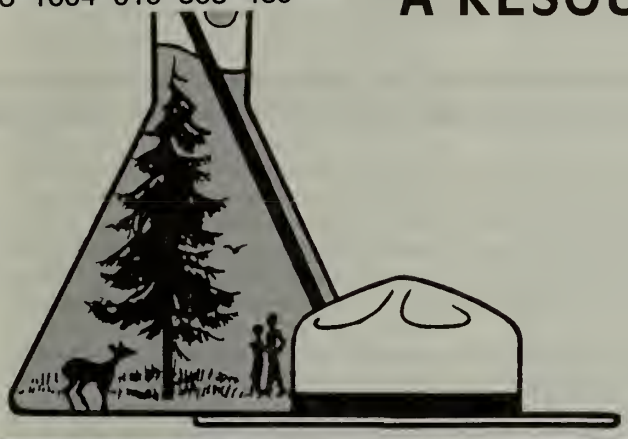
# PARK SCIENCE

## A RESOURCE MANAGEMENT BULLETIN



NATIONAL PARK SERVICE
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# PARK SCIENCE

NATIONAL PARK SERVICE

FALL 1985

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


## In This Issue



***Cover Photo:***
*Steve Cinnamon and Kent Turner collect aquatic insects with a Surber sampler in the course of water quality training in June at Colorado State University. See page 5.*

The "limits of acceptable change" article on page 9 of this issue is *Park Science's* initial response to a Winter 1985 letter to the editor from Carl Shipley of the C&O Canal National Historical Park Commission. Shipley was concerned primarily with the C&O Canal and what he perceived as signs of "overuse."

"There is always the problem of balance," Shipley wrote. "When does it become important to the public interest to deny some people use of these publicly-supported facilities in order to maintain the resource for future generations, as well as permit enjoyment for the luckier portion of the public who manage to use the facilities within the use limitations?"

The Marion/Cole/Reynolds article describes a scientifically controlled attempt to establish parameters for that elusive idea – "use limitations." Beyond this slippery and troublesome task, other hurdles challenge the manager. What are the political and social bases for *handling* "overuse," once it has been determined? Are society's values so strong and sharply defined as to enable management to make full use of the scientific information and techniques we already possess? If so, why don't we move, and if not, how can we most effectively work to overcome this gap?

NPS Director Mott spoke to this overall problem at his recent Yellowstone meeting with the NPS Regional Directors. He called for carrying capacity studies and for park interpretation that goes a country mile beyond "show and tell"... interpretation that tackles the tough management questions of how to perpetuate park resources in the face of mounting threats from without and within park boundaries.

The National Park Service has come a long way in the years since the crisis-reaction stance it had to assume at Yosemite in the late '70s. It has adopted stringent restrictions to visitor freedom to protect especially fragile treasures at Canyon de Chelly. It is moving with determination on several fronts to define and deal with the threatened Yellowstone ecosystem and its precious, irreplaceable components. It is conducting other carrying capacity and interpretation initiatives elsewhere in the system, and they will be the subject of other articles in the near future.

With strong, sensitive direction from the top, the NPS troops at the park level can begin to work toward solutions to the essentially System-wide problems that add up to System stress. And perhaps just as importantly, they can begin at the park level to enlighten the public and enlist its support for management actions designed to ensure enduring park quality.

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# Plant Biocontrol Quarantine Facility At Hawaii Volcanoes

**By Donald E. Gardner and Clifford W. Smith**

Hawaii, perhaps the showcase of the effects of geographic isolation on evolution, has a native terrestrial flora and fauna, 95 percent of which is unique. Since the arrival of man, these unique plants and animals have been subjected to an array of pressures that they rarely, if ever, experienced previously, e.g. fire, habitat disturbance, mammalian herbivores, parasites and parasitoids, and weeds. Because of these pressures, Hawaii has the ignoble distinction of having the largest number of extinct and/or endangered animals and plants in the world after corrections for area and original numbers of species are considered.

Legal controls over importation of plants are weak. Imported plants are inspected for nematodes, insects, and diseases which may affect principal agricultural products, but not necessarily for their potential weediness.

The weed problem in native Hawaiian ecosystems is enormous. Approximately 6,000 seed plants presently are known from the Hawaiian Islands, but only 1,400 (23%) of these are native. A large percentage of the alien flora consists of horticultural plants. Another significant element is small herbaceous weeds. Many are cosmopolitan, and most are thought to have a very minor impact on ecosystems. But approximately 100 species are significant weeds in native ecosystems and, once established, may dominate the area. Some are capable of invading undisturbed habitat, but the majority require some change in the native ecological process before they can take hold. Most of the disturbances are themselves alien influences, but natural events, such as high winds and landslides, are common enough to provide footholds even in pristine environments.

Most of these weeds are beyond conventional control techniques. Handpulling, extremely labor intensive, is useful only in small areas for cosmetic or critical ecosystem management. The activity of the weeders themselves can have a detrimental effect.

Herbicide use is not favored for various reasons, some of them specific to Hawaii, where highly porous soils and frequently low microbial activity levels allow chemicals to percolate rapidly down to the water table.

**The serious weed problems** are not isolated. Many are the result of complex interactions between alien plants and vertebrates. Others create environmental situations that exacerbate previously inconsequential phenomena such as fire. Some change the status of soil-related factors or nutrients in the ecosystem. Most of these ancillary factors are not controllable for practical or political reasons. The plants themselves, therefore, become the primary focus of alien control strategies.

One of the most widely appealing solutions is the concept of biological control (biocontrol), the use of natural predators or parasites that were not introduced with the alien plant. This procedure, however, necessitates adding to the number of alien organisms by introducing biocontrol agents. It is imperative, therefore, to determine that these organisms will serve their intended purpose and not themselves become future problems.

The aggressiveness of an invading plant species in the new habitat is frequently uncharacteristic of its behavior under native conditions. The goal of biocontrol is therefore to restore the mitigating agents – natural predators, parasites, and competitors – to the environment of the alien species. Although spectacular results, such as severe reduction or complete elimination of target species are sometimes obtained, biocontrol more frequently results in just a subtle reduction of the competitive edge of the target plants in favor of native species.

**The modern practice of biocontrol** of weeds in the U.S., and perhaps in the world, originated in Hawaii in 1902. Twenty-three species of insects were imported from Mexico by the Hawaii Board of Agriculture and Forestry to control lantana, an introduced ornamental that had escaped cultivation. Since that time, several additional plants and insect pests, which have threatened economic concerns, have been designated for biocontrol efforts in Hawaii. Biocontrol research of alien plants in natural systems conducted by NPS is a relatively recent expansion of the original agriculture-oriented concept. Whereas the screening process in the past has generally been limited to agricultural crops or ornamentals, the NPS program must also include native species.

The concept of biocontrol in natural areas remains controversial. Importation of organisms to Hawaii is under the legal jurisdiction of the State Department of Agriculture. Perhaps because there is not a significant forest industry in the islands (koa timber is marginal), the state has until recently given little attention to forest weeds.

Some of the most serious alien plant infestations in Hawaii's national parks, however, have become of concern not only to NPS managers, but also to other federal and state land managing agencies. Because of the wide variety of land management interests, a cooperative effort among five concerned agencies was established. The agreement delineates the five agencies' roles and responsibilities as follows:

NPS – construction and maintenance of the quarantine facility and provision of a research plant pathologist.

U.S. Forest Service – Provision of a research entomologist and furnishing certain facility equipment.

State Department of Land and Natural Resources – Foreign biocontrol exploratory work and steering committee chair.

State Department of Agriculture – Permit facilitation and coordination with other state programs.

University of Hawaii – Post-release evaluations and use of library, laboratory, and similar facilities.

A steering committee, consisting of one representative from each agency, establishes priorities, monitors work progress, and coordinates the contributions of each agency. However, all importation and release permits continue exclusively under the control of the State Department of Agriculture, which establishes advisory committees to consider each permit request on an individual basis.

**The current top-priority alien plant** targeted for

***(Continued on next page)***

***Inside the NPS*** *quarantine facility, double thicknesses of 100-mesh stainless steel screen cover the panels on either end where air enters and exits the facility. All photos by Dina Kageler.*

***NPS quarantine facility*** *at Hawaii Volcanoes National Park is designed as a greenhouse with natural sunlight and cooled by moving outside air through the secure area with large fans. The picture shadecloth is used in the summer to help control the inside temperature.*

***(Continued from previous page)***
biocontrol is the banana poka vine *(Passiflora mollissima)*, native to Columbia, Ecuador, and Peru and probably introduced to Hawaii as an ornamental. The plant produces large, showy pink flowers and juicy, yellow oblong fruit superficially resembling a banana. In Hawaii, feral pigs, themselves a serious alien problem, consume the fruit and carry the still-viable seeds in their digestive tracts throughout the forest. Alien fruit-eating birds also may aid in seed dispersal. Banana poka vines smother forest plants with dense mats of foliage in much the same manner as kudzu in forests of the southeastern U.S.

Exploration in the native countries of banana poka for potential control agents is currently underway through the cooperative agreement, with exploratory entomologists and plant pathologists from the University of Hawaii and the U.S. Department of Agriculture Biological Control of Weeds Laboratory in Albany, California. The U.S. Forest Service entomologist, duty stationed at the recently completed NPS quarantine facility in Hawaii Volcanoes National Park (HAVO), is designated as the quarantine officer. He is responsible for receiving and testing insects collected on banana poka and related plants in the countries of origin. The insects are tested for their effectiveness against target plants as well as for their host specificity. Insects that are destructive to plants of the target species but that may also attack other plants are not suitable, since they may become pests on desirable plant species. All host preference and other testing must be conducted under strict quarantine to prevent premature release of alien insects.

***The banana poka vine,*** *native to Columbia, Ecuador, and Peru, smothers Hawaii's native forest plants with dense mats of foliage, much as does kudzu in forests of the southeastern United States.*

**There are few laboratories** in the U.S. certified by state departments of agriculture and the USDA Animal and Plant Health Inspection Service as adequately secure for introduction and maintenance of foreign insects. Many of the insect quarantine facilities which do exist are completely enclosed, artificially lighted and temperature-controlled. The HAVO facility is unusual in that it is designed as a greenhouse with natural sunlight and cooled by movement of large volumes of outside air with fans through the secure area. Double thicknesses of 100-mesh stainless steel screen cover the panels on either end where air enters and exits the facility. Means to suspend shadecloth above the surface also are provided to aid in cooling as needed.

The Hawaii State Department of Agriculture's quarantine facility is located at sea level in Honolulu, an elevation at which banana poka will not grow under natural conditions. Since the target plants mostly occur above 3,000 ft. (920 m), a lowland facility would not serve the intended purpose.

The HAVO quarantine greenhouse is constructed with transparent Lexan Margard polycarbonate, an extremely strong and durable material with the light transmittance qualities of clear glass. All joints and seams are caulked and sealed to be insect-proof, and the facility is provided with three heavy, refrigerator-type sealing doors in sequence, which open into two black anterooms through which one must pass to enter and exist the facility. Light traps in the anterooms attract any stray insects, and the doors are provided with warning mechanisms to prevent more than one door from being opened at once. A large steam sterilizer with a door at each end is mounted through the outside wall of the insect receiving room so that all biological and other material used in the facility may be passed through it prior to being removed from quarantine. The insects themselves are confined on plants in cages or in incubators within the larger greenhouse area. Any escaped insect is promptly retrieved. Non-secure conventional greenhouse sections adjacent to the quarantine structure itself provide space for cultivating plants used in the biocontrol program.

The design and operation of HAVO's facility had little precedent. It was decided that a section of an existing conventional greenhouse, measuring 31 × 22 ft., could more feasibly be converted into an insect-secure structure than an entirely new building could be constructed. Furthermore, it was desirable to maintain as nearly as possible natural, rather than artificial lighting and temperature conditions for host plant growth and insect activity typical of the environment where target plant infestations occur. Of major concern was the capability of fans alone to provide outside temperatures inside, and at the same time maintain insect-security. Our experience since completion and inspection of the facility indicates that satisfactory temperatures can be maintained, aided by the use of shadecloth.

Because of the ventilation system and the use of screens to prevent escape of insects, the facility is only suitable for biocontrol work with entomological agents rather than plant disease organisms. Testing of the latter agents, many of which are microscopic fungi that produce airborne spores, must be conducted in other facilities designed to contain these microorganisms.

*Gardner is an NPS Research Scientist and Smith is an Associate Professor of Botany at the University of Hawaii; both are located at the University of Hawaii NPS/CPSU, of which Smith is Director.*

# Rainier Oil Spill Prompts Review

During the winter of 1984-85, approximately 7,000 gallons of diesel fuel were lost from a storage tank at Paradise day-use building, Mount Rainier National Park. A leak in the tank or overflow due to water infiltration of the tank resulted in a spill into soils around the tank, according to Bob Dunnagan, Assistant Superintendent.

The displaced fuel either flowed under the snowpack or through the soil to Barn Flat, about one-third of a mile downslope from the day-use building. In late June 1985, the smell of diesel fuel became evident at Narada Falls, on Paradise River about 3 miles downstream from the Barn Flat tributary. This prompted investigation, which revealed oil pooled on $^{9}/_{10}$ of an acre at Barn Flat.

Immediate cleanup of the contaminated area was begun, and continues, using temporary retaining dams and special absorbent pads made of a synthetic material that absorbs oil but not water.

In-house review of the entire situation is scheduled for mid-August, after which a *Park Science* article will be written describing the event from a number of perspectives. These will include the ecological effects, the regulatory maze, and the sociopolitical ramifications of handling such a situation.

"I think," said Dunnagan, "that a good deal of wisdom that will be useful throughout the Park System can be distilled from all this."

# *letters*

To the Editor:

The brief review of "Managing Wildlife with Experimental Rigor? Why Not?" *Park Science,* Spring 1985 reminded me of a debate I had last fall with Gary Davis, Research Scientist, Channel Islands. The point I attempted to make in the debate was that there should not be a marked distinction between research and resource management because practitioners in both groups require the application of the scientific method. The dichotomy that exists within NPS between research and resources management is an artifical construct, perhaps due to the careers of individuals or for historical reasons, which should not exist. The application of rigorous scientific methodology is necessary if we are to gain knowledge in other than a haphazard manner.

It is encouraging to know that others share this idea and present it more articulately than I. I hope the debate continues but the dichotomy dissolves.

**Judd A. Howell**
**Natural Resources Specialist**
**Golden Gate NRA**

# Water Resources Training Course Held at Colorado State University

By Juliette Wilson

Resource management specialists from NPS units across the nation participated in a five-day water quality training course held June 24 - 28 at Colorado State University in Fort Collins. Course topics included basic principles of hydrology, chemical analytical techniques, common water quality impacts, waterborne pathogens, use of biological indicators, acid rain, water rights, water quality legislation, and the development of water monitoring and management plans. Presentations were given by researchers, technical specialists, and administrators from Colorado State University as well as from NPS. One full day was devoted to field work in which trainees learned how to use different types of field equipment and collect water and aquatic insect samples. The following day was spent in the laboratory analyzing the previous day's samples for bacteria, chlorides, nitrates, and insect species and comparing results between sites.

A new feature of this year's course was a simulation exercise. Participants were divided into small working groups whose task was to develop a water quality monitoring plan for an imaginary park unit experiencing impacts from a variety of human activities. Monitoring plans were presented to a panel of water quality specialists, who compared and critiqued the different plans. In this way the trainees were able to experience some of the dynamics of planning and implementing such a plan, in addition to receiving immediate feedback on each plan's relative strengths and weaknesses.

Sam Kunkle and Mark Flora of the NPS Water Resources Division (WRD) at Colorado State University (CSU) designed the course and recruited the training staff. Coordination of the course was jointly provided by Ann Baugh, Horace M. Albright Training Center; Glenn Haas, Professor of Recreation Resources at CSU; and Juliette Wilson, WRD/CSU support staff.

***Trainees transfer*** *aquatic insect samples to trays for sorting and examination. From left, Bruce Bessken, Hank Snyder, Mike Bilecki (peeking through), Dennis Ditmanson, and Jim Walters.*

***Dissecting microscopes*** *aid Trainees Mel Poole (left) and Steve Cinnamon examine aquatic insects.*

***A group of trainees*** *learn how to measure stream flow. From left, Hank Snyder, Jim Walters (in stream), Dennis Ditmanson, Bruce Bessken, Fred Armstrong, Michael Rikard, Gary Smillie (instructor), Rick Ingliss (instructor) and Mike Bilecki.*

Research Notes

# Conservation Strategies: Island Biogeography And the Design of Nature Reserves

By James F. Quinn, Charles van Riper III, Richard Karban, George Robinson, and Susan P. Harrison

***Editor's Note:*** *Following is a longer than usual article, describing the work of five scientists to determine optimum park size where the main objective is to maximize species diversity. They describe some preliminary findings and the research plan for next year. According to Dr. Quinn, "The controversy we deal with is presently one of the hottest topics in conservation biology and our findings will no doubt add more fuel to the fire."*

With the recognition that some large fraction of the world's species is threatened with extinction through development and habitat destruction, the maintenance of the biological and genetic diversity of natural communities is becoming an increasingly important part of conservation strategies. Although zoos and "gene banks" will have a role to play, parks and nature reserves will continue to be the most important tool for managing and preserving the declining number of species and genetic pools.

The logistical difficulties of adequately surveying all of the biota of all potential reserve areas, so that informed choices can be made on purely empirical data, appear insurmountable. Consequently, ecological theory is likely to assume an important role in assessing opportunities for land and species preservation. One of the more promising applications of basic ecology to conservation strategies may be in the analysis discerning between the effectiveness of preserving a few large areas versus utilizing the same resources to acquire a number of smaller tracts, equal in area to the larger ones.

One of the more predictable patterns in nature is a regular relationship between the areas of islands, or other isolated patches of habitat such as mountaintops, and the number of species that they harbor. Typically, the species count increases in proportion to roughly the fourth root of island area. To explain this observation, theorists have developed the "Theory of Island Biogeography", proposing that island biotas may be viewed as persisting in a dynamic equilibrium in which species extinctions are balanced by immigration of new species.

Insofar as parks and refuges can be viewed as "islands" of pristine habitat, separated by areas that are usually unsuitable to threatened species, this research provides a tool for estimating the number of target species that might persist within a park of a particular size, and the rate at which species might be expected to disappear due to unforeseen random environmental or demographic fluctuations in the future.

It does not follow from an increasing species-area curve that a single contiguous area will harbor more species than the *same amount of land* set aside as a number of smaller reserves. On the contrary, mathematical models and empirical studies in the field and laboratory have often found that subdivided habitats promote regional coexistence of species that would be unable to coinhabit single homogeneous areas. On the other hand, it is well established that some populations, often of conspicuous species such as grizzly bears, condors, and other large vertebrate predators, require enormous areas to protect a viable population, and would not be expected to persist in a fragmented collection of small reserves. Such species are often of special importance in conservation strategies.

As a result, there is no clear agreement among researchers whether a diversity of target species is best protected by emphasizing large acquisitions, necessarily few in number, or emphasizing the number of parks and refuges, at the expense of individual reserve size.

More fundamentally, it is not known, as a matter of ecological principle, whether fragmented habitats are generally richer than comparable contiguous areas, because some populations are always protected by isolation from predators, diseases, competitors, or other species-wide calamities, or whether the large contiguous areas are richer because more complex ecosystems are intact, and particularly susceptible species are buffered from chance extinction.

Our project attempts to provide explicit tests of the effects of subdivision of habitats – size versus number – in several quite different settings. **We are conducting two experiments, one with grassland plants and insects, and another with marine intertidal invertebrates.** We explicitly test in a controllable field setting, whether single large areas contain more species than identical areas subdivided to various degrees. While the tests are admittedly artificial when applied to actual parks, they constitute, as far as we know, the most thorough experiments yet attempted on the possible ecological principles involved.

As a second approach, we have reexamined data from island censuses. Although there are shortcomings in using islands as models for parks, the models provide much of the data and motivation for current ideas on these topics. As habitats have been isolated for long periods of time, they also may provide a better model to patterns expected in the future, than do the still-changing communities of recently isolated parks.

Finally, we have assembled a database of censused species, mostly vertebrates and vascular plants, from National Parks in California, which we will use to examine real-world patterns of diversity as a function of park size and location.

### Does "Island Biogeography" Suggest That Effective Parks Must be Large?

The regularity of species-area relations in nature has led a number of workers to conclude that parks, like islands, must be large to maximize diversity. While it requires no theory to say that a large park in any given location will be better than a small one, it is not obvious that a single large park is better than two parks each half the size, or 100 one percent the size.

A hypothetical example will illustrate this point. Figure 1 depicts three "island" systems with identical species-area curves (shown in Fig. 1D). The letters denote individual species. The habitat in each archipelago consists, by area, of ⅓ small islands, ⅓ medium, and ⅓ large. By inspection, the agency with the resources to acquire ⅓ of the area to maximize existing diversity might choose the large island in Figure 1A, or perhaps the small islands in Figure 1B, and would have no clearcut choice in Figure 1C.

The "Diamond Isles" (Fig. 1A) represent a situation similar to that suggested by UCLA biologist Jared Diamond for birds of South Pacific islands. The large islands' greater environmental stability, larger population sizes, and diversity provides greater opportunities for specialization. As a result, a few "weedy" species (Diamond's "supertramps") with generalist habits and high dispersal abilities will predominate on the small islands, and the more specialized, unique, and competitively dominant species will be limited to large islands. In this scenario, a collection of reserves chosen from the largest islands will generally yield the most species.

In the "Lack Archipelago" (Fig. 1B – named after the great British ornithologist David Lack) similar species exclude one another, with the winner generally being the species which, by chance, colonizes the island first. The mechanism could be either a "priority effect", in which more abundant species compete more effectively, or perhaps modification of the habitat or ecological community by the first invader, making it less suitable for later species. Here, most of the species are restricted to small islands.

The "Tallahassee Archipelago" (Fig. 1C) is inspired by Daniel Simberloff and his colleagues at Florida State University, who have argued that patterns in island faunas generally do not differ from those expected from chance colonization. If the probability of a species successfully colonizing an island is proportional to its area, the small islands, in aggregate will harbor the same diversity as the same area on a single larger island. [Simberloff and Abele have recently observed that many real islands do not fit this "null" model, generally with departures in the direction of greater diversity on small islands.]

In our experiments we will look at each of the above 3 situations in an effort to discern which choices managers might make to most efficiently utilize their limited financial resources when purchasing and managing preserves. We will present several lines of evidence that, if the manager is interested in maximizing species diversity, his most effective option is generally to invest in a number of smaller land areas rather than one large preserve. With today's limited funds available for land purchases, and with the extensive subdivision and diverse ownership of available habitats, the acquisition of smaller preserves becomes an even more desirable option.

### Methods

1) Experimental Investigations. We have designed and initiated an experiment to directly compare species found in large artificial "parks", compared to numbers harbored in equal areas in multiple small "parks". The experimental system consists of fenced plots of three sizes in a field near the University of California's Davis campus. Plot numbers are adjusted to keep the total area in any given plot size constant (i.e. we have 32 plots of 2 $m^2$, 8 of 8 $m^2$, and 2 plots of 32 $m^2$, for a total of 64 $m^2$ per treatment). We have also established half this number of control plots, how-

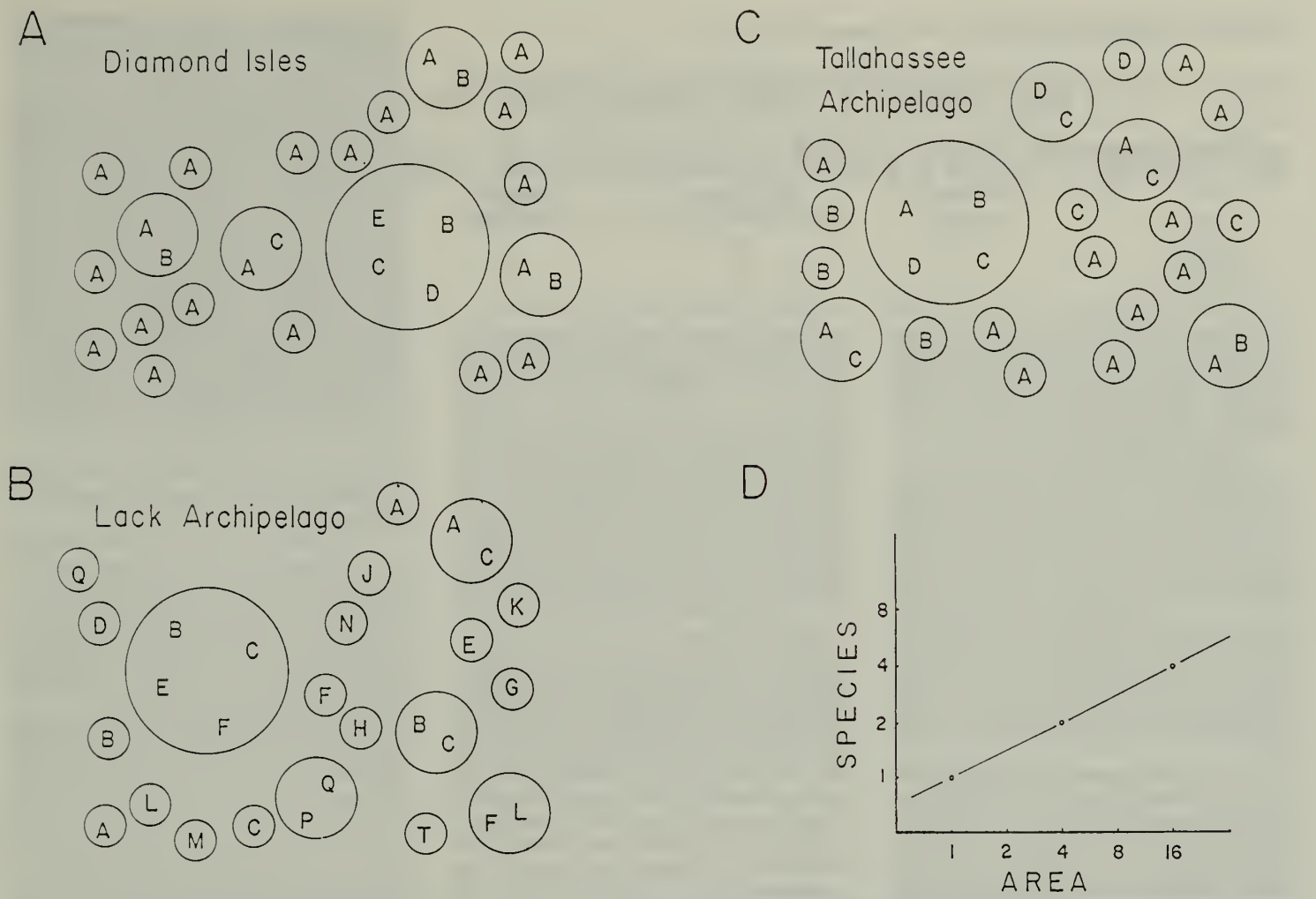


**Figure 1.** Hypothetical archipelagos with identical species-area curves (D) but favoring different acquisition strategies. In A, acquisition of large units would be favored. In B, the small units, in aggregate contain more species. In C, there is no clear advantage to single large, versus multiple small reserves.

ever these were not fenced. The areas between the plots are grazed intensively by sheep.

We are monitoring each plot for all plants and insects in this grasslands experiment. Using this design, we can test directly whether a single large unit contains more of the target species than the same area subdivided into smaller plots, as claimed. While this system is admittedly artificial, insects and annual plants found in plots isolated by grazing may be reasonably analogous to birds and trees in parks isolated by farmland, but on a spatial and temporal scale (and expense) amenable to experimentation.

We have just begun a second experiment of identical design in a marine community. Hard substrate settlement surfaces have been set in a sandflat area in the Bodega Marine Reserve, and the characteristic mussel-barnacle-limpet-starfish community is beginning to develop. Plate sizes range from $^1/_{64}$ to 1 $m^2$. In this community, even the smallest size may harbor in excess of 20 species and thousands of individuals.

2) Patterns on islands. We have analysed all censuses of species on oceanic islands or terrestrial "habitat islands" (e.g. forest plots and mountaintops) that we have been able to find published or cited in the modern biogeography literature. To date, we have located roughly 35 data sets sufficiently complete to be reliable.

3) Park censuses. For all National Parks, State Parks, and refuges in California for which information is available, we will assemble data on area, habitat type and species richness. Initially, we have concentrated on National Park Service lands in California. Because of the availability of reliable records from many locations, we have nearly completed the initial database of birds, mammals, trees, and wildflower species. Later we hope to expand the database to include all State Parks and Wildlife Refuges, and, as available, more taxa from NPS areas.

These data have been assembled in a way that should make them useful to managers and other researchers for a variety of uses. The data are stored in the Division of Environmental Studies computer facility on the University of California Davis campus. This is the first time that a centralized list of plant and animal species for California's parks has been assembled at one location. Any manager or researcher can now, with a short written request, receive a rapid response to what groups of plants or animals are presently known to occur in any park in the data base. We will continually update these lists as new information becomes available.

4) Data Analysis. Ideally, one would like to compare the species in a collection of small parks to those in a large park in the same geographical area. Since actual parks (and natural islands) do not generally have enough smaller units to allow the direct comparison, we have developed a technique to compare accumulated diversity for any given acreage under particular land acquisition strategies (i.e. small parks vs. large parks). These may be compared for effectiveness using cumulative species-area curves with relatively standard statistical techniques. We are examining patterns in both total species counts, and certain sets of rare and endangered species.

**Preliminary Results**

All of this research is still ongoing, but the preliminary results show an unexpected consistency among studies. In virtually all cases, collections of smaller areas harbor more species than single larger areas. We were surprised by this finding, given the diversity of data analysed and the divergence of opinion on this topic among conservation and ecological researchers. The areas considered vary from a few square meters to hundreds of thousands of square kilometers, the animal and plant groups studied include everything from annual weeds and ephemeral insects to redwoods and giant tortoises, and the locations range from equatorial islands to desert mountaintops.

***Experimental Studies***

The results of our grasslands experiment in 1984 are shown in Table 1 (next page). Over a 16-fold plot size difference, the most subdivided area contains roughly 78% more plant species and 53% more insect species than the undivided large plots. Early season patterns from 1985 appear similar. It is too early to assess the results of the marine experiment.

***Natural Islands***

In 31 of the 35 data sets that we have examined to date, collections of small islands consistently harbored more species than did the largest islands. Typical cases are provided by the Galapagos archipelago (most of which is an Ecuadorian national park), and the Hawaiian islands. Isabela, at 4607 $km^2$ is the single largest Galapagos island, comprising roughly 59% of the total land area of the archipelago. It also

***(Continued on next page)***

# Island Biogeography *(Continued from page 7)*

Table 1. Species diversity as a function of plot size in a California grassland community. All species observed during the summer of 1984.

**EXPERIMENTAL EXCLOSURES**

| Plot Size | Plant Species Number | Insect Species Number | Sample Size (# of plots) |
|---|---|---|---|
| Small (2 $m^2$) | 16 | 75 | 32 |
| Medium (8 $m^2$) | 13 | 62 | 8 |
| Large (32 $m^2$) | 9 | 49 | 2 |

contains much of the archipelago's montaine and cloud forest habitat, for which some groups, such as ferns, are especially adapted. Nevertheless, only 344 of the 655 reported land plant species are reported from Isabela, including 59 of the 86 ferns.

In comparison, the collection of smaller islands harbors 609 plant species, including 78 ferns. Just 204 of the 625 known Galapagos insect species are found on Isabela, versus 578 on the smaller islands. Twenty of 26 land birds, including 10 of the 13 Darwin's finches, breed on Isabela. *All* land birds are found elsewhere in the islands. Twenty-five of the land bird species can be found on the 14 smallest islands surveyed, totalling only 1042 $km^2$. Similarly, the island of Hawaii represents 63% of the land area of the Hawaiian archipelago, and is inhabited by 30 of the 70 extant native land bird species. The smaller islands together harbor 51 species.

Thus, most island groups seem to best resemble the "Lack Archipelago" scenario. The only exception we have found to date on actual islands are ground beetles from the Faroes Islands. Birds and mammals from mountaintops in the Great Basin, and alpine plants in the Adirondacks also depart from the general pattern. In all of these cases subdivision appears to have little effect on species diversity (the "Tallahassee Archipelago" scenario).

We have not yet found any data sets showing large islands or habitat patches containing significantly more species than a comparable-sized collection of small islands or patches (as in the "Diamond Isles"). Unfortunately, we have been unable to find any suitable data from tropical rainforests, in which this issue seems most controversial.

***National Parks***

The data from existing National Parks are still being corrected for taxonomic uncertainty and incompleteness, but overall the patterns are similar to what we have found in our grasslands experiment, and from the analysis of natural islands. Far more species are listed in the relatively small area of half a dozen dispersed small parks than in the largest parks in the system. For example, the combination of Redwood, North Cascades, and Big Bend National Parks, totalling some 5100 $km^2$, harbors 14 species of large mammals. Yellowstone is the largest park in the continental United States, and has the richest large mammal fauna. Yet with almost twice the area (9000 $km^2$), it has two fewer species.

The differences are far more dramatic in plants. Because the habitat diversity among small parks, compared to that within large parks, is considerable, this comparison may be somewhat misleading, and it is not obvious that the populations in all of the small parks will ultimately be self-sustaining. We plan analyses of habitat diversity to explore this subject further. Nevertheless, the data from American parks do not suggest from species counts alone that small reserves are less effective as conservation tools than large reserves.

**Summary**

It has been long-recognized that the sizes and spatial distributions of parks and refuges strongly influence their success in preserving natural species diversity and in preventing the decline or extinction of particular endangered populations. It is currently widely accepted that managers should dedicate available resources to establishing a small number of very large reserves. The proposition that this represents the most effective conservation strategy for maximizing species diversity does not follow logically from

Figure 2. The study area from the air.

Figure 3. A small exclosure.

known species-area relationships in either "island biogeography" or existing reserves, and is empirically poorly tested.

Our preliminary investigations of data from natural islands, National Parks, and a field experiment constructing artificial "parks" in a grassland and insect community suggest that acquiring larger numbers of (necessarily smaller) parks may be a substantially more effective strategy for conserving maximum biological diversity than is tying up available resources in a few very large units.

We do not suggest that these observations provide any particular policy prescription. Maximizing diversity is just one of the many goals of park formation. Feasibility of alternate strategies may be much more limited by political or aesthetic considerations than capital costs of land acquisition. In any case, both natural islands and our experimental plots provide imperfect analogs of parks and refuges, and are somewhat special examples of subdivided habitats.

Isolated island groups have biotas biassed toward species with exceptional dispersal abilities, and many groups show considerable endemism. Nearshore islands, by contrast, may be recolonized by mainland species that would not persist if the island were isolated, and thus be a poor model for self-sustaining reserves. The ecology of tractable experimental species may not be representative of that of rare and endangered species.

Particular target species (e.g. California condors, grizzly bears) may be threatened because large size and high trophic status keep populations sparse under the best of conditions. Such species undoubtedly require large refuge areas because of extensive home ranges, migratory patterns, or the need to maintain genetic diversity. Consequently, the minimum refuge size in many cases may be quite different from that suggested by species counts alone.

Nevertheless, we can assess the claim that ecological principles favor very large parks to maximize diversity. On the basis of our preliminary findings, such a claim seems suspect, although the value of large parks is certainly justified on other grounds.

At present, there is no way to assess conclusively the processes promoting diversity in collections of parks, islands, or even experimental plots. Their relative importance undoubtedly varies among locations and taxa. However, although the mechanistic basis for species-area effects is little understood, empirical observations suggest that greater species diversity is maintained on multiple "islands", whether real islands, isolated habitat patches, or plots, than on a comparable land area of a single large "island."

***(Continued on next page)***

# Limits of Acceptable Change: A Framework for Assessing Carrying Capacity

**By Jeffrey Marion, David Cole, David Reynolds**

*Editor's Note: Following is what promises to be only the first in a continuing series looking at various approaches to a complex set of problems that once were lumped under the heading "carrying capacity." The two "boxes" inserted into this article refer sketchily to other approaches that will be reported in future issues.* Park Science *welcomes word of any other efforts to deal with this generic problem and any observations from interested readers – either reactions to the published presentations or educated thoughts on the subject.*

Increasing recreational use of National Parks is forcing managers to deal more actively with problems of deteriorating resources and recreation experiences. If parks are not managed carefully, the very uses for which they were, in part, created can threaten the environmental integrity and recreational quality of their resources. One concept frequently advanced as a help in managing recreation use and its associated impacts is that of carrying capacity. The concept was borrowed from range and wildlife management, where it is a measure of the amount of use (in these cases, by animals) that an area of land can support on a sustained basis without destruction of the resource base.

In recreation, it was hoped that similar use limits (carrying capacities) could be set for recreationists, in such a way that quality resources and experiences could be maintained. Although the body of research on carrying capacity is voluminous, very little progress has been made toward realizing this hope. Nevertheless, legislative and agency directives have called for setting carrying capacities in many recreation areas, including the National Parks.

Meanwhile, in the course of trying to turn carrying capacity into "the" magic management tool, considerable progress has been made toward understanding why this attempt has failed. Research found that the level of resource deterioration is influenced by other factors such as type, location, and season of use, as well as amount of use; similarly, research has demonstrated only a weak relationship between visitor satisfaction and number of visitors. Limiting just the amount of use therefore is not the key to managing recreation. It can be helpful and, indeed, is necessary in places where use is extremely high, but it is only one of many management options available.

Over the years, the concept of recreational carrying capacity has been expanded to mean essentially "appropriate management." The original hope was to maintain quality resources and experiences through setting use limits. Attention now has shifted from fixed resource capabilities and amount of use to the desired resource and social conditions.

As modified, the carrying capacity concept now addresses how do manage use (amount, type, timing, location, etc.) to control biophysical and social impacts. The keys to doing this are setting objectives, monitoring conditions, and then gearing management to meet the objectives.

Managers have long recognized and accepted the inevitability of some deterioration in resources and recreational experiences, particularly in areas receiving heavy recreational use. But what constitutes excessive or "unacceptable" change and how do managers define these limits?

Recently, a group of researchers, working with the Forest Service's Wilderness Management Research Unit, put together a framework for management planning called "limits of acceptable change" (LAC) (Fig. 1, next page) that should do what carrying capacity was supposed to do. As so much of the "carrying

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Insofar as the "islands" we have examined provide valid models for parks and refuges, and a principal objective of conservation is the maintenance of overall species diversity, the number of refuges appears to be of equal or greater importance than the size of individual reserves. Policy prescriptions based on this observation should be approached with caution. It would be unfortunate, however, if exclusive emphasis on minimizing extinction rates in single large parks or islands caused planners to overlook the potential effectiveness of numerous and dispersed tracts in preserving a greater variety of species, habitats, and functioning ecological communities.

*This work was supported by a grant from the Hewlett Foundation through the University of California Public Service Research and Dissemination Program and the Facilitation Account of the University of California Cooperative National Park Resources Studies Unit. We thank Angela Lockwood and Steven Peterson for their help in the collection and reduction of field data.*

*All five authors are with the University of California, Davis, 95616; Quinn, Department of Environmental Studies and Department of Zoology; van Riper, NPS Cooperative Parks Study Unit and Department of Wildlife and Fisheries Biology; Karban and Harrison, Department of Entomology, and Robinson, Department of Botany.*

**Figure 4.** In the service of science.

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A Visitor Impact Management Process manual is one of three publications planned for 1986 as outgrowths of three years of work by the National Parks Conservation Association and a team of social and soil scientists from the University of Maryland. Funded by two foundations and directed by Laura Loomis, chief of grass roots and outreach for NCPA, the study has focused on two National Parks – Great Smoky Mountains and Glacier.

Two additional publications slated for Spring 1986 are a literature synthesis, discussing the state of the art of carrying capacity in general and five principles in particular – soil, vegetation, water, wildlife, and related social questions, and a bibliography with 1800 citations, by subject matter and with title key word coding.

"We have designed a process that will be useful on a broad scale in general management planning," Loomis said, "and should also be useful for solving so-called carrying capacity problems in any park."

A training program will be the final step in the project. Details of the study will be carried in a 1986 issue of *Park Science*.

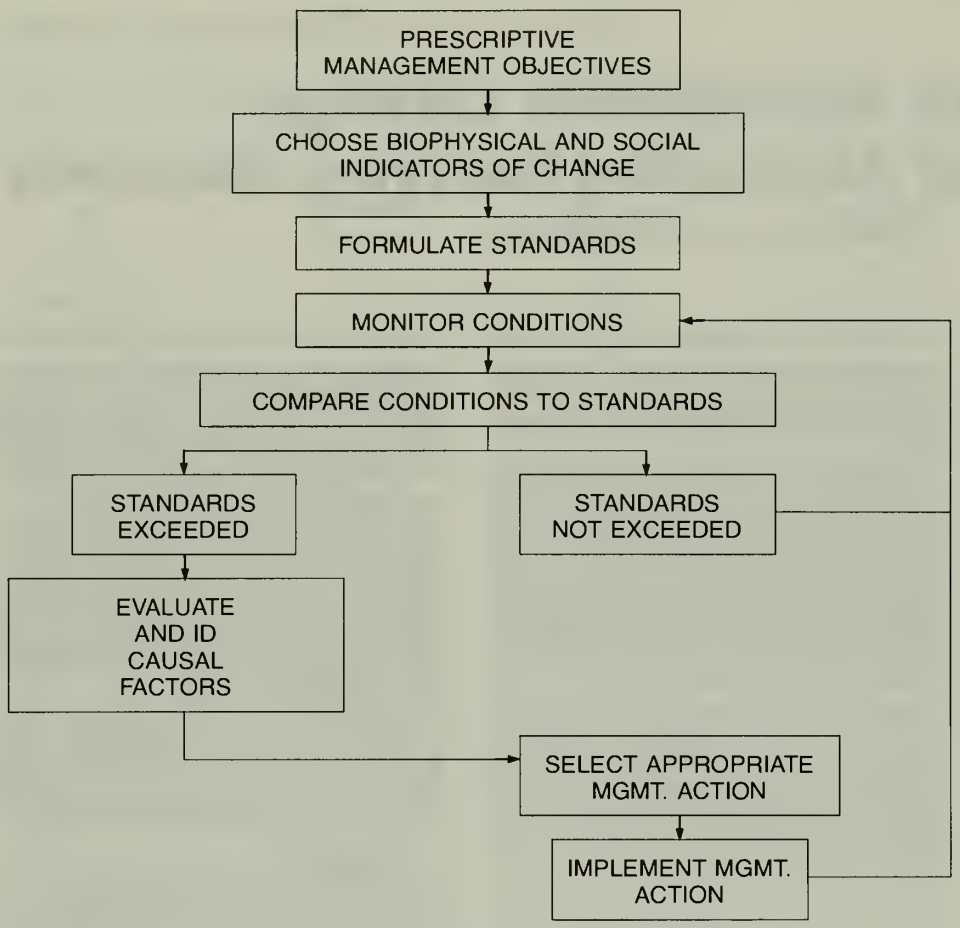


**Figure 1.** The simplified version of the limits of acceptable change (LAC) planning process.

***(Continued from previous page)***

capacity" literature stresses, everything flows from management objectives. These define the physical, biological, and social conditions within an area that management seeks to create, restore, or maintain. These objectives are made specific and subject to evaluation by developing quantitative standards for "indicators" of social and environmental conditions. Examples of standards might be "visitors will not encounter more than 10 other parties per day" or "bare ground will not exceed 500 $ft^2$ on any campsite."

Standards are established in several steps. First, indicators are selected – for example, number of encounters per day as an indicator of crowding. Current conditions for each indicator are then inventoried as the basis for the formulating individual indicator standards. Indicator standards specify the "limits of acceptable change," establishing a measurable reference point to which future conditions can be compared. These limits define the critical boundary line between acceptable and unacceptable conditions; they should set challenging yet realistic goals for managers. It is important to note that standards represent the *upper* limits of acceptable change. Conditions must not be permitted to deteriorate to this *highest* acceptable common denominator.

Implementation proceeds with the development of a standardized monitoring program, the purpose of which is to assess current conditions with respect to each indicator. Periodic monitoring data are compared with standards. If standards are not exceeded, then monitoring continues, perhaps with an evaluation to determine what changes are occurring and what preventive actions are appropriate. If standards are exceeded, more drastic measures are necessary. The cause of the problem must be identified and corrective actions taken. If the cause is too much use, then use must be reduced. Often the cause relates to use distribution or behavior; these require different actions. Where use limitation is necessary, deciding on appropriate limits is relatively easy because the critical factors already have been identified. For example, if the problem is four encounters per day in one lake basin, as opposed to a standard of three per day, it would make sense to reduce use in that area by one-fourth.

Once actions are selected, they must be implemented. The rest of the process is repetitive monitoring, a return to an earlier step in the process. **A detailed description of this framework recently appeared in USDA Forest Service Research Paper INT-176, available from the Intermountain Forest and Range Experiment Station, 507 25th Street, Ogden, UT 84401. The report is entitled "The limits of acceptable change (LAC) system for wilderness planning" and was written by George Stankey, David Cole, Bob Lucas, Margaret Petersen, and Sid Frissell.**

Currently this process is being applied in a number of places. Implementation is most advanced in the Bob Marshall Wilderness Complex, three contiguous Forest Service Wildernesses in Montana. A final draft for public review has been completed. David Cole, one of the LAC process developers, has been heavily involved in the Bob Marshall process and has completed a research project on backcountry campsites at Grand Canyon NP. Grand Canyon recently implemented a backcountry management plan, subject to yearly review. An LAC process may be used to incorporate data from this campsite study and a survey of park visitors into a revised plan.

Managers of the nation's most heavily used wilderness, the Boundary Waters Canoe Area (BWCA) in northeastern Minnesota, also are implementing the LAC planning system. To date, work has focused primarily on resource impacts on the area's 2000 designated campsites. Using campsite impact research by Jeff Marion, managers have selected a number of biophysical indicators, set preliminary standards, and developed a monitoring program. Managers also have identified water quality indicators and are beginning to assess air quality and social indicators.

Although developed for wilderness management, this process is equally suited to management of non-wilderness situations. Recently the Mid-Atlantic Region of NPS entered into a multi-year cooperative agreement with the USDA Forest Service's North Central Forest Experiment Station River Recreation Management Research Unit to investigate appropriate river recreation use in three park units. The LAC planning process has been identified as a potential vehicle for implementing research findings.

Research is underway at the Delaware Water Gap National Recreation Area and the New River Gorge National River to develop standardized impact assessment/monitoring sytems for campsites. These management-oriented systems provide site-specific information on the nature and severity of resource impacts that can aid in the formulation of indicator standards. When periodically reapplied as part of an

***(Continued on next page)***

# Evaluation of Indicators

**By Edwin E. Krumpe and Linda Merigliano**

In recent years, wilderness managers have become increasingly interested in developing monitoring programs to keep track of the condition of the natural resources. Several years ago, while working with USFS and NPS managers to integrate the "limits of acceptable change" concept into the management plan for the North, South and Middle Forks of the Flathead River, we discovered that a key element is choosing which indicators should be monitored.

This spring, the University of Idaho Wilderness Research Center began a study to identify and evaluate indicators of wilderness resource conditions. A panel of 100 physical, biological, and social scientists who have conducted wilderness research were asked to identify indicators that could be used in a monitoring program. Through an iterative process known as the Delphi technique, they narrowed their original list of over 200 indicators down to 32 which were most frequently selected. In the final stage, these scientists were asked to score whether or not each indicator meets nine specific criteria. (These criteria came from a review of the literature.) The outcome of this project will be (1) a comprehensive list of indicators, and (2) for the most frequently selected indicators, an evaluation of how well they should perform on nine criteria. This should prove useful to researchers and managers alike in a crucial step in the LAC process, choosing the best indicators to monitor wilderness resource conditions.

*Krumpe is Director of the Wilderness Research Center at the University of Idaho, Moscow, ID: Merigliano is a graduate assistant.*

impact-monitoring program, these systems allow managers to detect and evaluate deteriorating conditions and to judge the effectiveness of resource protection measures.

At New River Gorge, NPS Resource Management Specialist David Reynolds is planning to integrate the LAC process with the development of a River Management Plan for the area. The River Management Plan will focus on: 1) identifying the most appropriate river recreation experiences; 2) promoting opportunities for the public to have those experiences; and 3) minimizing adverse impacts on the natural, cultural and scenic qualities of the river environment. Following identification of the river management objectives, the LAC process will be used to formulate environmental and social standards not to be exceeded for the river environment and a method to monitor those conditions with a limited workforce.

Meetings are being scheduled to fully involve the public in the river management planning process at New River Gorge. Public involvement helps establish a consensus as to what is and is not a problem. An objective of those meetings is for the different river groups to provide input on the selection of the biophysical and social indicators of change and the formulation of standards. Public involvement in the LAC process also should facilitate the acceptance of any management actions that may be implemented to prevent the chosen standards from being exceeded.

*Marion is Assistant Professor, University of Wisconsin, River Falls, WI; Cole is Research Ecologist, Systems for Environmental Management, Missoula, MT; Reynolds is Resource Management Specialist, New River Gorge National River, Oak Hill, WV.*

# Book Review

***Editor's Note:*** *Too late for the Summer issue, this review of Larry Harris'* Fragmented Forest *arrived at the editor's desk. The reviewer, Fred B. Samson, is a research wildlife biologist with the U.S. Forest Service's Old Growth Wildlife Habitat Program. His thoughts on the book add another dimension to the review by Will Moir, carried in the Summer issue.*

**Larry D. Harris. 1984. The fragmented forest, island biogeographic theory and the preservation of biotic diversity. Univ. Chicago Press, Chicago and London, xviii, 211 p. With foreward by Kenton R. Miller.**

In 1935 then director of the National Park Service, Horace M. Albright, was alarmed by "the extreme difficulty of preserving these (Park) wildlife elements as to the completeness of species, numbers of each kind, and naturalness of the environment, in face of mushrooming growth in park travel and alarming depletion of wildlife resources" (1935:VI). His concern reflected the "failure of parks as independent units by virtue of boundary and size limitations" and. . . "the injection of man and his activities into the native animal environments" (1935:13). One could ask, have these challenges for wildlife conservation in parks changed and, are the issues raised different from those of the 1980s? The answer for many researchers and managers would be "no."

In the 1930s, the emerging field of wildlife management gained both acceptance among other sciences and recognition from the public with the appearance of Aldo Leopold's classic book, *Game Management.* Since then, a number of books have made major contributions to the field of wildlife management, particularly to the biology and management of big game in the western United States. There has not been a contribution that addresses the major issues for wildlife management in the broadest sense as did Leopold's book.

This has changed however with the appearance of a book by Larry Harris entitled *The Fragmented Forest. Island Biogeography Theory and the Preservation of Biotic Diversity,* published by the University of Chicago Press. In the book, Harris uses the old-growth forests of the Pacific Northwest to illustrate the application of island biogeographic theory to preserve biotic diversity. The first five chapters review the history of the area in terms of the characteristics of plant and animal communities and timber management. One is impressed with the history and detail given to the fragmentation of the forest and the description of the current mosiac of habitat islands.

Chapters 6 through 8 apply the equilibrium theory of island biology and ecological genetics to preserving wildlife in this fragmented habitat. The importance of area and isolation of habitat are considered within a framework of species extinction.

The equilibrium theory of island biogeography has been a conceptual focal point in the design of parks, refuges and natural areas for nearly two decades. This is, however, the first clear application to an inland landscape. In this frameowrk, the importance of area and isolation of habitat are considered with regard to species extinction. The need to consider the potential effects of genetic isolation of populations is reviewed and a number a recent efforts in this field are cited.

There is mounting evidence that as a park or natural area progressively becomes more isolated – either genetically or from similar habitat – the likelihood for species extinction increases. This leads to a discussion of a regional system of national parks, wilderness areas, and natural areas as "building blocks upon which a conservation strategy may be hinged" (1984:89). This latter topic, in principle, is in agreement with several recent symposia that are charting the direction to a more comprehensive landscape approach to preserve biotic diversity.

I have a few reservations about the book. It does ignore major criticisms of island biology by some authors and the known effects of factors such as migration and mutation on the genetic structure of populations. The influence of environmental and demographic stochastic events, particularly as they relate to the extinction of small populations, is not covered in the detail it deserves.

Nevertheless, this book is a very significant contribution to the field of wildlife management. It may not be the heir apparent to *Game Management,* but it is clearly a step in the right direction and should be required reading for all resource managers.

**Fred B. Samson, Research Wildlife Biologist**
**USDA Forest Service Old Growth Wildlife Habitat Program**
**3625 – 93rd Ave., S.W., Olympia, WA 98502**

# Old Growth Research Underway at Rainier NP

**By Stanley E. Schlegel and Cat Hawkins**

Since 1983, Mount Rainier National Park has been participating in the Old Growth Forest Wildlife Habitat Research and Development Program – a five-year program initiated in 1981 to plan, coordinate, and provide leadership for research in old growth forest ecosystems. Goals of the program, administered by the U.S. Forest Service, are:

1. to identify animal and plant species that depend on or find optimum habitat in old growth forests;
2. to describe, classify, and inventory old growth forest ecosystems;
3. to determine biological requirements and ecological relationships of species found in old growth stands; and
4. to evaluate old growth management alternatives and their economic impacts.

The study involves the U.S.F.S., Bureau of Land Management, U.S. Fish and Wildlife Service, National Park Service, conservation groups, and university scientists in Washington, Oregon, and California.

Within the 15 study plots selected at Mount Rainier, research teams are studying birds, small mammals, bats, reptiles, and amphibians. Although small mammal studies have been conducted at Mount Rainier periodically, it has been some time since the park's birds were studied in depth, and the reptiles and amphibians probably never have been thoroughly researched. The current studies will update old inventories, furnish valuable baseline data, and provide interpreters with recent information for their interpretive programs.

The park also will receive representative specimens of all small mammals, reptiles, and amphibians collected . . . valuable additions to the park's long-neglected natural history collections. Interim progress reports have been filed; specimens and specific information about the park's animals will come later.

Apart from what Mount Rainier NP will receive from the work, and perhaps even more important, is the park's contribution to knowledge of old growth forests. Here are extensive old growth stands, protected from past utilization and subject only to nature's hand. These stands are fully protected from future cutting. They now serve as a baseline from which better understanding of the functioning of old growth can be gained. In the future they will provide a standard against which to measure success in the management of other old growth forest areas and their attendant plants and animals.

*Schlegel is Resource Management Specialist and Hawkins is a Resource Management trainee at Mount Rainier NP.*

# Six Pixels in 3 Frames Add Up To One Bat

**By Milford Fletcher**
*Southwest Regional Chief Scientist*

Over the past 15 years, the bat population at Carlsbad Caverns NP has declined from an estimated six million to around 300,000 bats. This represents a population decline of 95 percent and is cause for great concern among both Park and Regional resource management staff. The cause of the decline appears to be DDT poisoning. In essence, insects pick up minute amounts of DDT from the soils in the vicinity and the DDT is transferred from the insect to the female bat in her normal feeding routine. The DDT, being fat-soluble, is then accumulated in the mother's body and transferred in the mother's milk to the baby bat, who then accumulates the DDT in its fatty tissues. When the young bat begins its migratory flight in the fall, the fat is used up, the DDT is released into the bloodstream, and the young bat undergoes behavioral or physiological changes that ultimately result in its death.

One requirement for addressing the problem is to know how many animals we are dealing with. How does one count huge numbers of bats? The "there's one, there's another" technique certainly won't work. The numbers are just too great. For example, if one counted one object each second, 8 hours/day and 5 days/week, it would take 6 weeks to count to one million. (To count to a billion would require 97 years.) In some cases, as many as six million bats may leave a cave in 2 or 3 hours, and it is literally impossible to count them with any accuracy.

In the past, various methods have been used to estimate bat numbers, but these have all had substantial errors inherent in the technique. One method used is to carefully measure the guano deposits and, by inference, estimate bat numbers. This technique has many of the same built-in errors that deer pellet transects have. Another method is to photograph bats while they rest on the cave ceiling, count the number of bats in a square foot in the photograph and extrapolate this to a total number. Since bats enter crevices which cannot be photographed, and Brazilian Free-tail Bats often hang two or three deep, this method was not satisfactory. In addition, the flashes of light necessary for good photography may adversely affect the bats.

In 1985, the National Park Service let a research and design contract to Comar, Inc. of Dallas, Texas to design a technique to count bats using methods which did not influence the bats' behavior, would not alter the physical environment of the cave, and guaranteed at least 90 percent accuracy. The contract stated that as many as 16 million bats were to be counted in 3 hours. (Braken Bat Cave near San Antonio, Texas is reputed to house as many as 16 million Brazilian Free-tail Bats.) An analysis of existing technology indicated that high-quality video tape could be analyzed, using a frame-grabber and computer to count the bats.

Each bat is assumed to occupy at least six pixels on a screen and each bat must be counted in three consecutive frames of video tape to be considered a bat. We are currently working on photographic techniques using infrared filters and extremely low-light video cameras. Ultimately, we intend to run the program on either Data General or IBM PC computers. The technique appears to work well with Brazilian Free-tail Bats, but needs refinement to count Grey and Indiana Bats, since they frequently "swarm" in and out of a cave. The computers now have to be programmed to both add bats as they leave the cave and subtract bats who reenter the cave.

The second year's contact is about to be let and by this time next year, not only will these techniques be in place at Carlsbad Caverns NP, but should be available to the scientific community at large. Numerous inquiries about the technique have been received, including speculation on whether this technique could be used to count fish in a fish wier, migratory birds, and caribou. All seem feasible at this time.

We feel this technique will be of great value in determining not only population trends but absolute numbers of bats. The techniques also have considerable potential for other uses where huge numbers of objects need to be counted.

# meetings of interest

**1985**

**Oct. 20-25, ARID LANDS: TODAY AND TOMORROW,** an international research and development conference, in Tucson, Ariz. Co-sponsors, AAAS, UNESCO, U.S. AID, the U.S. MAB Program, and U/Ariz. Contact, G.P. Nabham, Office of Arid Lands Studies, U/Ariz., Tucson, 85721.

**Nov. 18-22, MANAGING PEOPLE IN PARKS AND FORESTS,** Oregon State U, Corvallis, 97331. Contact, Donald R. Field, OSU/CPSU.

**Oct. 1-4, FIRST INTERNATIONAL SYMPOSIUM ON KEMP'S RIDLEY SEA TURTLE BIOLOGY,** conservation and management, at Texas A&M U, Galveston, Tex. Contact Milford Fletcher, P.O. Box 728, Santa Fe, NM 87501.

**Nov. 4-7, FIRST REGIONAL CONFERENCE OF THE RIO GRANDE BORDER STATES ON PARKS AND WILDLIFE,** with three separate agendas: wildlife, recreation, and parks. Contact Milford Fletcher (see above) reports that "the state of Texas and Mexican officials are strongly supportive of the conference."

**1986**

**March 21-26, 5ost NORTH AMERICAN WILDLIFE AND NATURAL RESOURCES CONFERENCE,** MGM Grand, Reno, NV.

**May 12-16, FIRST NATIONAL SYMPOSIUM ON SOCIAL SCIENCE IN RESOURCE MANAGEMENT,** at Oregon State U, Corvallis. Contact, Donald R. Field, NPS/CPSU, OSU 97331.

**July 13-20, CONFERENCE ON RESEARCH IN THE NATIONAL PARKS,** NPS and George Wright Society co-sponsors. At Col. State U, Fort Collins. Contact, Ray Herrmann, Room 107-C, Natural Resources, CSU, Fort Collins 80523.

**July 23-26, NATIONAL WILDERNESS RESEARCH CONFERENCE,** Fort Collins, CO 80523. Contact, Dr. Glenn E. Haas, Chairman; Recreation Resources, CSU.

**Oct. 25-28, CALIFORNIA CHANNEL ISLANDS SYMPOSIUM,** Santa Barbara, CA. Contact, Gary E. Davis, Channel Islands NP, 1901 Spinnaker Dr., Ventura CA 93003.

**1987**

**Sept. 12-19, THE FOURTH WORLD WILDERNESS CONGRESS.** Denver, Estes Park, and Fort Collins, CO. Contact Dr. Jay Hughes, Chairman, Dean of Coll. of For & Natural Resources, Col. State U, Fort Collins, CO 80523.

*See also* ***Meetings of Interest*** *in previous issues of* ***Park Science.***

*Mexican Freetail Bat Bats? We count 'em – coming*

*and going*

# information crossfile

**Daniel E. Koshland, Jr.,** editor of *Science,* in his May 24, 1985 editorial writes with feeling (and humor) about the self-deceptions practiced by scientists and by their editors. He describes the "low-paying profession of science" with all its exasperations: "Mother Nature . . . our implacable enemy . . . who guards her secrets more closely than the CIA" and students whose illegible hieroglyphics are "sometimes called handwriting." Koshland magnanimously forgives all scientists who, in the face of such odds, call upon "a touch of fantasy in regard to the importance of (their) missions and the elegance with which they should be recounted."

Koshland concedes that "up to a point, delusions of grandeur are valuable and desirable" but eventually, he points out, problems arise.

"The distilled product," he says, "is a manuscript – the ballad of the troubador, to be delivered to what he perceives as an eager audience. But there are too many ballads. Moreover, troubadors convince themselves that audiences want to hear every detail of the odyssey. Someone," he insists, "must select whose song is sung and at what length. Thus enter on the scene new characters with icewater in their veins, hearts resistant to fire, and epidermises that are not dissolved by tears. They are editors."

Koshland maintains that "editors are paid and treated worse than authors," but that they are sustained by their own peculiar delusion, *righteousness*!!!

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**In response to numerous requests** for advice on interpreting water quality data, the staff of the NPS Water Resources Branch in Fort Collins, Colo., has compiled a 46 page booklet: *Water Quality Criteria: An Overview for Park Natural Resource Specialists.* The report is designed to (1) provide the basic information needed to determine from water quality data whether a pollution problem exists in a watercourse, and (2) suggest references providing more specific information about each constituent. The 39 water quality constituents discussed are those that NPS personnel are likely to encounter when reviewing and interpreting water quality data. Authors are Hydrologists Mark Flora and Sam Kunkle and Research Assistants Juliette Wilson and Thomas Ricketts. The publication is available from the NPS Water Resources Branch, Colorado State University, Fort Collins 80523.

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**The June 25 issue of the** *Christian Science Monitor* carries word of Dr. Charles Jonkel and his "adverse conditioning laboratory" for grizzly bears. Dr. Jonkel, a professor at the University of Montana, is director of the Border Grizzly Project, a private US and Canadian effort. He believes that "problem bears" can be taught to give humans a wide berth. Jonkel has trained and released about a dozen problem bears to Montana forests and "only one got himself shot and killed – by invading a chicken coop." Umbrellas, railroad flares, and cayenne pepper in aerosol form are part of the "aversiveness training" the bears undergo.

⁂

The Summer 1985 issue of *Orion,* nature quarterly publication of the Myrin Institute, Inc. (136 E. 64th St., NYC 10021), carries two articles on Biosphere Reserves: one by William P. Gregg, Jr. and Betsy Ann McGean ("Biosphere Reserves: Their History and Their Promise") and one by J. Ronald Engel ("Biosphere Reserves as Sacred Space"). The following two excerpts are from these pieces, the first by Bill Gregg.

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"To understand the power of symbolism in the conservation of protected areas, we need only look at the time-honored success of the national park concept. Thoughts of national parks evoke visions of breathtaking vistas and unique natural features, pride in one's natural heritage, and protectiveness toward the masterworks of nature. For millions, the spiritual renewal and the opportunities for aesthetic experience and recreation found in these landscapes can be duplicated nowhere else. The symbolic value of the national park is clear, effective, and enduring – its power to inspire and motivate people far surpasses that of any other category of protected area.

"A biosphere reserve may in time prove to be an equally compelling symbol, although quite distinct from that of the national park. For increasing numbers, the biosphere reserve evokes the image of a large, self-sustaining, and well-protected ecosystem, harboring a vast archive of information essential to mankind's future well-being. This information is stored in ecological relationships and genetic codes and unlocked through scientific study, so that it may be applied practically through enlightened management. The image of the biosphere reserve includes the human element – people working together to build a model program that demonstrates the value of conservation within a particular natural region. On a broader scale, it is a center for cooperation among nations allied in the search for solutions to regional and global environmental problems, such as acid precipitation. The emotions elicited by the reserves are those of compassion for the condition of the human family and the world's ecosystems, and enthusiasm for human cooperation to improve that condition. Just as for national parks, these feelings involve intense protectiveness, but in the case of the biosphere reserves, the protectiveness extends beyond the resources themselves to what they represent – an inexhaustible library of information for advancing human welfare.

"The national park draws its life as a symbol primarily from the association with humanity's spiritual well-being. The biosphere reserve draws its vitality primarily from its association with our material progress. The widely promoted values of aesthetics and recreation have made it difficult for most national parks to realize their potential as scientific and educational resources. Biosphere reserves can be catalysts for developing this potential. When a national park becomes part of a biosphere reserve, two powerful symbols are joined. Such unions can open immense opportunities for particular geographic areas to serve humanity and at the same time broaden support for the conservation of protected areas."

*Gregg, an NPS ecologist, is co-chairman of the U.S. MAB Project Directorate on Biosphere Reserves. McGean is a Yale graduate student.*

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The Engel piece focuses on Parc National des Cévennes in southern France – officially declared a Biosphere Reserve on Dec. 8, 1984.

"Science in the Cévennes park is conceived as one of the human arts to be used on behalf of the total creative experience of the community life. The scientific program of research serves to enhance both human actualization and natural evolution. The great vulture was reintroduced with the help of science, the strains of mountain rye are being preserved with the help of science, the fertility of the mountain soil is being increased with the help of science, new and more adequate building materials are being introduced with the help of science. In each of these cases, science is a means to the coevolution of humanity and nature. And in each of these cases, the contribution of science to sustaining life is made possible by visible working relationships between scientists and local people. Knowledge is constantly being looped back into consequences people can see and understand and into projects in which they can participate and from which they can benefit. When the literature of the biosphere reserves speaks of the human ecosystem as the ultimate unit of scientific accountability, this, concretely, is what it is talking about.

"The cosmic order the biosphere reserve represents is not that of an objective eternal reality unaffected by human aspiration and choice, but the dynamic order of creative coevolutionary advance."

*Engle is professor of social ethics at Meadville/Lombard Theological School, affiliated with the University of Chicago; author of* Sacred Sands: *The Struggle for Community in the Indiana Dunes, and an article in the latest George Wright Society FORUM (Vol. 4 No. 2), "Promoting the Development and Adoption of Environmental Ethics."*

***The Wildlifer,*** periodical of the Wildlife Society, carries news in its May-June issue of two training films by Drs. Ulysses S. Seal and L. David Mech, covering the basics of the animal immobilization process. Together they provide a complete rundown of the information needed to use drugs to anesthetize wild animals for research, management, or vet care. The 16mm films are in color, with sound, and run 24 minutes each. They are available for sale or rental through CompuCap, Inc., 8437 Yates Ave. N., Brooklyn Park, MN 55443. (612) 424-2373.

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***The EYAS,*** newsletter from the Institute for Wildlife Research's Raptor Information Center, tells (in Vol. 8 No. 1 Winter 1985) of new concern for the Spotted Owl as rapid harvesting of remaining low elevation old-growth forests continues in Washington State and elsewhere. David A. Manuwal of U/WA College of Forest Resources, warns that this harvesting "may be providing suitable habitat for a competitor (the Barred Owl) and a predator/potential competitor (the Great Horned Owl).

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**Coastal and marine protected areas** will be the subject of two ambitious international seminars slated

***(Continued on next page)***

# Information Crossfile

*(Continued from page 13)*

for March and April 1986, according to word published in the April-June 1985 issue of *Parks*, the IUCN quarterly. A registration fee of $2000 (US) will cover the in-country travel, lodging, meals, and associated expenses of each participant.

The marine seminar will be hosted by the Sanctuary Programs Division of NOAA and oriented toward the needs of professional government staff who manage programs for marine protected areas around the world. It will take place in April 1986 at the Key Largo and Looe Key National Marine Sanctuaries in the Florida Keys and the Channel Islands National Marine Sanctuary and NP in southern California.

The coastal area seminar has been scheduled to begin March 8 and end March 26, 1986, consisting of site visits to inshore and coastal parks and protected areas ranging from Key Biscayne, Rookery Bay and the University of Miami during week one, continuing to St. Croix, U.S. Virgin Islands, the West Indies Laboratory, and Buck Island National Monument, and concluding with six days at Trinidad and Tobago. The NPS will manage this seminar.

Contacts are: Marine Seminar, Dr. Nancy Foster, Sanctuary Programs Division, NOAA, 3300 Whitehaven St. N.W., Washington, DC 20235; phone 202/634-4236. Coastal Seminar, Hugh Bell Muller, International Seminar, NPS, School of Natural Resources, U/Mich, Ann Arbor 48109; phone 313/763-4029.

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**Dr. Craig W. Allin** is seeking essays on history, description, and administration of national parks and comparable preserves in approximately 30 nations, to be compiled into *The International Handbook of National Parks and Nature Preserves*. Contributors are being solicited from academia and park administration. The handbook's aim is "to present a meaningful and literate discussion of parks and preservation in a representative selection of nations from around the world." Contributor selection will be completed by January 1986 and essays will be due by August 1986.

The Handbook will be published in 1987 by Greenwood Press, Inc., of Westport, Conn., a subsidiary of Congressional Information Service, Inc. Dr. Allin, Handbook editor, is presently professor of political science and Chairman, Department of Politics, Cornell College, Mt. Vernon, Iowa 52314.

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**From *Science*** (Vol. 229 p. 450) comes an item describing the lawsuit filed July 15, 1985 in U.S. District Court for the District of Columbia by the National Wildlife Federation, challenging the Interior Department's system for lifting restrictions on access to wilderness areas and other protected public lands. NWF charges that wildlife habitats, biological systems, and the natural beauty of lands in 17 states could be irreparably damaged by mining and other forms of development. Affected are 173 million acres.

"The NWF challenge, which has been under preparation for a year, could have far-reaching effects on metals and coal-mining companies as well as mineral exploration activities," the article states. NWF has asked the court to reinstate all protective designations until environmental statements and landuse plans are prepared. NWF also seeks a preliminary injunction to freeze all actions related to these properties, including leasing, mining, land exchanges, and exploration.

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From Tom Lucke, Chief, NPS Water Resources Division in Fort Collins, Colo., comes an article out of *Land and Water Law Review* (Vol. XX No. 2, pp 355-420) by Robert B. Keiter, "On Protecting the National Parks from the External Threats Dilemma." Prof. Keiter feels that the NPS does not have sufficient authority to protect national parks from the adverse effects of external activities. He describes how energy development, timber harvesting, and other activities affect the quality of visitor experiences and degrade park resources. By using Glacier NP as an illustrative case, the author then shows that, under existing legislation, the NPS is unable to deal adequately with the various external threats. Prof. Keiter concludes by presenting legislative proposals that would enable the NPS to protect its natural resources.

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**From Edwin E. Krumpe,** director of the University of Idaho Wilderness Research Center (Moscow, ID 83843), comes a 14-page booklet representing the culmination of two years of work begun at the *National Wilderness Management Workshop* conducted in 1983 at the University of Idaho. A national steering committee was formed there to pull together the issues generated at the workshop and, through broad public input, to develop a program of recommended action for dealing with major wilderness management issues.

The four-color booklet sets forth a five-year action program covering education of the public, education and training of managers, capacity and concentrated use, interagency coordination and consistency, and wilderness management practices. Of the 23 recommended actions, the five considered most crucial for the next five years are summarized by the committee at the booklet's end. Copies may be had by writing Krumpe or calling him at (208) 885-7911.

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**The Fish and Wildlife Reference Service** has access to two databases under contract from the Division of Federal Aid, U.S. Fish and Wildlife Service, according to the *Fish and Wildlife Reference Service Newsletter,* No. 68, Summer 1985. DIALOG file 920 – Current Federal Aid Research – includes state fish and wildlife research studies in progress, funded by the Federal Aid in Sport Fish Restoration (Dingell-Johnson) Act and the Federal Aid in Wildlife Restoration (Pittman-Robertson) Act. This database complements the CFAR-Fish and CFAR-Wildlife reports issued annually by the USFWS; its purpose is to provide state fish and wildlife agencies with readily retrievable information pertaining to research being conducted by the state agencies.

The second database, DIALOG File 957, includes indexed documents from the Federal Aid in Fish and Wildlife Restoration Program, the Anadromous Fish Conservation Program, the Endangered Species Grants Program, the Cooperative Fisheries and Wildlife Research Units, and state fish and wildlife agencies. The documents include reports, published papers, technical publications, theses, and special materials such as endangered species recovery plans. The 957 file, updated in June 1985, contains 16,247 records and will be updated quarterly.

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# regional highlights

## Pacific Northwest

All 23 NPS resource management trainees were in Corvallis in August for two weeks of instruction in fisheries and aquatic systems at the Oregon State University Cooperative Park Studies Unit. The sessions began with a "whole systems" approach and covered concepts and principles of fisheries and aquatic systems and their management. Lectures and field work focused on management evaluation of fishery resources, habitat, use opportunities, and potential conflicts.

Course coordinator Elena Karnaugh, graduate research assistant to Gary Larson at the OSU/CPSU, had high praise for the enthusiasm and energy levels displayed by the trainees. "They arrived here straight from four intensive weeks of vegetation work at U/Cal Davis," she said, "and they didn't miss a beat. They even asked us to set up unscheduled weekend field trips."

* * *

Deputy Regional Director William J. Briggle has announced a Resource Management Workshop to be held at Regional headquarters in Seattle on Oct. 23-24. PNR scientists will participate. The workshop will focus on guidelines for Resource Management Plans and other subject areas such as Natural Resource Preservation Program (NRPP) and Integrated Pest Management Program requirements and resource problem prioritization.

* * *

Ed Starkey has been named chairman of the newly formed Elk Subcommittee established by the Oregon-Washington Interagency Wildlife Committee. Dr. Starkey is with the NPS/CPSU at Oregon State University in Corvallis. The Subcommittee is charged with identifying issues regarding elk management guidelines both east and west of the Cascade mountains, evaluating significance of habitat changes, examining how the needs of elk and the different objectives of major landowners can be accommodated, providing technical assistance to requesting agencies, providing a forum for information exchange, seeking opportunities to coordinate research and monitoring activities, and seeking standardization of monitoring techniques where comparative data would be beneficial to several agencies.

* * *

## Southwest Region

See *Meetings of Interest* for news of Kemp's Ridley Sea Turtle Symposium and a Rio Grande Border States conference on Parks and Wildlife.

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## Rocky Mountain

Golden Spike National Historic Site park lands were treated recently with Nasema locustae (an endemic

*(Continued on page 16)*

# Some Reflections on a Career

**By Neil "Jim" Reid**

I know it may appear incredible to some of you, but truly my whole career has not been as the Regional Chief Scientist for the Rocky Mountain Region. No. I started out as a park warden ($2,974/annum) monitoring trespass cattle at Theodore Roosevelt. There has been a myriad of changes both in the Service and myself since those carefree days in western North Dakota. My personal attitude gradually shifted from one of pure idealism to one of optimistic realism. Oh, yes, there have been periods when cynicism bubbled to the surface. All-in-all though, the Service has been good to me, and all of my assignments have been exciting, rewarding, and thoroughly enjoyable.

The National Parks are known worldwide as the crown jewels of the nation's cultural and natural heritage. It is the dedicated people, however, that make the Service great – the elite among Federal bureaus. I was fortunate indeed, early in my career to be tutored in the meaning and philosophy of the National Park Service by such outstanding Park people as Allyn Hanks, Harvey Reynolds, and Charlie Humberger.

The NPS has undergone a number of changes during the past three and a half decades. By change, I do not mean the periodic reorganizations, which are as predictable as the tides. Rather, it is the vast increase in the number of units within the National Park System; the increase in the number and complexity of issues facing today's park manager; the increase in the workforce; and the new methods we use in carrying out our tasks – including an acknowledgement that scientific research, or the knowledge derived from such research, is useful in the decision-making process.

At the close of the Wright-Dixon-Thompson era in the mid-1940s the Service lapsed into a period of relative scientific quiescence. Not everyone, of course – there were still Walt Kittams at Yellowstone, Bill Robertson at Everglades, and Ade Murie at Grant Teton and Mount McKinley. And the Service did have a fine complement of Archeologists and Research Historians. But natural science was left almost entirely to the park naturalists as a collateral duty – "if they were so inclined." A good deal of good work was done; for instance Jim Larson's work on the dark-rumped petrel in Halrakala NP, and there were many, many other examples.

The significant thing is that the majority of these projects were tolerated, but they did not have the financial support of the Service. Indeed, at that time there was a serious question posed by Congress and throughout the Service as to whether or not the NPS had a mandate, or any other reason, to engage in research activities. The general consensus was that the Service was not a "research agency," and any knowledge required could be readily obtained from the Fish and Wildlife Service, Forest Service, and Geological Survey. Even some of the field managers were skeptical that research could provide information useful to park management. Common sense was all one needed to run a park.

Times have changed. The Robbins Report and the Leopold Committee Report of the 1960s have made it clear that we do not always have adequate knowledge of park resources and ecological processes to intelligently maintain the integrity of park environments. As 20th Century civilization has steadily encroached on park boundaries, what at one time were protective buffers of undeveloped land, have been transformed into productive oil and gas fields, mining operations, ski and other recreation areas, urban development, and access roads. All of these developments have had a profound effect on wildlife movements, air and water quality, noise and light pollution, distribution of exotics, and the patterns of public park use. We no longer have the luxury of depending primarily on Nature to overcome the impacts of modern man on park resources. The perturbations are too great to ignore, and they require ecologically sound mitigation. The latter, of course, requires considerable research, and the application of the research findings to management actions requires considerable wisdom and sensitivity. Therefore, a thorough testing and evaluation of management methods should be mandatory.

Congress, through passage of the National Environmental Policy Act, the Clean Air and Clean Water Acts, the Endangered Species Act, and other conservation legislation, has confirmed that, indeed, the Service has responsibilities in the protection of natural resources on park lands. Most responsible Service officials agree that a research effort is essential in carrying out our mission. But questions still need to be resolved. First and foremost, what is the role of natural science research, and where does it fit, in the National Park Service? Current Service policy requires that any research to be undertaken must be proposed in an approved natural resource management plan.

In my view, this is a myopic policy which unnecessarily limits the scope and role of natural science in the Service. True, there is a close relationship between natural resource management and natural science. Planners, however, are not all resource management specialists, and they need the research information up front, before a plan has been formalized and "approved." GMPs, DCPs, interpretive plans, and other planning documents need to be based on research before the decisions are made, not afterwards. A common sense approach to the need for and role of research should be in the Service but it has not happened in over 30 years, and I don't expect that such a phenomenon will occur soon. Not, at least, until there is agreement that we have but one Service and one purpose.

There have been many solutions as to where research should be placed in the organization – ranging from maintaining a one-man branch (sans secretary) under the Ranger Activities Division in the Rocky Mountain Region to elevating science temporarily to the Associate Regional Director level in the Pacific Northwest Region. Then again, there are the WASO divisions of Air and Water Quality and Energy, Mining and Minerals under the Associate Director for Natural Resources. While my preference is that research be closely aligned with planning, the exact organizational structure is not important, provided science responds to the users' (planners') need. I am not convinced this proviso is universally respected and suspect that many research projects are undertaken based on the researcher's interest, rather than management's needs.

Another area of special concern is the need to strengthen park funding bases for both research and resources management. A number of parks are faced with the problem of carrying out long-term research, management, and monitoring programs on "soft funds" provided through regionwide natural science programs or one of the several servicewide science bases. Some of these funding sources, such as the $7+ million Natural Resources Preservation Program (NRPP), have administratively imposed time limits on the length of projects. The uncertainty of funding makes it impossible to respond to significant and critical resource problems such as grizzly bear management and endangered species restoration, which require time in excess of 3 years. Some way, funds must be allocated to the field areas where the work is to be accomplished. It does relatively little good for parks to submit 10-237s if those submissions are merely used to justify base increases in the Washington Office. The funds may be used for legitimate and worthy causes, but the initial problem will remain.

Lawrence Slobodkin, in his book *Growth and Regulation of Animal Populations* (Holt, Rinehart and Winston, New York, 1962), remarked: "If, as is quite likely, vital aspects of man's ecology are dependent on undomesticated species, nature sanctuaries not only are of esthetic, sentimental and recreational value but are indispensable reserves of biological raw material to be used for retracing of our ecological steps." Man, indeed, has changed the land upon which we live, and continues to do so at an ever increasing rate. National parks will be much more than "pleasuring grounds" as we move toward the 21st century. Labels such as wilderness area and international Biosphere Reserves will assist in focusing public attention on the National Parks. But labels in themselves will not protect the resources or the ecological process upon which they depend. Knowledge, expertise, and wisdom are needed. The years ahead will be an exciting challenge for the National Park Service. There will be no easy solutions and no miracles – just hard, dedicated work.

It appears Director Mott will make every effort to breathe new fire into the organization – or perhaps, more correctly, rekindle the old dedication to the principles and ideals of the Service in each of its employees. No matter how nostalgic the remembrance of those carefree days of 30 years ago, there is no room today for nostalgia or complacency. The challenges, some of which have not yet been identified even as problems, are staggering. I no longer will be directly involved, but I have every confidence in each of you that the challenges will be squarely met, and the purpose of the National Park Service will be faithfully and surely carried out.

Good luck and farewell.

# Regional Highlights

*(Continued from page 14)*

spore) to control the grasshopper infestations. The private landowners whose property surrounds the park, were treating with Sevin and Malathion treated bran. The site received a 60% reduction after a 2-week period.

* * *

At Dionsaur National Monument, the National Parks and Conservation Association and Sierra Club brought an injunction against APHIS and the Department of Agriculture for spraying sevin and malathion treated brans near the monument for Mormon cricket control. The purpose of the injunction was to prohibit aerial spraying within 10 miles of peregrine falcon areas and ¼ mile from the Green and Yampa Rivers.

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Canyonlands and Zion NPs recently received final approval for their complex Fire Management Plans. This should allow them to reestablish some natural zones in these two areas, and to experiment with fire toward Tamarisk eradication.

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Colorado National Monument is now ready to do some native seeding to begin the revegetation of the former bison range. The last bison died this past winter and the bulk of the animals caught were transferred to Badlands NP to bring new blood into the herd there.

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Fossil Butte National Monument is currently working with the Kemmerer Bureau of Land Management on the reintroduction of beaver. This will halt the erosion along Chicken Creek and allow the area to begin some restoration work.

* * *

Glacier NP is working with the Department of Agriculture on the testing of various biological controls and their effect upon leafy spurge.

* * *

Theodore Roosevelt NP relocated 49 elk from Wind Cave NP this spring in cooperation with both North and South Dakota Fish and Game Departments. As of this writing (July 31) there were 16 calves in their new home.

* * *

Yellowstone NP has discovered Eastern Brook trout in Arnica Creek that drains into Yellowstone Lake. A mass effort is being planned to eradicate this exotic species.

## Western Region

Dave Graber and Dave Parsons attended and presented papers at the National Research Conference in Fort Collins last week (Graber: "Conflicts between wilderness users and black bears: a Sierra Nevada case study"; Parsons: "Campsite impact data as a basis for determining wilderness use capacities"). Other papers presented by Western Region scientists were "Fire: research on fire's role in creating natural conditions, fuel accumulation processes, fire impacts and management practices" (Bruce Kilgore), "The determination of carrying capacities for the Yosemite Wilderness (Jan van Wagtendonk) and "Variation of vegetation and soil characteristics within wilderness campsites" (Tom Stohlgren). In addition, Director Mott gave a keynote address that highlighted the role of science in carrying out his 12 point plan.

* * *

Boyd Evison and Dave Parsons, plus a number of other NPS superintendents testified before Bruce Vento's House Subcommittee on Parks and Recration regarding air pollution threats to the National Parks. The hearings were held in Washington May 20-21.

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The Missoula Fire Conference Proceedings were recently published. They contain articles by many NPS personnel.

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The NPS/CPSU, at U/Cal Davis, now has available three new publications. Technical Report No. 18, by Kimberly T. Lathrop and Peter J. P. Gogan and entitled "Plant Communities of the Tule Elk Range, Point Reyes National Seashore," describes 17 plant communities and documents vegetational changes to those communities over the past 30 years. Technical Report No. 19, by Gary E. Davis and entitled "Kelp Forest Monitoring Program: A Preliminary Report on Biological Sampling Design, Channel Islands National Park and Sampling," outlines the standardized indicator organisms, sampling techniques and analyses, and reporting systems for monitoring kelp forests within the National Park and Marine Sanctuary. Technical Report No. 20, by Charles B. Halpern and entitled "Hydric Montane Meadows of Sequoia National Park, California: A Literature Review and Classification," presents an account of human and domestic livestock influences on meadows of the southern Sierra Nevada, a description of geomorphic and hydrologic properties of meadows and a discussion of the stability of meadow ecosystems, and a vegetation analysis of hydric montane meadows of Sequoia NP.

* * *

Three technical reports published recently by the NPS/CPSU, U/Nev, Las Vegas, are now available. "Vegetation and Flora of the Funeral Mountains, Death Valley National Monument, California – Nevada" by Carol R. Annable, presents a classification of the vegetation and an annotated checklist – including descriptions of growth habit, relative abundance, habitat, associations and/or communities of occurrence, and historic collections – of 413 taxa. "A Model of Climatic Variables Affecting Bighorn Lamb Survival in Canyonlands NP, Utah," by Charles L. Douglas and Carol R. Annable, identifies relationships that will enable managers to predict lamb survival in a given year from known climatic variables easily obtainable from weather records. "Spring Flow in a Portion of Grand Canyon NP, Arizona," by David B. Gorings, examines the structurally controlled, interconnected hydrologic flow system associated with springs that feed Hermit, Monument, Salt and Horn Creeks in Grand Canyon.

* * *

Charles van Riper III, Unit Leader of the NPS/CPSU at U/Cal Davis, was recently elected for a three-year term to the Board of Directors of the Cooper Ornithological Society. He was also selected as Chairman of a committee that will revise the American Ornithologists' Union brochure entitled "Career Opportunities in Ornithology."

* * *

NPS and U/Cal Davis together conducted a resources management trainee course, entitled "Measurement and Management of Vegetation" from July 22 to August 18. It included such topics as ecology of alien plant species; analysis of transects across park boundaries; vegetation inventory, monitoring and evaluation; decision analysis using system modeling; revegetation of disturbed lands; brush and herbaceous weed control; vertebrate pest control; and effects of air pollution on plants. Course curriculum included field trips to Point Reyes NS, Golden Gate NRA, and Redwood NP.

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Two new technical reports recently published by the NPS/CPSU at University of Hawaii are T.R. No. 53, by Clifford W. Smith, Julia E. Williams, and Karen E. Asherman, entitled "Vegetation Map and Resource Management Recommendations for Kipahulu Valley (Below 700 Metres), Haleakala NP" (presents a vegetation map and classification system for 105 structural-floristic communities). T.R. No. 54, "*Myrica Faya:* Potential Biological Control Agents," by Charles S. Hodges, Jr., and Donald E. Gardner (briefly summarizes the native habitat of *Myrica Faya* and describes six fungi and two insects as potential biocontrol agents of this introduced species commonly known in Hawaii as fire brush or firetree).

## North Atlantic

A new report, "Establishment of White Pine Biomonitoring Plots in Acadia National Park," describes ozone injury as documented in a study conducted by Dr. Michael Treshow of the University of Utah and sponsored by the Air Quality Division – Denver. The study showed that 12 percent of the 1984 white pine needles examined exhibited symptoms of ozone injury; 55 percent of the 1983 and 22 percent of the 1982 needles exhibited injury. Treshow's plots are being resurveyed this summer and several are being monitored closely to document development of needle injury symptoms.

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The NAR office has initiated, through the Rutgers Cooperative Research Unit, a technical evaluation of all available information on the Fountain Avenue and Pennsylvania Avenue landfills at Gateway NRA. The objective will be to define the additional data necessary for ensuring adequate closure of these sites. Emphasis will be given to the geohydrology of leachate formation as well as the impacts of leachate and possibly toxic wastes.

* * *

Jim Allen has been busy answering reprint requests for his articles published recently in the *Journal of Coastal Research and Coastal Engineering* on field measurement of longshore sediment transport and beach profile dynamics performed at Gateway NRA's Sandy Hook. He is also continuing his study of beach-bar interaction at Fire Island this summer with extensive use of their resource management personnel. Following this he will be attending the 1st International Geomorphic Conference in Manchester, England, to talk about systematic variations in dune crest mobility at Fire Island.

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University of Massachusetts entomologists are conducting a study of the effects of defoliation by the browntail moth on dune stabilization plants within Cape Cod National Seashore. The browntail is an exotic that appeared in the eastern United States in the mid-1980's, but today is found only on Cape Cod and several islands in Casco Bay, Maine. However, during the past several years the browntail has expanded its territory on the Cape and appears to be systematically killing most of the shrubby plants used to protect the dunes along the Outer Beach.

* * *

The North Atlantic Region has three white-tailed deer management studies under way this summer, each involving the use of radio collars to monitor the daily and seasonal movements of individual deer. Our hope is to be able to determine whether the deer populations at the three sites – Fire Island NS, Saratoga NHP, and Morristown NHS – act and react similarly and, if so, whether there are certain general tenents concerning deer management on park lands in our region that NPS managers may be able to follow.

# Research On a Shoestring? Gateway Finds the Answer In 'Research Networking'

**By John T. Tanacredi**

Few dollars! Fewer personnel! Even less time! Excuses we have become accustomed to during these times of reduced appropriations. With the completion of the Gateway National Recreation Area's Resource Management Plan, the magnitude of threats has not gone away. In order even to attempt to reduce or eliminate these threats to our natural and cultural resources, some innovative approaches to getting research work done must be contemplated.

While some progress has been made at Gateway in the ten years since the Park's creation to document and research impacts on our natural and cultural resources, the task of protecting, preserving and enhancing the remnant ecotypes that make-up this 26,000-acre park, within the largest metropolitan area in the world still awaits us. Since Gateway is a coastal park, much must be understood if we are going to protect effectively these fragile, remnant ecosystems. Traditionally, waterfront or coastal use runs in direct opposition to environmental protection.

Existing Park Service funding mechanisms usually have provided support for projects of very high priority or for highly visible problem areas. In light of the Park Service's basic mandates to "allow nature to take its course", few dollars are earmarked for monitoring programs unless some extraordinary circumstance exists or the monitoring is part of a major network. Thus, an attempt is underway at Gateway to tap the academic, research and regulatory institutions in the New York metropolitan region to form a network – an overall umbrella group geared toward the study of natural resources associated with this National Park unit.

Several things can be accomplished through this approach. First, Gateway will be able to manage more effectively its natural resources by having access to necessary data at considerably reduced cost to the federal government. Second, academic institutions and research facilities would be allowed to conduct a portion of their existing programs in a unit of the National Park system. Third, the Park will be the laboratory to explore, manipulate and observe developing natural systems in an urban context.

Therefore, Gateway NRA, in cooperation with other institutions in the New York metropolitan region, has established within the park, the *Gateway Institute for Natural Resource Sciences* (GINRS), dedicated to comprehensive research, maintenance and monitoring of our natural resources. Drawing on the talents and expertise of several institutions, the GINRS will coordinate the approaches of researchers into the study of significant resource management problems identified in the Park's Resource Management Plan. Individual investigators work separately in their own disciplines, but toward a common goal, integrating their knowledge in a systems approach. The primary initiatives can be summarized as follows:

1. To develop a core of academic and scientific institutions directing their cooperative research and monitoring efforts at the myriad of identified threats to natural resources of Gateway NRA.
2. To maintain a comprehensive inventory of natural resources in order to develop plans at the park level for managing these resources.
3. To establish accurate baseline data on park resources and to conduct comprehensive monitoring programs designed to detect and measure changes in these resources and in the ecosystems within which they exist.
4. To identify and mitigate those threats which are associated with sources and activities both internal and external to the Park.
5. To improve our capability to better quantify and document the impacts of various threats, particularly those that are believed most seriously to affect important park resources and National Park values.

These objectives are to be accomplished by:

1. To gear research and monitoring projects toward increasing knowledge of our natural resources along with peoples' role in their protection, use and development both in an inventory and ecosystem dynamics manner.
2. To make complex scientific data and information palatable to the general public so that they may understand and participate effectively in decisions that are made regarding natural resources.
3. To emphasize the significance of our National Parks and how this research and monitoring activity will reduce or, at a minimum allow for greater understanding of the identified "threats" to our National Park System.

Presently, research and monitoring topics have followed the major headings under Natural Resource Preservation Program (NRPP's) listed in the Park's Resource Management Plan. A number of the natural resource research and monitoring activities are underway or at some stage in development by other research institutions or agencies. It is the purpose of the Institute to foster these projects within the jurisdictional boundaries of this National Park unit.

By no means however, will research be limited to the natural sciences. Social scientists at the GINRS will be involved in sociological and planning aspects of Gateway, tying together many of the Institute's studies into long-term cost/benefit analyses and/or cause/effect relationship analysis. In addition to the natural resources research and monitoring, the Institute is anticipating conducting conferences, workshops, debates and other activities designed to explore the many approaches to reducing the many threats to the resources in National Parks. The GINRS will thus serve as a significant forum for those professionally interested in natural resource management issues and policy development.

The response to date has been excellent; more than 25 local institutions participated in our first all-day orientation/workshop. We have completed several projects and reports. For example, a detailed floral inventory and herbarium reference-filing system (over 375 species & plants) for the park was the first project under GINRS. Total cost to the Park Service was approximately $7,000, supporting three Ph.D. researchers. Similar proposals, had they been submitted under a competitive contract awarding framework would, it has been estimated, have cost the Park Service in the neighborhood of $75,000.

Of course, quality control is an important factor with all efforts, so that reliance on the individual researcher or professor must be coordinated closely. Within the purpose of the Institute, the Park's Natural Resource Management Specialist must work closely with the Institute participants and provide guidance, critical review of data and final evaluation of performance of the scientific investigation. When projects are "team projects", each individual researcher works in his/her area of expertise and always has the option to publish the work in a peer reviewable journal or proceedings. Already we have had several papers presented at International conferences and workshops.

It is hoped that should monies become more available in the future, longer-term, larger-scale ecosystem studies could be accomplished. Should the budgetary climate remain as it is presently, this Institute approach should go a long way to increase the level of scientific output required for effective management of our natural resources at Gateway National Recreation Area.

These projects have been completed to date and are available on written request to: Mr. John T. Tanacredi, NRMS, National Park Service, Gateway Institute for National Resource Services, Floyd Bennett Field, Brooklyn, New York 11234.

| Researcher | Project Title | Date |
|---|---|---|
| Dr. Richard Stalter<br>St. John's University | 1. The Plant Communities for Four New York City Landfills | 1983 |
| | 2. Plant Communities, Breezy Point Tip, Gateway National Recreation Area | 1982 |
| | 3. *Ilex opaca* and Plant Community Dynamics, Sandy Hook, New Jersey | 1980 |
| Dr. A.M. Greller<br>Queens College, CUNY | 1. Forty-six plant species additions to Gateway Reference Herbarium File | 1984 |
| Dr. G.F. Rogers<br>Columbia University | 1. Vegetation Mapping and Repeat Photography of Terrestrial Habitat, Gateway NRA | 1984 |
| | 2. Phragmites Fire Ecology (with E. Kracauer-Hartig) | 1984 |
| | 3. A Large-Scale Application of a Physiognomic-Ecological Vegetation Classification System (with P. Grady) | 1984 |

*Tanacredi is National Resource Management Specialist at Gateway NRA.*

# Night Sky — A Valuable Resource In the Nation's National Parks

By Donald Henderson, Mark A. Yocke and Henry Hogo

*"It was in the cool and pleasant month of September; and long after going to bed we lay awake under the blankets watching the stars that on clear nights always shine with such intense brightness over the lonely Western plains."*

*". . . along the Little Missouri . . . at night the stars shone with extraordinary brilliancy."*

These above quotes, attributed to Theodore Roosevelt approximately 100 years ago, emphasize the significance of the night sky at what is now Theodore Roosevelt NP.

Pete Parry, Canyonlands NP Superintendent, expressed a thought that may represent the thinking of many visitors to the great western national parks: "One of the great Canyonlands experiences is lying spread eagle on a rock in the stillness of a pitch black night observing the myriad of stars overhead."

EPA acknowledges the nighttime skies are an important part of the wilderness experience, especially to campers and backpackers, and feels that this aspect can be considered a value for use in establishing visibility objectives by the Federal land managers.

A magnitude scale for describing the apparent brightness of objects in the sky has been developed by astronomers. The magnitude scale varies from −26.7 for the brightest object in the sky, the sun, to +23 which is the faintest star observed by the 200-inch Mount Palomar telescope. When stars of magnitude six are visible to an unaided eye, the Milky Way galaxy is usually visible. **The magnitude is established such that a change of five units of magnitude indicates a factor of one hundred difference in star brightness.** To illustrate the use of the magnitude scale, the star Sirius in the constellation Carris Majoris is the brightest star in the sky with a magnitude of −1.5. (The planets are excluded.) Polaris (the North Star), has a variable magnitude of about +2.0. Therefore, the magnitude of Polaris is 3.5 units greater than Sirius, and the brightness of Sirius is about 25 times greater than Polaris. The planet Venus is the third brightest object in the sky, exceeded only by the sun and the moon.

The distribution of objects in the sky and their apparent brightness at a given location provide the beauty of the night sky. Man-made lighting and man-made air pollution affects the clarity of the night sky as seen by an observer.

Increased light in the night sky caused by reflection of sunlight from the full moon will decrease the number of visible stars, and reduce the visibility of the Milky Way. These subtle effects of the moon are a natural part of the night sky experience to which most observers do not object. Increased light in the night sky caused by light produced by mans' activities in urban areas (light pollution) diminishes the number of visible stars.

As urban areas have increased in size, light pollution has increased. In recent years this artificial illumination has been a major concern to astronomers. Ground-based astronomical measurements of faint objects made with large telescopes are very sensitive to interference from artificial lighting. The astronomical community has been influential in causing changes in some city ordinances to require control of outdoor lighting to reduce the interference of light pollution on astronomical observations. The cities of Tucson, Ariz., San Jose, Calif., and some small communities near Palomar Observatory have passed ordinances to control outdoor lighting.

No methods for controlling the interference of the moon have been discovered!

The effects of air pollution pose a serious problem to the quality of the night sky. Control of air pollution is being actively pursued under the Clean Air Act Amendments.

Many national park-managed lands have been designated class I under the Clean Air Act Amendments, which specify that air pollution will be controlled to preserve, protect, and enhance the air quality in national parks. Because national parks are to be kept clean from air pollution, efforts are made to prevent industrial development and urban spread near national park class I areas. Therefore, national parks are prime areas for locating astronomical observatories because light and air pollution are controlled. **For this reason, the National Science Foundation is examining the possibility of selecting a national park as a suitable site for future construction and operation of an astronomical observatory.**

Even though provisions exist for controlling intrusion of air pollution in national parks, and light pollution from urban sprawl, or large industries, weaknesses in assessment techniques and the difficulty of enforcing the regulations, may allow threats to diminish the value of the night sky resource in national parks.

Recently, the Department of Energy proposed to locate and operate a nuclear waste repository within one mile of Canyonlands NP. The repository would operate 24-hours each day with necessary outdoor lighting to perform the work and provide lighting for security at night. If this facility were allowed to be constructed and operate at the proposed location (Davis or Lavender Canyon) just east of the park boundary, the type of experiences related by President Theodore Roosevelt and Superintendent Parry would be diminished.

Superintendent Parry, and Tom Wylie, Resource Management Specialist, Canyonlands NP (currently Superintendent, Florissant Fossil Beds National Monument) and Cecil Lewis, Air Quality Coordinator, Rocky Mountain Regional Office, recommended an evaluation of the effects of outdoor lighting from the proposed nuclear waste repository were it to be located near Canyonlands NP. The Air Quality Division contracted to Systems Applications, Inc. to perform the study. The purpose was to determine if human perception of night sky brightness viewed from Canyonlands NP would be significantly affected by 24-hour operation of the proposed nuclear waste repository.

Those conducting the study recognize that the park has "outstanding opportunities for solitude." Park visitors have identified solitude, including viewing the pristine nighttime sky, as a value contributing to their enjoyment of the park.

Systems Applications, Inc. developed a mathematical technique to study the potential impact of light pollution from the proposed repository sites in Davis and Lavender Canyons. In this study night sky glow and terrain illumination resulting from nighttime operation of the proposed nuclear waste repository were calculated, and estimates of the potential for human perception of these effects were made. The study involved the following steps: (1) Development of a mathematical model of atmospheric optics to predict the night sky glow effects; (2) Verification of the model's prediction performance; (3) Application of the model to the area surrounding the proposed facility; (4) Estimation of the potential of the night sky glow to obscure starlight; and (5) Development of a computer program to depict graphically the views of terrain features under different conditions of illumination.

Two computer programs were written for this study. The first is a numerical model of atmospheric optics for prediction of night sky glow.

The Night Sky Glow Model was designed to predict the luminosity of scattered light in the night sky due to operation of the proposed nuclear waste repository. Such a model must be capable of predicting the glow in any portion of the sky under various atmospheric conditions and must be flexible enough to address any combination of facility sites and viewing points within the park. Because of the complexity of the equations and the large number of calculations required, a numerical (computer) modeling approach was used.

The second program produces three-dimensional views of terrain features visible from within the park and shows the relative luminosity of these terrain features during nighttime operations of the proposed repository. The program models terrain illumination from both natural and artificial light sources, and then plots simulated nighttime photographs.

Figures 1 and 2 are examples of graphic output from the night sky glow predictions. The four shading patterns indicate the degree of perceptibility of the predicted night glow. It should be noted that the perceived brightnesses of the shading patterns do not illustrate the actual brightness of the sky predicted by the model. The patterns only aid in interpreting the results.

The nighttime response of the human visual system has been estimated in psychophysiological studies. From the data in these studies it is clear that the threshold of visual detection (i.e., the minimum amount of light that can be visually detected) varies considerably among individuals and depends to a significant extent upon acclimation time and background lighting. On the basis of these studies we adopted a threshold of detectability (or the luminosity increment that is just barely perceptible) for the average human population to be about $5 \times 10^{-4}$ $lm/m^2/sr$ (lumens per square meter per steradian) above a background nighttime sky luminosity. Using these same data, we selected about $2 \times 10^{-3}$ $lm/m^2/sr$ and about $5 \times 10^{-3}$ $lm/m^2/sr$ to represent, respectively, "perceptible" and "very perceptible" luminosity.

Figures 1 and 2 reveal that the predicted night glow associated with the Davis Canyon site would be perceptible for either of the two extreme visual range values of 30 or 391 kilometers. The impacts are predicted to be greatest at the closest viewing sites and to decrease with increasing distance from the sites.

***(Continued on next page)***

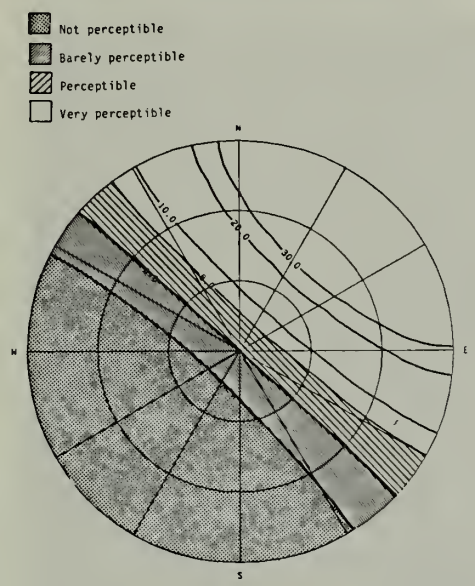



***Figure 1.*** *Spatial distribution of sky brightness ($10^{-3}$ $1m/m^2/sr$) due to the facility located at Davis Canyon as seen from Davis Canyon. (Assumed visual range of 30 km.)*

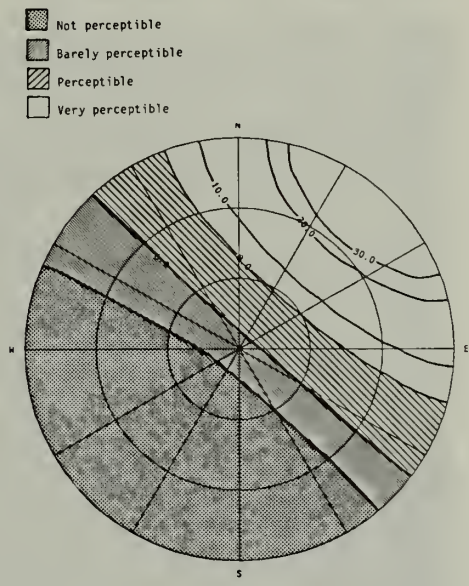



***Figure 2.*** *Spatial distribution of sky brightness ($10^{-3}$ $1m/m^2/sr$) due to the facility located at Davis Canyon as seen from Davis Canyon. (Assumed visual range of 391 km.*

Comparison of observed and predicted brightness provides some encouragement that the model predicts luminosities that are approximately correct. The tendency of the model to underpredict sky brightness close to the source is probably attributable to uncertainty about the actual light source distribution. One would expect that the effect of uncertainty about the source distribution is greatest close to the source and diminishes with increasing distance from the source. This tendency is exhibited in the model results.

Given the uncertainty in the light source data as well as other input to the model, we conclude that the model performance is acceptable and that the model is appropriate for application to the Canyonlands area. This evaluation of the Night Sky Glow Model is by no means comprehensive. A more thorough evaluation of the model is required if great confidence must be placed in its predictions.

When applied to the light emission of the proposed nuclear waste repository the Night Sky Glow Model predicts sky luminosities that should be perceptible (from either the Davis Canyon or Lavender Canyon site). As one would expect, the night glow is predicted to be greatest at the closest viewing sites and to decrease with increasing distance from the sites. The size and character of the night glow "dome" varies depending on the viewing site and the atmospheric aerosol.

Typically, the extent of the brightness portions of the night glow "dome" is larger for a polluted atmosphere than for a clear atmosphere. This is because under polluted conditions the amount of light scattered is greatest near the source due to higher aerosol concentrations (recall that night glow is caused only by light that is scattered back to the observer). However, as the light propagates from the source under polluted conditions, it is rapidly attenuated (because of the large amount of light that is scattered out of the light path). Therefore, the overall extent of the night glow "dome" is smaller in a polluted atmosphere than in a clean atmosphere.

The following conclusions can be drawn from this study:

The proposed nuclear waste repository, located at either the Davis Canyon or Lavender Canyon site, will probably cause a perceptible night glow and obscure the view of dim stars and the Milky Way in some portions of the sky from many locations within Canyonlands NP.

Some terrain features visible from Canyonlands NP will be illuminated directly by repository lighting at either of the two proposed repository sites and would be visible from adjacent parts of the park.

We have performed only limited verification and evaluation of predictions of the models developed and used in this study. More comprehensive evaluation of the models is required before great confidence can be placed in their predictions.

*Henderson is an NPS Meteorologist in the Air Quality Division, Denver Service Center; Yocke and Hogo are with Systems Applications, Inc., 101 Lucas Valley Rd., San Rafael, CA 94903.*

## BioScience Devotes Issue To Holistic Handling Of Stressed Ecosystems

Of particular interest to *Park Science* readers is the July/August issue of *BioScience* (Vol. 35, No. 7), featuring five articles that grew out of the symposium "Holistic Approaches to Description and Management of Stressed Ecosystems," sponsored by the Ecological Society of America at the 1984 AIBS meeting in Fort Collins, Colo.

Peter H. Raven, immediate past president of the American Institute for Biological Sciences, introduces the summer issue with editorial comments on the proliferation of new and highly specialized fields of science that are springing into being. He acknowledges that "subdivision signals vigor," but warns that "fragmentation can become counterproductive," and he posits an AIBS role that "can knit biological concepts and interests together and represent them effectively at the national level."

The five authors and their works, which make up the main body of the issue, are Paul G. Risser, "Toward a Holistic Management Perspective;" Eugene P. Odum, "Trends Expected in Stressed Ecosystems;" Gary W. Barrett, "A Problem-Solving Approach to Resource Management;" Orie L. Loucks, "Looking for Surprise in Managing Stressed Ecosystems;" and Frank H. Bormann, "Air Pollution and Forests: An Ecological Perspective."

Barrett, who coordinated the July/August issue, takes an approach that may be of particular interest to managers. It recognizes socioeconomic as well as biological and physical factors in resource management and presents a 19-step algorithm as a help to applied ecologists in tackling management problems "holistically, objectively, and systematically." Barrett is with the Department of Zoology of Miami University, Oxford, Ohio.

Finally, the same issue of *BioScience* contains an Opinion piece by William R. Jordan III, editor of *Restoration Management Notes* at the University of Wisconsin Arboretum in Madison, and John D. Aber, U/WI professor of forestry. Jordan and Aber propose that "the emerging field of restoration ecology could provide a framework for . . . systematic study and reconstruction of communities and ecosystems."

They note that a recent symposium, sponsored by the U/WI Arboretum, drew scientists from a wide range of traditionally distinct disciplines to look for a common ground on which to build a holistic approach to restoration. The term "restoration ecology" was introduced there as a technique for basic research and as a way of altering the prevailing view that human activity always represents a negative impact on the landscape.

"While exploitation and preservation will continue in those areas that remain productive or pristine," they said, "a third approach – restoration – may become a viable option with important implications for both management and preservation."

Proceedings of the 1984 Madison symposium are slated for early 1986 publication.

# Revegetating Highly Acidic Mine Spoil on the Big South Fork National River

By Ed Buckner, Michael Rikard, and Sam Kunkle

The Big South Fork River and Recreation Area (BISO) in north-central Tennessee, established in 1976, is a relatively new project for the National Park Service. Development of BISO is currently the shared responsibility of the U.S. Army Corps of Engineers and of NPS. Full administrative responsibility will be assumed by NPS once development is completed. Of primary public interest in BISO is the Big South Fork of the Cumberland River and the gorge it has carved into the Cumberland Plateau.

Most of the land under development is U.S. Forest Service land acquired in 1937 from the Stearns Coal and Lumber Company. During the company's ownership, essentially all of the marketable timber was cut. In 1936-37, exercising their mineral rights, the company began coal mining operations that continued for 25 years. These lumbering and mining activities left marks on the landscape that still are visible today.

The coal-bearing strata were too deep for surface mining but were accessible for deep mining at points where they outcropped along the gorge wall. A seam of highly acidic, pyritic shale that overlies or is mixed with the coal in this region had to be removed with the coal and disposed of as tailings. Since no reclamation laws applied to this region at that time, the shale was simply dumped at the mine entrances. The resulting spoil banks extend from the mine openings, most of which are situated about halfway up the north wall of the gorge, down to the river. Many once extended into the river, but flooding has truncated these at the high-water line.

Although much of the area has been abandoned for more than 30 years, and despite the availability of seeds from trees growing on bluffs above, these spoil banks have remained essentially devoid of vegetation. It is evident that growing conditions on these south-facing embankments with their dark, heat-absorption surfaces, are not suitable for natural revegetation. Such barren, eroding embankments are of particular concern since they are situated just upstream from Devils Jump, a popular rapid with white-water enthusiasts.

The existence of pine plantations established during a USFS reclamation program in the mid-1960s on spoil just upstream from the study area indicated that spoils in the area could be revegetated. Soil tests confirmed that these fully-stocked and reasonably vigorous stands were growing on spoil essentially identical to that on the problem sites. Further investigation revealed that the Forest Service program was terminated because of the extreme cost of the project. For each seedling planted, a hole large enough to accommodate approximately one cubic foot of topsoil had to be dug. Thus, a less expensive means of revegetation was needed.

Our study was started in the fall of 1983 to establish techniques and guidelines for permanently revegetating these spoil banks to reduce water pollution and erosion and to improve the aesthetic quality of the gorge.

**Soil testing revealed** that extremely acid conditions still prevail, with average pH values of 2.6 at the spoil surface and 2.3 at the 10-15 inch depth (Table 1). This is considerably below the lower limit recommended for even the most acid-tolerant trees used in surface mine reclamation, according to Fribourg et al. 1981.*

***Pine plantation** stands on an old mine spoil area in the Big South Fork NRRA. Author Michael Rikard stands in front.*

**Table 1.** Spoil pH and conductivity.

| Spoil Samples | pH | Conductivity (micromhos*/cm) |
|---|---|---|
| Surface: | | |
| not limed | 2.6 | 1,000 |
| limed | 5.6 | 1,400 |
| At 10-15 inch depth: | | |
| not limed | 2.3 | 3,800 |
| limed | 2.2 | 3,700 |

*measurement of resistance to electrical flow

Grading was considered to better regulate water movement across the spoil banks, but there was concern since any spoil disturbance would expose the higher acidity at the 10-15 inch depth. Weathering at the spoil surface apparently had ameliorated the very low pH. But of even greater consequence to plant establishment and growth was the high conductivity below the spoil surface: such high conductivity is generally toxic to plants.

**A preliminary grading test** was established in the fall of 1983 to evaluate the consequences of exposing fresh spoil. A small area of fresh spoil exposed by bulldozer activity in constructing a hiking trail enabled the planting of containerized Virginia pine seedlings in the following spoil conditions: 1) disturbed spoil, 2) undisturbed spoil, and 3) undisturbed spoil limed at the rate of 3 tons of agricultural lime per acre. A survival count in late April 1984, revealed that the pine seedlings survived at the rate of only 10% for disturbed spoil condition, 28% for undisturbed spoil and 50% for undisturbed, limed spoil. The finding that in spoils disturbed by grading, 90% of the pines did *not* survive, made it apparent that grading the spoil banks was not conducive to plant establishment and growth.

**Greenhouse studies over the winter** of 1983-84 using surface spoil from the problem sites confirmed that pine seeds would germinate and grow on the spoil material. Stratified seed of both loblolly (*Pinus taeda* L.) and Virginia pine actually germinated better on the surface of mine spoil than on a greenhouse rooting mix. Since there was a natural source for Virginia pine seed in the spoils area, it is likely that seeds germinated each spring but did not survive the summer. This was observed to be the case during the spring and summer of 1984, an observation that implicates the high surface temperatures on these black, south-facing spoil banks as the primary reason for their barren condition. In fact, the only surviving growth found on the embankments was located in shade.

The feasibility of planting bare-rooted pine seedlings directly in the spoil was investigated further in the greenhouse studies using spoil from the problem sites. Seedlings of both loblolly and Virginia pine survived well in unlimed surface spoil but survived satisfactorily in the deep spoil only where it was limed. Water movement through pots containing the deeper spoil was excessive, with very little retained to serve as available for water for plants. There was, however, sufficient fine material in surface spoil to slow water movement enough to increase its availability to plant roots. Despite the likelihood of higher erosion during heavy rains on the undisturbed spoil, this was further evidence that any disturbance to these sites would make them more difficult to revegetate.

**Based on the greenhouse findings**, field plantings of test plots were established in the spring of 1984. Seedlings of both loblolly and Virginia pine were planted on undisturbed spoil treated in the following

*Fribourg, A., C. Jent, S. Mayer, J. Burns, and J.H. Paugh. 1981. Guide to revegetating surface mined areas in Tennessee. USDA and Institute of Agriculture, University of Tennessee, Knoxville.

manner: 1) limed at 5 tons per acre of agricultural lime; 2) limed as above and fertilized at the rate of 150 pounds of nitrogen (N) and 35 pounds of phosphorus (P) per acre; 3) mulched with pine straw to a depth of 2-4 inches; and 4) untreated (control).

Survival, height growth, and vigor (a composite of foliage color and density) were measured at the end of the first growing season (around September 1). As in the previous tests, evaluation was based largely on seedling survival, since establishing vegetation was the primary concern, seedling mortality after the first growing season is generally very low, and growth the first season commonly reflects an "adjustment" period and is not a good indicator of species/site relationships. Results are presented in Table 2.

As in the preliminary study, soil tests confirmed that lime reduced soil acidity at the spoil surface, changing pH from approximately 2.6 to 5.1, but had no influence at the 10-15 inch depth. Liming significantly improved survival rates, especially for the Virginia pine, which experienced high mortality in the unlimed control plots. This was not expected as Virginia pine is claimed to be one of the more acid-tolerant of the yellow pines (Fribourg et al. 1981). Further, survival was generally highest where lime alone was applied. The addition of fertilizer generally reduced survival rates (significant at the 90 percent probability level); for loblolly pine, survival rates fell below levels yielded by control conditions. Mulching produced variable results, partly due to compaction and scattering by wind. Even so, mulching appears to have a beneficial influence on loblolly pine survival.

Measurements of height growth and vigor generally supported the beneficial influence of lime. The tallest and most vigorous trees were in the limed and fertilized plots even though survival was poorer than in the limed-only plots. This has been a common finding where fertilizers are applied at planting time. Although results have been variable, pellets containing slowly available fertilizer placed in the closing hole at planting time have successfully averted this problem.

***Eroding mine spoil embankment*** *dwarfs the human figure in the gorge area of Big South Fork National River and Recreation Area.*

***An ugly, poisonous edge*** *to the Big South Fork is provided by this sprawling bank of mine spoil.*

**Table 2.** Survival (percent) of seedlings after one growing season in undisturbed mine spoil according to treatments.

| Treatments | Loblolly pine | | | Virginia pine | | |
|---|---|---|---|---|---|---|
| | un-mulched | mulched | Average | un-mulched | mulched | Average |
| Control | 37 | 46 | 41 | 16 | 12 | 14 |
| Limed | 48 | 71 | 59 | 79 | 54 | 67 |
| Limed & fert. | 29 | 35 | 32 | 52 | 54 | 53 |
| Average | 38 | 51 | 45 | 49 | 40 | 45 |

### Conclusions and Recommendations

It is apparent that liming is critical to the establishment and survival of vegetation on spoil banks. In addition, mulching provides protective shade, without which (as evidence by field observation of the current growth on the spoils) it is unlikely that seedlings can survive. Under no conditions should the mine-spoil embankments be graded, since this disturbance exposes material that is more acidic and less retentive of water; such conditions only exacerbate revegetation problems. With these points in mind, the following recommendations for the Big South area have been developed, based on the results of these investigations and other studies pertinent to revegetating acid sites:

1. Do not disturb the sites.
2. Lime at the rate of 5-7 tons/acre.
3. Mulch to a depth of 5-8 inches (approximately 200 bales of hay at 10,000 pounds/acre), and secure with erosion-control netting.
4. Place a fertilizer pellet containing nitrogen and phosphorus (but no potassium) in the closing hole at planting time.
5. Plant between mid-February and mid-March an even mixture (one-third of each species) of Virginia pine, loblolly pine, and black locust (*Robinia pseudoacacia* L.) seedlings. This should be late enough to avoid frost heaving of seedlings but early enough to allow root establishment before rapid top growth begins. Because black locust fixes atmospheric nitrogen and tolerates highly acid sites, it should improve spoil fertility. Spacing should be no greater than 6′ × 6′.
6. In late spring direct-seed a mixture of the native hardwoods that are commonly found as secondary successional species in this area. The mixture should include red maple, sourwood (*Oxydendron arboreum* L.) river birch (*Betula nigra* L.), black birch (*Betula lenta* L.), scarlet oak (*Quetcus coccinea* Muenchh.), chestnut oak (*Quercus prinus* L.), sycamore (*Platanus occidentalis* L.), and alder (*Alnus sp*).

These recommendations were implemented on the study sites in the winter and spring of 1985 through a contract with the Tennessee Valley Authority.

*Buckner is a professor of forestry with the University of Tennessee in Knoxville; Rikard is a hydrologist with the Big South Fork NRRA; Kunkle is a forest hydrologist with the NPS Water Resources Division, Fort Collins, CO.*

# Big Bend NP Provides Water for Rare Fish

By Gerard Hoddenbach and William Werrell

The top-water minnow, *Gambusia gaigei,* still receives management and research support to promote its survival in Big Bend National Park, Texas.

Since discovery of this rare, endangered fish by Frederick M. Gaige in August 1928, the Big Bend Gambusia has been seriously threatened with extinction numerous times and continual efforts are still being made to ensure its survival. The history and details of NPS activities from the mid 1950s to 1981 to perpetuate this fish were documented in *Park Science* (Volume 2, No. 3: p. 12; Spring 1982). Subsequent research and planning are reported here.

One option to provide suitable habitat for Big Bend Gambusia was a plan to drill a well in the vicinity of the present Gambusia refugium pond. It was anticipated that the well would flow at the surface at about 15 gpm by intercepting the aquifer, which produces the natural spring flows supplying the present Gambusia refugium. Thus, the water would be expected to be chemically and thermally acceptable to the fish. A constructed channel leading away from the well would provide a desirable flowing water habitat.

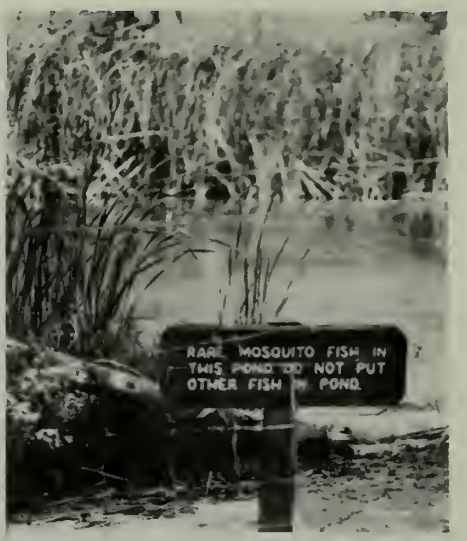
Southwest Regional Hydrologist, Gary Moore, carefully selected a site, and, in the fall of 1983, the well was drilled to a depth of 290 feet. The well bottomed in fractured rock in the lower 40-foot interval believed to be within the aquifer responsible for spring flows in the area. Construction of the well properly included placing cement grout from the surface to a 175-foot depth to prevent loss of aquifer head in the upper portion of the boring where it adjoined adjacent alluvium.

The authors conducted an aquifer test of the well in early 1984. Although the well had not flowed during construction, it was hoped additional pumping and development would cause surface flow. Unfortunately, testing results showed that the static water level of the well was 3.91 feet below ground surface. In view of these data and the perceived hydrologic system present, it was not recommended another well drilling attempt be made.

Further evaluation of possibilities has led the authors to recommend modification of the developed spring cistern. That plan details placement of several pipes at different elevations in the side of the cistern and construction of a pond adjacent to the spring source. Water from the cistern would be released to the ponds in desired flow and at required thermal rates by appropriately valving a pipe at the proper elevation while lower pipes remain capped.

This plan further allows flow adjustments to accommodate seasonal and annual flow variations. A variably terraced stream running at the desired 15-20 gpm could be constructed from the pond overflow and provided shade by planned vegetational plantings. After stabilization and further testing, the pond and outflow would be stocked with Gambusia.

This new recommendation provides a naturally occurring water habitat – one not relying upon a difficult-to-maintain, remote electrical power supply. Should water level in the cistern fall below the lowest outlet pipe, a solar-powered pump would provide water to the pond and stream habitat.




***Gambusia Pond** is marked with this sign, warning against putting other fish in the pond, plus another wooden marker wtih the legend "FISH SO FRAGILE: This pond contains the world's population of Gambusia gaigei. These minnow-sized fish have lived here since mastodons. Unique and fraguile, they survive today only because man wants to make it so."*

Two back-up populations of Gambusia are currently maintained. A small permanent population is located at the U.S. Fish and Wildlife Service fish hatchery in Dexter, New Mexico. The second, now within the present refugium pond, would be maintained for two or more years after completion of modifications at the cistern site to assure unsuspected flooding or other catastrophe does not jeopardize the continued existence of this rare and unique fish.

*Hoddenbach is a Biologist with the NPS Southwest Region; Werrell is a Hydrologist with the NPS Water Services at Fort Collins, Colo.*

# From Grizzlies to Geysers: Science Challenges Tradition

By Robert D. Barbee and John D. Varley

***Editor's Note:** As promised in the Summer issue of* Park Science, *here is an an abstract of Yellowstone Superintendent Barbee's contribution to the AAAS panel on "How Can Science Be Used More Effectively To Manage National Park Resources?" – held in Los Angeles in May 1985. Co-author John D. Varley is Research Administrator at Yellowstone NP. Contributions of the other three panelists, John Dennis, David Graber, and Cliff Martinka, were carried in the Spring and Summer issues. The full text of the Barbee/Varley paper will be carried in the next issue of* FORUM, *the George Wright Society Journal.*

This paper acknowledges the first major impetus toward ecological park management, under Interior Secretary Stewart L. Udall, and the attendant roll call of environmental compliance legislation and Executive Orders that guided and supported this effort. It also considers the costs – financial and otherwise – of the renaissance of science that is now well underway.

Grizzly bears, for example, are today managed by a bewildering consortium of government executives, managers, and scientists. The manager, waiting for inspired direction, spends a great deal of time in a state of acute anxiety, attempting a balancing act between bear politics, bear management, and bear research.

Science also helps exacerbate the differences between what must be done to protect resources and what the public expects in the way of traditional use patterns. Seasonal closures of prime bear habitat to reduce the opportunity for bear-caused human injuries seems defensible, yet public reaction and political outcry is intense and hostile. The desire to implement science-based recommendations cannot keep pace with the manager's ability to convince supporters of the parks that it is a good idea.

The complexities of ecological science have reached a level of sophistication that often makes it difficult for the scientist to communicate his reasons and his recommendations to the manager and to the public.

Science has never fit well into the Federal budget process – especially funding for long-term monitoring and research. The cutthroat trout studies in Yellowstone Lake (now 35 years old and ongonig) and the Yellowstone elk are cases in point.

Crises often occur and give rise to dollars; everyone wants the answer tomorrow; then the controversy dies and the dollars dry up.

The proprietary interests of some scientists are another stumbling block for management. Egos and reputations are seen as "at stake." The scientist may take his ball and go home. Or he may elect to "go public." In any event, the park may have a lifelong enemy as a result.

Despite these hazards, all significant advances in NP resource management have come about through the efforts of science. The problem comes where scientific findings, no matter how well-founded, come head to head with tradition.

Sir Napier Shaw wrote, in 1926: "Every theory of the course of events in nature is necessarily based on some process of simplification of the phenomenon and is to some extent therefore a fairy tale."

Vigor and strength in organizational life are maintained through a continuing process of adjustment and renewal. Today the NPS needs the energizing revalidation of principles. Just as such former giants as Lane (1918), Wright et al (1933), Robbins et al (1963), and Leopold et al (1963) each brought park science and resource management into synchronization with contemporary ecological thought in the past, we again need a reaffirmation of that distinctive blend of tradition and the avant garde.

# mab notes

**By William P. Gregg, Jr.**
*NPS Coordinator of the*
*Man and the Biosphere Program*

A Tropical Forests Symposium was held Aug. 14 at the University of Florida in Gainesville. An overview of U.S. MAB's tropical research program was presented by Dr. Ariel Lugo, Chairman of the MAB Directorate on Tropical Forests, members of the Directorate, and principal investigators of specific research projects funded by MAB. Special emphasis was given to 22 research projects awarded grants through the MAB/Agency "Consortium for the Study of Man's Relationship with the Global Environment," and to several special tropical studies commissioned by MAB.

The July 1985 MAB Bulletin (Vol. 8, No. 1), lists the most recently funded MAB projects, all proposals for which must now emanate from the U.S. MAB Directorates. This was deemed necessary to keep the Directorates together in a period of limited resources.

The U.S. State Department has at last added two fulltime staffers to the MAB Directorate. Ms. Inez Hockaday, a budget analyst, will assume the accounting responsibilities formerly handled by Phyl Rubin. Brian Payne, USFS, will leave his MAB assignment to be replaced by J.L. Whitmore of the Forest Service. A new permanent secretary will soon join the staff. The MAB Directorate office has moved to 2100 K St., N.W., Suite 506, Washington DC. The mailing address now is U.S. MAB Program, OES/ENR/MAB, SA-9, Suite 506, Dept. of State, DC 20520.

The MAB-4 Directorate, Arid and Semi-arid Ecosystems, will meet in conjunction with the International Arid Lands Conference in Tucson, Ariz., Oct. 20-Nov. 1.

PARKS magazine, published by I.U.C.N. for the exchange of information on the planning, use and management of the world's national parks and other protected areas, has dedicated its summer 1985 issue to Biosphere Reserves.

# Great Smoky Mountains Establishes A Biosphere Reserve Plan

**By Ro Wauer**

Great Smoky Mountains National Park Superintendent John Cook took initial steps recently to establish a progressive action program for the Great Smoky Mountains Biosphere Reserve. Superintendent Cook handed out a three-page directive at the park's June 25 staff meeting and stated that it was time for this park to take significant actions to achieve goals established for Biosphere Reserves. He said, "I believe that a well conceived Biosphere Reserve program has great potential for providing a better management system that can lead toward a better relationship with our neighbors for our mutual well-being."

The Great Smoky Mountains Biosphere Reserve program includes a wide variety of projects, most of which are multidisciplinary in nature. Many are long-term and require careful planning and development. A major emphasis of the program is better understanding and relations with park neighbors, and so the long-term goal of restoring the American Chestnut tree to the Southern Appalachian ecosystem will serve as the umbrella concept. The park will develop a comprehensive plan around that idea that will include the establishment of gene banks and the eventual cultivation, growing and planting of this largely extirpated species. All of the various related projects will provide greater visibility to the importance of protecting the natural watersheds and the interconnections between the native resources of the core area and the surrounding floral, faunal and human resources.

Some of the additional closely related science projects include (1) developing a compatible watershed research project with the U.S. Forest Service's Coweeta Hydrological Laboratory as a continuum of mutually beneficial studies; (2) establishing a project on roadside and powerline rights-of-way vegetation to stress the use of native plants, and creation of low maintenance plant communities, and reduction of herbicide use; (3) initiating a workshop on methods to establish permanent vegatation plots in a Biosphere Reserve and address data management protocols; (4) developing international agreements regarding cooperative data files on the conservation of biological diversity.

A research fellowship for special MAB projects to be undertaken at Great Smoky Mountains Biosphere Reserve will be established with non-federal organizations or industry.

The prototype Resources Information Tracking System (RITS) will also be finalized. RITS will be used in tracking all resource management and science activities underway and anticipated, related five-years of programming, principal investigators and specialists involved with each of the science and resource management projects, and the resultant publications and reports. RITS will be park-specific and available for use with IBM-PC with a hard disk and dBase-III. This project is in the final development stage at Clemson University, and has been supported by this park and three Regional offices, Southeast, Mid-Atlantic and Midwest.

The Great Smoky Mountains Biosphere Reserve program is designed to address early-on some essential requirements. In-park training for all park employees is scheduled for fall 1985; this project can also serve as a useful prototype for other Biosphere Reserves. In-park training is vitally important to assure full understanding and support ***inside*** the park. Expansion of the park's ***outreach*** program is also an important phase of the program and includes greater use of some of the tried and true interpretive methods on which the National Park Service built its reputation for communicating with the young and old outside of the parks. The park plans to develop a prototype outreach program, within the umbrella of the Biosphere

***(Continued on next page)***

# "Man and the Biosphere" Video

A 25-35 minute video titled "Man and the Biosphere" will be available for use by Biosphere Reserve managers and others by winter 1985. The script of this video, which is in final drafting stage, is being written by Ro Wauer, Great Smoky Mountains NP. Video production will be done by a crew from Public Broadcasting Station (PBS) Channel 2 in Knoxville, Tennessee. Wauer said: "We have thousands of feet of 16mm film and video footage from a wide assortment of Biosphere Reserves across the continent, and several thousand more footage taken by PBS of special activities and at special locations. This includes all of the first-day presentations, some workshops, and several interviews from the November 1984 MAB Conference held at the Smokies."

The video is designed for use as an interpretive and educational tool to sell the idea of Biosphere Reserves both inside and outside of the Reserves. The text should provide a better understanding of what a Biosphere Reserve is all about and how the designation of a Biosphere Resource relates to the core areas (usually parks or Forests) and neighboring communities. Copies of the video will be available for a minimum cost and distributed by the National Parks and Conservation Association.

# The Paradox of Repeating Error From NP to BR and Beyond

**By Robert D. Barbee and John D. Varley**

Most of the renewable and nonrenewable resource problems that Yellowstone National Park faces today trace back to its creation over 100 years ago. When the park was set aside in 1872, protection of geologic wonders was paramount. Forests and wildlife, two of the most important aspects of the park today, were recognized by Congress in an almost off-hand way. The boundaries they set failed to encompass a complete ecological unit. Later boundary changes attempted to remedy this but it was too little, too late. When the park was designated a Biosphere Reserve a century later, it was again set aside for its geological borders, which repeated and reaffirmed the earlier congressional oversight.

While the first designation did not consider the ecological integrity of the area, the second failed to consider that the greater Yellowstone region is likely the largest, essentially intact wild ecosystem remaining in the temperate zone of the earth. As a result of the development of the West, the greater Yellowstone area has become an ecological island, one which is managed by over two dozen separate political and administrative entities.

If the natural condition of this massive ecosystem is to survive in the future, an innovative new strategy for management must be devised. Supporters of the Biosphere Reserve concept seek to test and prove the concept of a model Biosphere Reserve as a practical management tool for the next generation. The designation of the greater Yellowstone ecosystem as a model International Biosphere Reserve may be the most efficient and politically acceptable way of preserving this area.

*Editor's Note: The above is an abstract of the presentation made by Yellowstone NP Supt. Barbee and John D. Varley at the Man and the Biosphere conference for managers of Biosphere Reserves at the Great Smoky Mountains in November 1984.*

## Great Smoky Mountains

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Reserve concept, that the Service can utilize as a model. This park already has the key ingredients of experienced and dedicated interpreters; the Tremont Environmental Center in the park, which is operated by the Cooperative Association and maintains contacts with a wide variety of school systems and concerned educators; and the fact that the park is located in the heart of a section of the country with a high rural population, closely related to the land.

The park also will initiate a workshop with many of its neighbors to discuss various ideas relating to either expansion of the Biosphere Reserve boundary or the cluster concept for the Southern Appalachians. This and a number of other identified projects, including the development of a Biosphere Reserve Coordinating Committee, also are under consideration.

*Wauer is Assistant Superintendent at Great Smoky Mountains NP.*

## In the Next Issue

"Prairie Management at Herbert Hoover NHS" by Steve Robinson; "Dogwood Centhracnose Fungus Threatens Catoctin Mt. Park" by Manfred Mielke and Keith Fangdon; "Through Darkest New Mexico With Tongue in Cheek – or The Exotic African Oryx" by Milford Fletcher; "Cultural Landscape Management at Buffalo National River" by Ric Alesch; "Fort Vancouver Builds Its Own" by Herbert Bump and Frank Gilson; and "From Trace Elements to Prehistoric Diets" by Judith Miles.

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