places such as the Pinelands and the Great Swamp (both in New Jersey and both protected) where there is little or no pollution. He added that a relatively unspoiled environment permits a tremendous variety of life forms to flourish, whereas the number of species in a polluted ecosystem narrows considerably.

Resource Management Ranks Due for Boost

The May 1980 report to the Congress on the State of the Parks "revealed unexpected problems throughout," NPS Director Russell E. Dickenson told the Association of National Park Rangers at the Ranger Rendezvous October 22, 1981, at Lake Tahoe.

The report, he said "suggested that some of the basic resources, for which the parks had originally been established, were being seriously threatened by a wide assortment of both internal and external activities."

The Director described in a general way a program currently under development in Washington "designed to place a cadre of highly qualified natural resource management specialists in as many as 30 park areas." Trainees for these positions, ranging from GS-7 to GS-11, would complete 18 to 24 months of training, in a move to widen the manpower pool in this crucial management area.

He described natural and cultural resource training courses and workshops that would include natural resources management courses for managers and mid-level employees, three courses for preservation and protection of cultural resources and objects, and two workshops for natural resource specialists on threat identification, assessment and mitigation. He also announced greater emphasis on acquisition of baseline information, conceding that "few parks presently have an adequate inventory of their natural and cultural resources" of the kind needed "to implement enlightened management strategies. Good knowledge of the identity and location of park resources," he told the rangers, "is prerequisite to wise stewardship."

The skeletons of the natural parks – the Grand Tetons, Half Dome, Denali – show no perceptible changes, Dickenson said. "But close up, and usually not evident to most park visitors or the uninformed, changes are taking place. And some of that change is affecting park resources in ways that, if continued, will seriously degrade the natural and cultural resources for which we are held accountable."