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SEAs Successful as Alien Species Controls

By Tim Tunison and Chris Zimmer

Alien species pose a critical threat to native biota in Hawaii; already they have altered many ecosystems at Hawaii Volcanoes NP. Special Ecological Areas (SEAs) are intensive management units in which alien species control that is not affordable or feasible on a parkwide basis is conducted. (Tunison et al. 1986). An SEA approach has guided alien plant management since 1985 and this report evaluates its success in controlling alien vegetation.

Alien Species Threats

Ecosystems of remote islands such as Hawaii are especially vulnerable to alien species invasions (Loope and Mueller-Dombois 1989). The native biota have evolved free from disturbance factors such as ungulates and fire. Feral ungulates and alien plants have altered much of the natural vegetation of Hawaii Volcanoes NP and feral goats have devastated large portions of the coastal lowland zone by preferentially grazing on native species.

Feral pigs disturb soil, disrupt the understory in wet and mesic forest, and disperse the seeds of exotic plants. Over 35 (of 600) non-native plant species in the park can be considered to be habitat-disruptive. Some of these form mono-specific stands. Others alter fire, nutrient, and soil-moisture regimes (Smith 1985).

The SEA Approach to Management

The Special Ecological Area concept developed out of the need to protect immediately some of the most biologically valuable sites in the park from alien plants while these still were manageable. SEAs were selected largely on the basis of intactness, manageability, species richness, immediacy of alien plant threats, and presence of rare flora. Other factors included potential for research and interpretation, uniqueness, preserve design considerations, and need for experimental management.

An attempt was made to locate SEAs in all six ecological zones in the park, to make them as large as possible, and to link them in some fashion. SEA management demonstrates the park's decision to solve weed problems systematically and incrementally. SEAs are intended as models for management of other areas. As alien species are reduced to management levels and workload requirements drop, SEAs are expanded and new SEAs started.

All disruptive alien plants, even those targeted for biological control research, are controlled by manual, mechanical, or herbicidal means in SEAs. Many of these cannot be controlled parkwide because they are too widespread. Feral ungulates generally are controlled in larger units that include the SEAs.

SEAs also are foci for research and interpretation. An understanding of Hawaiian biota and ecosystems is

(Continued on page 3)

***Using a periscope device**, Julie Leialoha, Biological Technician, measures canopy cover in a tree-fern dominated rain forest site recovering from feral pig damage and following removal of alien plants. Monitoring is an integral component of alien plant control efforts in SEAs. Population levels of target plants are monitored along extensive belt transects. Intensive plots are located randomly in recovering sites of special interest to evaluate total vegetation changes.*

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

ARTICLES

- SEAs Successful as Alien Species Controls 1
- Native Plants Delight Visitors at Columbia Gorge Plot 4
- NPS and SCS Cooperate on Native Plant Materials Program 5
- Great Basin to Test Electronic "Ear Ring" as Cattle Control 6
- Colorado Plateau NPs Hold First Biennial Science Conference 6
- Gypsy Moths May Alter Black Bear Population Dynamics in Shenandoah National Park 7
- Mountain Lion-Human Interaction Studied 8
- Western Rattlesnake Ecology at Natural Bridges NM, Utah 10
- Director's Achievement Awards Go to Van Riper, Taylor, Rambur 15
- National Park Biotic Inventories Assessed 16
- Mexican Spotted Owls in Zion NP: Inventory and Monitoring Methods 18
- Keystone Dialogue on Biological Diversity on Federal Lands Goes to Field 20
- Seagrass Die-off Threatens Ecology of Florida Bay 21
- A GIS Note From the Everglades 21
- Where the Mind Runs Free: Observations of an Interpreter 23

DEPARTMENTS

- Editorial 2
- Letters 8
- Notes From Abroad 9
- Regional Highlights 12
- Information Crossfile 14
- Meetings of Interest 15
- MAB Notes 19
- Book Review 20
- Publications 20

MISCELLANEOUS

- A Slice of Parks' Future? 6
- Falcons Carry Heavy Nomenclature 9
- Galapagos Position 9
- ***Park Science*** Index Readied 13
- NPS Visitor Report Published 13
- GWS 1992 Conference Theme: "Partners in Stewardship" 15
- GIS Users Conference at Denver in November 15
- Haleakala Rabbits Declared Eradicated (For Now) 17
- In the Next Issue 19

editorial

An event that, on the face of it, was much like similar events taking place elsewhere in the National Park System, occurred the week of July 21 in Flagstaff, Ariz., (see story on p. 6). But there was a difference.

The event was the First Biennial Science Conference on Colorado Plateau NPs, sponsored by the CPSU at Northern Arizona University, and it featured the usual progress reports on scientific research in national parks.

The difference involved a comprehensive new focus for Cooperative Park Study Units – one that already has attracted unprecedented multi-Regional support.

Bruce Kilgore, Western Regional Chief Scientist, pointed out that the NAU/CPSU is the first to offer such an array of scientific expertise, targeted at such a wide-ranging but coherent region (the Colorado Plateau). Dan Huff, Rocky Mountain Regional Chief Scientist, echoed that sentiment, and pointed out that two – and possibly soon three – NPS Regions are enthusiastically (and financially) helping underwrite this Unit.

And the event was not without recognition from the top of the Service. NPS A/D Eugene Hester came to Flagstaff with strong words of encouragement for "this kind of cooperative relationship" as "a vital way to fill vital needs." He spoke of the strengths inherent in an approach that provides scientific expertise of all kinds to parks, many of which are too small for science personnel of their own.

The growing partnership among NPS, other governmental agencies, and universities in pursuit of answers to pressing park management problems is producing far more science services than the Park Service alone could provide. And beyond that, the path being blazed by the NAU/CPSU is providing what Dr. Hester termed "a synergistic effect" that is more profound than anyone could have predicted.

This synergism is apparent in varying degrees at CPSUs all over the National Park System, but it was in Flagstaff, where the effect is perhaps farthest advanced, that it was given its most specific airing. The multi-Region support (Western, Rocky Mountain, and possibly soon the Southwest Region) being given this CPSU indicates that the Northern Arizona Unit is doing something very right. Capably led by Charles van Riper III, the NAU/CPSU has gone a long way toward dissolving the reservations that many park and Regional personnel still hold with regard to the CPSU approach.

It was obvious as the conference progressed that enthusiasm was one of the powerful multiplier effects at work – enthusiasm generated among scientists by the new insights that cross-disciplinary approaches provided and among resource managers who saw new problem-solving avenues opening up.

It occurred to this observer that what was happening here was akin to controlled fusion, resulting from a critical mass of mostly off-the-shelf items:

- A biogeographical approach to research and resource management that crossed NPS Regional boundaries;
- A multidisciplinary and interagency mix of scientific expertise;
- A group of park managers with shared problems and a willingness to look beyond NPS Regional boundaries toward a wider concept of "region;"
- An academic community ready to work collegially with NPS researchers; and
- A CPSU willing to make trade-off arrangements between its own staff and those of the Colorado Plateau parks.

From the opening words brought by Dr. Hester to the closing buzz of interacting scientists, resource managers, and academicians, the overall impression was of a smooth-working team of many parts. It was a team focused and fit to tackle current problems, and equipped to jump out in front of them before they become crises.

The CPSU idea is achieving critical mass and the benefits seem likely to match the high expectations for "controlled fusion."

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SEAs Successful as Alien Species Controls

(Continued from page 1)

best gained through long-term monitoring and research in the most intact, representative areas. These areas then can be used to educate the public about native ecosystems, alien species threats, and management.

Management Effectiveness

SEA management began in 1985 with alien plant control efforts in six SEAs totalling 3,800 ha (Fig. 1). By 1990, the original six SEAs had been expanded to 12 areas comprising 12,000 ha, and included several sites each in four of the six ecological zones of the park (Fig. 1). SEA management now is beginning to emphasize rain forest ecosystems. SEA expansions were possible because of declining workload requirements resulting from successful control efforts. Approximately 1,019 worker-days were needed for control work and monitoring in the first year in the three representative SEAs. This requirement declined rapidly in the second year, and only one fifth of the original workload was required in the sixth year (Table 1).

Eleven habitat-disruptive exotic plant species were yargeted for control in the 12 SEAs. Changes in population levels of eight of these are described for three representative SEAs. These SEAs were used because they have been managed for the longest time, are located in highly disparate environments, and received the greatest management attention. They also represent a broad range of sizes, an important factor for dispersal of alien plant seeds in SEAs.

A Mesic Forest Site

Kipuka Puaulu is a 100 ha SEA in mesic forest surrounded by a 910 ha buffer zone (Fig. 1). It was selected because of its unique mesic forest vegetation, abundance of rare plant species, manageability, and potential for research and interpretation.

Faya tree, kahili ginger, strawberry guava, Jerusalem cherry, and nasturtium were targeted for control. Faya tree can form monspecific stands and is potantially disruptive at lower densities because it fixes nitrogen in normally nitrogen-poor volcanic soils. Kahili ginger is a rhizomatous herbaceous plant that forms a monospecific understory layer; Jerusalem cherry is a shrub with the same capacity. Strawberry guava forms impenetrable thickets in the understory of native forests from root sprouts and precludes native tree reproduction. Nasturtium grows in single species stands in forest gaps.

All target species declined measurably with control efforts, three of the five by an order of magnitude, and one species by nearly two orders of magnitude. (Table 1).

Fern Dominated Rain Forest

Thurston SEA is a 50 ha site in 'ohi'a/tree fern dominated rain forest typical of the summit of Kilauea volcano (Fig. 1). It also is the site of a heavily used nature trail and of considerable research in the past. It was selected as an SEA for its relative intactness, representativeness, and potential for research and interpretation. Another consideration was the experimental value of managing an SEA surrounded by areas with high densities of exotic plant species to be managed. High levels of recruitment were anticipated because of seed dispersal into a relatively small area.

Faya tree, strawberry guava, kahili ginger, and palm grass were targeted for removal. Palm grass is a one-meter tall shade tolerant grass that can form dense understory stands. Populations of target alien plant species and workload declined significantly in Thurston SEA. Faya tree and strawberry guava populations decreased even more than they did in Kipuka Puaulu (Table 1).

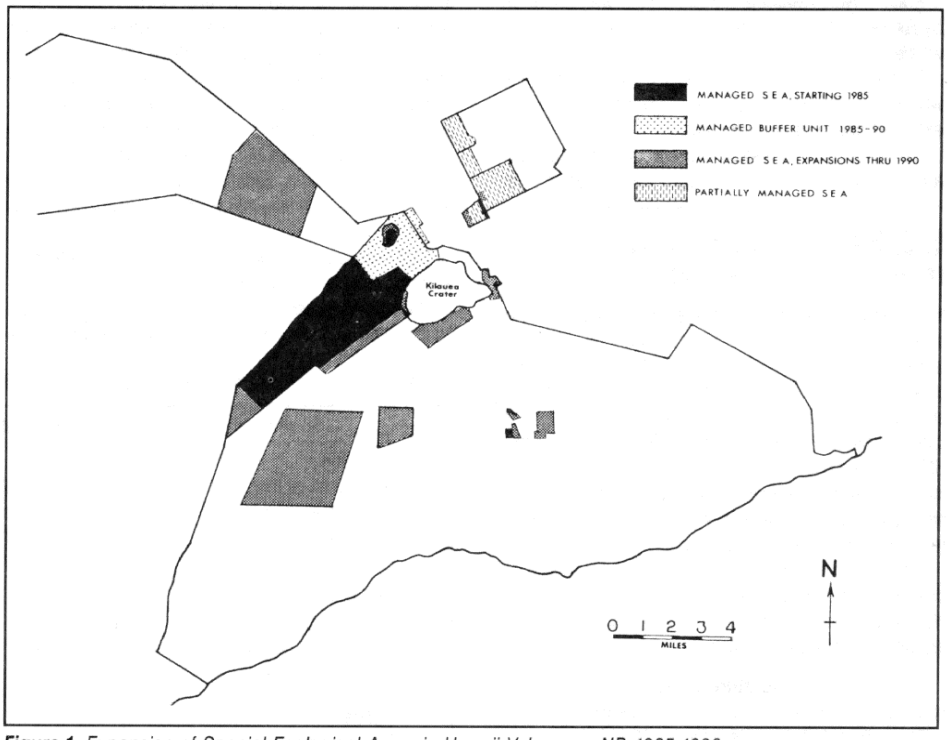


Figure 1. *Expansion of Special Ecological Areas in Hawaii Volcanoes NP, 1985-1990.*

Summer-Dry Native Scrub

Keamoku is a 1985 ha SEA characterized by summer-dry native scrub with scattered short statured 'ohi'a or koa (Fig. 1). It was selected mainly for its intactness and representativeness. Faya tree, silky oak, and fountain grass were targeted for control. Silky oak is an introduced tree that forms dense stands. Fountain grass is a bunchgrass that raises fuel loadings to unnaturally high levels and interferes with primary succession on new lava flows. All target species declined by levels similar to those in other SEAs (Table 1).

Conclusions

Successful control efforts from 1985-1990 demonstrate the value of the SEA approach to alien plant

(Continued on page 4)

Table 1. *Population levels of target weed species treated in three representative SEAs, 1985-1990. Unless specified, these data were derived from tallies of alien plants treated in systematic annual control efforts.*

SEA/TARGET SPECIES	YEAR					
	1	2	3	4	5	6
Kipuka Puaulu						
Faya tree*	5,100	12,950	11,647	6,645	6,314	1,425
Kahili ginger**	1,800	1,500	325	130	275	184
Strawberry guava*	600	715	315	90	334	54
Jerusalem cherry***	ND	6,050	325	250	280	50
Nasturtium****	67	44	14	2	ND	<1
Thurston						
Faya tree*	1,493	324	172	32	85	ND
Kahili ginger**	10,913	3,763	1,288	245	204	184
Strawberry guava*	20,572	3,121	5,367	1,480	1,660	54
Palm grass***	180	70	81	17	10	ND
Keamoku						
Faya tree*	5,500	3,975	706	1,363	1,302	585
Silk oak*	960	1	7	3	ND	ND
Fountain grass*	6	4	1	0	0	2
TOTAL WORKLOAD	1,019	486	305	273	274	210

*Number of individuals or stems uprooted or cut and treated with herbicide.
**Total area treated with herbicide.
***Total fresh weight of rhizome uprooted and removed.
****Percent cover in monitoring plots.

Native Plants Delight Visitors at Columbia Gorge Plot

Editor's Note: Material for this article was provided by Berta Youtie – all except the parts that say what a whale of a job she did.

It all goes to show that information collected at a site where it "didn't work out" can sometimes be put to excellent use at a different site.

Berta Youtie, The Nature Conservancy's land steward for Oregon's Governor Tom McCall Preserve, located within the Columbia River Gorge National Scenic Area, once worked for the National Park Service investigating techniques to restore the overgrazed ranches that comprise the John Day Fossil Beds National Monument in arid Eastern Oregon. Collecting seeds from the site, growing bunchgrass plugs in the greenhouse, and then transplanting them to the field was found to be very successful on a small scale, but wasn't considered feasible on the Monument's large scale.

That was back in 1981. Today is another site and another story – this one with a happier ending.

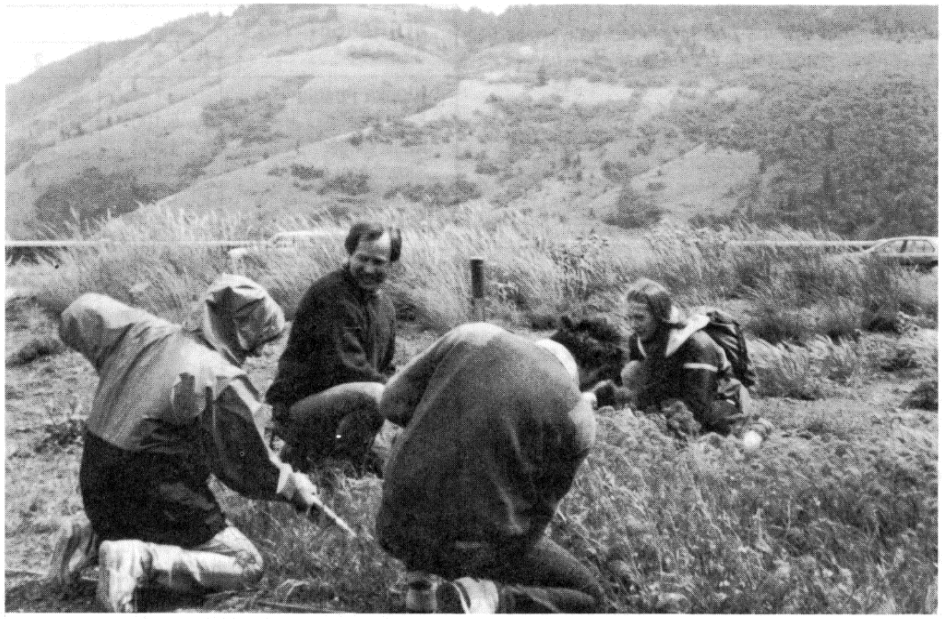
The site in question is two acres of what is called "disturbed habitat" – in this case, a somewhat euphemistic term for part of a parking area that had become almost rock-hard by compaction. Today, because Berta Youtie saw the possibilities and remembered the techniques, the site is drawing the admiration of Gorge visitors who pause there to see the recently established display of wildflowers. The area now is a native plant garden, being used as an interpretive tool to heighten people's appreciation for the natural beauty of native species and to teach the art and science of restoration ecology.

The preserve is located on a plateau between Hood River and The Dallas and is home to more than 300 species of plants. They grow among the oak savanna, vernal pools, rocky basalt cliffs, biscuit scablands, and

Table 1. *Native plant material used at the Rowena Crest Native Plant Garden in 1990.*

Species	Habitat	Propagule	Survival*
Grasses			
Agropyron spicatum	mound	seed	+
Festuca Idahoensis	mound	seed	+
Stipa lemmoni	mound	seed	+
Sitanion hystrix	scab	seed	+
Shrubs			
Rosa nutkana	scab	cutting	+
Holodiscus discolor	scab	cutting	+
Philadelphus lewisii	scab	cutting	+
Forbs			
Balsamorhiza careyana	mound	plant	+
Eriogonum compositum	scab	cutting	+
Eriogonum strictum	scab	cutting	+
Eriophylum lanatum	scab	plant & seed	+
Lomatium columbiana	mound	seed	–
Lomatium dissectum	mound	seed	–
Lomatium grayi	scab	seed	–
Lomatium nudicaule	scab	seed	–
Lupinus latifolius	mound	seed	+
Penstemon richarsonii	scab	plant	+
Phacelia hastata	scab	plant	+

*Survival = + majority of plants survived first year
– majority of plants did not survive
? too early to judge



Volunteers dig in *to the job of introducing native transplants.*

SEAs Successful

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management; the approach also has protected the most important sites in the park. Population levels of target species have declined markedly, typically by an order of magnitude, in spite of some recruitment from surrounding areas. Workloads have decreased by a factor of five. Hawaii Volcanoes NP will continue the SEA approach to management, and encourages this incremental, experimental strategy for parks and preserves where alien species or native ecosystem restoration problems are overwhelming.

Tunison is a Resource Management Specialist in charge of the vegetation management program at Hawaii Volcanoes NP; Zimmer is field supervisor for the alien plant control program.

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"... by applying molecular biology to the study of evolution, taxonomic sleuths have identified two California cousins of the Hawaiian silversword 'alliance,' a grouping of 28 closely related plants. The findings also furnish genetic clues suggesting that all existing silversword species may have evolved from a single seed. Plant evolutionist Bruce G. Baldwin suspects the genealogic evidence he has collected may even inspire new thinking about how plants worldwide 'came to be where they are'."

"From Tarweed to Silversword" is the title of an article by Wendy Gibbons in the April 27, 1991 issue of *Science News*, suggesting that Hawaiian plants with California roots "challenge botanical dogma." Researchers Donald W. Kyhos of U/CA Davis and Gerald D. Carr of U/HI Honolulu attempted to confirm the apparent kinship between a Hawaiian silversword specimen and two California tarweeds with sets of mutations closely resembling those of the Hawaiian plants by crossing them. "We could hardly believe our eyes when the results came in," Kyhos said. The matings produced healthy hybrid plants, suggesting that a single tarweed progenitor established itself on one Hawaiian island and that subsequent generations from that single plant "probably evolved into the diverse group of silverswords now evident in Hawaii."

Columbia Gorge Native Plants Plot *(Continued from page 4)*

grassy slopes. The Nature Conservancy joined forces with Oregon State Parks and other local organizations to work their restoration miracle.

Permission for the project was obtained from the USFS, Columbia Gorge Commission, Citizen's Advisory Board for the Columbia River Gorge Scenic Highway (and of course Oregon State Parks). Last year, TNC won an award from the Oregon Native Plant Society in "the best use of native plants" category.

Landscape gardener Michelle Zimmerman initially designed the garden with some subsequent redesign from Kathy Schuttt, a landscape architect for Oregon State Parks. Before planting, it was necessary to recreate the natural mounded prairie topography of the previously leveled site. The Oregon Highway Department provided much of the construction means – heavy equipment, as well as volunteers with shovels and rakes for shaping and grading the mound surfaces.

Seeds of forbs and bunchgrass species (Table 1) were collected in the summer of 1989 from adjacent areas. Local Portland garden organizations experimented with scarification techniques for wildflower species and grew seedlings in their greenhouses. Balsamroot transplanting occurred from the wild. Small plants were removed from an area designated for development. More than 90 percent of the 200 transplants have survived the first two years. Bunchgrass seedlings were propagated in greenhouses. Shrub cuttings also were planted on the site.

Small signs now identify the scientific and common names of the plants and an interpretive sign is being created to promote understanding of restoration using native plants.

With survival having been overwhelmingly successful, the site was dedicated on June 16, 1991, to Robert Ellis, a conservationist and member of the Oregon Roadside Council.

A handy, well-illustrated visitor brochure describes the Tom McCall Preserve, its early history, geology, vegetation, wildlife, and management, and highlights "guidelines for use."

Although the National Park Service is not among those listed in the "credits," Berta Youtie's work, arranged through the NPS/CPSU at Oregon State University, remains a solid underpinning for this recent attestation to the value of Cooperative Park Study Units and to the far-flung successes that sometimes stem from seeming failures.

More signing is planned *to interpret the area as well as sharing the credit.*

This lush growth *of bunchgrass seems to be waving enthusiastic thanks to the volunteers who helped restore it.*

NPS and SCS Cooperate On Native Plant Materials Program

By William R. Beavers and Wendell G. Hassell

The National Park System of the United States comprises 356 areas covering almost 80 million acres in 49 states, the District of Columbia, American Samoa, Guam, Puerto Rico, Saipan, and the Virgin Islands. The diversity of the System is relfected in the variety of the park unit titles.

The National Park Service's mandate to preserve resources while providing for public enjoyment, faces park adminstrators with a delicate balancing act. Revegetation and reclamation activities present special problems for those trying to maintain native plant populations in areas impacted by visitor facilities.

To the extent possible, plantings in park units consist of species that are native to the park or are historically appropriate for the event commemorated. To this end, a cooperative agreement between the NPS and the Soil Conservation Service (SCS) was developed in 1989. This Plant Materials Program seeks to draw upon the strengths of the two federal agencies in the development, testing, and establishment of native species for disturbed sites within NPS units (see ***Park Science***, 11:3, p.7).

Program Development

The plant materials program between the two agencies initially focused on development of native plants for the revegetation of areas disturbed by road construction. The park roads program is the ideal starting point for the plant material program. Since advancedscheduling and funding appropriations are critical to the success of this program, the park roads program assures that all plant materials projects can be funded adequately and that sufficient lead time will be available to complete plant production schedules.

The SCS maintains 26 plant material centers throughout the United States, including Alaska and Hawaii. Each center is located to take advantage of common characteristics of climate, topography, and soils in parts of two or more states. They are at Pullman, WA; Corvallis, OR; Lockeford, CA; Aberdeen, ID; Tucson, AZ; Meeker, CO; Los Lomas, NM; Bridger, MT; Bismarck, ND; Manhattan, KS; Knox City, Nacogdoches, and Kingsville, TX; Elsberry, MO; Boonesville, AR; Golden Meadow, LA; Jackson, MS; Quicksand, KY; Rose Lake, MI; Americus, GA; Brooksville, FL; Big Flats, NY; Cape May, NJ; Palmer, AK; and Hoolehua, HI. The National Plant Materials Center is in Beltsville, MD.

Current Programs

Presently, the NPS and SCS have developed plant materials agreements for 20 park road projects. In addition, a parkwide plant materials program is under development within the Rocky Mountain Region of the NPS and will be implemented in selected parks before the end of the year. Within the next 5 years, the plant materials program can be expected to grow, addressing needs in over 40 parks. The plant program and information generated over the coming years will add to the information base and help develop park indigenous species that are locally adaptive. This program also will provide the needed reclamation technolgies to develop successful revegetation techniques in reestablishing these native park species.

Beavers and Hassell are National Technical Advisors for Plant Materials for the NPS and SCS respectively. Beavers may be contacted at (303) 969-2734.

Great Basin To Test Electronic "Ear Ring" As Cattle Control

By William Brock, Arthur Tiedemann and Thomas Quigley

The enabling legislation that created Great Basin NP identified livestock grazing as an appropriate historic use and its continuation was specifically enacted "subject to constraints imposed by the Secretary to ensure proper rangeland management practices."

The environs of Great Basin NP, as well as of many other areas of the intermountain west, have been considerably altered by expansive livestock production which began in the early 1900s (Young et al. 1978). Contributing factors of fire suppression and perhaps climate change have interacted with grazing to cause an increase in upland woody plant cover. This has reduced upland forage productivity, forcing cattle to concentrate in limited and highly sensitive riparian areas.

At Great Basin NP, riparian habitats extend over an approximate 1320 m elevational gradient from 1850 m to 3170 m (Murray and Smith 1990). Although riparian habitats comprise only a small proportion of the total park area, they are the nucleus of the greatest diversity and highest productivity. These areas provide a direct physical and biological link between different community types (Brown 1982), as well as providing food, water, and breeding site resources for resident and migratory wildlife. Livestock grazing, and particularly intensive, protracted use, can have an adverse effect on riparian vegetation structure and function, soil stability, and water quality. Controlling livestock use in these critical areas is a priority management need.

Section 319(h) of the Clean Water Act provides 60 percent matching funding to qualified State sponsored projects. These grants are awarded to projects specifically focused on developing new technologies leading to best management practices for non-point source water pollution problems. Great Basin NP, in cooperation with the USFS Pacific Northwest Research Station, Oregon State University, the Texas Agricultural Extension Service, and Baker Ranches, Inc., has secured $251,000 in project support through a Section 319(h) funding proposal to develop and test management alternatives to fencing, for controlling livestock use in sensitive riparian areas.

The technology involves using an electrical stimulus from specially designed ear tags to achieve animal avoidance of designated exclusion areas. The basic concept is that an animal can be controlled by electrical stimulation to the ear as the animal enters the zone of influence of a signal from a remote, battery powered transmitter installed in the area of desired exclusion. Funding for this project will support the development of prototype electronic ear tags and transmitters, controlled experiments on effectiveness, and field trials in Texas and Great Basin NP.

We anticipate that the results of this project will point the way for accelerated development and distribution of a new "best management practice" for controlling livestock movement on rangelands and pasturelands, resulting in improved riparian management and water quality. If successful, this technology will have application not only to the 27 NPS areas that currently authorize livestock grazing, but also to other NPS situations unrelated to livestock management.

The project is scheduled for completion in September 1992.

Brock is Resource Management Specialist at Great Basin NP; Tiedemann is Chief Ecologist and Quigley is a Range Scientist with the USFS PNW Research Station.

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Colorado Plateau NPs Hold First Biennial Science Conference

The First Biennial Conference on Research in Colorado Plateau NPs, held July 22-24 on the Flagstaff campus of Northern Arizona University, comprised 39 presentations. They covered the entire range of plateau park research, from grazing impacts through birds and fish, mammals, geology, archeology, sociology, hydrology, air quality, vegetation, and Geographic Information Systems.

John Davis, who will soon be leaving the superintendency of Grand Canyon NP for Washington, D.C.,to become NPS A/D for Operations, welcomed the conferees, as did Patricia Reed, NAU vice-president of academic affairs.

NPS A/D for Natural Resources Eugene Hester flew in from Washington to congratulate the gathering on the biogeographic approach that has been taken by Colorado plateau parks research. (See editorial). Bruce Kilgore, Western Regional Chief Scientist, described the history of the recently established NAU Cooperative Park Studies Unit (CPSU) and the role of its leader, Charles van Riper III, in conceptualizing and establishing the science program. The Unit's holistic approach to research and problem-solving in a biogeographic region of related problems and resources has been responsible, Kilgore said, for support from two, and possibly three NPS Regions – something that has never happened before in NPS history.

(The Unit is based in the Western Region, enjoys Rocky Mountain Region support, and may soon receive additional support from the Southwest Region.)

Dan Huff, Rocky Mountain Regional Chief Scientist, spoke of the need for a synergy of management and its concomitant need – a synergy of science. The double-barreled NPS mission, to maintain ecological preserves and to serve as a recreation agency, demands the best in natural and social science research, Huff said, "and if you don't *like* this problem," he added;, "I can only quote Barbee [Yellowstone NP Supt. Robert Barbee]: 'The U.S. Postal Service needs a few good people.'"

Following the plenary session, at which John Cherry, Assoc. Director of the Western Region; Homer Rouse, Assoc. Director of the Rocky Mountain Region, Henry Hooper, Assoc. V-P of Academic Affairs at NAU, and van Riper, all spoke, the three-day session went into high gear. Many of the studies presented will appear in future issues of *Park Science.*

A lively symposium on air quality brought all the conferees together for two hours on the second morning. Roger Clark, director of research for the Grand Canyon Trust, chaired a panel of five: John C. Freemuth of Boise State University; C.V. Mathai, principal scientist for Arizona Public Service; Linda Mazzu, Grand Canyon NP Resource Management Specialist; Debra Mangis of the NPS Air Quality Division, Denver; and Ken Luckow, Air Quality Specialist for the USFS, Region IV, AZ.

Visitor concern over the high profile problem of visibility in parks was cited as factor in the heightening of general public concern over air quality. Mathai maintained that "one point source alone isn't responsible for all the lowered air quality. Electric generators," he said, "are highly visible point sources. But they are furnishing things the public also wants, and *society* must make a decision as to how much it is willing to let rates rise in order to provide cleaner air."

Luckow responded that the Clean Air Act already reflects society's decision that air must be cleaned up. Mathai responded that "the Act also states specifically that costs to point sources must be justified by cost/benefit ratios."

The conference was hosted and organized by the NAU/CPSU and co-sponsored by Bryce Canyon Natural History Assn., the Petrified Forest Museum Assn., and Zion Natural History Assn. Van Riper, the NAU Unit Leader, served as Conference chair; Mark Sogge was conference leader.

A program containing abstracts of presented posters and papers is available from the NAU/CPSU, Flagstaff, AZ 86002; (602) 523-9080

Jean Matthews, Editor
Park Science

A Slice of Parks' Future?

Conservation in Regional Landscapes is the title of a graduate course at U/Cal Davis, designed and taught last winter term by NPS research scientist Christine Schonewald-Cox with four of her colleagues. The course focused on habitat conservation on a broad regional scale, using the Sacramento valley as subject area and zeroing in on two main objectives:

1. To see what capacity this region has to protect biodiversity taking into account theory in biogeography, population biology, evolution, landscape ecology, and emerging conservation biology, and
2. To examine how the presence of humanly modified landscapes, culture, human demographic changes, and law place constraints on the direct application of theoretical principles.

The class was charged with trying to integrate theory and practice in the planning of regionwide habitat protection. Schonewald-Cox sees the valley as the "connector" between the coastal range and the sierra and suggests that in the urbanized sections "we can see the forerunners of conditions that will likely surround many of our presently remote parks."

Gypsy Moths May Alter Black Bear Population Dynamics In Shenandoah National Park

By Michael R. Vaughan and John Karish

Shenandoah NP (SNP) is home to what likely is one of the densest black bear (*Ursus americanus*) populations in the conterminous United States (Carney 1985). However, recent invasion of the park by gypsy moths (*Lymantria dispar*) threatens the continued stability of the bear population.

When the 777 km2 park (Fig. 1) was established in 1935 in the Blue Ridge Mountains of northern Virginia, it was largely deforested due to homesteading (Mazzeo 1979), and black bears reportedly were observed infrequently. But with protection from hunting and favorable habitat changes, the population apparently increased quickly. By the mid-1970s, it had reached a reported density of one bear per 2.6 km2 (Raybourne 1976, Dubrock 1980). With construction of Skyline Drive and improvement of park visitor facilities, human visitation also increased, and bear/human interactions became an issue (Garner and Vaughan 1989). Bear damage to property adjoining the park also increased.

In response, the park implemented a bear management plan in 1976 with goals of (1) restoring and maintaining the natural integrity, distribution, and behavior of the bear population, (2), minimizing nuisance bear conflicts, and (3) providing visitors the opportunity to view bears in a natural setting. The plan called for a number of practices aimed at reducing front country use by bears, plus research on the bear population that would provide information essential for dealing effectively with this valuable resource.

In 1982 the NPS established an interagency agreement with the Virginia Cooperative Fish and Wildlife Research Unit at Virginia Polytechnic Institute and State University to study the black bear population at SNP. This long-term project, still in progress, had as its initial objective to determine demographic characteristics of the park's bear population and to describe movement, distribution, and habitat use patterns. More recently, research has focused on effects of gypsy moth induced defoliation on the bear population. Thus far, four graduate students, several technicians, and numerous volunteers have participated in the research.

Demographics

The bear research started with an intensive capture and marking program. From April 1982 through November 1983, 115 different bears were captured 149 times in the 298 km2 Central District study area (Fig. 1), and 47 were equipped with radio transmitters. The overall sex ratio of first-time captures was 2.03 males per female. However, for adult bears (estimated by tooth sectioning to be >3 years old) and for subadults (1-3 years old) the ratios were 1.3 and 3.8 males per female, respectively.

While it is generally accepted that males are more vulnerable to trapping than females and may be captured 1.5 to 2.5 times as frequently as females, the greatly disproportionate ratios for subadults and the similarity of capture frequencies for adult males and females was an indication of an unusual age distribution for SNP bears. The average age of captured females was 5.1 ($N=36$) while for males it was 3.2 ($N=76$). Bears less than 1 year old ($N=3$) were excluded from sex and age ratio analyses.

In the first three years of study about 50 percent of marked bears denned on the ground. Ground dens

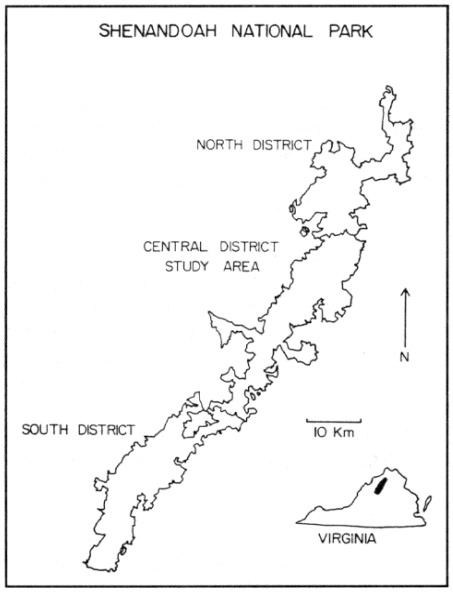

Figure 1.

and, where possible, tree dens were checked in late winter prior to emergence to determine reproductive effort. The average litter size of 21 reproductive females was 2.0. No females produced more than 3 cubs per litter during the initial study, although the first litter of 4 in SNP was recorded in 1990. All but 2 reproductive females were estimated to be at least 4 years old when they gave birth. The 2 exceptions were estimated to be 3 years old when they gave birth, meaning they had bred at 2 years of age. Generally, females gave birth every second year unless they lost their entire litters during the summer, in which case they gave birth in consecutive years.

Forty-four of the 47 radio equipped bears were adults and 28 of the 44 were alive at the end of the study. The remaining 16 were legally (7) or illegally (5) harvested, disappeared (3), or were removed (1) because of nuisance activity. The annual adult male mortality rate was 41 percent; the adult female mortality rate was only 7 percent.

The capture data were processed through programs CAPTURE and JOLLY to estimate bear density in the central district of SNP. The estimated density (an average of all estimators) ranged from 0.67 to 1.04 bears per square kilometer (1.7 to 2.7 bears/mi2). This extremely high bear density represents one of the highest density estimates reported in North America.

Contributory Factors

Why does SNP have such a high bear density? Probably several factors contibute. The area was a mosaic of homesteads prior to becoming a national park, and most of these old home sites had fruit trees (apple, cherry, pear) growing nearby. Our investigation of old home sites and bear movements (Garner 1986) indicated that these sites produced substantial amounts of fruit and were important to bears, particularly in late summer and early fall. In addition, natural food supplies were abundant. Although we made no quantitive measures of food availability, we noted good production of berries and forbs in summer months, and cherries, grapes and acorns in the fall.

The forest in SNP is over 70 percent oak and normally produces high quantities of acorns, which made up almost 50 percent of the bears' annual diet. (Fig. 2). Thus, the park appears capable of supporting a high number of bears. The discovery of a high degree of home range overlap among adult female bears (up to 90%) further strengthened the conclusion that food was abundant.

The sex and age ratios, average ages of male *vs* female bears, and differences in mortality rates of male *vs* female bears, all suggested that the male segment of the population was exploited while the female segment appeared not to be exploited. When we examined bear movements we found that females rarely left the park (15% of location out of the park) while males were twice as likely (32%) to be out of the park. When adult males were outside the park they suffered high mortality from poaching and legal harvest (we did not radio tag subadult males and do not know how frequently they left the park or their mortality rate).

(Continued on page 8)

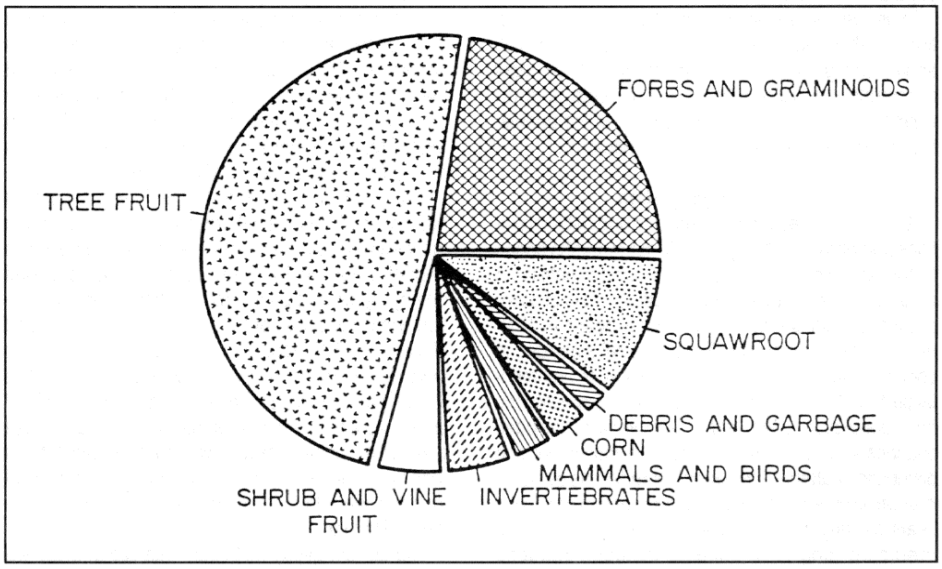

Figure 2.

letters

To the Editor:

John W. Laundre, "Mountain Goats in Yellowstone" (***Park Science***, Summer 1991), states that there is no historical evidence for mountain goats in Yellowstone NP. His bibliography, however, gives no indication that archaeological data from Yellowstone NP were consulted in this study. Archaeology is an ideal tool for the research biologist in determining environmental circumstances of the past.

Michael P. Sampson, State Archeologist
California Dept. of Parks & Recreation

Further Word From Mary K. Black

To the Editor:

I was perhaps not clear enough in my letter. When I said the killing of wildlife was "philosophically out of context for the NPS," I meant in an ethical, not a policy, sense. This is especially important for the perception the general public has of the Park Serivce. Further, whether Theodore Roosevelt was a "mighty hunter" does not dispel the increasing public criticism of the so-called National Wildlife Refuge System.

Living by another's rules is not a sound basis for a personal philosophy, nor an escape from personal assessment of one's actions. I am sorry Mr. Lovaas is "disturbed" that I do not believe he cares deeply for wildlife. If reveling in the wild spirit of an animal and the wilderness that nurtured it – while gratuitously taking its life and devouring it – is a mark of caring deeply for nonhuman animals, then disturbed he shall remain.

Mary Kelly Black, Staff, *Women's Rights NHP*

Mountain Lion-Human Interaction Studied

By Katherine L. Jope

Numerous mountain lion incidents, resulting in hum an injury, have occurred throughout the West with increasing frequency in recent years. To help address this growing problem, a workshop on interactions between mountain lions and people was held in Denver on April 24-26, hosted by the Colorado Division of Wildlife.

The workshop was co-sponsored by the NPS, USFWS, USFS, USDA Extension Service, BLM, and the Colorado Chapter of the Wildlife Society, plus 14 state and provincial wildlife agencies. The purpose of the workshop, attended by about 300, was to bring people together and search for patterns in the incidents.

Incidents seem to occur most often where suburban developments are expanding into mountain lion habitat. Other factors that appear to contribute to the likelihood of incidents are (1) residents feeding deer; (2) high deer populations; (3) people keeping dogs, cats, ducks, geese, or other small animals outdoors, and (4) keeping pet food outdoors.

Incidents involving hikers and joggers have occurred primarily in areas where deer populations are high. The presence of a dog seems to contribute to likelihood of attack. Children are victims more often than adults.

Evidence supports a theory that intensive hunting contributes to the likelihood of attacks. Since most mountain lion hunting is done using packs of hounds, the lions most likely to escape are the more aggressive ones, while the more passive mountain lions are removed. The consequence of this selection may be a population with a tendency toward more aggressive behavior. Of the 50 injury attacks recorded, 29 occurred in British Columbia, where there is intensive hunting.

The behavior displayed in these incidents is typical predatory behavior. There is little doubt that the intent is to prey on the person or domestic animal involved. Any person who encounters a mountain lion that does not run away should treat the situation as threatening. The recommendation is for the person threatened to behave as aggressively as possible, trying to appear dangerous to the mountain lion.

There was some tendency for dispersing yearlings to be involved in incidents more than adult mountain lions. No association was found with abnormalities such as disease or starvation.

Jope is Regional Resource Management Specialist at NPS/PNRO in Seattle, WA.

Gypsy Moths Affect Bear Populations at Shenandoah *(Continued from page 7)*

This discovery helped explain why the average age of male bears on the park was so low and why adult males showed up in the trapped sample in lower proportion than expected. It also suggested why so many juvenile males were trapped in the park. Kemp (1976) earlier showed that by selectively removing adult males from a population of bears in Alberta, Canada, population size increased as several young males moved i8nto the territory vacated by each larger adult male. Adult males are believed to be important in regulating bear populations by killing excess cubs and yearlings and by forcing young males to leave the population (forced egress).

Thus, we believe that the high density bear population in SNP is due to (1) an abundant food supply which enhances reproduction and survival and allows bears to tolerate extensive home range overlap; and (2) exploitation of the adult male segment of the population, which lessens their regulatory influence.

Enter the Gypsy Moth

As we concluded the demographic and habitat relations portions of our study in 1985, gypsy moths began to appear in the park. These insects can defoliate large areas of oak (and other) trees, resulting in loss of acorn production (McConnel 1988). Since bears in SNP depend heavily on acorns (Fig. 2), the NPS decided to continue bear research to determine how environmental perturbations caused by gypsy moths impacted the bear population. Likely short term impacts included changes in food habitats, changes in movement and distribution patterns, increased depredations by bears in areas adjacent to the park, and increased harvest of bears as they moved off the park in search of food. Predicted long-term impacts included reduced reproduction and survival because of poor nutrition, and thus a reduced population level.

Defoliation in 1985 was light, but in 1986, 1987, 1988, 1989, and 1990, 551 ha, 2,633 ha, 6,500 ha, 17,400 ha, and 15,891 ha respectively, were defoliated within the park. Acorn production in defoliated stands from 1987-1990 was essentially nonexistent (McConnel 1988, Ksbohm and Vaughan 1990) and bears in those stands had to use alternative food sources or move during the fall hyperphagic (over-eating) stage.

Because defoliation opens up the forest canopy, some soft mast crops, grape in particular, were abundant in defoliated stands and bears fed heavily on them. Some long-range movements (>10 km) were recorded, but without complete data analysis it is not clear at this time if all movements were related to defoliation. Reproduction has remained good, but there are preliminary indications that cub survival may be down. Data from the initial four years of defoliation related research is being analyzed and data collection for the final year of field study soon will begin.

Nine years of research on the SNP bear population has provided valuable information to the NPS and to the Virginia Department of Game and Inland Fisheries (VDGIF). For the NPS, the research has provided demographic and bear/habitat relationship information, identified areas of SNP important to bears, and allowed SNP Resource Management personnel to develop a management strategy for park bears. The VDGIF has benefitted from the research because SNP serves as a reservoir of bear reproduction, and those that spill out of the park are available for harvest. More than 50 percent of the bears harvested in Virginia (614 in 1990) were harvested from the eight counties in which SNP lies.

The current gypsy moth/bear interaction study will be useful not only to the NPS but to other agencies trying to predict how loss of acorn crops will impact wildlife populations dependent on this valuable resource. SNP has provided a unique opportunity to study (1) the potential of a bear population under natural conditions, (2) the effects of a natural disaster (gypsy moth) on the bear population, and (3) the interactions that occur at the interface between a national park and the adjacent private land.

Karish is Chief Scientist for the NPS Mid-Atlantic Region; Vaughan is Asst. Leader, F&W Coop. Research Unit at VA Tech.

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notes from abroad

Editor's Note: Grassland and prairie management in the United States and England, similarities and differences in approach, is the subject of this issue's Notes from Abroad. Dr. Jackson, Professor of Biology at Missouri Southern State College in Joplin, spent a year's sabbatical as Visiting Scholar at Wolfson College, Oxford University. Hearn is Adviser on Nature Conservation with the Estates Advisers Office, The National Trust, Cirencester, Gloucestershire, England. Jackson is a Cooperative Researcher and has done limestone glades prairie research for the NPS at Wilson's Creek National Battlefield in Missouri.

By James R. Jackson and Katherine A. Hearn

After working separately for over 10 years on grassland management at historic sites for the Midwest Region of the National Park Service in the U.S. and for the National Trust in England, we now are working together on grassland management in England. We have realized that there are some interesting similarities and differences in our approach to grassland management. The areas most interesting for comparison are: threats to the grasslands, serious management problems, differences in management practices, areas needing more research, and the development of management objectives for grasslands.

In the United States and in England the most important threat to grasslands is their loss to agricultural practices. This problem is more acute in England than in the U.S. for several reasons. England is a small country by U.S. standards and there are not vast proportions of the country that have historically been grassland. Also, during the Second World War and until Britain became part of the European Economic Community, agricultural self-sufficiency was an important political goal; farmers were encouraged to convert grassland to arable land. Because of this, 97 percent of lowland grassland existing in England before the war has been lost to farming practices such as plowing, reseeding, and fertilization.

Lastly, unlike the U.S., land in England has historically been in private ownership so when valuable grassland is discovered, it has to be purchased or a cooperative management plan has to be developed in order to protect that area. In the U.S., most protected native grasslands are owned by state, federal, or local government while in England the National Trust is the biggest landowner. The National Trust is a private charity which is committed to preserving the natural and cultural history of England.

The most serious management problems on managed or owned grasslands differ somewhat between England and the U.S. Until recently, the naturally occurring rabbit population in England has been kept in check by density-dependent diseases. However, the rabbit population has developed immunity to the most serious of these diseases in the past few years, causing it to increase at an alarming rate and destroy a significant amount of valuable grassland. Generally, rabbits are not a serious problem in U.S. grasslands. In the U.S., the invasion of exotic herbaceous plants such as thistle and cheatgrass, is a serious threat to even well managed prairies. In England this is not a significant problem.

In both the United States and in England the protection of rare and endangered species is a serious management concern and both countries are significantly involved in this process. A difference in the approach to this management problem is the location and identification of rare and endangered species. Often in areas managed by the National Park Service the occurrence of an important species comes to light only secondarily in the course of unrelated surveys or analysis. In England the National Trust conducts an intensive survey of all of its landholdings every 12 years. The goal of this survey is to document what is present and to identify important species.

Visitor impact is a much more serious problem in England than it is in the U.S. England has over 60 million people in an area roughly the size of Oregon so the impact of factors like trail erosion and dog fouling is uniformly at a high level that is rarely seen in the U.S.

Invasion of grassland areas by encroaching woody scrub is a serious problem in parts of the U.S. and in England. This problem came about in the U.S. by the suppression of fire and the cessation of grazing by large herbivores. The source of the problem in England is a series of political changes over the last several hundred years that affected sheep grazing. Cheap cotton from England's colonies reduced the demand for wool. Most of the grassland was common land and was lost due to a series of enclosure acts, designed to convert grassland to more lucrative arable land in the 17th, 18th, and 19th centuries. This left a remnant patchwork array of grasslands that were not accessible or large enough to support sheep production. This disused grassland rapidly became overgrown with encroaching woody species.

The grassland management practices used in the U.S. and England are similar but with some exceptions. Hay cutting and scrub removal are examples of similar management practices, but even scrub removal has some different approaches. In the tallgrass prairie of the U.S., scrub encroachment is controlled by grazing, burning, and physical removal, but herbicides are rarely used. The NPS used of herbicides in all its management areas is allowed by special permission only, and then only when the problem is severe and no alternative is available; whereas the National Trust in England, among its other herbicide recommendations, suggests that wick-applied herbicides be used consistently with brush cutting.

Burning is used to control large tracts of encroaching heather, bracken, and gorse in English moorland grassland, but it is rarely suggested as a method of control for promoting native species and inhibiting exotics as it is in the American prairies. The obvious reason for this difference is that fire was never a natural phenomenon in English grassland while native U.S. prairie grasses evolved in a fire-frequent environment.

Grazing is the most valuable grassland management tool in England. This is because English grasslands have had at least 2,000 years of adaptation to sheep grazing. Herds of ancient breeds of sheep are now being established for the sole purpose of maintaining and restoring grassland vegetation composition.

Reseeding is not part of the English philosophy of grassland management. Genetically similar strains of native tall grass prairie plants are routinely planted to restore the natural species composition in National Park prairies of the U.S. The English believe that reseeding addresses the symptoms but not the problems of grassland restoration. They also feel that reseeding can forever upset the competitive and successional balance that grassland ecosystems require for stability and stress resistance.

Additional research in grassland management is a pressing need in both countries for most aspects of grassland management but three areas are of particular importance. In both countries there has been a large number of specific management programs on grassland, but the results of many of these individual case studies have not been published or collected into a single accessible source. If this source included case studies from both countries, it would be of tremendous value. A second area of urgent research need is increased autecological studies (studies of the response of individual plants to their environments and management schemes). The third area, being vigorously addressed by both countries, is the effect of global climate change on grasslands.

An interesting difference between grassland management in U.S. historic sites and in England is the development of management objectives. In the U.S. the objective usually centers around the reestablishment of pre-settlement vegetation. The U.S. has a well-documented idea of a stable natural vegetation that existed before the influence of European settlers. High density population and significant agricultural influence has been part of the English landscape for more than 3,000 years, so there is no pristine pre-agrarian natural landscape to use as a management objective goal. The English Natural Trust can only use preservation of what exists as a management goal. Survey and assessment for each site will determine what aspects of the natural and cultural environment are precious for that specific area. The management goal will then usually center around the conservation of those aspects in an integrated manner.

Falcons Carry Heavy Nomenclature

In commemoration of the 75th anniversary of the creation of the National Park Service, peregrine falcons released this summer at Isle Royale NP were named for the 12 past NPS Directors: Mather, Albright, Cammerer, Drury, Demarayh, Wirth, Hartzog, Walker, Everhardt, Whalen, Dickenson, and Mott.

Peregrine falcons are doing well in the Great Lakes Region, considering that the breeding population was completely eliminated in the 1960s. According to Dr. Pat Redig of the Raptor Center in St. Paul, MN, there are five nesting pairs in the Twin Cities this year and at least three pairs in northern Minnesota. Michigan's uipper peninsula also has three nesting pairs.

Galapagos Position

The Charles Darwin Foundation for the Galapagos Islands (CDF) is seeking a director for its international research, conservation and education center, the CDRS. They are seeking an M.S. or (preferably) a Ph.D. or equivalent in a field of natural sciences, natural resource management or similar, with at least four years practical experience, preferably in Latin America; bilingual English/Spanish; 25-55 years old; at a starting salary of $20,000 US with many benefits.

Deadline for applications is Oct. 15, 1991, but if the deadline is past and you are interested, you may phone or Fax Dr. David Challinor at the Smithsonian in Washington, DC; Tel: (202) 673-4705; Fax: 202-673-4607.

Western Rattlesnake Ecology At Natural Bridges NM, Utah

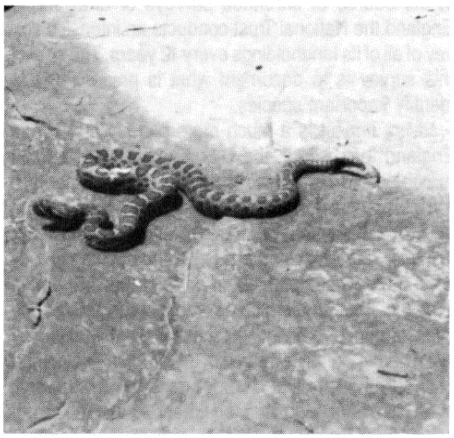
By Tim B. Graham

Western rattlesnake (*Crotalus viridis*) is common on the Colorado Plateau, but infrequently seen. At Natural Bridges National Monument, these rattlesnakes are encountered often in the residence/visitor center area (R/VC). While only one person has been bitten (dry bite) in the developed area, (the victim apparently was drunk and tried to pick up the snake), the abundance of snakes in the R/VC is perceived as a safety issue. Snakes in the Natural Bridges population are generally very docile, and rarely attack, even when provoked. A young girl stepped on one in the campground in 1991; the snake rattled and crawled away.

The population of rattlesnakes at Natural Bridges appears to be an intergrade between two subspecies of *C. viridis* – the midget faded rattlesnake (*C. v. concolor*), and the prairie rattlesnake (*C. v. viridis*). The venom of *C. v. concolor* is more toxic than other species of *C. v. viridis*, and treatment of bites by *C. v. concolor* is different than for other subspecies (J. Glenn, pers. comm.). Work is continuing to determine the implications of hybridization on management of snake bites in the area.

Explanations for the abundance of snakes in the R/VC are numerous. It was suggested that the residence area was built on a den site. The pseudo-riparian habitat and abundance of food in the housing area have created higher prey densities than native pinon-juniper habitat, perhaps attracting the large numbers of snakes. The possibility that the R/VC was built in the path of migration routes between summer and winter snake habitat also exists.

Prior to 1983, rattlesnakes found in the R/VC were trapped and taken 3 km outside the Monument for release. A monitoring program was begun in 1983 to assess snake numbers and movements in the R/VC.



Rattlesnake captured at den site *April 1991. Bright white marks on back are paint marks used to indicate this individual already had been captured at the den in the past few days. The elongated dark blotch near the tail (actually a number of blotches fused together), can be used to identify this individual year after year. (Photo by Tim Graham)*

All snakes encountered there were captured, anesthetized, and marked. Many marking techniques were tried, including sewing colored sequins onto rattles, and painting rattles. The most effective marking technique was found to be a natural one. Snakes have unique blotch patterns on their backs, which allow identification of individuals. From 1984 to 1988, each snake was photocopied (yes, actually stretched out on a xerox machine) to record its blotch patterns. Beginning in 1989, Polaroid photos were taken instead.

In 1988, a radio-tracking study was initiated to document overwintering sites, and movements of *C. viridis* in the R/VC. The accumulated data of snake captures and recaptures since 1983 also were analyzed for patterns of recaptures, numbers of unique individuals, and timing of observations.

Based on capture data from 1983-1988, and the available radio-tracking data, we are beginning to understand the role played by the R/VC in this area's rattlesnake ecology. It was believed the large number of sightings were actually multiple sightings of a few snakes returning year after year. However, data on snake captures and recaptures from 1983 to 1990 do not support this idea. Most snakes are found in the R/VC in only one year; in fact, most individuals are seen only once (Fig. 1). Snakes appear to be moving through the R/VC, perhaps foraging for a few days, then moving on.

We have identified 80 snakes since 1983; 17 were seen only at den sites, 6 were young of a radio-tagged snake, and 9 are known dead (5 road kills, 4 radio-

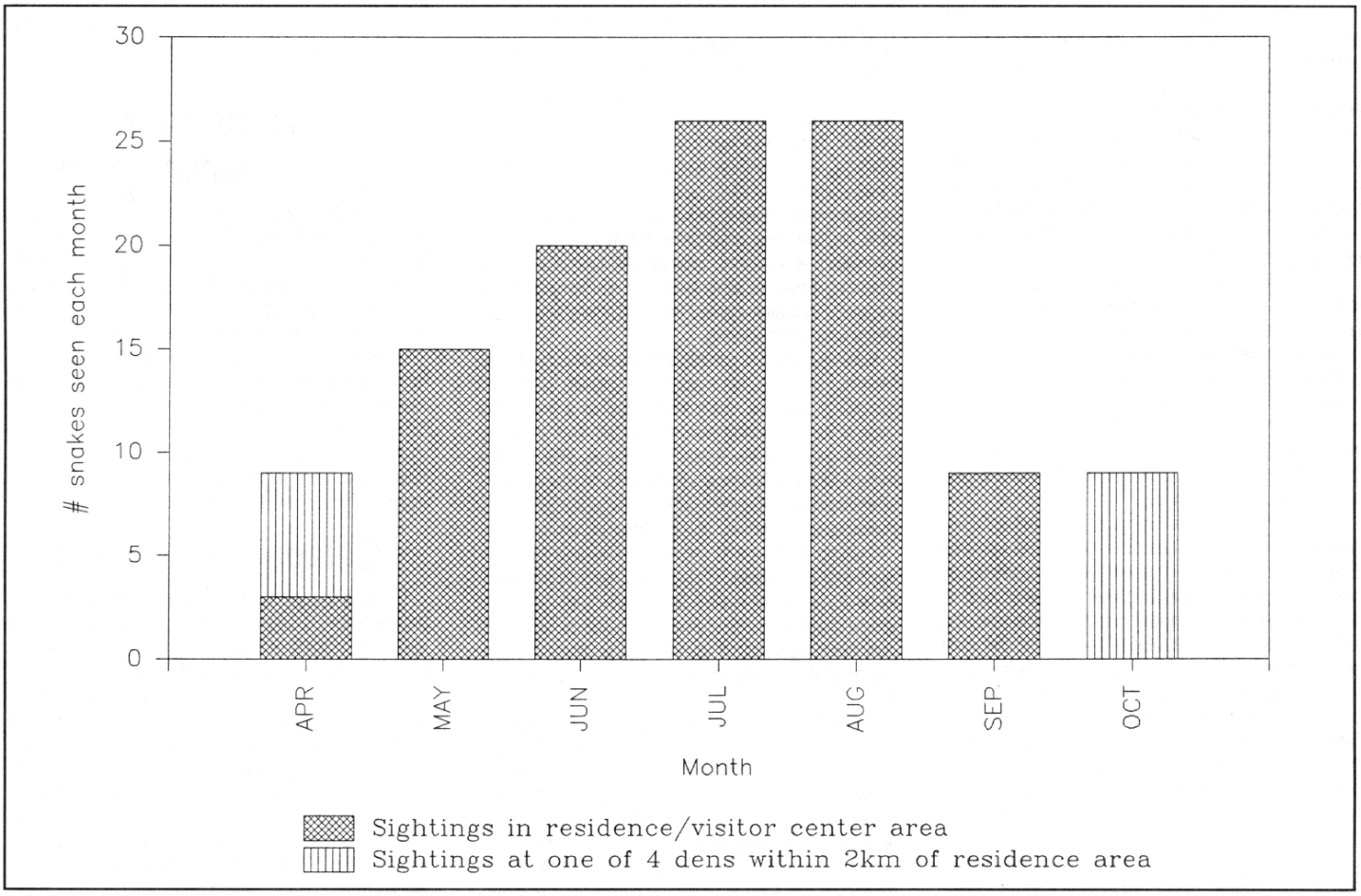


Figure 2. *Numbers of snakes located each month, pooled over the years 1983-1990, in the residence/visitor center area and/or den sites.*

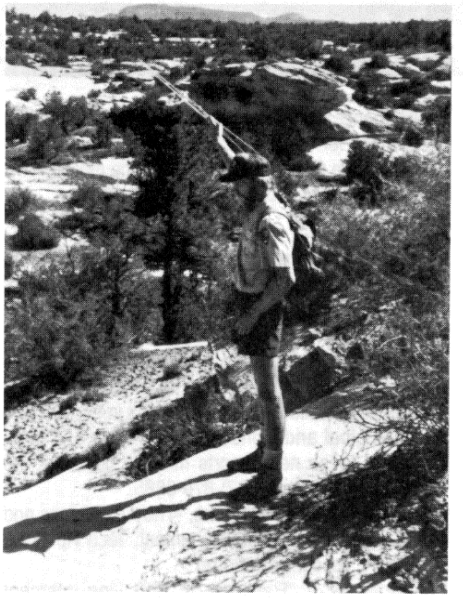
Rattlesnake Ecology

(Continued from page 10)

tagged snakes). Four overwintering sites have been located, and 17 snakes have been marked at den sites in 2 years. One of those snakes (#42) later showed up at the R/VC. In 1991, an additional 65 snakes were identified at two dens.

Small mammals were trapped in the R/VC in 1985 and 1988. Comparable trapping also was done in nearby pinon-juniper habitat. Results indicate that mice populations in the R/VC are much higher than in surrounding native habitat. However, radio-tracking has shown that at least radio-tagged snakes spend little time in the R/VC itself. Most radio-tagged snakes established home ranges outside the R.VC, though within 200-300 m of the developed area. Some movement into and out of the R/VC has occurred, but these movements are infrequent and do not appear to be consistently related to foraging. These data suggest snakes are not attracted to the R/VC because of its high prey densities.

The R/VC was built approximately halfway between two westward draining canyons. Den sites are in the upper reaches of these canyons in rocky ledges and outcrops. There probably are many sites suitable for overwintering along the south and southwest facing canyon walls. Movements of radio-tagged snakes indicate that snakes leave the dens and move onto the uplands between canyons to spend the summer. Frequent snake sightings in the R/VC are thought to be the result of proximity of the R/VC to two areas of quality den sites. Snakes disperse in all directions from both den areas. Snakes heading south from the north dens, and those going north from the south dens, move into/through the R/VC, increasing opportunities for encounters. A few snakes remain near the R/VC all summer, others pass through and don't return except perhaps en route to their dens in autumn. Most snake sightings are in July and August (Fig. 2), which is consistent with snakes dispersing from their dens, eventually reaching the R/VC.



Technician Trevor Persons *tracking rattlesnake with implanted radio transmitter at Natural Bridges National Monument. Snakes are located once or twice each day. Body temperature and a suite of microhabitat characteristics data are collected each time a snake is located. (Photo by Paul Menard)*

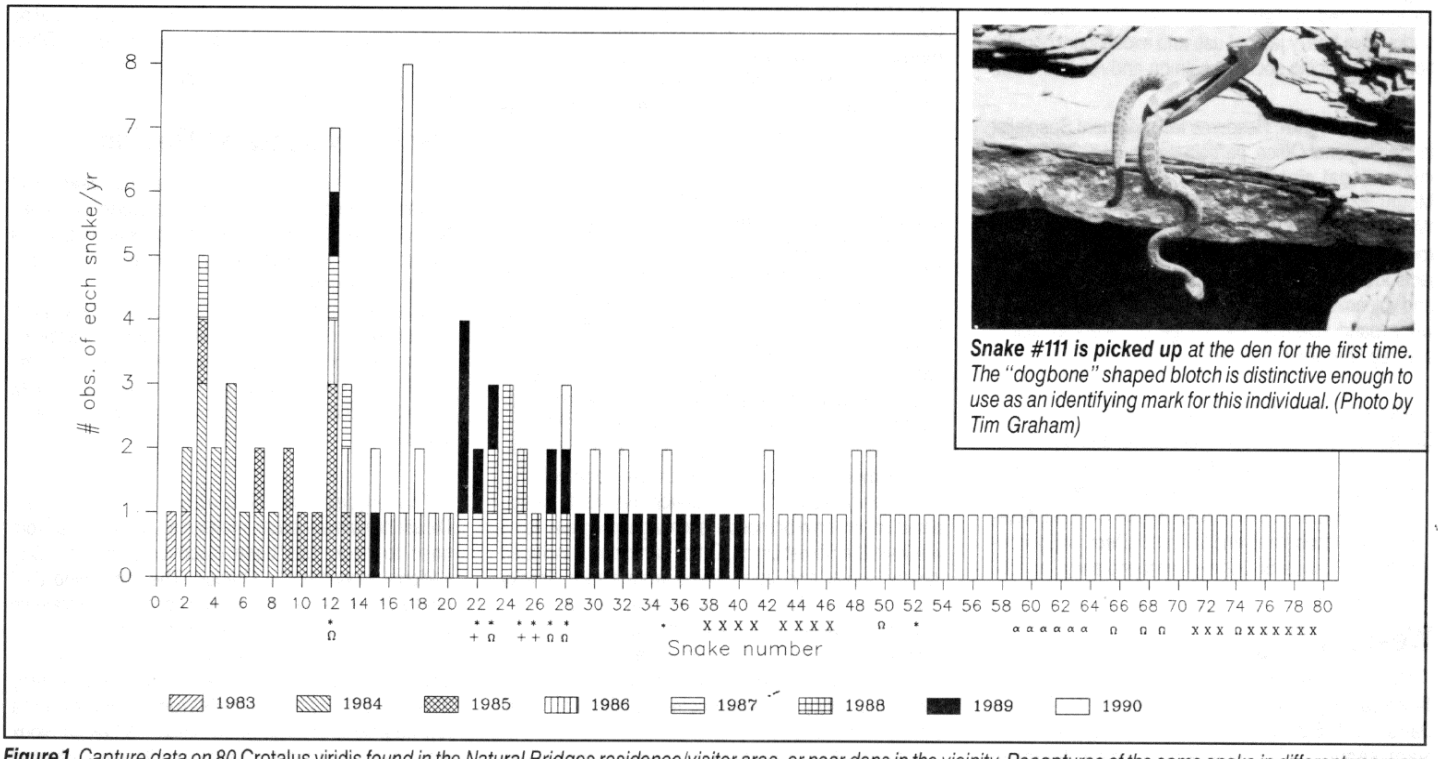
Crotalus viridis probably have been moving through the area now occupied by the R/VC at Natural Bridges for centuries. Changes in the area as a result of building and maintaining a residence area do not appear to have influenced snake movements or home range establishment significantly. There is no reason to expect that changes in the residence area character (e.g. removal of domestic landscaping, elimination of unnaturally high densities of small rodents) would affect the numbers of snake encounters in the R/VC. However, removing these characteristics of the R/VC habitat would provide a good test of the validity of the migration route theory.

Management options for dealing with the snakes are limited because of the nature of the problem. The R/VC could be fenced to exclude snakes. Certain parts of the R/VC have been fenced in the past – the community garden and a children's play area. These areas did remain snakeless most of the time, although occasionally snakes were found in the garden. Trying to exclude snakes from the entire area, while allowing access for vehicles, visitors, and residents, would be expensive, difficult, and most likely ineffective.

Snakes could be relocated if found in the R/VC area in an attempt to reduce interactions with people. This would have deleterious effects on the snake population, as relocated snakes would have difficulty finding their dens in the fall and probably would die for lack of adequate shelter. Given the densities of snakes at dens (over 60 individual snakes were identified at a single den in spring 1991), removing snakes from the R/VC may not solve the problem. Other snakes are likely to expand their home ranges into the R/VC area to occupy vacated home ranges.

Only one person having been bitten during 25 years of human occupation of the area, safety does not seem to be a significant issue at Natural Bridges NM. Given the non-aggressive character of *Crotalus viridis*, vigilance in the R/VC probably will prevent most encounters.

Graham is a Biologist at Canyonlands NP.



Snake #111 is picked up *at the den for the first time. The "dogbone" shaped blotch is distinctive enough to use as an identifying mark for this individual. (Photo by Tim Graham)*

Figure 1. *Capture data on 80* Crotalus viridis *found in the Natural Bridges residence/visitor area, or near dens in the vicinity. Recaptures of the same snake in different years are shown in different patterns, and stacked. Snakes marked with * had radios implanted in 1988, 1989, and/or 1990. Snakes marked with Ω were either found dead (road kills), or died while carrying a radio, those marked with + had radios, but disappeared during the study. Snakes seen only at dens are indicated with X's, the offspring of #12 are marked with α.*

Wildlife and Vegetation Division

A new employee, Sharon Taylor, was welcomed aboard. Trained as a veterinarian, Taylor will be assisting in addressing the brucellosis issue.

* * *

Regional Chief Scientists Dan Huff (RMRO) and Ron Hiebert (MWRO) were in Washington at the Division in July, working on a strategic ecological research plan for national level research. The plan is being coordinated with the Ecological Society of America's plan to meet research needs in ecology.

North Atlantic Region

The Region will sponsor the Second Conference on Science and Resource Management in Northeast NPs Nov. 19-20, 1991 in Newport, RI. Further information can be had from Dr. Charles Roman, Director, NPS/CPSU, Coastal Research Center, U/RI, Narragansett, RI 02882-1197; 401/792-6886.

* * *

The NAR Office of Scientific Studies has been moved. We are not located at 50 Congress St., Suite 6, Boston, MA 02109.

* * *

Charisse Sydoriak, formerly the Fire Management office in the NAR, now is the Regional Resource Management Specialist.

Alaska Region

The Region recently entered into an interagency agreement with the USFWS to conduct a 3-year study on effects of jetboat use on salmon eggs, rainbow trout eggs, and fry survival in stream gravels. Field work will be conducted in Katmai and Lake Clark NPs. Both parks have heavy jetboat use and exceptional populations of spawning sockeye salmon and rainbow trout.

* * *

Paul McLaughlin, Resource Management Specialist in the Regional Office, participated in a USGS-funded international glaciological research expedition to Mount Bona (a 16,500 foot glaciated volcano in Wrangell-Saint Elias NP&P). The team collected snow, rock, and firn-gas samples for multiple research projects involving glacial dynamics, regional climatology, and volcanic geology. Future ice coring work at the site will expand scientific knowledge of paleoclimatoloty and regional volcanic history.

* * *

Recent published reports include:

Davis, J.L., L G. Adams, P. Valkenburg, and D.J. Reed. 1991. Relationships between body weight, early puberty, and reproductive histories in central Alaskan caribou. Fourth North American Caribou Workshop. Newfoundland and Labrador Dept. of Environment and Lands. St. Johns, Newfoundland, Canada. 115-140.

Western Region

Thomas J. Stohlgren is the author of a 220-page Technical Report (No. 43) from the CPSU at U/CA Davis, titled "Size distributions and spatial patterns of giant sequoia (*Sequoiadendron giganteum*) in Sequoia and Kings Canyon National Parks, California." Stohlgren's work stemmed from the lack of detailed information available in the size distributions, response to disturbance, spatial patterns, and role of intra-specific competition for the giant sequoia and aims at better directed future research on the underlying mechanisms causing the patterns observed on the landscape.

* * *

Three technical reports have been completed and two of them are sporting a new cover designed by CPSU/UA Editorial Asst. Gloria Maender. The cover photo was taken Oct. 4, 1935, in Saguaro National Monument, by the first NPS photographer, George Alexander Grant (1891-1964). The photo is from the George Grant collection, which resides in the Western Archeological and Conservation Center archives. Copies of these new reports may be had from the CPSU/UA in Tucson; (602) 670-6885.

1. Lowe, C.H. and P.A. Holm, "The Amphibians and Reptiles at Saguaro Nat'l Monument. Tech Rpt #37. CPSU/UA. Tucson, AZ. 20 pp.
2. Brian, N.J., "Resurvey of 1961 Line Intercept Transects at Tonto Nat'l Monument, AZ." Tech Rpt #38. CPSU/UA. Tucson, AZ. 67 pp.
3. Brown, B., "Land Use Trends Surrounding Organ Pipe Cactus Nat'l Monument (English version). Tech Rpt #39. CPSU/UA. Tucson, AZ. 65 pp.

Southeast Region

Joe Meiman and Marty Ryan have completed one year of water quality monitoring and one year of hydrology research on the north side of Mammoth Cave NP. Twenty-five successful dye traces have consistently demonstrated that north side water flows along the strike rather than the dip of the bedrock. This pattern is the opposite of what hydrologic research has shown on the south side of the river. According to George Gregory, "North side research is already rewriting the textbooks on the hydrogeology of Mammoth Cave." Researchers also have found an amphipod – a tiny shrimp-like animal, in pristine springs on the north side and are examining specimens in order to determine its taxonomic classification.

* * *

From Stephen Nodvin, leader of the NPS/CPSU at U/TN, comes word of the following developments:

1. The EPA has expressed interest in using the Noland Divide Watershed and related monitoring activities at Great Smoky Mountains NP as part of their program for long term monitoring of air pollution and acidic deposition effects. NDW is a candidate for a national network of 3 watersheds that would be used to monitor changes important relative to regulations introduced by the Clean Air Act Amendments of 1990. The proposed network would include sites from the northeast, midwest, and southeast-Southern Appalachians.
2. Ellen Williams, U/TN research assistant, participated in an environmental exchange program for 3 weeks in the Soviet Union. Other participants included Jason Houck and John Peine from Great Smoky Mountains and Dominic Dottavio from SERO.
3. Hope Barrett, an ecology graduate student, has been working with ERDAS software and Great Smoky Mountains GIS data to create models of susceptibility and vulnerability to gypsy moth infestation at Great Smoky Mountains NP.
4. Maria Leary, a Geography graduate student, has been working on completion of her Master's thesis on acid mine drainage at Big South Fork National River and Recreation Area.

* * *

Copies of "Scientific Studies in the Coastal and Estuarine Areas of Everglades National Park: An Annotated Bibliography" are available from South Florida Research Center, Everglades NP, PO Box 279, Homestead, FL 33030.

Midwest Region

The USFWS on July 22, 1991, classified a mussel, the winged mapleleaf freshwater mussel (*Quadrula fragosa*), as endangered. This species is similar in general appearance to the mapleleaf mussel (*Quadrula quadrula*), which is still widespread throughout the central U.S., but there are differences in the shape of the shells. The two species also can be distinguished by their habitat needs; while *Q. fragosa* seems to prefer clean riffle areas, *Q. quadrula* can exploit impoundments and a muddy substrate.

The winged mapleleaf historically occurred throughout the Mississippi, Ohio, Tennessee, and Cumberland River drainages, in at least 12 states. Approximately 99 percent of its habitat has been lost due to impoundments, channelization, pollution, and sedimentation resulting from soil erosion. The single known remaining population occurs along fewer than 5 miles of the St. Croix River within Saint Croix National Scenic Riverway on the Minnesota/Wisconsin border. This population's small size and restricted range makes it vulnerable to extinction from additional habitat degradation. Threats of a more indirect nature could include problems with the species of host fish (so far unknown) that the winged mapleleaf needs to parasitize during its larval stage.

An apparent lack of reproduction in the winged mapleleaf population is a concern. During surveys in 1988 and 1989, no gravid females were located, and no indivuals younger than 4 years could be found. Other mussel species in the same area did not show such reproductive failures.

Pacific Northwest Region

Jon Jarvis, who for the past 5 years has been Chief of Natural Resource Management at North Cascades National Park Complex in the state of Washington, has moved to the superintendency of Craters of the Moon National Monument in Idaho.

Another change at North Cascades is the acquisition of Reed Glesne as aquatic ecologist, replacing Bob Wasem who retired last year after 22 years with the Service. Glesne, who joined the park staff in July, came from the USFWS, where he had worked for 15 years.

* * *

The biggest skull known of *Rhinocerotidae Diceratherium armatum*, measuring almost 2 feet from nose to neck, has been discovered at John Day National Monument in Oregon. The rhino, who died nearly 25 million years ago, was covered by water-lain volcanic tuffs spewed from vents in Central Oregon or the early Cascades. He shared his tomb in the Oligocene tuffs of the Fossil Beds with oreodonts, early horses, giant pigs (Entelodonts), rodents, turtles, and a few fragments of Ekgmowechshala – a Lakota Sioux word meaning "cat that looks like a little man" – the last primate known in North America.

Ted Fremd, the monument's paleontologist, describes the finding of fossils like this as "part dili-

gence, part luck." The discovery of the rhino came on a fall day in 1989, when Ellen Stepleton – a graduate student working on other projects with Fremd, wasn on a cross country hike. The skull was so firmly embedded in surrounding rock that it was decided to let time help remove it. Preservatives and plaster were applied at once and again in 1990, and now the twice-postponed exhumation is about to occur.

Fremd says he hopes to learn an enormous amount from this skull – the largest ever found and complete, from nose to neck, including the rare "postcranial" area.

* * *

Boone Kauffman, fire ecologist with the Oregon State University Department of Rangeland Resources, is currently in Brazil on a fire ecology consultant mission, hence unable to fulfill his commitment to write a piece for ***Park Science*** on the role of fire in restoring natural ecosystems (promised on page 7 of ***Park Science***, summer 1991). He suggests instead a "Notes From Abroad" later on, describing his work in northeastern Brazil with tropical dry forests and the effects of fire on nutrients in the soil, forest, and atmosphere.

"It's the hottest, most miserable work anybody could possibly do," Kauffman told Carol Savonen for a story in OSU's ***Agricultural Progress*** (Winter 1990). "The temperatures in clearcuts get up to 112 to 115 degrees. And the insects are unbearable. You are constantly climbing through slash or areas that literally look like moonscapes – nothing but gray ash and charred trunks." Look for more on this in coming issues.

* * *

Entomologists at Oregon State University have identified an insect allatostatin – a neuropeptide that insects use to turn off their synthesis of juvenile hormone – critical to the growth and reproductive ability of an insect. This type of natural, non-toxic pesticide could be highly effective, specific only to harmful insects, and valuable in the ongoing struggle against pesticide resistance according to OSU Entomologist Grahame Pratt.

The work is a major advance toward development of a totally new type of insecticide. The neuropeptide is too easily degraded to work in a natural environment, Pratt said, but the findings may allow researchers to develop a more stable compound that mimics the biological action of the peptide.

If juvenile hormone is produced in too-low levels, the insect changes from a larva to an adult prematurely, reducing the time spent in its most destructive, plant-eating stage. It also becomes a sterile adult, causing insect populations to crash rapidly.

Rocky Mountain Region

Glen Canyon has issued permits for a research project on razorback sucker (*Xyrauchen texanus*) in Lake Powell and the Colorado River inflow area, and is considering a second proposal for similar work on the San Juan River and adjacent lake waters. The second project would concentrate on Colorado Squawfish (*Ptychocheilus lucius*), which have been found in the vicinity. The razorback is expected to be Federally listed as endangered in the near future and is considered one of the rarest Colorado river native fish. The squawfish already is listed as endangered.

The razorback study, led by the USFWS and Bureau of Reclamation, is a propagation and genetics investigation where fish are being collected for captive rearing and propagation under controlled conditions. The genetic makeup of the fish will be documented for comparison with closely related species. Park resource management staff participated in the study in April, assisting Utah biologists in collecting 2 adult razorbacks from upper Lake Powell. Both fish were healthy – in the 2 kg, 60 cm size range; one was a male in spawning condition, indicating some reproductive activities, even though recruitment has not been documented in the region in many years. Upon completion of the study, the original fish or an equal number of progeny will be returned to the areas where the collections were made.

The squawfish work would involve collection, measurement, tagging, and radio-monitoring by Bureau of Reclamation biologists in summer and fall of 1991. Both studies are part of interagency recovery efforts in the upper Colorado River basin. Glen Canyon has submitted a proposal to the Recovery Program for population and habitat research on both species.

* * *

Several research projects were undertaken at Bryce Canyon this summer. Dr. Karl McKnight of St. Lawrence University began work on forest succession dynamics, building on an existing database developed over the past 30 years. U/SD botanist Dr. Frederick Peabody began a 3-year study of rare plant distribution and abundance and will develop a long term monitoring program for the park. Fire history research in the mixed conifer/aspen community type was conducted by Dr. Michael Jenkins of Utah State U, and Dr. John Hoogland of U/MD started a long term study of the ecology of threatened Utah prairie dogs.

* * *

Badlands NP has implemented a research effort on prairie dogs related to the anticipated reintroduction of the black-footed ferret. Gillian Bowser, NPS employee currently enrolled in a Ph.D. program at U/MO-St. Louis, will use portions of the study for her dissertation.

Mid-Atlantic Region

Supt. Bill Wade and Resource Manager Dave Haskell of Shenandoah NP travelled to the Soviet Union as part of a Park Service/Soviet Union Exchange program. A group of Soviet park managers visited Shenandoah NP, Prince William Forest Park, and various NCR units in early August.

* * *

The Appalachian Mountain Club (AMC) and Regional Scientist Jeff Marion are nearing completion on "A Comprehensive Trail Inventory and Development Plan for Delaware Water Gap NRA." The project involved rapid trail surveys of all existing trails and woods roads in the park (for input into the park's GIS) and detailed prescriptive work logs of trail segments proposed for the new trail system.

Innovative procedures for developing the prescriptive work logs were perfected as part of the study. Pushing a trail measuring wheel, an experienced AMC worker dictated information regarding trail conditions, maintenance work needs, and suggested reroutes into a portable tape recorder. This information was transcribed to produce standardized trail work logs and summary tables that can be used to direct trail maintenance and estimate costs and personnel needs.

For copies of the report or information regarding the prescriptive work logs, contact Jeff Marion, NPS/CPSU, Virginia Tech Dept. of Forestry, Blacksburg, VA 24061-0324.

* * *

Virginia Tech research foresters are conducting a vegetation inventory for 10 units of Richmond National Battlefield Park. Current vegetation types do not always reflect the conditions existing at the time of the civil war battles the park commemorates and seeks to portray for park visitors. Therefore, park managers want to restore and maintain historic vegetation patterns in selected areas. Historical research into regimental histories, personal letters, and photographs have revealed remarkably descriptive vegetative references from which historic vegetative maps are produced. Comparison with current vegetative conditions will allow the research foresters to recommend appropriate silvicultural strategies and actions for restoring and maintaining the historic vegetation types.

* * *

John Karish announces availability of the following reports:

NPS/MAR/NRTR-91/049 - Identification, Restoration, and Maintenance of Historic Woodlots at Gettysburg National Military Park.

NPS/MAR/NRTR-91/050 - Floral Inventory and Vegetative Cover Type Mapping of Gettysburg National Military Park and Eisenhower National Historic Site.

NPS/MAR/NRTR-91/051 - Species of Special Concern, Exemplary Natural Communities and Wetlands within the Steamtown National Historic Site and Excursion Railroad.

Park Science Index Readied

In the next (Winter 1992) issue of ***Park Science***, an index of all four numbers for Vol. 11 will be published, listed by author, subject, and park. This same information is now available for all 10 of the previous volumes of ***Park Science*** and can be accommodated on any floppy disk. From now on, No. 1 of each new ***Park Science*** volume will contain an index of the previous four issues. Those wishing to have the index for the entire 10 previous years may have it by sending a floppy disk to Nancy Hori, Pacific Northwest Region Librarian, National Park Service, 83 S. King St., Seattle, WA 98104. Thank you, Nancy!

NPS Visitor Report Published

A handsome, 30-page, slick paper report, illustrated with graphs and photos and titled *A Diversity of Visitors* has been published at the University of Idaho as an NPS Visitor Services project. Written by Margaret Littlejohn, an NPS employee duty-stationed at the U/ID NPS/CPSU, the booklet describes Visitor Services Project accomplishments over the last eight years and some insights about park visitors. The report makes delightful use of handwritten visitor comments, reproducing them as part of the illustrations.

Dr. Gary E. Machlis is Sociology Project leader and director of the Visitor Services Project team.

"Your Pond or Mine?" is the light-hearted title of a piece by Carol Ezzell in ***Science News*** (Vol. 140, p. 12), describing the mating habits of *Hyla chrysoscelis*, the gray tree frog, as they are detailed in a much-praised study by two Duke University population ecologists. The new research shows that males and females of this nonterritorial species have somewhat different criteria for what constitutes the ultimate love puddle, according to Ezzell.

William J. Resetarits Jr. and Henry M. Wilbur, the researchers, explained: "We're really interested not only in the behavior of individual species, but what effect their behavior may have on the community."

The research, published in the June ***Ecology***, reports on the results of 52 "long, sweaty summer nights" in the woods of North Carolina, monitoring the frogs' mating quirks at 45 "pseudo-ponds" (blue plastic wading pools painstakingly equipped to represent known types of breeding pools and laced with a wide variety of the varying life forms that make up different pond communities). Males proved interested only in finding mates; females were far more eager to finding the right pond conditions ... a fact that makes it appear the sexes are often "out of synch."

David McCauley, an ecologist at Vanderbilt University, commented: "I was quite surprised. The males were rarely at the right place at the right time, regardless of what was in the pond."

⁂

Researchers at Oregon State University have again documented a massive die-off of toad eggs at a lake in the central Oregon Cascades. Together with unexplained amphibian declines and extinctions worldwide, this event has speeded efforts to understand the phenomenon. One possibility is rising levels of ultraviolet radiation. The National Science Foundation recently approved a three-year, $272,000 grant to OSU scientists to explore the amphibian declines. Zoologists Andrew Blaustein and Frank Moore and agricultural chemist John Hays are the principal investigators.

⁂

T. Destry Jarvis, publisher, and Joan Moody, editor of the newly organized ***Earth Work***, published monthly by the Student Conservation Assn., promise in their August 1991 editorial that the September issue will "examine whether the conservation field is prepared for the year 2000, when two-thirds of the entering workforce will be women and minorities."

⁂

Susan Power Bratton, research ecologist and head of the NPS/CPSU at U/GA, is leaving the NPS for an academic career in Pennsylvania. She is represented in the Summer 1991 issue of ***Orion*** with an article titled "Sleeping with Lions: The Wild and the Holy," in which she examines the evidence for early Christian monks living with or befriending the wild. *Orion* is the quarterly publication of The Myrin Institute of 136 East 64th St., New York, NY 10021, in association with Conservation International.

⁂

The Fire Research Institute, PO Box 241, Roslyn, WA 98941-0241, announces three publications:

International Journal of Wildland Fire, devoted solely to issues in wildland fire, is now accepting manuscripts dealing with wildland fire science, management, or technology. Chief Editor, Canadian ecologist Ross Wein and his international editorial board ask that manuscripts be submitted to the Roslyn address.

The International Directory of Wildland Fire is a complete listing of managers, academics, organizations, vendors and consultants, education institutions, libraries, granting agencies, journals and newsletters involved in research, management, or publishing concerning wildland fire. The directory is updated annually, and is available in paperback and also on disk.

The International Bibliography of Wildland Fire contains more than 40,000 references to publications concerning all areas of wildland fire – science, management, and technology. Updated annually and available in both print and disk. For information, write the Institute in Roslyn.

⁂

Kathy Dimont, editor the annual report of the Glacier NP and U/MT Cooperative Park Studies Unit, announces availability of ***Science in Glacier NP 1990***. Asst. Supt. Richard Peterson discusses "Research as a Management Tool;" Chief Scientist Clifford Martinka steps (figuratively) into the year 2072 and reports on "Our National Parks – A View from the Future;" and Dennis Murphy and Stuart Weiss take a look at Glacier's peculiar advantages for monitoring climatic effects on an ecosystem that is largely wilderness. The rest of the 58-page document covers visitor services, ecosystem studies, vegetation, wildlife, aquatics, and geology.

⁂

Lawrence Baker, Alan Herlihy, Philip Kaufmann, and Joseph Eilers furnish a scholarly review in the May 24 ***Science*** (Vol. 252:1151-1154) of the National Surface Water Survey conducted by the EPA in acid-sensitive areas of the U.S. This statistically designed survey of lakes and streams found that atmospheric deposition was the dominant source of acid anions in 75 percent of the acidic lakes and 47 percent of acidic streams. Organic anions were dominant in one-fourth of the acidic lakes and streams; acidic mine drainage was the dominant acid source in 26 percent of the acidic streams. Other causes were relatively unimportant on a regional scale. Nearly all the deposition-dominated acidic systems were found in six well-delineated subpopulations that represent about one-fourth of the NSWS lake population and one-third of the NSWS stream population.

⁂

An interdisciplinary group of climatologists, oceanographers, meteorologists, marine biologists, ecologists and other reef experts have found greenhouse warming unlikely to be the culprit in the coral reef bleaching currently attracting worldwide attention. At their National Science Foundation-funded June meeting in Miami, the experts found that "something is clearly amiss on the world's reefs," according to Leslie Roberts in the July 19, 1991 issue of ***Science***. But the group concluded dthat the biggest threat to reef health worldwide is "the cumulative effect of local perturbations" from population growth, land use, and resource exploitation. Christopher D'Elia, director of the U/MD Sea Grant College, said: "We are quick to worry about climate change but not so quick to worry about local effects."

The group recommended to the meeting's sponsoring agencies – NSF, NOAA, and the EPA – an international program of intensive, long-term monitoring throughout the world to collect data on all the physical and biological factors that affect reef health.

⁂

Readers interested in endangered species in general and those that occur in national parks in particular may want to look up the March 8, 1991 issue of ***Science*** for articles by Chuck Fergus ("The Florida Panther Verges on Extinction") and by Stephen O'Brien and Ernst Mayr ("Bureaucratic Mischief: Recognizing Endangered Species and Subspecies"), and the July 19 issue for provocative letters commenting on these articles and answers by the authors.

The implications for those trying to protect and perpetuate threatened or endangered species, and for those who must decide what shall be protected, would appear to be confused, complex, and profound. What are the operational definitions of "species," "subspecies," and "populations" as they relate to protection afforded by the Endangered Species Act of 1973? In the case of the Florida panther, does the discovery that two very distinct genetic stocks are represented in the surviving animals mean that they are now unprotected, due to the Interior Department's "Hybrid Policy"? And how might the unresolved dilemma be exploited by development interests targeting panther habitat?

The gray wolf (*Canis lupus*) and the red wolf (*Canis rufus*) are similar cases in point. Is the red wolf today a hybrid between gray wolf subspecies and coyotes, and thus imperiled by strict enforcement of the Hybrid Policy? Already that policy has prompted a formal petition from the Farm Bureaus of Wyoming, Montana, and Idaho to remove the gray wolf from the Endangered and Threatened List. Similar logic has been used to prevent reintroduction of gray wolves into Yellowstone NP.

In the July 19 Letters column, some high-powered experts from various backgrounds go at the problems being raised – whether species should be defined on the basis of process or pattern, whether molecular data always provide final answers, how increasing knowledge of the natural occurrence of hybridization should affect management policy –. Although none of the questions raised are laid to rest, and only more questions are suggested, a reading of these two issues will deepen (and darken) the maze out of which operational decisions will emerge.

⁂

Jill Baron and Sarah Spaulding of the NPS Water Resources Lab in Fort Collins, C), are co-authors with Diane McKnight, Richard Smith and J. Platt Bradbury of the USGS of an article titled "Phytoplankton Dynamics in Three Rocky Mountain Lakes, Colorado, U.S.A." that appeared in ***Arctic and Alpine Research***, Vol. 22, No. 3, 1990, 264-274. Three periods were evident: a spring bloom during snowmelt of the planktonic diatom *Asterionella formosa*, a midsummer period of minimal algal abundance, and a fall bloom of the blue-green alga *Oscillatoria limnetica*. Rapid growth of *A. formosa* during spring was followed by decline after snowmelt and may be related to grazing by developing zooplankton populations.

⁂

In a 10-author article titled "Effects of Climatic Warming on Lakes of the Central Boreal Forest" in the Nov.

16, 1990 issue of ***Science***, 20 years of climatic, hydrologic, and ecological records for the Experimental Lakes Area of northwestern Ontario are used to show that air and lake temperatures have increased by 2 degrees C and the length of the ice-free season has increased by 3 weeks. Also, higher than normal evaporation and lower than average precipitation have decreased rates of water renewal in lakes. Concentrations of most chemicals have incrased in both lakes and streams due to decreased water renewal and forest fires in the catchments. Thermoclines deepened and summer habitats for cold stenothermic organisms like lake trout and opposum shrimp decreased. Said the authors:

"Our observations may provide a preview of the effects of increased greenhouse warming on boreal lakes." Lead author is D.W. Schindler.

A January 1991 ***BioScience*** article, "Shrimp Stocking, Salmon Collapse, and Eagle Displacement," by Craig Spencer, B. Riley McClelland, and Jack Stanford, describes the altered interactions in the food web of a large aquatic ecosystem (the Flathead River-Lake) caused by introduction of the opossum shrimp (*Mysis relicta*). Owing to predation by the shrimp, the authors say, "copepod and cladoceran zooplankton populations declined dramatically, contributing to the collapse of an important planktivorous fish population. Loss of this formerly abundant forage fish caused displacement of birds and mammals that had fed on them in an upstream tributary within Glacier NP."

The cascading negative effects from such introductions include, in this case, "the diminished number of human visitors to Glacier NP in autumn" due to the collapse of the kokanee spawning run, which once brought 100 eagles at a time to the visitor viewing area. Viewing area human visitors, who numbered 46,500 in 1983, were fewer than 1000 in 1989.

GWS 1992 Conference Theme: "Partners In Stewardship"

The George Wright Society (GWS)'s 1992 Conference on Research and Resource Management in Natural and Cultural Parks and Reserves is slated to be held in November in Jacksonville, FL, around the theme of "Partners in Stewardship." Co-chairpersons are John Donahue for the natural resource program and Harry Butowsky for the cultural side of the program.

Goals for the 1992 conference include increased participation by cultural resource experts, by other federal, state, provincial, and local agencies, and by non-governmental organizations. The planning committee and board members are soliciting opinions and suggestions and will welcome all input. Donahue can be reached at FTS 268-4274 and (202) 268-4274 Butowsky at FTS 343-8155 or (202) 343-8155. They may also be reached at USDI, NPS MIB, PO Box 37127, Washington, DC 20013.

GIS Users Conference At Denver in November

The Second National Park Service GIS Users Conference will bring together for the first time in more than three years all NPS users of geographic data technology to discuss their respective interests, achievements, applications and concerns.

On Nov. 18-22, 1991, this official NPS training opportunity will offer up to 12 workshops (depending on sign-ups), at a cost of 0 to $50, depending on the workshop. Potential workshops will cover hardware, software, Global Positioning System, image processing, photointerpretation and data transfer, map preparation for digitizing, text database, position descriptions and classification, electric power, networking, data documentation and quality control/quality assurance, and data distribution and the Freedom of Information Act.

Conference location is the Sheraton Hotel at Lakewood, CO; Leslie Manfull of the GIS Division is conference coordinator, (303) 969-2590; FTS 327-2590.

Director's Achievement Awards Go to Van Riper, Taylor, Rambur

Charles van Riper III, Dan Taylor, and Richard Rambur were named in August as the 1991 winners of the NPS Director's Annual Achievement awards for research, natural resource management and superintendency, respectively.

Van Riper, currently leader of the newly established CPSU at Northern Arizona University (see p. 6), was cited for being "instrumental in breaking down state and regional barriers by promoting the first ecosystem-based CPSU. His high caliber research encompasses ornithology, conservation biology, and wildlife management," for having more than 50 peer reviewed publications, and for assisting in important resource management projects such as removal of feral pigs to reduce disease impacts on native Hawaiian birds and improved traffic contol techniques to protect endangered Great Grey Owls in Yosemite NP. He also was commended for "ability to synthesize research results into easily understood procedures that NPS management personnel can put to practical use."

Taylor, Chief of Resource Management at Hawaii Volcanoes NP, has been a leader in his park and in the region in addressing "an impressive array of resource problems, including management of feral pigs and goats, exotic plant control, protection of lava tube caves, and monitoring of aircraft overflights." His innovative approaches to problems have served as a model for other parks throughout the Service. The Western Region recognized him for his abilities in working with industry and agency representatives to solve problem threats and for "his optimism in the face of tremendous natural resource problems in Hawaii."

The first ever NPS Director's award for Natural Resource Stewardship by a Superintendent followed on the heels of such an award last year by the NPS Western Region. This year's recipient, Rambur, is in charge of Antietam National Battlefield, where he "completely redefined" the park's resource management objectives and began their aggressive implementation. He laid the groundwork for restoration of the woodlands and the historic agricultural scene, to preserve landscape and increase wildlife habitat. He is using a GIS to address external issues and to aid historic scene restoration, and has taken steps to modify or curtail in-park activities adversely affecting natural resources.

meetings of interest

1991

Nov. 3-8, THIRD GLOBAL CONGRESS OF HERITAGE INTERPRETATION INTERNATIONAL - JOINING HANDS FOR QUALITY TOURISM, in Honolulu. For registration and travel/housing information: Ray Tabata, UH Sea Grant, 1000 Pope Rd,., MSB 226, Honolulu, HI 96822 USA; (808) 956-2866; FAX (808) 956-2825.

Nov. 4-7, MEETING THE BIODIVERSITY CHALLENGE a short course for decision-makers, sponsored by BLM, USFWS, USFS, and NPS, at Phoenix Training Center, AZ. Contact: John Dennis, (202) 243-8128.

Nov. 16, NEZ PERCE ART EXHIBITION opens at the Nez Perce National Historical Park, Spalding, ID. To run through Jan. 12, 1991. Contact: Nez Perce NHP, PO Box 93, Spalding, ID 83511; (208) 843-2261.

Nov. 19-20, SECOND CONFERENCE ON SCIENCE AND RESOURCE MANAGEMENT IN NORTHEAST NATIONAL PARKS, in Newport, RI. Contact: Dr. Charles Roman, NPS/CPSU, Coastal Research Center, U/RI, Narragansett, RI 02882-1197; (401) 792-6886.

1992

Jan. 21-23, FIRE IN PACIFIC NORTHWEST ECOSYSTEMS: EXPLORING EMERGING ISSUES, at Red Lion Hotel, Portland, OR, featuring 40 regional and national experts on various aspects of wildfire presenting state-of-the-art information on historical and ecological aspects of fire and its use to achieve management objectives. Contact Conference Assistant, College of Forestry, Oregon State U, Corvallis, OR 97331; (503) 737-2329.

Feb. 10-21, FOURTH WORLD PARKS CONGRESS, in Caracas, Venezuela; a technical, invitational, working meeting of leading world authorities on protected area management, sponsored by the IUCN and co-sponsored by UN agencies, governments, and national agencies including the NPS.

Feb. 19-22, SOCIAL ASPECTS AND RECREATION RESEARCH SYMPOSIUM, Theme: "Social Aspects of the Wildland/Urban Interface," at the Clarion Hotel, Ontario, CA. Contact: Debbie Chavez, USDA Forest Service, 4955 Canyon Crest Dr., Riverside, CA 92507.

May 17-20, FOURTH NORTH AMERICAN SYMPOSIUM ON SOCIETY AND RESOURCE MANAGEMENT, in Madison, WI. Contact: Donald R. Field, 1450 Linden Dr., Madison, WI 53706.

National Park Biotic Inventories Assessed

By Thomas Stohlgren, Michael Ruggiero, James Quinn and Gary Waggoner

As part of the National Park Service's Inventory and Monitoring (I&M) Program, we are reporting results from a recently completed survey of biotic inventories in Western Region parks and preliminary results from a similar nation-wide survey of 240 national park units (175 reporting in so far).

In the completed Western Region Survey, Stohlgren and Quinn (CPSU Technical Report No.44, UC Davis, 1991) evaluated existing natural resource data from 40 national parks and monuments in Arizona, California, Hawaii, Nevada, and several Pacific Trust Territories. The primary objectives of this survey and the nation-wide survey were to: (1) provide a qualitative assessment (categorical summary) of the status of species lists for various biological groups (vascular plants, mammals, birds, reptiles, amphibians, terrestrial and aquatic invertebrates, and non-vascular plants); (2) inventory mapped information on vegetation, soils, geology and other natural resources; and (3) inventory photographic series, aerial and satellite imagery, and digitally processed information.

Methods

Western Region Survey

Species occurrence records were broken up by taxonomic group. Each group was scored by the park experts for completeness on a scale of 1 to 7 in each of three categories – geographical completeness, ecological completeness, and taxonomic completeness (Biological Inventory Status (BIS) scores; Table 1).

Geographic completeness refers to the percentage of the entire park included by previous inventories. Ecological completeness refers to the percentage of the total number ecological communities previously sampled. Taxonomic completeness refers to the probable percentage of extant species currently listed. These were summed to give an overall idea of completeness ranging from 3 (extensive knowledge) to 18 to 19 (essentially nothing known).

Also, the number of new (or recently discovered) species over the past 10 years was recorded. Information on maps (thematic and cartographic) and imagery (aerial photographs and digital satellite images) was catalogued (additional details on methods are given in Stohlgren and Quinn 1990).

Nation-wide Survey

In the nation-wide survey, the same data were recorded for the major biological groups, although most regions did not address invertebrates or non-vascular plants. The amount of time spent in the national park unit varied.

For the nation-wide and Western Region surveys, the data were self reported by park staffs and reflect the state of their knowledge. Results have not yet been verified. Thus, data that exist but were unknown to the park staff are not reported. We have discovered several cases of important park inventory records (e.g., geologic maps, published species lists) whose existence was not known to the current resource specialist in the park.In some cases, this may lead to an underestimate of the quality of inventory information. On the other hand, it is also is likely that "completeness" in many cases was substantially overestimated (see Stohlgren and Quinn 1990).

Table 1. *Biological Inventory Status Codes*

Individual Scores for Taxonomic, Geographic, and Ecological Completeness:

1 = Inventory probably >95% complete
2 = Inventory 80% to 95% complete.
3 = Inventory 50% to 80% complete.
4 = Inventory <50% complete.
5 = Inventory contains good information about a few taxa, in a local area or in a few communities.
6 = Inventory poor to nonexistent.
7 = Taxonomic completeness unknown.

Composite Score (Taxonomic + Geographic + Ecological Completeness):

3 = Inventory probably >95% complete.
4-6 = Inventory 80% to 95% complete.
7-9 = Inventory 50% to 80% complete.
10-13 = Inventory <50% complete.
14-17 = Inventory contains good information about a few taxa, in a local area or in a few communities.
18-19 = Inventory poor to nonexistent or unknown.

Table 2. *Preliminary results from Biological Inventory Status from the nationwide survey. A mean composite score >6 of taxonomic, geographical, and ecological completeness suggested species lists were <80% complete.*

Biological Group	No. Parks Reporting	No. Parks With Lists <80% Complete	% Parks With Lists <80% Complete
Vascular Plants	175	113	64.6%
Mammals	172	140	81.4%
Birds	172	121	70.3%
Fishes	153	123	80.9%
Reptiles	173	147	85.0%
Amphibians	168	142	84.5%

Results and Discussion

Western Region Survey

Fewer than 10 parks in Western Region reported that their species inventories were "probably complete" (i.e., thought to be at least 95% complete) taxonomically, geographically and ecologically (composite score of 3; Fig. 1). The vast majority (>73%) of the lists are thought to be less than 80% complete in their taxonomic, geographic and ecological (community type) coverage. Most Western Region parks knew more about vascular plants and birds than about other groups, but many parks had high composite scores for even the best known groups (Fig. 1). About half the parks reported essentially no research on invertebrates or non-vascular plants: major components of biological diversity. Very few parks have attempted systematic surveys (studies by specialists on the group in question according to a sample protocol from which relative completeness can be judged) for any of the biological groups.

Staffs of large parks tend to know more about their natural resources than those of smaller parks that historically have received less funding for research and resource management activities, although an extensive I&M program in small parks may produce much of the total biological diversity of the park system.

In the past 10 years, 1439 vascular plant species, 111 bird species and 15 mammalian species have been added to parks' species lists. 859 new species terrestrial invertebrate were added to seven park species lists. These data illustrate the incompleteness of current species lists.

While 85%, 52.5% and 65% of the 40 parks surveyed had maps of vegetation, soils and geology, respectively, none of these maps have been checked systematically for accuracy. There has been little standardization of classification schemes among parks.

Nation-wide Survey: Preliminary Results

Preliminary results from 175 park units from 8 regions (including Western Region) show striking similarities to the Western Region survey results (Table 2). Again, the vast majority (>77%) of the lists are thought to be less than 80% complete in their taxonomic, geographic and ecological coverage.Likewise, information on vascular plants and birds is generally better than that for the other biological groups.

In the Western Region and nation-wide surveys, the actual status of information is difficult to assess due to a lack of catalogued and readily accessible information on past studies of resources, essentially no standardization in recording procedures, missing or poorly maintained voucher specimens, and disproportionate attention to "popular" taxa.

Stohlgren and Quinn (1991) suggest minimum inventory needs for most biological groups in most parks include: (1) systematic, standardized surveys in each park; (2) increased collection and improved curating of voucher specimens (e.g., using the Automated National Catalog System); (3) expert checking of problematic specimens for proper identification; (4) in-park personal computer-based, standardized and compatible software for easy data entry, editing, and reporting and for ease of use and for interagency exchange of information; (5) a central "clearing house" for handling taxonomic synonyms, duplicate voucher specimens and data exchange; and (6) development of standard-

Biotic Inventories *(Cont'd)*

ized field techniques to assess the "completeness" of species lists.

We are continuing to create FLORA and FAUNA databases that contain species listings and associated data for each park based on documented occurrences of plant and animal species in parks. We have completed these listings for more than 60 parks and expect to complete all of the parks this year. Two other related data bases are being created.

We now are working to complete the Phase I survey of BIS data for the 240 parks with significant natural resources. We are beginning to develop alternative strategies for a long-term, service-wide I&M Program (NPS-75; Stohlgren and Quinn 1991). We will identify those servicewide biotic resources which are least well known, based on the Phase I I&M results. We will suggest "minimum standards" for natural resource inventories in national parks areas. A conceptual framework for evaluating the accuracy and completeness of available species lists will be developed. We will begin to review the available literature on appropriate theoretical, conceptual and mathematical models to evaluate completeness. We also will evaluate new developments in sampling design strategies for inventory and monitoring biotic resources.

By October 1992, we plan to produce the following: (1) a system-wide assessment of the completeness of biological inventories of vascular flora and vertebrate fauna, (2) an inventory of "candidate" flora and fauna of the National Park System in both printed and data base format, specific for individual parks and aggregated for regional and national levels, (3) a "user-friendly", PC-based computer program and associated data base for each park that can be consolidated at the regional and national levels, (4) a system-wide analysis of the biological similarity among parks based upon flora and fauna information, and (5) a strategy for acquiring and managing new flora and fauna data as we proceed toward our goal in the year 2000.

Stohlgren is a Research Scientist with the NPS/CPSU at U/CA/Davis; Ruggiero is Chief of the NPS Wildlife and Vegetation Division in Washington, DC; Quinn is with the U/CA/Davis Divison of Environmental Studies; Waggoner is with the NPS/GIS Division at the Denver Service Center.

Haleakala Rabbits Declared Eradicated (For Now)

As of May 1991, the rabbit outbreak at Haleakala NP (see ***Park Science*** 11(1):21) is believed to be under control. A total of 97 rabbits were removed between August 1990 and March 1991, primarily by snaring. The population is believed to have originated in October 1989 with the release of six pet rabbits. It was discovered in July 1990, at which time it occupied 60 acres. I would state the lessons learned from this experience as follows:

1. There is an abundance of pet rabbits on the island of Maui. Many pet owners are irresponsible (and break the law), based on the dozens of reported instances of loose rabbits during the past year. Much potential exists for recurring outbreaks of rabbits on Maui unless preventive steps are taken.

2. Rabbits usually occupy small home ranges and are very likely to escape detection in the early stages of population buildup.

3. Haleakala NP has apparently succeeded in eradicating this rabbit infestation. Factors contributing to this success included: (a) an unambiguous mandate from the park superintendent, a strong commitment by many individuals, and exceptional cooperation among park personnel to prevent permanent establishment of rabbits; (b) availability of personnel experienced in snaring and other feral animal control and monitoring techniques; (c) a group of domestic rabbits that were, at least initially, more naive and vulnerable to a control program than their wild counterparts (evidenced by lack of diurnal tendencies and significant burrowing); (d) the flexibility of the park to act promptly with considerable attention to detail (high density of snaring network, rigorous monitoring, careful media relations) and to expedite environmental impact assessments.

4. Snaring was the most effective control method, largely because the rabbits followed discrete (also discreet) paths amongst the dense shrub/grass vegetation. Snaring became much less efficient as rabbit density became sparse and individual rabbits became snare shy. If snaring had not worked there were no other obviously good options for control.

Lloyd Loope, Research Scientist, *Haleakala NP*

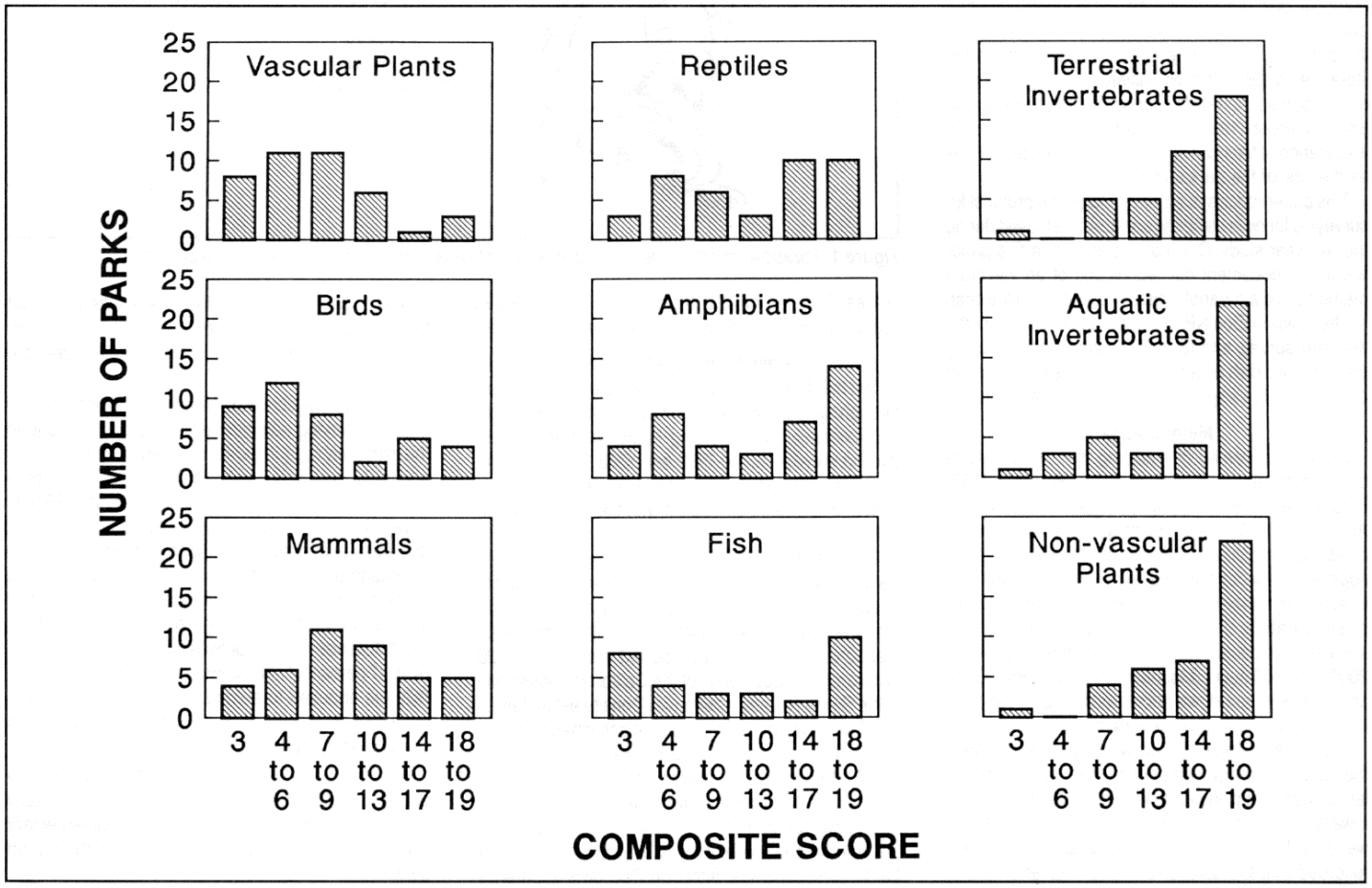


Figure 1. *Composite scores (taxonomic + geographical + ecological completeness) for vascular plants, mammals, birds, reptiles, amphibians, fish, terrestrial and aquatic invertebrates, and non-vascular plants in Western Region park areas.*

Mexican Spotted Owls in Zion NP: Inventory and Monitoring Methods

By Sarah E. Rinkevich

The recent listing of the Northern spotted owl (*Strix occidentalis caurina*) by the USFWS as a threatened species (Federal Register 1990) continues the debate over the long term survival of this species (Thomas et al. 1990). Following on the heels of this controversy, the Mexican spotted owl (*S. o. lucida*) currently is under consideration for federal listing as threatened or endangered (Wilcove 1987, Smith 1990). This subspecies already is listed as threatened by Arizona (Arizona Game and Fish Commission 1988).

While much is known about the Northern subspecies and the California subspecies (*S. o. occidentalis*), little information is available on home range, winter habitat use, or demography of the Mexican spotted owls of the southwestern United States. In addition, very little is known of the status and ecology of spotted owls in canyonland habitat such as Zion NP. It is crucial that Mexican spotted owl distribution and abundance be assessed in areas that are isolated (extinction prone) and receive heavy human use.

Early studies of spotted owls in Zion (Kertell 1976, Murphy 1988) reported only a few owl locations widely distributed throughout the park. Owls appeared to be associated with narrow, steep walled canyons as well as "hanging canyons." The rugged terrain of Zion park was a major obstacle for biolgists conducting spotted owl surveys. According to Murphy (1988), the use of a parabolic dish proved instrumental in locating spotted owls in the park. Few published studies in the use of the parabolic microphone in avian studies exist in the literature. In 1989, Zion NP initiated a two year survey of Mexican spotted owls. During this study, Rinkevich and Gutierrez (1991) documented distribution and abundance of Mexican spotted owls in the park as well as the use of the parabolic dish.

This paper reports our methodology and protocol for surveying for owls using the parabolic dish used during the two year study. Our main objectives in this paper are to: (1) document our techniques of an inventory method using a parabolic dish for detection of Mexican spotted owls in Zion NP, (2) report on our results of the two year survey, and (3) make suggestions for using the parabolic dish as a tool for future Mexican spotted owl surveys in canyonland country such as Zion.

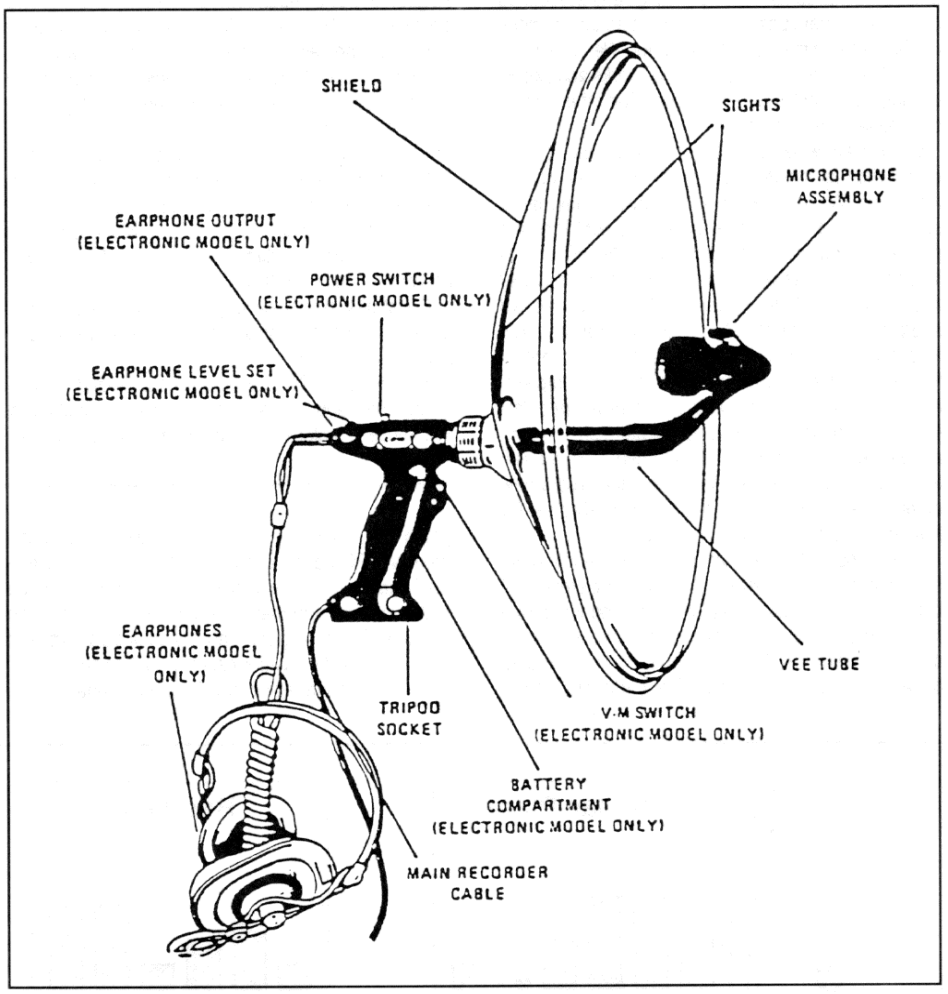


Figure 1. *Parabolic microphone used to listen for Mexican spotted owls in Zion National Park.*

Methodology

Owls were located by imitating their vocalizations during both day and night surveys (Forsman 1983, Freanklin et al. 1990) from May-August 1989 and April-August 1990. We used "point surveys" which were conducted by calling 10 minutes each hour at selected ridge and mesa-top vantage points within the park. We listened the remaining time, using a 45.7 cm diameter plastic parabolic dish and microphone (Fig. 1). These surveys were conducted for 3-5 hour periods between 2000 and 0500 hours (Mountain Standard Time). Once an owl(s) was heard, we attempted to locate the owl's roost site during a daytime walk-in survey.

Since many areas of Zion were canyon networks, the parabolic reflector was not oriented to any particular compass point. Instead, we pointed the microphone toward the direction of potentially suitable habitat as well as historical sightings of Mexican spotted owls. We recorded time and duration of the survey, temperature, wind speed, cloud cover, and other owl species detected. Sex of spotted owls was determined by their voices; females have a higher tonal pitch. Plateau regions within the park also were intensively surveyed.

Results and Discussion

Two hundred and nineteen surveys were conducted throughout canyons and plateau areas in Zion NP. Approximately 4200 working hours were spent conducting surveys during 1989 and 1990. Mexican spotted owls were uncommon but widely distributed in the park and appeared coincident with the patchy canyon habitat.

All spotted owls were found in deep, steep walled canyons in nine locations (Table 1). The crude density of owls in the park was 0.03 owls/km2, which is lower than the density of such birds in other western states. Bias and Gutierrez (1988) reported a density of 0.20 owls/km2 for a population of the California subspecies in the Sierra Nevada, California. Density estimates for two California spotted owl populations inhabiting habitat islands in southern California were 0.19 owls/km2 and 0.64 owls/km2 (Gutierrez and Pritchard 1990).

This density estimate provides an initial step in estimating owl abundance in the park and also represents the first comparison of density among populations of the three subspecies. Although Zion owls apparently occurred in a much lower density than other spotted owl populations, I do not know that this reflects poor habitat quality (Van Horne 1983); our results also could be due to low vocal response rates of owls, weather, or a sampling problem related to the park's inaccessible terrain.

Access to owl sites was the major limitation encountered. Surveying potential habitat was difficult due to the extremely rugged park terrain, which has few roads and trails. Relatively few avian studies have been conducted in areas with rugged terrain (Dawson 1981). In several instances, my method for surveying unaccessible areas (e.g. climbing neighboring mesa tops to gain a vantage point) proved successful in finding owls. In many instances, the parabolic was needed to confirm a response at these vantage points because of the great distance (>5 km) between observed owls. Moreover, 37 percent of detections I encountered were naturally (as opposed to elicited responses) calling owls, even though spontaneous calling by spotted owls is considered infrequent (Forsman 1983).

Although gusts of wind and nose from stream flow posed some problems, the parabolic dish greatly improved the chances of hearing an owl, expecially given the variety of topographic conditions in Zion park.

Hanging canyons appeared to be an important habitat type for Mexican spotted owls in Zion. Fifty-six

Spotted Owls in Zion *(Continued)*

percent of owls I detected were located in hanging canyons. The remaining 44 percent were in canyons with inaccessible cliff sites. The rate of erosion of these hanging canyons lags behind that of the main canyon, resulting in a smaller watershed. Because these hanging canyons are generally inaccessible to biologists, the parabolic dish was necessary for surveying this type of habitat. I attempted to survey all hanging canyons that I could traverse or survey from a vantage point. I am unable to speculate on the total number of suitable hanging canyons within the park and I believe there is more potentially suitable owl habitat left unsurveyed because of inaccessibility.

Recommendations

The use of the parabolic reflector combine with calling surveys proved a useful tool in Zion's rugged canyon country for detecting Mexican spotted owls. The dish should not be used when wind gusts exceed 20 mph. Areas with potentially suitable habitat should be revisited even if not response has been heard, since it often takes several visits to elicit a response (Franklin 1986).

Although parabolic reflectors are not useful for locating roosting owls during daytime searches, it provided information on distribution and density estimates that is crucial for species management in Zion NP. The parabolic unit is light (about 3 lbs.) easily dissembled and portable through dense vegetation, and can be quickly reassembled when a vantage point is located. Current cost of the parabolic reflector unit begins at $600.

Knowledge of the biology of Mexican spotted owls in Zion is limited and changing rapidly. Long term monitoring plans and habitat studies have been initiated within Zion park, and the overall knowledge gained will benefit from similar studies in other parks as well. Montoring of known sites is crucial in determining population stability and productivity and will increase understanding of spotted owl biology. Studies focusing on owl prey base and juvenile dispersal also should be considered. In order that proper management criteria can be set, better understanding of the Mexican spotted owl throughout its range in the southwestern United States is needed.

Rinkevich is a seasonal wildlife biologist, working at Zion NP.

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Acknowledgments

I thank Larry Hays for reviews of this manuscript, and also R.J. Gutierrez (principal investigator) for his guidance and insightful ideas. Michael Alexander I thank for his contribution – athletic ability resulting in a pair of owls I probably would not have detected, and assistance. Doug Call and Kari Norgaard assisted in the 1989 inventory.

Table 1. *Summary of canyon names, owl status and a brief description of the site used by Mexican spotted owls during 1989-1990, Zion National Park, Utah.*

Canyon Name	Owl Status N=17	Description of Site
Echo Gorge[1]	1 pair, juveniles	Narrow gorge
Kolob Creek Canyon	1 pair	High-walled canyon
Lady Mt. Canyon[3]	1 pair	Hanging canyon
La Verkin Creek/Willis Creek[3]	1 male, status unknown	Steep-walls/cliff
Oak Creek Canyon[3]	1 pair	Hanging canyon w/cliff sites
Orderville Canyon[2]	1 pair	High-walled canyon
Pine Creek Canyon[1]	1 pair, juveniles	Narrow canyon w/smaller, hanging from canyons present
Refrigerator Canyon[1]	1 male, status unknown	Hanging canyon
Right Fork[2]	1 pair	Narrow canyon

[1]Access to owl site was moderately difficult requiring minimum rock climbing (class I, II) (Brereton and Dunaway 1988).
[2]Access to owl site was difficult and required intense rock climbing; a rope and harness was needed for belays and repel (class III-V) (Brereton and Dunaway 1988).
[3]Owl site was completely unaccessible.

mab notes

The FY 1991 grant awards made by the U.S. National MAB Committee include several of particular interest to the NPS.

- an interdisciplinary project by MAB's Human Dominated Ecosystems Directorate to develop coupled models of regional ecological and social systems. The models focus on improving managers' capability to assess and predict the implications of alternative ecosystem use and management policies, through case studies in the Pinelands, Virginia Coast, and Everglades Biosphere Reserves. The project involves specialists from six universities. Directorate member John Hadidian, urban ecologist in the National Capital Region, is participating in regional modeling relating to threatened and endangered species.
- an international workshop for managers of high latitude BRs, proposed by Dale Taylor of the Alaska Regional Office, to be held at Denali BR in September 1992. The workshop will focus on identifying resource issues and research goals, comparing management approaches, and developing recommendations for cooperation in the tundra biome.
- a comparative study in Jamaica and the U.S. Virgin Islands to look at ecological, social, and economic factors affecting mangrove ecosystems.

The National Committee called on the Coordinating Committee for Biosphere Reserves to submit its **draft plan for the U.S. biosphere reserve program** for review by October 1991. The plan will present the conceptual basis for establishing and organizing BRs in the U.S.: Centers for learning how to maintain biodiversity within regional and global change.

The **World Parks Congress** in February 1991 will include a workshop on development of BRs over the past 5 years, when establishment of new BRs provided for their intended functions much better than in earlier years. Bill Gregg, NPS MAB Coordinator, is scheduled to present a synthesis paper with Silvio Olivieri of Conservation International on "Biosphere Reserve Designations, New Organization and Holistic Problem Solving."

Napier Shelton
NPS Washington Office

In the Next Issue

"GIS at Colonial NHP: A New Approach" by Devine, Rafkind, and Karish; "Great Smoky Plants and Ozone Sensitivity" by Hacker and Renfro; "Shenandoah GIS Viewshed Analysis" by Teetor and Haskell; "Remedial Measures for Great Smokies Acidified Streams" by Kucken, Maas, and Patch; "GIS Program Started at U/AZ CPSU" by Potter, Kunzmann, and Guertin; "External Development Effects at Theodore Roosevelt NP" by Wallace; "Historic Landscape Restoration at Wilson's Creek NB" by Thomas; "Native Seedbank Project at New River NR" by Pollio and Davidson; and "Professionalism in Resource Management" by Jope.

book review

Paul Schullery, who has worked in Yellowstone NP as a ranger-naturalist, a park historian, a research consultant, and a technical writer, is represented on the new books shelves of the nation by three new publications: *Yellowstone Bear-Tales*, (Roberts Rinehart, Inc., 1991), *Pregnant Bears and Crawdad Eyes*, (published by The Mountaineers, Seattle, WA, 1991, 176 pp), and *The National Park Service:A 75th Anniversary Album* (Roberts Rinehart Publishers, 1991, 120 pp).

The Yellowstone bear book is a collection of bear observations and encounters beginning with one by Philetus Norris, who served as second superintendent of Yellowstone from 1877 to 1882, and wandering through notebooks, newspaper accounts, and research papers up to the 1950 piece by then Chief Park Naturalist David de L. Condon on "The Size of Grizzly Bear," enlivened and given continuity by Schullery's introductions and commentaries.

Pregnant Bears, "a book of processes" that explores why and how other life forms act as they do, was reviewed in *The Washington Post Book World*, Where Dennis Drabelle noted:

"Schullery's gift is for probing matters that most of us skip right over: the coordinated movements of wild flocks; swimming deer; predators that hang around backyard bird feeders; the attraction oF wildlife to roadsides. In *Pregnant Bears & Crawdad Eyes*, he develops these and a score of other topics into essays of high polish over solid substance."

And finally, the NPS 75th Anniversary Album is a delightfully "dated," authentic photographic history that portrays the people and places that have comprised what Wallace Stegner has called "the best idea we ever had" – the national parks. This handsome, cloth-bound book is an outstanding addition to the 75th anniversary celebration of the National Park Service. The quality of the old photographs speaks to the mastery of the picture-takers; the *clarity* of the pictures is startling to the modern viewer, and testifies to the air quality in those bygone days.

All three books are present now in most bookstores across the nation, although *Yellowstone Bear Tales* may be easier to find in and around Montana.

For this reviewer, a few additional words about *Pregnant Bears & Crawdad Eyes* are necessary: Paul Schullery is an adult expression of that most charming of all childhood stages – the walking question mark. His writing skills are as sharply honed as those of Lewis Thomas (his words carry meaning modestly without calling attention to themselves), and the overall effect is more a general paeon in praise of curiosity than a dissertation on any particular subject. He exudes childlike delight in the *pursuit* of knowledge. Instead of throwing facts at us from some lofty perch of erudition, he takes us cozily by the hand and suggests that we agree about how lucky we are to be peeking, poking, prying creatures, with the whole delightful Earth to ask questions of.

I lay this book aside and wonder if perhaps human evolution might be taking us toward the day when *all* of us will see our world/s – those "other nations, caught with ourselves in the net of life and time" – as worthy of our curiosity, our respect, and our loving carefulness. Paul Schullery, just for a magic moment, makes it seem possible.

Jean Matthews

Keystone Dialogue On Biological Diversity On Federal Lands Goes to Field

By John Dennis

In mid-April, 1991, The Keystone Center published its *Final Consensus Report of the Keystone Policy Dialogue on Biological Diversity on Federal Lands*, which provides the results of a 2-year multidisciplinary dialogue on biological diversity. In a June 21 memorandum, NPS Acting Director Herb Cables distributed the report to NPS senior managers and superintendents and strongly urged them to consider its findings and examine their own programs with respect to its recommendations.

The report's central thesis is that maintaining biological diversity on *all* federal lands is important. To establish the basis and urgency of its recommendations, the report provides information on the value of biological diversity to humans, the problems that impede its conservation, the criticality of federal lands to maintaining this diversity, and the key role that humans play. The report defines biological diversity as:

• The variety of life and its processes, including the variety of living organisms, genetic differences among them, and communities and ecosystems where they occur.

It identifies factors causing the loss of biological diversity to include actual and threatened extinctions of genotypes, populations, and entire species; loss of plant and animal habitats; spread of exotic species; and loss of natural biological communities. It suggests a national goal:

• To conserve, protect, and restore biological diversity on federal lands to sustain the health of the ecological systems, to provide for human well-being, and because of the intrinsic value of biological diversity.

The report also encourages federal agencies to coordinate their programs and to cooperate in conducting program evaluation, inventory, monitoring, research, data management, information transfer, planning, and budgeting activities that respond to the recommended goal. It discusses the need for identifying indicators of success to help people understand what conditions are desired and when the desired conditions are being achieved. It recognizes that achieving these recommendations may require additional funding and personnel.

It recommends specifically that each federal land management agency and each agency conducting activities on federal lands should pursue strategies cumulatively to meet all of the following seven related objectives:

• Maintain viable populations of the nation's native plants and animals well distributed throughout their geographic range.

• Maintain natural genetic variability within and among populations of native species.

• Maintain representative examples of the full spectrum of ecosystems, biological communities, habitats and their ecological processes.

• Increase scientific understanding of biological diversity and conservation.

• Achieve public awareness and understanding of biological diversity.

• Enable and encourage the private sector to develop and apply innovative approaches to the conservation of biological diversity.

In addition, it recommends that agencies should develop and implement mechanisms for coordination, including forming a Federal Biological Diversity Policy and Coordination Committee.

The report provides specific discussion and recommendations on such program topics as maintaining viable populations of native species; maintaining genetic variability; maintaining ecosystems, biological communities, habitats, and ecological processes; integrating conservation of biological diversity with other human needs; increasing scientific understanding; achieving public awareness and understanding; and encouraging private sector involvement.

Also, the report provides information about the five federal land managing organizations, including the National Park Service, that are responsible for managing most of the federal land holdings. Similarly, the report gives a synopsis of the Environmental Protection Agency and The Nature Conservancy. It offers information about the USFWS's "Gap Analysis" process, contains background information about genetic diversity and the relationship of selected biological traits to relative endangerability, and provides a glossary of terms.

The Keystone Policy Dialogue on Biological Diversity on Federal Lands involved personnel from federal agencies, Congressional staffs, environmental organizations, commodity organizations, private industry, and academia. Although supported by their parent organizations, these dialogue participants acted individually, not as representatives of their organizations.

NPS participants listed in the final report include John Byrne, Superintendent of the George Washington Memorial Parkway, now Project Manager, Appalachian Trail; John Dennis, Chief of the Science Branch, Wildlife and Vegetation Division, NPS Washington Office (WASO), and Mike Ruggiero, Chief, Wildlife and Vegetation Division, WASO.

Copies of the report may be purchased for $20 from The Keystone Center, PO Box 606, Keystone, CO 80435 (303)468-5822.

publications

From the Southeast Region come the following abstracts of recently published research reports/documents.

Exotic Plant Species Management Strategies and List of Exotic Species in Prioritized Categories for Everglades NP. Whiteaker, Louis D. and Robert F. Doren. 1989. NPS Research/Resource Management Report SER-89/04, SERO, Atlanta, GA 30303. 21 pp.

Everglades NP presently contains an excellent example of southern Florida's original flora and vegetation. About 950 vascular plant species have been recorded, including about half the species endemic to southern Florida and numerous other rare plant species (Avery and Loope 1980, Avery and Loope 1983, Loope and Avery 1979). However, the plant communities and individual taxa of southern Florida have proved extremely vulnerable to disturbance from human acitivities. Deterioration began in the early 1900s and has continued, through agricultural development, urbanization, drainage, deliberate and accidental burning, and introduction of exotic species. Exotic plants have posed one of the greatest threats to

Seagrass Die-off Threatens Ecology Of Florida Bay

By Michael B. Robblee and W. Jill DiDomenico

Everglades NP is known for the numerous water resource problems assailing the integrity of its freshwater marsh and upland ecosystem. Less well publicized is that more than half the park is comprised of marine and estuarine habitats dominated by mangrove forests and shallow water seagrass meadows. These ecosystems, located at the end of the freshwater "pipeline," share in the stress visited upon the everglades by the diversion of water in south Florida for urban and agricultural use and for flood control.

Forida Bay, located between mainland Florida and the Florida Keys, is the largest of the park's marine systems. Perhaps symptomatic of the stress that it is under, Florida Bay has been experiencing widespread and occasionally rapid mortality of turtle grass, *Thalassia testudinum*, the bay's dominant seagrass.

Since 1987, an estimated 4,000 ha of dense *Thalassia*-dominated seagrass bottom in western Florida Bay have been denuded, and an additional 23,000 ha have been impacted to a lesser degree. Loss of seagrass habitat on this scale is unprecedented in tropical seagrass systems and potentially threatens the bay's water quality, its sport fishery, and its nursery function. This is because seagrasses serve as the dominant primary-producer and trophic base, provide shelter for animals, stabilize sediments, and influence nutrient relationships (Zieman, 1982).

An analogous situation, the eelgrass (*Zostera marina*) wasting disease, has been observed previously (Rassmussen, 1977). During the 1930s, eelgrass disappeared over much of its range along the east coast of the United States and in Europe, presumably due to an epidemic of a marine slime mold of the genera *Labyrinthula* (Muehlstein, *et al.*, 1987). Severe habitat alterations, disappearance of species dependent on eelgrass, and declines in fisheries were attributed to the eelgrass decline.

In Florida Bay, necrotic lesions on *Thalassia* leaves are often the first visible symptom of die-off. Short-shoots, vertical stems attached to the rhizome bearing leaves and roots, become chlorotic and leaves abscise or decay at the leaf base. Rhizome and root death seem to follow leaf loss at some sites. At other sites, however, below-ground tissue mortality apparently precedes visible leaf stress and death. *Thalassia* beds develop a mottled appearance as patches of chlorotic and dead seagrass enlarge and coalesce.

The rate of spread and size of die-off patches vary considerably among sites and appear to reflect variations in levels of naturally occurring stress in Florida Bay. At this time, seagrass die-off is known only to occur in dense grass bed habitats and apparently proceeds most rapidly in the autumn (Fig. 1A). At its worst, seagrass die-off can denude hundreds of hectares of dense turtle grass within several months; in its aftermath, only the stubble of dead short-shoots remain. After a period of declining water clarity and epibenthic algal accumulation associated with the decomposition of plant materials, recolonization of these former grass beds by the pioneering seagrass *Halodule wrightii* (shoal grass) is the first sign of recovery (Fig. 1B).

In 1988, the observed contagious distribution of die-off patches, the rapidity of the die-off process, and the recent resurgence of the eelgrass wasting disease along the east coast, strongly suggested that a pathogen may have been the primary cause of seagrass die-off in Florida Bay (Short *et al.*, 1986; 1987). It was feared that seagrass meadows regionally in south Florida would be affected, as was the case with the eelgrass die-off in the 1930s. This fear has not been realized yet, although a relatively virulent species of *Labyrinthula* has been isolated from seagrasses associated with die-off in the bay, and in the laboratory it has demonstrated the ability to cause necrotic lesions (Porter and Muehlstein, 1989). It remains uncertain at this time, but is considered unlikely, that a pathogen is the primary cause of what we are observing as seagrass die-off in Florida Bay.

(Continued on page 22)

Publications *(Cont. from p. 20)*

Everglades ecosystem integrity. This report lists 221 species of introduced plants that occur within the park and was created primarily by referring to the Everglades NP plants listed by Avery and Loope (1983), and further collections and identifications by the authors. The listed exotic plant species have been classified into 5 categories based on current distribution, potential to spread and invade native vegetation, and the corresponding management approaches for each group of species. This species list is intended for use by resource managers as a guide for exotic plant management strategy in Everglades NP and adjacent areas. It will be updated as necessary in conjunctin with mapping and site information that are part of the park's ongoing monitoring program.

Comparison of Economic Feasibility of Chemical Control Strategies on Differing Age and Density Classes of Schinus terebinthifolius. Doren, F. and Louis D. Whiteaker. 1990. Natural Areas Journal 10(1):28-34.

Schinus terebinthifolius (Brazilian pepper), which is native to Brazil, has become an aggressive, woody weed in southern Florida, displacing native vegetation and rapidly invading disturbed sites. Studies on the effective use of herbicides to control the plant began in 1982. Concurrent studies of the labor, time, and costs of control, using herbicides, were begun to determine the cost criteria for future implementation of *S. terebinthifolius* programs. Comparisons were made between different age and density classes and between matricide (killing female trees only) and complete control strategies. Stand structure also was evaluated. The numbers of trees and stems and amount of herbaceous cover varied according to age and stand density. The young successional sites average 1453 stems/ha and less than 14 cm understory height. Costs were directly related to numbers of trees and stems per unit area. Principal costs were labor, not herbicide, and did not vary significantly between matricide or complete control strategies.

A GIS Note From the Everglades

By Michael Rose, David Buker, and Frank Draugh

Editor's Note: On June 6, 1991, the A/D Natural Resources for the NPS sent a memo to all RDs on the role and function of the GIS Division. In part he said: "I acknowledge that implementation of the Servicewide GIS program objectives will take time and will require a significant commitment ... (but) I can point to early successes that reinforce our approach ... I am convinced that the Servicewide strategy developed by the GIS Division is a positive step, which strengthens the Division's partnership with the Regional Offices."

Everglades NP is a subtropical bank of biological diversity. Its 1.4 million acres of south Florida wilderness provides a sanctuary for flora and fauna from both the tropic and temperate zones. Geographic Information System technologies are being utilized by the park to integrate research databases into the natural resource management decision-making process for this national treasure.

Baseline databases are being developed for use by a variety of research and resource management projects. The park also has acquired high resolution photography and digital scanner data for the entire park area. These will be used to develop a vegetation map for the park. A project to develop freshwater hydrological themes on a regular basis also is underway. A variety of wildlife distribution databases, including wading birds, alligator nests, deer, Florida panthers, and manatees are on the systen, and many other databases are presently on the system of soon will be added. Many of these themes form the basic information needed to evaluate long-term changes in the park's plant and animal communities. Additional work directly addressing global climate change can be integrated with this existing information to predict and monitor effects on the park.

A number of studies of major importance to the park are using the GIS. One of these is evaluation of proposed changes to water management structures and management. Results of these analyses were documented in "An Assessment of Hydrological Improvements and Wildlife Benefits from Proposed Alternatives for the U.S. Army Corps of Engineers' General Design Memorandum for Modified Water Deliveries to Everglades NP" (June 1990).

The hardware includes a UNIX-based dual-processor Masscomp 6700 supermicrocomputer, a UNIX-based SUN SparcStation 2, a Polaroid ACT II color plotter, Tektronix 4596 Graphic printer, a Versatec electrostatic color plotter (36" format), Calcomp 9100 digitizer (36" by 48"), and a Calcomp 2300 digitizer (24" by 36"). The Masscomp system has two high resolution graphics display terminals, 1.2 gigabytes (GB) of fixed disk storage, a 1 GB read/write optical disk (with removable optical disks), a 45 megabyte (MB) cartridge tape drive, and a 9-track tape drive. The SUN system has one graphics display terminal, 2 GB of fixed disk storage, a 150 MB cartridge tape drive, and a 2.3 GB 8 millimeter tape drive. These two computers are on an Ethernet local area network, so data can easily be exchanged between the two systems.

GIS software consists of GRASS (Geographical Resource Analysis Support System) on both the Masscomp and SUN systems, ELAS (Earth Resources Laboratory Applications Software) on the Masscomp, and Arc/Info on the SUN, MAPGEN from USDA SCS on the Masscomp and SUN, and Home Range wildlife survey software on a PC. ORACLE database management system software also is presently available on the Masscomp, and soon will be added to the SUN, for both GIS and non-GIS related databases.

Rose is a Remote Sensing Specialist, Buker is Program Manager for Computer Operations, and Draughn is a GIS Specialist at Everglades NP.

Seagrass Die-Off

(Continued from page 21)

In 1987, Florida Bay may have been poised for seagrass die-off. Current thinking suggests that the synergism of several stress factors may have caused a production/respiration imbalance resulting in seagrass die-off (Zieman *et al*., 1988; Robblee *et al*., in press). First, Florida Bay,. which historically has averaged one hurricane in about every seven or eight years, has not experienced a significant hurricane since Donna in 1960 (Gentry, 1984). The lack of major storm perturbation in recent years may have allowed *Thalassia* communities to develop to very high densities and biomass, with consequent high respiratory demands.

Second, unusually warm autumn temperatures have occurred in the late 1980s; temperature anomalies were as great as 3 degrees C above a 50-year mean for Gulf of Mexico waters adjacent to Florida Bay. Relatively high autumn temperatures have kept seagrass respiration high at a time when productivity naturally declines with shorter days.

Third, seagrass roots and rhizomes exist in anaerobic sediments, so aerobic respiration is dependent on photosynthesis in the leaves. If the photosynthetic capacity of *Thallassia* leaves is reduced or plant respiratory demands increase, hypoxic stress may result. In Florida Bay, the risk of hypoxic stress is heightened because the calcium carbonate sediments in the bay are low in amorphous iron minerals, which precipitate dissolved sulfide. As such, sediment interstitial-water sulfide concentrations are high, with a correspondingly high chemical oxygen demand. Within this context of interacting stress factors, it is possible that disease functions as either an additional stress factor or as a disease agent attacking stressed seagrasses.

Many of the effects of seagrass die-off that were predicted previously (Robblee, 1988), have been observed. Most notable is declining water quality and increasing epiphytism over the past two years, especially in the vicinity of active die-off. Also, an increased frequency of fish kills has been observed in relatively stressed areas of Florida Bay that have been heavily impacted by seagrass die-off.

Poor water clarity and increasing epiphytism also are associated with areas of new die-off, where these factors are very likely promoting, at least in part, continued die-off. Reduced benthic fish and invertebrate abundances in areas of the bay experiencing die-offs have been documented (Robblee, 1989). In Johnson Key Basin, an area of dense grass beds in western Florida Bay suffering extensive die-off, abundances of pink shrimp, caridean shrimp, and small fishes have declined in seagrass habitats affected by die-off (Fig. 2).

Florida Bay may be the principal nursery ground for the Tortugas pink shrimp fishery (Costello and Allen, 1966). This fishery has experienced historic lows in the latter half of the 1980s, coincident with seagrass die-off in Florida Bay (Nance and Patella, 1989). This decline in an offshore fishery may reflect a decline in the health of Florida Bay, the inshore nursery ground.

Seagrass die-off research has been organized within a framework of cooperative studies. Individuals whose work and data are summarized here and who can provide detailed information on their research findings are: Dr. Paul Carlson and Michael Durako of the Florida Marine Research Institute, Florida Dept. of Natural Resources (sediment chemistry and plant morphology), Dr. Ronald Jones of Florida International University (nutrient relationships and water quality), Dr. David Porter of the University of Georgia (seagrass pathogens), Dr. Joseph Zieman and James Fourqurean of the University of Virginia (seagrass productivity and nutrient relationships), and Dr. Michael B. Robblee of the South Florida Research Center, Everglades NP (faunal relationships). This research has been supported by the NPS, the Florida Dept. of Natural Resources, and the South Floprida Water Management District. At this time research is scheduled to continue through FY '93.

Robblee is Acting Marine Program Director at Everglades NP; DiDomenico is a Biological Technician at the park's Research Center.

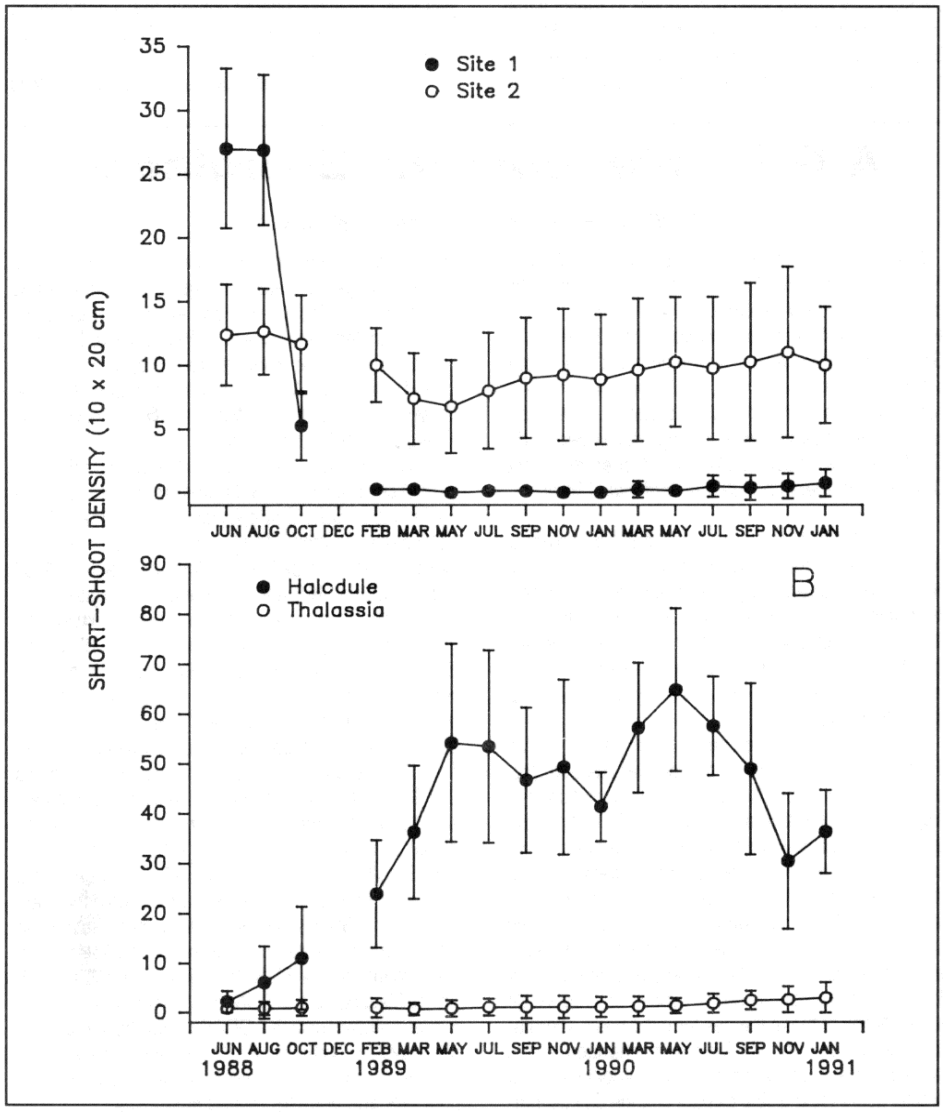

Figure 1. *Changes in the grass canopy in Johnson Key Basin since May 1988. A) Variation in seagrass die-off at 2 monitoring sites initially exhibiting* Thalassia testudinum*-dominated, visually healthy seagrass. B) Recolonization of a die-off patch by* Halodule wrightii. *Data are mean ±1 sd short-shoot density in 8 replicate 200 cm² quadrats.*

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Seagrass Die-Off *(Continued from page 22)*

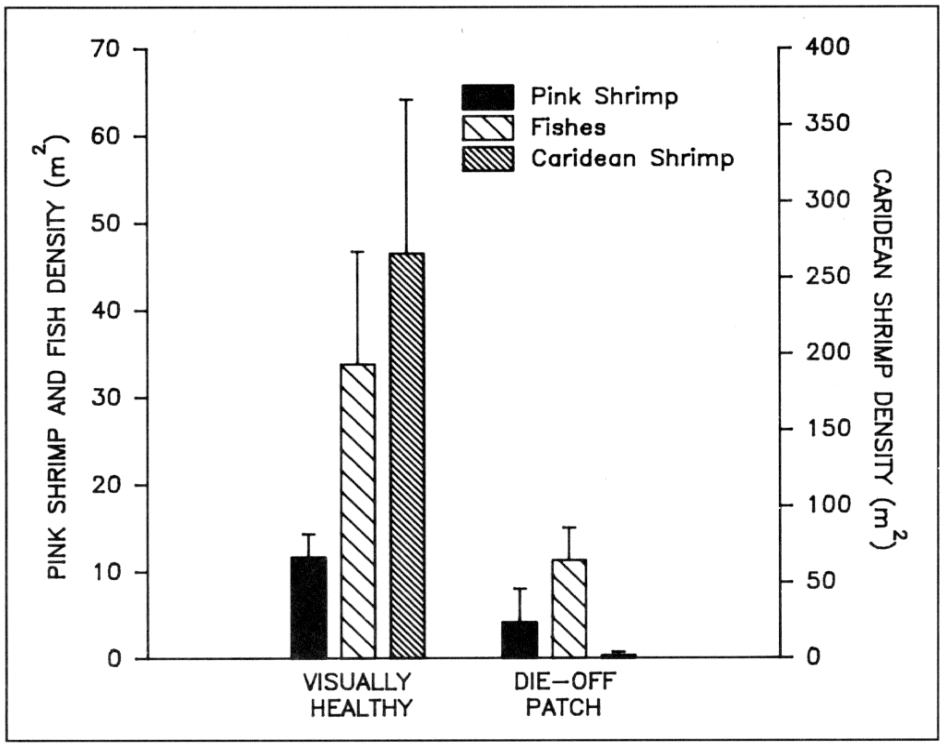
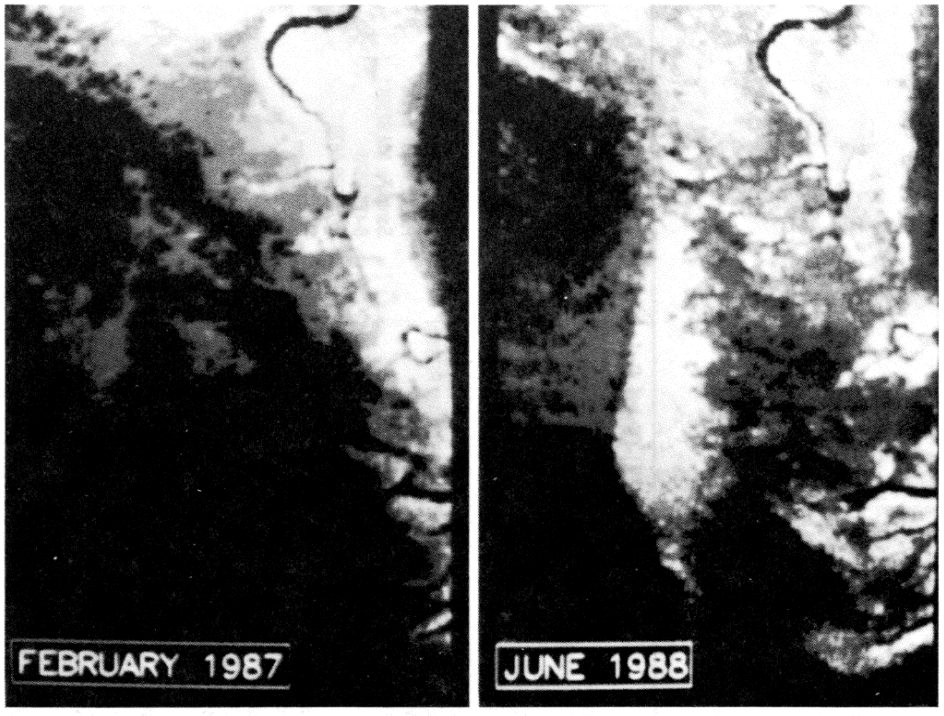


Figure 2. *Comparison of animal abundances between visually healthy and die-off patch seagrass habitats in Johnson Key Basin in August 1989. Data are mean ±1 sd individuals/m² in 6 replicate throw traps.*



Satellite images *of the Rabbit Keys in western Florida Bay document the spread of seagrass die-off between February 1987 and June 1988. In both panels black, grey, and white areas represent dense to sparse seagrasses. Dark lines evident in the white areas of upper and center right are deep water motes which partially surround Big and Little Rabbit Keys. The light patch evident in the center in June 1988 is a 49-acre area of severe die-off, dead-zone, which developed between late summer 1987 and spring 1988. An additional 295 acres of less severely damaged seagrass, patchy die-off, was also estimated to have occurred during this time.*

Where the Mind Runs Free: Observations of An Interpreter

Aural voyeurism (eavesdropping) is not deemed proper social behavior, but at times it can provide valuable insights. So the overheard comments of a couple at Dinosaur National Monument brought a lesson beyond what social research in parks could do.

The couple was viewing activities at the Quarry Visitor Center, where paleontologists were painstakingly exposing the spectacular fossil remains of a dozen species of dinosaurs and turtles.

"Well," said one, "if it is a hoax, it's sure an impressive one."

That comment, honest and revealing, bespoke the challenges to education in parks. What is said by interpreters is not necessarily what is heard; what is heard is not necessarily what is understood; and what is understood is not necessarily what is embraced within one's belief system. That colors the interpreters' strategies. "The canny art of intellectual temptation" is how Jerome S. Bruner described effective teaching – offering a tantalizing buffet and letting individuals decide for themselves which morsels they wish to taste.

As that couple revealed, the barriers to learning are real and formidable. "From our earliest years," observes Marilyn Ferguson, "we are seduced into a system of beliefs that becomes so inextricably braided into our experience that we cannot tell culture from nature." In a thousand ways, schools, movies, news, and families shape our constructs of reality. We accept most without questions and find ourselves comfortable with information that confirms our particular sense of reality. We are discomfited by what does not. Thus it is natural that many who visit parks seek to affirm their own concepts of history and the workings of nature. They seek corroboration, and it is most natural that they do.

But for decades now, a powerful transformation has been at work. As with the turning of an aircraft carrier, the changes have come without fanfare and with inexorable force. Based upon sound research, and using revelation as the fulcrum of learning, interpretation has profoundly shaped the expectations of travelers. This change in expectations cannot be overstated. At Hawaii Volcanoes NP, visitors can witness examples of evolution more dramatic than anything Darwin found in the Galapagos Islands. At Cape Cod National Seashore, travelers may discover that the Pilgrims, so often portrayed in heroic posture, possessed their ugly side. At Salinas Pueblo Missions National Monument, the story of missions and the missionary process reveals both sublime intent and manipulation of the indigenous people.

What people are discovering, then, is often at odds with their past training. For some this is unpleasant, and the gates to thinking close. For this shrinking minority, parks should display signs announcing: "Warning - Dangerous Ideas Ahead." But for others, this is the removal of a fog. They have embraced Carl Sagan's discovery: "We do not advance the human cause by refusing to consider ideas that make us frightened."

A legion of travelers now realizes the extent to which it has been taken in by an educational system; thus,

(Continued on page 24)

An Interpreter's Observations

(Continued from page 23)

the excitement with which parks are approached. Where once there was only light pleasure, blinders can be removed. Out of the tangible resources of parks, abetted by research and the building of extraordinary information bases, have risen intellectual resources – the most powerful resources of all.

"Since I first gained the use of reason," penned Juana Ines de la Cruz, "my inclination toward learning has been so violent and strong that neither the scoldings of other people ... nor my own reflections ... have been able to stop this natural impulse." The aspirations of Cruz, expressed in 1691, speak of opportunities recognized on an unprecedented scale. The "flight of the unfettered mind" is there, for those who seek it.

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