



PARK SCIENCE

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Reorganization of the South Florida Research Center

By Michael Soukup and Robert F. Doren

Editor's Note: The following article was submitted prior to announcement of the proposed Biological Survey at the Department of the Interior. It is presented as an example of the kinds of research and management problems that have increasingly plagued resource management throughout the nation and that the proposed National Biological Survey is positioning itself to deal with.

Congress has not legislated clear direction for a scientific foundation for national park management (NAS 1992); hence the role of science in the NPS has never been clearly defined (Sellars 1991). Consequently, the Service has not developed the organi-

The mangrove wilderness of Everglades National Park is a large labyrinth with irregular shaped islands.

zational, financial, and personnel requirements for a science program to match resource needs (Jarvis 1991). Perhaps the best example of recognition and substantial support of a park's science needs is the 1978 establishment, amid regional and park opposition, of the South Florida Research Center.

Everglades NP represents only the downstream fragment of the functional system it was intended to preserve. Since designation of Everglades NP, major flood control, water supply, and agricultural projects have continued to displace natural processes in the upper watershed; as a result, hydrological and biological systems in the park continue their decline.

Realistically, Everglades NP now is directly tied to a totally managed system. Much of the remaining Everglades ecosystem is managed by the South Florida Water Management District and the U.S. Army Corps of

Engineers for flood control, water supply, support of agriculture, and protection of the Everglades. This circumstance leaves since 1.3 million acres of designated Wilderness dependent upon how these four objectives balance out before water is delivered through structures.

A Future in Doubt

Given this reality, the future of the Everglades is seriously in doubt. Perhaps the best one can hope for is a comprehensive management regime, which if skillfully crafted, will provide the vast expanses of Everglades NP with a water regime that mimics the original Everglades. However, even this—active restoration of the quantity, quality, timing, and distribution of water—requires a substantial and detailed system level understanding. And whether the park will now be managed for this kind of restoration, or only for visitor

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NATIONAL PARK SERVICE

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

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Editorial

In this issue, we focus on change.

Science in the National Park System and Service has been an evolving entity, shifting with the currents of the surrounding system within which it was embedded. There are two sayings that have pertinent currency within the General Systems Theory crowd: (1) a system self-designs, and (2) no system can understand itself.

These two rules of general systems theory help explain the position in which NPS scientific research, application, and interpretation find themselves today. The best of intentions, a host of well-educated, well-meaning personnel grappling with fragments of an ever-growing mountain of resource problems, led to a dawning recognition in the larger "system" surrounding the Park System that something different **had** to be done.

Beginning on page 1 of this issue, Michael Soukup and Robert Doren present an example of how informed resource specialists, in one of the National Park System's most threatened parks, have been attempting to solve the formidable problems of one park—a park that is inextricably linked with other parks in the region and with other management agencies.

Paired with this presentation is an article by Associate Director Gene Hester, describing what Stephen Jay Gould would probably call "punctuated equilibrium" in the evolution of science in the National Parks. In effect, the sudden shift from "park biology" to a National Biological Survey, as an approach to solving our growing biological resource dilemmas, is an indication of a system that was struggling valiantly to "understand itself" but that needed an outside look, and push, in order to make the evolutionary leap to the next level of self-design.

The new NBS will **not** completely understand itself, and it **will** self-design. But out of this larger, more inclusive approach to biological resource problems that no longer can be contained or solved within the National Park System alone, will come greater ability to "see" the problems, and better-armed ways of dealing with them.

Or so we all hope and pray!

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Dare to Save the Everglades

Editor's Note: The following piece is excerpted from an article by Nathaniel P. Reed, former assistant secretary of the Department of the Interior, veteran of 35 years working on Everglades problems, adviser to two Florida governors, and now a member of the South Florida Water Management District. It was carried in the Feb. 21, 1993 edition of the Miami Herald.

Last year—the year of great hope for the Everglades—may yet rank as the Year of Great Frustration, due to the gap between our grand promises and our minuscule accomplishments.

The National Park Service and the environmental community consistently rank Everglades NP as the most threatened of all our nation's parks. *The Miami Herald* has well reported the increasing sea-grass die-offs and algal blooms in Florida Bay. The visible problems have compounded quickly and the repercussions are now widespread.

That water is the heart of the problem is universally recognized. Water flows to the Everglades and Florida Bay have been dramatically modified by man. Water of the wrong quality now arrives at the wrong times and in the wrong amounts.

In 1992, with great fanfare, numerous agencies—the South Florida Water Management District, the U.S. Army Corps of Engineers, the National Park Service—all made commitments to move forward aggressively with Everglades Park restoration efforts.

So what happened? The water management district, with great publicity, installed a temporary pump capable of moving an additional 100 cubic feet per second of water into the water-starved Taylor Slough and has proposed to “test” it for the next two years. This additional water is generally recognized by resource managers as wholly inadequate and a rather meaningless “test.” The action also delays addressing the complex issues of delivering larger amounts of water while lessening potential adverse impacts upon competing users of the flood-control system.

In 1987, the water management district initiated a similar experimental two-year water delivery program from the Tamiami Trail gates into Everglades NP. Six years later, that “experiment” is just routinely extended with no effort to analyze the results and modify the program accordingly.

The NPS has been repeatedly asked to define the water needs of the park so that water managers can evaluate options to provide it. This critical work was again promised in 1992, but still remains uncompleted. The Corps of Engineers must stop stalling, stop equivocating, stop endless studying. The fate of the entire Everglades system—

from the Kissimmee River Restoration, to Lake Okeechobee's mandated water-level schedules, to the water delivery systems to the Shark River and Taylor Slough—must be their “priority,” not a difficult stepchild that needs another round of study and restudy.

The prevailing reasons given for government inaction are “the federal pollution lawsuit,” insufficient funding, or Hurricane Andrew. The real reason is a lack of coordination, cooperation, and priorities.

Why haven't we accomplished anything significant? It's not lack of knowledge—we are indeed studying the Everglades to its death.

Perhaps the greatest problem is that the current bureaucratic process now effectively stifles government action. Restoration efforts have stalled for three reasons:

- **There is no agreement on what “restoration” means.** What level of recovery and/or protection are we trying to achieve in the Everglades? The goals range from meeting the needs of a single species to the undefined needs of “the ecosystem.” There is no consensus regarding what parts we are trying to protect and what parts must also serve other public needs.

- **There is no clear game plan to get there.** Each agency is pursuing some part of the puzzle and frequently using the failure of a sister agency to move forward as an excuse to further delay its own efforts. We lack measurable milestones, deadlines, and responsibilities to move forward.

- **There is no leadership to ensure that all the important players work together with a sense of urgency.** There has clearly been no strong leadership or vision among the resource managers with responsibilities in the Everglades arena.

I believe it is well past time for a new approach—one built upon communication, cooperation, leadership, and “dare.” It also is time to focus public attention squarely on the performance of the key players in achieving the goal they all profess to share.

As a first step, all the agencies need to form a high-level task team to define the restoration goal. I abhor forming yet another Everglades team, but the participants seem in such wide disarray that the only restarting point seems to be to lock them in one room and give them a collective shake! The team

must have a fixed time frame—say, a short 45 days—to redefine the collective goals and define their respective obligations. The new secretary of the Interior, Bruce Babbitt, must intervene directly if necessary, to end longstanding conflicts between components of his agencies to produce a unified approach.

The new administration must also commit to promptly resolve conflicts between agencies such as Interior and the Corps of Engineers. Gov. Lawton Chiles must ensure that involved state agencies participate actively and constructively. The product must be a clear, concise plan for all agencies that the public can understand and track.

(In a discussion of “the Frog Pond” and “Rocky Glades,” two properties within the historic eastern Everglades' watershed where competing interests have kept massive quantities of water from Taylor Slough and eventually from Florida Bay, Reed suggests that old conflicts must be settled and fundamental errors of public policy reversed.)

Florida Bay has too little patience left! We must take serious strides, not just shuffle our feet if we wish to save the Everglades/Florida Bay system. Bureaucrats too content to just step in place and deliver speeches at conventions should not be tolerated any longer. They should be held to standards of productivity and accountability.

The moment is opportune—we have informed, committed leadership in Gov. Chiles. The U.S. Department of the Interior, at last, has a knowledgeable, dedicated conservationist as secretary and the backing of an administration supportive of natural resource protection. I would challenge these resource managers to immediately define the key components of an effective plan for Everglades restoration. I would further challenge the Everglades Coalition to assertively and impartially chart their progress.

At presstime

June 14, 1993 – Interior Secretary Bruce Babbitt announced that NPS Associate Director Gene Hester has been assigned to a fulltime acting detail until October 1 as Special Assistant to the Assistant Secretary for Fish and Wildlife and Parks, heading up the effort to create the National Biological Survey. In the interim, Dennis Fenn is assuming Hester's duties, acting as Associate Director for Natural Resources.

use during further biological decline, will be decided as much (or more) *outside* its boundary as within ... in technically-grounded political arenas.

Thus the NPS's hope for success in the Everglades depends on sound, proactive, technically-based programs, about which park managers can focus and rally the broad national and international public support that exists for the Everglades. With adequate technical power from its scientists closely linked with clear objectives and effective political skill from its managers, the portion of the Everglades that is the national park can be restored and preserved.

Need for Reorganization

The South Florida Research Center (SFRC), as Everglades NP's main source of technical support needs to be organized to support management efficiently as it grapples with these realities, and it must be supported at the funding level necessary to match the tasks at hand.

Currently the Center's base budget has remained essentially fixed since its inception, plus it has taken on nearly all the park's resource management responsibilities. To compensate, the Center has been forced to focus solely on Everglades NP (leaving Biscayne NP and Big Cypress National Preserve to develop their own programs). The Center's research effort has been weakened. The Center also has been forced to compete for "soft money," now bringing in over \$2 million per year from other agencies for park-related research. However, dependency on such erratic funding does not allow a strong stable program. Thus we have looked for ways to become more efficient with our base funds.

Over the last two years, while immersed in such management realities as the Everglades Water Quality Lawsuit (among others), the SFRC staff engaged in many discussions on how to organize to respond better to park issues, accomplish a solid long-term research mission, and provide information in a more effective, timely way.

Subject-Oriented Approach Invalid

We concluded that the subject-oriented organizational approach in place since the Center's inception no longer provided appropriate working relationships or communication links. For example, the Hydrology, Wildlife, Vegetation, Marine Science, and Data Management programs did not work together because each was largely independent, somewhat redundant in staffing, and competitive. While each program was self sufficient (e.g. each carried out its own monitoring effort), none had any depth.

In preparing our presentation for the recent Targeted Parks Initiative for FY 92, it became clear to us that in order to tip the balance of the park's future toward restoration, the SFRC must succeed in four basic functions, which should be carried out by four **programs**:

- 1) inventory and monitoring (**I&M**);
- 2) Data storage, organization and access in a relational framework (**DATA MANAGEMENT**);
- 3) hypothesis testing, and the assembly of models (**RESEARCH**);
- 4) applications of science (**RESOURCE MANAGEMENT**) within the park and outside in the public decision-making arenas and processes.

Hence we decided to organize for these functions.

The **INVENTORY AND MONITORING PROGRAM** will provide data that drive hypothesis testing, model development, model verification, and trend assessment. With all monitoring under the I&M Program Manager, the present overlap in monitoring effort can be eliminated, with greater quality control as well. All components of the system will now be tracked and trends will be interpreted more frequently by the Program Manager.

Before, these activities were carried out in each topic-based program. The I&M Program now will undergo close evaluation as to priority, sampling protocols, and usefulness of the data by internal review. In each year's budget exercise, the monitoring program's effectiveness will be gauged by researchers for usefulness in model-building and testing, as well as by resource managers for identifying issues and tracking their resolution. Frequent analysis of monitoring data will inform managers of the results achieved by their decisions (either toward restoration or further resource impacts) in a much more timely fashion.

The **DATA MANAGEMENT PROGRAM** will receive all monitoring and inventory data and provide the relational framework (ORACLE-based), including spatial array (GIS), so the data can be used by scientists, resource managers, other agency managers and scientists. We have large volumes of data that never have been accessible and are, for all practical purposes, useless. Bringing these into the ORACLE relational framework will provide a return on this investment that will illustrate that data on the past Everglades—when accessible—are priceless. The beginnings of this process are well underway, and the work of our

present Computer Division is our most exemplary internal communications effort to date.

The **RESEARCH PROGRAM** can field about 7 research scientists under the present level of funding. Presently we are very weak in modeling impacts of new threats as well as the effects of our own restoration proposals. Assembly of models from the relationships evident from monitoring and hypothesis-testing must be a cautious process. It is, however, the inevitable methodology for impact or restoration analysis in such a massive, complicated system.

Although two additional positions plus technicians, were requested under Targeted Parks funding, much of the future effort should be accomplished cooperatively with other agencies and universities, and through contracts. When sufficient funds become available, a large portion should be applied to balancing the in-house effort with work under cooperative agreements. This will allow maximum flexibility and reduce the isolation of our research scientists and staff. Each research scientist will provide up to 50 percent of his/her time directly to issues; such issues involvement will be tracked by the Program Manager of **RESOURCE MANAGEMENT** through Task Directives and timelines. The Research Director chooses task team members, monitors progress, products, and performance.

The **RESOURCE MANAGEMENT PROGRAM** will translate information into action. This Program will implement and direct resource management activities (exotics control, regional water supply planning, regional water quality issues, restoration implications for regional interests, recreational fisheries impacts and regulation, Endangered Species, Section 404 (USACOE) permit review, resource management planning, etc.) and coordinate Program activities with other SFRC Programs and park divisions.

Increased emphasis on plans and public awareness (with closer work with the Interpretation Division), and close direct linkage with the Research Program are priorities for the new Program. This Program will work directly with the Ranger Division, which will contribute on-the-ground implementation of resource management projects that are compatible with their needs to respond to many unscheduled events.

The need for coordination and logistical support for university researchers will continue and should grow. Likewise the need for editorial and archival support for publications, reports, and reprints will increase as our RGE positions and outside research ef-

forts expand. These functions are adequately covered in the current structure for the foreseeable future.

Research Director's Duties

The Research Director position will remain substantially encumbered as Technical Coordinator for the federal agencies while the Everglades Water Quality issues move from the federal courts to the State Administrative Hearing Process, or mediation. Additional duties also will fall to the Research Director's position as the NPS designee to the Technical Oversight Committee (TOC) established as part of the recent Settlement Agreement with the State of Florida. This Committee of technical representatives from five agencies will design all water quality monitoring and research programs in Loxahatchee National Wildlife Refuge, Everglades NP, and Water Conservation Areas 2 and 3, as required by the Settlement Agreement.

Extensive research programs to define numerically the state's Class III water quality standard, which protects the Everglades from nutrient induced imbalances in fauna and flora, also are required. The TOC will have responsibility to evaluate resource trends and certify compliance with water quality standards, at least until the year 2002—all of this in a public workshop format. Moreover, the TOC also has the unique opportunity to

coordinate the federal and state research programs for all of South Florida, for the first time; a joint, cooperative approach would vastly improve the long-term chances of the Everglades.

Assistant Research Director Position Needed

The existing workload, added to the additional time required to address these other long-term issues, has developed into a need for an Assistant Research Director position. This position, redescribed from the former Wildlife Program manager position, directs all operations and support functions and assists the Research Director in setting policies and priorities for the SFRC.

Each new Program now depends to a significant degree on the successful performance of the others. Researchers support the I&M effort because their models depend on the right data collected correctly; the I&M personnel have a stake in working with the researchers to publish trend analyses and other characteristics of the system stemming from their data.

Everyone is dependent on the data management group to make the database accessible and useful. All the other groups rely on the Resource Management scientists to deal with issues at agency forums, etc., and the resource management group uses output from all three other groups, identifies research needs through the resource management

plan update process, and provides feedback on how the combined efforts are doing in successfully addressing the main objective: supporting the Everglades ecosystem with timely and accurate information.

The new structure reflects the functional inter-relationships plus administrative support capability. The missing ingredient is simply enough base funding to fill our permanent positions.

There is strong internal support and enthusiasm for this change, and this year the process of inter-program presentations and budget critique worked well. As with any organizational structure, it will succeed or fail on the performance and cooperation of those involved. We hope this approach will contribute to the Center's effectiveness in determining the future of the Everglades.

Soukup, Director of the South Florida Research Center, is on detail for one year to the CPSU at Florida International University in Miami; Doren is Assistant Research Director of the SFRC.

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National Biological Survey: A Progress Report

By Eugene Hester

Associate Director for Natural Resources

Only a few months ago, the National Biological Survey (NBS) was only a concept and a commitment by Secretary Babbitt soon after his arrival as Interior Secretary. Much has happened in those few months and this new bureau is now a formal part of the Administration's FY 1994 budget proposal. It is scheduled to be a functioning new bureau by October 1.

I think of this proposal as entering its third phase. Phase one was a bold new concept, clearly and forcefully presented by the Secretary. He explained the need for a non-advocacy scientific biological sciences bureau and his vision for creating it. He reasoned that it could provide more and better data, understand the functioning of ecosystems, and enable managers to recognize ecosystems in trouble before the eleventh hour crises (ecological train wrecks)

caused by the listing of endangered species and the attendant protective mechanisms required by the Endangered Species Act.

The second phase was the development of the FY 1994 budget by determining which parts of the nine existing Interior bureaus should be moved to the new bureau. This included FY 1993 base funding and new FY 1994 funds already proposed by each bureau. A task force of people drawn from several bureaus was given the responsibility. Basically, the research, inventory and monitoring, and information transfer capabilities within existing bureaus were closely examined for transfer, since these are to be the main responsibilities of the new National Biological Survey.

The evolution of this concept involved the development of a Science Council and a Policy Board. The Science Council will be made up of representatives from other Federal agencies, state agencies, professional societies and non governmental non-profit and research organizations. It will assist in

improving coordination with entities outside of Interior and will offer suggestions about science trends and needs for the NBS.

The Policy Board will consist of senior representatives from all Interior bureaus. It will offer guidance to identify priorities for the NBS, so that it can produce data useful to resource managers.

We have now entered the third phase. This involves interaction with the existing bureaus as organizational units, not just task force members. It also involves interacting with Congress to approve the budget and with authorizing legislation which will be needed for a few specific items now in the Fish and Wildlife Service.

It also will involve development of specific mechanisms by which the objectives will be accomplished. These details will be necessary in order for people to understand organizational, supervisory, budgeting, and other aspects of how the work will get done. It will provide specifics to further develop the NBS from a concept to a functioning bureau by October 1, 1993.

Action vs. Rhetoric: Resource Management at the Crossroads

By Jonathan B. Jarvis

At the 1992 Ranger Rendezvous in Spokane, WA, I conducted two workshops titled "Action vs. Rhetoric: NPS Resource Management at the Crossroads" for a total of about 40 people. The intent of the sessions was to discuss and capture the attendees' feelings about the relationship between research, resource management, and park management, and to record recommendations for improving that relationship. This is a report from those workshops. I began each session with a talk that is summarized below. Following the summary is the input from those attending the workshops.

Presentation Summary

Now we have the final Vail Agenda to add to our bookshelf of reports on the "state" of the National Park System and Service. The Vail Agenda certainly is not the first such report, nor will it be the last; however it makes many excellent observations and recommendations. But what will it take to turn this rhetoric into action? Out there in the parks, on the front lines of resource conservation, protection, management, and understanding—how will this and other reports be converted into something that will truly make a difference in our jobs and in the future of park resources?

Picture yourself here:

You are the Superintendent of Big Mountains National Park, located in the wild west. You've got a solid staff, vast natural resources, a couple of horses for those frequent forays out to scenic backcountry cabins, a quality concessionaire, and a steady flow of happy campers. The sunsets are great, the air clean, and other than a meager budget, some run-down Mission 66 housing and a few personnel problems, everything is just the way you want it.

Monday morning: By noon the sh... has hit the fan.

- A local county commissioner, objecting to your policy of protecting the natural flow of the Big River, has enlisted the Army Corps of Engineers to dredge and realign the river channel. They are to begin work on Friday.

- The State Fish and Game Department calls to let you know they are stocking all your naturally fish free lakes in direct opposition to your policy against exotic species. Stocking will commence Wednesday.

- The Senior Attorney for the Sierra Club Legal Defense Fund (SCLDF) calls to inform you they have filed a lawsuit in U.S. District

Count on the grounds that your General Management Plan did not contain adequate data to analyze the impact of the decisions and development proposals.

- A seasonal maintenance worker has reported a thick, oily film on a wetland near the concessionaire's lodge. The film covers much of the marsh and has a petroleum smell.

- A seasonal patrol ranger caught a visitor family loading their car with over 200 pounds of wild mushrooms collected in the park. They are edible and the visitors state they are for personal consumption, however there is a strong local gourmet market for wild mushrooms.

- The local paper is running an article about a visitor who reported a near miss with a cougar on a park trail yesterday. The adult lion jumped into the trail within feet of their 5-year-old son, and was repelled only by the presence of their dog. That particular trail is closed to dogs. The visitor states he is going to call his congresswoman.

You call in your staff and find out that:

- You have virtually no baseline information on the Big River and only a smattering of water quality data. The district ranger knows there are bald eagles nesting along the river, but the resource management specialist says there are no monitoring data on the success of the nests.

- The backcountry ranger says they have good information on backcountry use, but nothing on the number of anglers. The resource management specialist says we have baseline data on only a few of the park lakes and she has no knowledge of research on the effects of fish stocking to fish free lakes.

- Your resource management specialist tells you that what SCLDF alleges is most likely true—that the planning team and the park didn't even have good maps of the area for the General Management Plan, much less any quantitative data.

- The chief of maintenance reports that over 1000 gallons of fuel oil are missing from the underground storage tanks at the concessionaire's lodge. The tanks are on a hillside overlooking the marshy wetland. The wetland below the fuel tanks is identified by the Fish and Wildlife Service in their wetland inventory but it is not mapped properly and there is no baseline on the vegetation found

there. The chief of interpretation says several state-listed sensitive plants probably occur within the wetland.

- The chief ranger says this is the third incident this year with mushroom collecting for apparent commercial sale. The resource management specialist says the park has zero information on its fungi species.

- The chief ranger reports that mountain lion incidents have been on the increase in the park for the last three years and the past superintendent had been funding some cougar research out of park base, but you took the funding this year to build a new fee collection booth at the entrance.

Is this the time for Mylanta? Jose Cuervo? A look at the pink sheets? The only good news is that the rangers did not cite the visitor with the dog.

These are not made up; they are real life occurrences within NPS areas.

What are the connecting threads among these problems?

First: These are resource issues! Threatened river systems, alteration of naturally fish free lakes, impacts of development plans, wetlands and hazardous materials spills, resource exploitation, and wildlife encounters with visitors.

Second: They are crises with short and long term environmental consequences.

Third: There are no easy answers.

Fourth: Every one of them could go to court, or to the press, and likely will become very political.

Fifth: You have good **qualitative** information about the resources at risk, such as the local knowledge of the bald eagle nests, the sensitive plants, and the backcountry use; however, you have very little **quantitative** data on the resources at risk from these problems. While the qualitative information is valuable in recognizing a concern, it is the quantitative information you need in order to formulate a credible response to the situations in all their political, public relations, and legal implications.

Beyond all that, what is the best course of action for the resources themselves? How many mushrooms can be collected before there is an adverse impact on the fungi population; how do cougars respond to aversive conditioning and relocation, what resources have you lost in the wetland, and how will those lakes be affected when exotic fish are introduced?

Our defense of resources with only... gut feelings, apple pie and sunsets is increasingly difficult...

Superintendents are faced again and again with making decisions that may have long term detrimental consequences to resources, and we continue to make those decisions without reliable or adequate scientific information. We also are faced with protecting, conserving, and defending park resources that we cannot even quantify.

Our defense of those resources with only qualitative information, policies, gut feelings, apple pie and sunsets, is increasingly difficult in the legal arena, the court of public opinion, and the political process. And I am not sure it is the best we can do for the resources themselves.

We need actions to convert the excellent qualitative sense of the resource felt by those working in the field into a quantitative information base that is useable and scientifically credible upon which to make management decisions.

To manage and protect the parks in today's arena, we need reliable, credible, understandable, relevant, and retrievable information about all the resources entrusted to us. The key to solid resource management is to convert the qualitative to quantitative through a solid research and monitoring program that is systematically interpreted for use by the park staff in educating the public, in decision making, in protection priorities, in planning and development, and in just plain understanding.

Fifteen years ago, in 1977, A. Starker Leopold and Durward Allen reviewed the NPS science program and made the following statement—still relevant today:

The National Park Service has reached a time in its history, and in the history of the nation, when science and research should be given a much greater and clearly recognized responsibility in policy making, planning, and operations. Seat of the pants guesses in resource preservation and management are open to challenge and do not stand up well in court or in the forum of public opinion.

At least 12 reports since 1963 have dealt with NPS management of resources and the relationship between science and management. One of the first and most often quoted was the Leopold report, *Wildlife Management in the National Parks*, named for its chairman, A. Starker Leopold. The report recommended that modern scientifically based management techniques be applied



and that park research programs be expanded. Since then, a succession of similar reports have come up with similar findings.

Also in 1963, the National Research Council made specific recommendations that the NPS strengthen research and have greater consultation between management and research units.

In 1979, the National Parks and Conservation Association Report, *No Park is an Island*, indicated that parks were indeed threatened, and this galvanized Congress into directing the NPS to survey itself. The result was the 1980 *State of the Parks Report*, one of the first self admissions of our lack of knowledge of the resources we were supposed to be protecting. The report stated that 75 percent of the reported threats were inadequately documented and that the natural science research personnel represented only 1.1 percent of the total NPS staff. The report recommended specifics for improving the NPS research and resource management program.

In 1987, the General Accounting Office (GAO) reviewed the NPS implementation of the recommendations from the *State of the Parks Report* and concluded: "The Park Service's strategy for better managing park resources has yet to be fully implemented."

In 1988, NPCA produced its magnum opus, the *National Park System Plan, Volume 2 on Research in the Parks: An Assessment of Needs*. It too made specific recommendations on increasing the role of science in park management.

In 1989, the Commission on Research and Resource Management Policy in the National Park System produced the so-called Gordon Report, *From Vignettes to a Global*

View. This report, funded by the Mellon Foundation, recommended the NPS adopt a new vision, based on ecosystem management and sound research.

And now we have two more reports:

The Vail Agenda identified a variety of actions for NPS to take to revitalize the agency. Four Working Groups made some insightful and at times critical observations: "The NPS must engage in a sustained and integrated program of natural, cultural, and social science resource management and research aimed at acquiring and using the information needed to manage and protect park resources."

The most recent report, produced by the National Research Council of the National Academy of Sciences and titled *Science and the National Parks*, does an excellent job of recounting the numerous times the NPS has been told to get its research act together:

"The recommendations of many serious reviews over nearly three decades reveal both a unanimity of opinion about the need for research to support resource management in the national parks and an abysmal lack of response by the NPS."

On page 9 of its report, the National Research Council observes: "However, the committee soon determined that the crucial problems in the NPS research program are not at the level of individual projects. Instead they are more fundamental, rooted in the culture of the NPS and in the structure and support it gives to research."

The fact that essentially the same set of recommendations has been made at least 12 times over the past 29 years with little concrete response lends credence to the allega-

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Interpreting Resource Management On a Self-Guiding Trail

By Dave Clark

Several years ago, our supply of trail folders for one of the self-guided trails at Craters of the Moon National Monument ran out. The brochure describing the cinder cones and lava flows of the area known as Devil's Orchard could easily have been reprinted. However, since the current guide was somewhat less than inspirational, we began to look for other ways to interpret this volcanic landscape. The decision was made to use this 1/2 mile trail to discuss resource management activities at Craters of the Moon. Changing the interpretive presentation proved to be quite a challenge. Presenting a series of resource management concepts in a logical manner while still relating the material to what the visitor saw at each stop seemed a daunting task.

Brainstorming sessions, however, soon suggested there were many different possibilities for developing site specific material. Features such as the broken surface of a lava flow were chosen as the focus of a discussion about visitor impacts on the volcanic features. Rocks heavily encrusted with lichens provided a site to present information on how air pollution was slowly invading the monument and destroying the cells of these plants. And finally, a grove of dead limber pine became the setting for a segment on how, in the 1960s, park managers cut down or chemically killed more than 5,000 trees infected with dwarf mistletoe. This was an attempt to prevent the development of grotesque growths known as witches' brooms, which managers of this time believed were "unsightly".

At other locations along the trail, the National Park Service's mission, the process of resource management, and the role visitor input plays also were discussed. At one location, the visitor is asked, "How would you keep people from walking off of the trails?" At the same time, they are provided with a variety of possible solutions that have been tried in other areas of the monument. The purpose of this exercise is to demonstrate the complexity of resource problems, the conflict between use and preservation, and the difficulty in finding solutions that work. All of this information will be displayed on a set of eight wayside exhibits funded with a grant from the National Park Foundation. In addition, the Craters of the Moon Natural History Association will be publishing a guide that provides more in-depth information about resource management issues. This guide will be different from most trail folders because it will not be used by visitors while

they are walking the trail. Instead the guide will be provided at the end of the trail. In some ways, the success of our efforts will be measured by the number of visitors whose interest in resource management is piqued enough to want additional information.

Prior to the final development of this project, the monument's staff used a mock guide and set of waysides to test the visitor's reaction to our presentation. A focus group survey resulted in some interesting comments that revealed the following:

- Visitors are preconditioned to expect a traditional interpretive presentation on a "nature trail". Visitors are much more receptive when the reasons for a new approach are explained to them.
- A small group of visitors considered the presentation of this material the ultimate in "bureaucratic propaganda." Other visitors felt the interpretive message should be even more aggressive and hard hitting. The majority of visitors were very receptive to an interpretive presentation with a resource management theme.
- Parents had no problem with the material being presented at an adult level. They were willing, and in some cases delighted, to explain the information to their children. Many parents commented that this was a subject they particularly wanted their children to better understand.



Visitors pause to read about how park managers in the 1960s tried to stamp out as "unsightly" the grotesque growths of "witches broom" (dwarf mistletoe) that grew in the park. The efforts killed more than 5,000 trees, of which this dead limber pine and its companion growths are an example.

Interpretation IS Management

By Charles W. (Corky) Mayo
Chief of NPS Interpretation

The two articles included in this issue by Lois Winter and Dave Clark address an important concern regarding involvement of interpretation and interpreters in the NPS resource management story. If you believe that good information (facts) provide the building blocks of the interpretive story then it is a foregone conclusion that any and all involvement with those who collect and analyze the facts can only support our delivery of the park story.

Upon my recent arrival in Washington, I was pleased to hear from Bob Huggins that the Division of Interpretation is directly involved with several task force groups dealing with science and resource management. These groups include fire education, white-tail deer management, and natural resource education.

In the 80s, we banded about the idea that interpretation is a tool of management. I would encourage you to read these two articles, for as they clearly point out, good interpretation is not a tool of management, but indeed management itself—with an equal and justifiable seat at the place of park decision-making.

- When the area is a magnificent experience in itself, it is difficult to entice some visitors into interacting with displays or publications.
- Interpreters need to be extremely careful when working with concepts that are well-known to them, but less familiar to the visitor. Review by different readers and experts revealed that the information can be perceived in many different ways. Constant testing of the material and its presentation provided many surprises and improved our ability to communicate complicated ideas.

We know of several other self-guided trails in the National Parks that deal with specific resource issues (the recently built trail discussing the role of fire in Yellowstone is a good example). The trail at Devil's Orchard may be the first to attempt to define the entire process of resource management. During the summer of 1993, the production of a set of permanent wayside exhibits, the construction of a barrier free trail, and the publication of a guide titled, *Resource Management: The Science of Erasing Footprints*, will make our efforts to better interpret resource management a reality.

Clark is Chief of Interpretation at CRMO.

Bridging the Communication Gap: Linking Interpreters, Resource Managers, and Researchers

By Lols Winter

Editor's Note: This is a slightly edited version of an article that appeared in the Fall 1991 issue of Interpretation—an issue that is no longer available.

In the Summer 1989 issue of *Interpretation*, Al Lovaas, Regional Chief Scientist in Alaska, stated: "If research can be thought of as the inquisitive and analytical mind of the National Park Service, interpretation is its heart." Parks desperately need scientists to document what resources we oversee and how we can protect those resources. But while scientific data is essential in courtrooms, and parks are invaluable control areas for researchers, parks are important for more than their scientific values.

I believe that in the minds of many visitors, the greatest value of parks resides in their inspirational qualities. But science is essential to interpretation, and to effectively inspire our sophisticated audience, interpreters need (among other things) current and accurate scientific information. Therefore, if we hope to protect park resources, researchers and resource managers need interpreters, and interpreters need researchers and resource managers.

Only when visitors understand the critical problems that threaten park resources can we expect them to play a role in minimizing those problems. Interpreters must use current research and resource management projects as tools to focus attention on resource issues confronting our parks.

In addition, interpreting research projects allows visitors to explore the value of parks as laboratories for social, cultural, and natural resource studies, an important park value that visitors may not intuitively appreciate. Furthermore, staying in touch with researchers helps interpreters remain current in their thinking and helps assure that information directed to the public is up to date. Finally, research and resource management are FUN to talk about! Effective interpreters are eager to enliven their presentations with new information, and visitors love to hear up to date reports describing what's going on behind the scenes to protect the parks.

Obviously, a communication link between researchers, resource managers, and interpreters benefits us all. But how successful are we at maintaining that link? Based on years

of experience in interpretation, my two years in research, and discussions with tens of researchers and NPS employees, here are my recommendations for bridging the communication gap:

1. Designate a research liaison in the Interpretive Division of each park with the formalized duty of forging an effective link among resource managers, researchers, and interpreters. Many Park Service employees wax eloquent about the need for such communication, but a collective responsibility is one that tends to remain undone. By directing the responsibility to one individual it is far more likely that the job will get the attention it deserves. Duties could include any or all of the following:

a. Maintain good working relations with the park's resource management staff. Understand resource management's objectives, demonstrate familiarity with the Resource Management Plan, stay abreast of current initiatives, attend resource management staff meetings, and suggest new research questions. Read scientific reports and journal articles relevant to park issues and attend science conferences. Occasionally observe and/or participate in field research projects.

b. Review draft research project proposals that define and formalize the NPS involvement with researchers. Carefully limit comments to the researcher-interpreter communications link.

c. When a new research project begins, attend meetings ordinarily scheduled between the park's resource management staff and the researchers. Cultivate a realistic understanding of the research project's objectives and limitations. Discuss ways that resource managers and researchers can assist interpreters to understand the research and interpret it to visitors... Assure researchers that their efforts to communicate with the research liaison will be evident in the park's interpretive program.

d. Throughout the project, remain in contact with resource managers to monitor progress. Researchers may be encouraged to lead a field trip, present a lecture, or write an update for field interpreters and/or park visitors.

e. At the end of the research project, maintain contact with the resource management specialist to confirm that all require-

ments in the research proposal with regard to the communications link have been met and final questions resolved.

f. Establish a network with nearby universities and state conservation agencies. Timely and important research directly relevant to park interpretation happens outside the parks' boundaries.

g. Digest, compile, and summarize research reports and other information from researchers and resource managers. Summaries can provide field interpreters a maximum amount of information in a minimum of time. Summaries can include a bibliography to direct interpreters to more detailed information sources. Encourage field interpreters to include relevant, accurate information on research in their programs.

h. Make sure a copy of every research report is accessioned in the park library. Deliver appropriate annotated research project slides and photographs to interpretive files.

i. Organize a lecture series on research and resource management projects relevant to the park for NPS staff, local residents, and visitors.

j. Design interpretive activities that highlight research or resource management projects. Invite visitors to participate in actual or simulated nesting surveys, gypsy moth trapping, air quality monitoring, beaver management activities, etc.

2. When drafting research project proposals, Regional Office Science Division employees should incorporate specific requirements to assure that park interpreters have access to important information from researchers. Ways of establishing the link might include:

a. Require that copies of the research proposal, thesis proposals, and final project reports and/or theses be delivered to the Interpretive Division's research liaison.

b. Require researchers to meet with the research liaison and resource managers at scheduled intervals until the project's conclusion.

c. At project conclusion, require the researcher to write a brief report in layman's language, summarizing research methods, results, remaining questions, and concerns that should be relayed to the public.

d. Researchers should be encouraged to make their required final oral report to the park staff at a time when a maximum number of "seasonals" are available to hear the presentation.

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tion that there is something about the NPS culture that is holding back the use of research in park management.

The NPS culture is exceptionally strong. The Association of National Park Rangers is evidence of that, as was the response by the NPS "family" to the tragedies of Hurricane Andrew at the Everglades. Our legacy of the committed, knowledgeable, field skilled, helpful ranger is as strong as ever. Our resistance to change and interference from hostile administrations is legendary. All of this is part of our culture and our strength. But we must look closely at our culture to determine if it also is part of a **problem** when one considers our slow response to the need for research and sound scientific data in making management decisions. As with the alcoholic, recognition that you have a problem puts you half way to recovery. My suggestion is that there are **cultural** barriers within the NPS that prevent research and resource information from playing a significant role in management decision making. Therefore, in order to make meaningful change, we should recognize those barriers and act positively to overcome them.

Workshop Responses

After the above presentation, I posed two questions to the group: **"What are the cultural barriers to the improvement of our understanding, conservation and protection of resources at the park level?"** and **"What are the actions needed to correct or overcome these barriers?"**

The response by participants was open and candid and offers insight into the question of organizational culture. The full response is available upon request, however the following is a summary. Concerning cultural barriers, some of the comments were:

- frequent transfers and lack of continuity
- lack of superintendents' understanding of research
- old school, scenery management
- crisis management
- rivalry and turf battles between resource management and rangers.
- rewards to superintendents for politics and facility development rather than research and resource management
- organization of resource management within the ranger division
- frequently changing "thrusts" in funding priorities

Based on the active participation by workshop attendees and their open and at times excited discussion, there are some strong

ideas and feelings about "cultural" barriers that could be changed within the NPS to improve the relationship between management and science. Common threads I have identified from the above are:

- There is a need for training in resource management, monitoring, and research methods for everyone, but particularly for Superintendents.
- There is a need for accountability, again for all staff but particularly for Superintendents.
- There is a need for team building and reduction of rivalry between divisions through recognition that research and resource management enhance all jobs rather than competing with them.
- There is a strong need for funding continuity and the avoidance of seasonally changing "thrusts."
- There is the need to maintain continuity of research and resource management programs through staff changes, particularly at the Division Chief and Superintendent levels.
- There is a need to provide organizational consistency, with resource management as a division function in line authority to the Superintendent.

Many of the items above are within our individual control at the park or regional level. I believe, by recognizing the "cultural barriers" and taking actions to correct or alter them, we will make significant strides toward the long term protection, scientific understanding, and informed management of park resources.

Jarvis is Superintendent of Craters of the Moon National Monument.

Bridging the Gap continued from page 9

e. Require researchers to provide slides, specimens, or other tangible items that can be used in interpretive programs.

3. Because research may have significance in parks other than the one in which it was carried out, every Regional Chief of Interpretation should stay in touch with the Region's Chief Scientist. By maintaining a basic awareness of ongoing nationwide NPS research, the Interpretation Chief can alert each park's research liaison of potentially relevant research in other parks.

4. To emphasize its importance, incorporate a section in the Statement for Interpretation detailing interesting research

Interpreters Note!

The following excerpts, from an article by Chris Maser, author of *The Redesigned Forest*, that appeared in the March 27 issue of the *Corvallis Gazette-Times*, provide material for illuminating the sometimes elusive subject of biodiversity.

"Biodiversity—the diversity of living species and their biological functions and processes—acts as an ecological insurance policy for the flexibility of future choice of management options. This is because every ecosystem adapts in some way to changes in its environment. In turn, the degree of a system's adaptability depends on the richness of its biodiversity, which provides a redundancy of function that retains the system's ability to respond to continual change.

"Redundancy—duplication or repetition of the elements of a system—provides alternative functional channels in case of a failure. Each ecosystem contains built-in redundancies that give it the resilience to resist change or to bounce back after disturbance ...

"There is a point, however, at which the loss of one more species will tip the balance and cause the system to begin an irreversible change that may well signal a decline in quality and productivity. This point of irreversibility is an unknown biological threshold in that we don't know which species' extinction will trigger its effects. That's why it pays us to save every species we can.

results and describing progress and stumbling blocks in establishing and maintaining the interpreter-researcher connection. Establishment of the communication link among interpreters, researchers, and resource managers, possibly along the lines outlined above, will provide a vital tool for mobilizing public support for long term park protection.

Winter is presently Chief of Interpretation at Minute Man National Historical Park, P.O. Box 160, Concord, MA 01742.

USGS Provides Baselines For Two Alaska Parks

By J.G. Crock, R.C. Severson, and L.P. Gough

Through the cooperative efforts of the National Park Service, over the past two years U.S. Geological Survey (USGS) has worked in Alaska to develop geochemical and biogeochemical baselines for Denali NP and Preserve (DENA) and Wrangell-St. Elias NP and Preserve (WSEP).

Three fundamental objectives are common to all baseline studies, but first, a basic definition: A baseline represents the concentration of a given parameter measured at some point in time—a snapshot—and may not represent a natural concentration devoid of human influence.

Inherent in establishing baselines is the need to describe the nature and variation of the environment—important for attaching a confidence level to any geochemical map produced. Next is the need to assess the extent or intensity of alteration to the environment—how much has the system been disturbed (either naturally or by humans). Finally, we want to provide basic information for studying environmental processes—information for formulating hypotheses on the mobilization, transportation, and deposition of elements.

At DENA, in central Alaska, a coal-fired power plant in the town of Healy near the park's northeast corner may be enlarged from 25 to 75 MW. At WSEP, a proposed 10 MW coal-fired power plant near the town of Gakona would provide power for a proposed radar complex. At both sites our studies were to establish the feasibility of preparing geochemical and biogeochemical maps and to establish baseline information for native vegetation and soils. This information could then be used to assess possible geochemical impacts on the biological resources of the parks.

For these studies, we sampled *Hylocomium splendens* (feather moss), *Picea glauca* (white spruce), *Peltigera aphthosa* (soil lichen), and the top, organic-rich soil horizon. All samples were analyzed for their major, minor, and trace element content by a variety of analytical techniques by the Branch of Geochemistry staff.

Sampling sites for the DENA study were positioned at geometric intervals along three generally west to east traverses and one north to south traverse, all starting about 0.25 km from the existing power plant. The samples for the WSEP study consisted of three traverses originating from the proposed power plant site and going south and east into the park. Two different methods of baseline calculation were used. For DENA, baselines were calculated as a range of observed values from the samples collected at sites beyond 6 km from the existing power plant. This distance

proved to be beyond the probable influence of the facility. For WSEP baselines were calculated from the total range of all samples collected.

Elemental concentration baselines for both areas followed the general trend of soil > moss > or = lichen > or = spruce. For most elements, there is good agreement with the limited available literature. For a given element, for a given medium, WSEP was similar to DENA. Noticeable point-source element concentration trends do exist for all

the media sampled for the DENA study, but for many of the environmentally important elements there is a leveling-off effect seen 6 km and beyond from the existing power plant.

Crock, a Research Geochemist, Gough, and Severson, all are with the USGS, Branch of Geochemistry, in Denver, CO. Open-file reports on these two studies are available from Dr. Crock at USGS, Federal Center, Box 25046, MS 973, Denver, CO 80225.

Meetings of Interest

1993

Aug. 24-26

12th WILLIAM T. PECORA REMOTE SENSING SYMPOSIUM, "Land Information from Space-Based Systems," Sioux Falls, SD. Sponsored by the USGS in cooperation with other federal agencies. Contact: Dr. Robert Haas, Symposium chair, (605) 594-6007 or Dr. James W. Merchant, Program chair, (402) 472-7531.

Aug. 24-26

CREATING A FORESTRY FOR THE 21st CENTURY: A Landmark Symposium, Portland, OR, sponsored by the Olympic Natural Resources Center at Univ of Washington; to examine the state of knowledge with respect to forest systems and explore implications of that knowledge for management, planning, and policy. Plenary sessions, displays, demonstrations, discussions and field trips will culminate in production of a book. Contact: Kathy Kohn, U/WA, Coll. of For. Resources AR-10, Seattle, WA 98195; (206) 685-4724; (for registration information, (206) 543-0867).

Sept. 19-21

ECOLOGICAL IMPLICATIONS OF FIRE IN GREATER YELLOWSTONE, The Second Biennial Scientific Congerence on the Greater Yellowstone Ecosystem, at Mammoth Hot Springs Hotel, Yellowstone NP. Contact: Conference Registration, P.O. Box 117, Yellowstone NP, WY 82190.

Sept. 30-Oct. 2

1st BIENNIAL ROCKY MOUNTAIN ANTHROPOLOGICAL CONFERENCE, Jackson, WY, featuring a full-day symposium on "Mountainous Environments and Human Adaptation: The Greater Yellowstone Area," dealing with landscapes, fossil insect studies for understanding paleoenvironmental change, prehistoric settlement of the region, obsidian studies, rock art, geoarcheology and paleoecology of the uplands, and management issues in the mountains. Contact: Jamie Schoen, Bridger-Teton NF, P.O. Box 1888, Jackson, WY 83001 (307) 739-5523.

Oct. 25-28

SECOND BIENNIAL CONFERENCE ON RESEARCH IN COLORADO PLATEAU NPs, at Northern AZ University, Flagstaff, highlighting biological, cultural, social, and physical science research in NPs and related areas on the Plateau. Contact: Mark Sogge, CPSU/NAU, Box 5614, Northern Arizona U, Flagstaff, AZ 86001; (602) 523-9090.

1994

June 7-10

FIFTH INTERNATIONAL SYMPOSIUM ON SOCIETY AND RESOURCE MANAGEMENT, CO/State/U, Fort Collins, CO. Michael J. Manfredi, Program chair, has called for papers by Nov. 1, 1993, to Manfredi, Human Dimensions in Natural Resources Unit, CO/State/U, Fort Collins, CO 80523.

Wilderness Research Institute Named For Aldo Leopold

By Alan E. Watson

Aldo Leopold was an important participant in pioneering the concepts of ecological integrity and preserving wild places in America. Though the beginnings were modest, the current size of the National Wilderness Preservation System exceeds 95 million acres. The attention of federal land management agencies must now turn energetically to managing the values related to those areas.

Aldo Leopold, second from the right in this photo, posed with fellow foresters in this "Arizona foresters at work" photo taken July 25, 1910.



Aldo Leopold and his creative management vision were honored recently, when the USFS Chief announced establishment of the Aldo Leopold Wilderness Research Institute in Missoula, MT.

The Institute's mission will be to obtain and provide information necessary to sustain wilderness resources in an ecologically and socially sound manner for present and future generations. This mission will be accomplished through research, publication, and training, using partnerships among agencies with wilderness responsibilities, non-governmental organizations, and universities.

To reflect the research needs of the entire National Wilderness Preservation System, representatives from the USFS, the NPS, the USFWS, and the BLM will serve on the Institute's Steering Committee. This Committee will participate in defining short- and long-term work objectives for the research program supported by the Institute.

Currently it is anticipated that Institute scientists will lead research in five broad topic areas: (1) to protect the wilderness resource from both internal and external threats; (2) to facilitate provision of the beneficial uses of wilderness; (3) to allow comparison of relatively pristine wilderness with more intensively managed lands; (4) to understand global changes in resource conditions; and (5) to determine trends in use and condition of the System.

The core team of Institute scientists will come from the Forest Service's current wilderness management research project at the Intermountain Research Station in Missoula. These scientists will work with scientists around the world at universities or wilderness management agencies. The Institute will be located on campus at the University of Montana. Dedication of the Institute is scheduled for Aug. 21, 1993. Questions can be addressed to Director, Aldo Leopold Wilderness Research Institute, USDA Forest Service, Box 8089, Missoula, MT 59807.

Watson is a USFS Research Social Scientist at the Institute.

When Scientific and Cultural Values Meet

Editor's Note: This note on a trail ride accompanied Alan Watson's article on the Wilderness Research Institute; it deserves sharing.

It was early September, along the North Fork of the Sun River in western Montana. Daytime temperatures in the 60s contrasted wonderfully with the cold nights and early morning frost as we drew near the Continental Divide. Our group of six scientists and wilderness managers was on a 3-day, 75-mile packtrip into the Sun River Game Preserve portion of the 1.5 million acre Bob Marshall Wilderness Complex. Our purpose was to examine the effects of the 52,000 acre Gates Park Fire, on one of the less well-known, though substantial, wildland fires of 1988.

While our intent was to discuss vegetative changes and visitor reactions to the vast burned landscape, what remains in my memory is a strong symbolic image of wilderness. The skeletal remains of the forest presented a black and white landscape, punctuated by bursts of color from vigorous clumps of young aspen, from brilliant patches of crimson fireweed, from scattered lodgepole pine seedlings, and from the occasional bunch grasses of luminescent green. As we rode, Kelly, who grew up in nearby Choteau, mentioned he didn't see much of his young wife during the summer and fall months when he was a wilderness ranger in the highcountry of "the Bob." He said his other love, however, was always with him in this wilderness, especially in the burned over Gates Park area.

When we jokingly inquired as to this other love, Kelly dismounted, cut a thimbleberry stalk low to the ground, and went to work

with his knife. As we watched, he hollowed out the pithy stem and made expert cuts at both ends of what looked like a green flute. He worked only a few minutes, then pressed the thimbleberry stalk to his lips and blew hard. The loose, stringy fibers vibrated in the tube as the air rushed through, creating a high pitched "bugle." An immediate bugle response came from a bull elk on high ground above the river bottom. It left no doubt in our minds that the identity of Kelly's "other love" was the feeling of belonging to this place.

With his demonstration of primitive skill in the middle of this vast burned laboratory, this young man reminded us of the many values wildlands offer. What I learned about human resourcefulness, the kinship between people and elk, and the symbolic interaction between humans and the land provided me with a lasting impression of wilderness that evades precise scientific description.

Service Reviews Effectiveness Of Resource Management Plans

By Steve Cinnamon, Adrienne Anderson, and Karen Rhem

A workshop on resource management plan (RMP) guidelines was held in Tucson, AZ, in early March to evaluate the existing process and guidelines and to make recommendations for their improvement. All Regions were represented by personnel who have responsibility for resource management planning activities.

Six parks, and staff representing all Regions, were involved in presentations and panel sessions on subjects including park programs, park, regional, and Washington office use of the RMP, role of RMP in planning and budget cycles, compliance concerns, and the software developed to capture Servicewide issues and needs.

It became apparent from the outset that not all Regions are using the plans effectively or in a consistent manner. The initial session on the history of RMPs indicated mediocre compliance with the 1981 guidelines. A review of the current status of the approved RMPs underlined the problem. It appeared to participants that for the most part the Service has not taken seriously the task of writing and following RMPs. As of December 1992, only 43 RMPs had been approved Servicewide. However, current information indicates that 220 Plans are in various stages of revision. The March 1989 guidelines held that all Plans were to be updated within the 4-year period.

Two key sessions were Mac Brock's (VOYA) presentation on how a park could use an RMP effectively, and Charles Van Riper III's step-down process, used to identify various program entities that need to be accomplished to achieve an end result. These two sessions demonstrated that resource problems are divided amongst various program area responsibilities; they were cited throughout the workshop as examples of how RMPs could be used effectively.

Central office support for RMPs is provided on the natural resource side by Jen Coffey in the WASO (Washington Office) Wildlife and Vegetation Division, and on the cultural resource side by Laura Feller in the WASO History Division. The WASO natural and cultural resource staffs are working together to support Regions and parks in RMP policy development and review. As awareness of resource management has increased, the importance of RMPs as the foundation on which resource management programs are built is being realized.

As regional representatives discussed tactics to implement the 1989 guidelines, it was apparent that the Southeast Region's approach to complete scoping sessions and to keep parks on a timetable has been effective. The scoping process, amended from that described by NEPA, has been applied with some success in six Regions. Regions that have not applied the scoping process, intend to try this approach.

The value of the RMP was discussed at a panel session with park, regional, and Washington office representatives. Some presented the RMP as a budget document, with brief narratives describing the problem and proposed action. These views were countered with perspectives that the Plans are keystone documents for the parks. The parks' resource management programs should be the heart of the Plans. The Plans serve several purposes: as an institutional memory; as a document reviewed by the public, researchers, and various agencies; and as a park program document reviewed by park management and fiscal managers.

The Plan has been project oriented with the problem statements reflecting how ecosystems are disrupted and how natural resource communities are jeopardized. Rather than brief narratives typically associated with budget documents, it was proposed that the Plan narratives be complete enough to describe why the resources are in the condition they are in; the narrative describing the park's strategy should be detailed enough to match the complexity of the resource issue. Current use of the RMP as a budget driven document competes with the view that the document should provide a programmatic approach to management of our resources. The various regional approaches to the use of 10-238s and outline of park planning requirements (OPRs) indicate that as a Service we are not on the same interstate highway. Instead, we are analogous to a number of frontage roads at various distances from the thoroughfare.

If the Service is to begin to consolidate the resource needs to meet its management objectives, focus should be realigned to emphasize the importance of the RMP as a tactical and strategic planning document. The Plan is used by a variety of people who have different data needs and interests. The Plan and project statements must serve as the institutional memory and be the environmental conscience driving park management.

Participants were reminded that the Plan is the central document that reflects the park's tactical and strategic plan for resource management. The project statements reflect problems facing our resources. The majority of the project statements on natural resources reflect "violations" of basic ecological principles. Habitats no longer are intact; populations are fragmented and unable to sustain themselves; air and water quality have deteriorated to the point that basic requirements for organisms or ecosystems to sustain themselves cannot be met. These conditions reinforce the observation that the park RMPs are rooted in conservation biology principles. As these principles are further violated, it will be more critical to look at management strategies to preserve the resources for future generations.

For cultural resource managers, the RMP Workshop was a thought provoking look at future management trends being developed for natural resources with an eye to applying them to management of the vast array of cultural resources in the National Park System. After extensive discussion, a consensus was reached that the R-MAP (Resource Management Assessment Program) process, developed by the Western Region (which develops sub-programs relating to resource needs), could provide programmatic direction for RMP development. The R-MAP staffing requirements relate to the personnel on hand and provide managers with a unique opportunity to visualize their staffing needs. While it is unclear whether WASO will develop a R-MAP program for cultural resources, there are several possibilities for expanding the use of integrated management techniques in addressing cultural and natural issues through the RMP process.

The Vail Agenda identified the need for natural and cultural resource management to work together in addressing the urgent needs and potential threats affecting the special places under our stewardship. The RMP can be the tool to implement a stewardship program based on the resources, rather than on personal preferences. Perhaps the most valuable insight gained was that there is common ground where natural and cultural resources can meet and provide a better future for all.

Walt Sydoriak (software contractor), Lincoln Fairchild (computer specialist, Cultural Resources), and Tim Goddard (computer specialist, Wildlife and Vegetation Division) presented a session on software development

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Insularity Problems in Rocky Mountain Bighorns

By Francis J. Singer

Most populations of bighorn sheep are small and isolated. Their populations in western U.S. are presently only a fraction (about 2-4%) of their estimated historic numbers. Most populations were extirpated in the late 1800s and early 1900s, due to overharvest (including extensive market hunting), habitat disturbances, and disease epidemics resulting from stressful contacts or transmissions from domestic livestock.

Eighteen of the NPS units (parks, monuments, and recreation areas) in the Rocky Mountain region historically supported bighorn populations. One of three subspecies inhabiting the region—the Badlands subspecies of the Dakotas and eastern Montana—was extirpated. Bighorns survived in only 5 of the 18 NPS units. Limited restoration efforts occurred over the past three decades until now some bighorns occupy 16 of the units. Many of the herds, however, occur in fragmented, isolated groups; 66 percent of the herds number fewer than 100 individuals. Five herds contain only 6-17 animals and are in immediate danger of extirpation (Fig. 1).

A few success stories exist. Bighorns survived the die-offs in Canyonlands and Rocky Mountain NPs and with some transplanting both parks are completely occupied by bighorn populations numbering about 1,000 each. Transplanted bighorns in Badlands NP tripled their numbers; they invaded the Stronghold unit on their own during the 1980s.

Insularity and Fragmentation

Life history and habitat requirements of bighorns in concert with human disturbances tend to predispose the species to fragmentation and small population sizes. Bighorns occupy patchy habitat, consisting of open cliffs and nearby grasslands. The animals avoid forested and low flat terrain and are poor dispersers. Knowledge of migration routes through such dangerous terrain is passed among generations; knowledge of the routes, lost with extirpated herds, may never be reestablished by transplanted groups.

Bighorn populations are hypersensitive to disease pathogens that wipe out some herds, further isolating any surviving groups. A dominance hierarchy among the males limits participation in breeding to only the oldest (7+ years), largest-horned, and most dominant males. Restriction of successful breeding to as few as 10-25 percent of the males reduces the effective genetic size of the group. Extreme inbreeding has been shown to result



in smaller horn size in bighorns, and in reduced dominance, fecundity, and fertility in many mammals.

Factors likely responsible for failure of past restoration efforts include

- (1) too few transplants occurred and much occupiable habitat remains;
- (2) transplanted groups are notoriously poor dispersers and typically remain on or near the release site;
- (3) most transplant groups number fewer than 20, and if initial population growth is slow, inbreeding is likely;
- (4) small, sedentary groups of bighorns are easy for predators to relocate, thus increasing the relative impact of predation, and
- (5) transplanted bighorns may avoid historic habitats now overgrown with tall shrubs and trees due to fire suppression.

The Regional Initiative

Bighorn needs, assessments, and planning are underway in FYs 1991-93, with a WASO NRPP funded initiative. The program's goal is to restore bighorns to all occupiable habitat in the region. A first step was visitation to 15 of the units by scientific advisory committees. This process was completed in 1991.

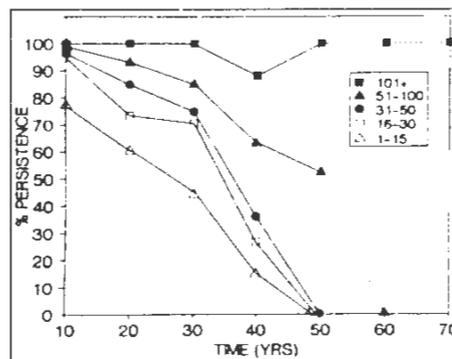


Figure 1. Persistence over time of bighorn populations of varying size (from Berger 1990). No population of less than 50 animals survived for 5 decades.

Secondly, GIS-based habitat assessments will be made of the suitability of potential transplant sites, to be accomplished by the end of FY 1993. Disease and genetic surveys will be conducted in all potential source herds for transplants and in any remaining resident groups.

A new census technique is being tested, the better to evaluate management programs. Experimental burning is being done in Badlands and Dinosaur in an attempt to enhance bighorn movements and recovery. Studies of the number of males participating in the rut and surveys of genetic heterozygosity will better define minimum viable population sizes. Interagency metapopulation restoration plans will then be drafted, source stock requested, any habitat improvements (e.g. prescribed burning) conducted, and then transplants and the follow-up monitoring conducted.

Ten interagency working groups have been convened. As a result of interagency cooperation, bighorn assessment expenditures on lands adjacent to NPS lands exceeds the original NRPP funding by a factor of 2.5 times. Most NPS areas are too small to support the entire metapopulation size necessary for long-term viability, thus cooperation with BLM, USFS, and various state agencies is essential. Restoration efforts are predicted to take another four years after the assessments and planning efforts are completed.

Two reports available from the author, at the NPS/CPSU, Natural Resources Ecology Lab, Colorado State University, Fort Collins, CO 80523, are:

Bighorn Sheep in the Rocky Mountain Region. Reports of Five Scientific Advisory Committees to the NPS. 39 pp. NPS, Natural Resource Publication Series, Denver, CO; and *Problems of Insularity of Bighorn Sheep in the Rocky Mountain Region*; a review of current status and success of transplant efforts. NPS Natural Resources Technical Report Series, Denver, CO.

Singer is a Research Ecologist at the NPS/CPSU, CO: State U, Fort Collins.

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Olympic Mountain Goat Update

By Paul Crawford

Bighorn die-offs due to diseases severely hamper restoration efforts. The largest recent die-off occurred in southeastern Utah in Canyonlands NP, Glen Canyon NRA, and adjoining BLM lands. The die-off started in or near the Needles district of Canyonlands in 1985, and by 1989 it had traveled nearly 100 linear miles through the North and then the South San Juan herds. Where once 1,000 desert bighorns roamed, fewer than 100 now exist. No evidence of recovery has yet been observed. Lamb survival still is essentially non-existent each year, and as recently as 1992, 3 of 5 adults captured in the Needles district were sick. Cause of this die-off has not yet been determined.

In 1992, WASO NPS selected the bighorn problem for Servicewide program development. Objectives are to (1) sample select herds for disease organisms, especially those with recent history of infectious diseases outbreak and/or chronic poor recruitment; (2) survey diseases in herds for potential transfer to avoid introduction of a novel pathogen, and (3) develop protocols as a model for other regions with wildlife disease problems.

From *Bighorn Diseases in the Rocky Mountain Region: a Servicewide Wildlife Disease Surveillance Program*. By Drs. of Veterinary Medicine Sharon Taylor, Mike Miller, Terry Spraker and Beth Williams.

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and the most recent versions thereof. The software has strength to meet many WASO or regional needs, yet does not lend itself well to park requirements for an attractive public document. The recent improvements include expanded reporting capabilities that will aid management inquiries and budget calls. Park people in attendance reminded the group that the software still needs betterment in order to meet their needs.

Workshop results emphasize improving existing guidelines and procedures. First, the software revision process will be bettered. A "software testing team" will review and test future versions of the software before they are released. A "software development team" will analyze feedback and set priorities for future software enhancements required by parks and Regions. A "technical support team" will be formulated to provide detailed software support for all users, via telephone or electronic mail.

Cinnamon represented the Midwest Region; Anderson, the Rocky Mountain Region, and Rhem, the Southeast Region.

In the 1920s, 12 mountain goats were introduced into what would, in 1938, become Olympic National Park. By the 1980s, their population had grown to more than 1000 animals. Mountain goats, though a native North American mammal, are not native to the Olympic Peninsula; serious damage to the park ecosystem from their presence has been documented.

Park research on goats and their effects on native ecosystems has taken place from the 1970s to the present. Work has concentrated on impacts to soils and vegetation (including rare and threatened plants), biology of goats, sterilization/contraception as a population control, and live capture methods. Subject matter professionals from around the country have been consulted for advice and peer review in several aspects of the issue. A number of papers resulting from goat research have been published in refereed journals.

The park has written two prior NEPA documents: a 1981 environmental assessment on experimental management and a 1987 assessment on the first management plan. Many public meetings were conducted.

Between 1981 and 1989, 407 goats were live-captured, removed from the park, and released elsewhere in Washington and other western states. The live-capture program cost the park an average of approximately \$1,000 per goat in 1989. In 1988, after 10 years of peer-reviewed research (including experimental live removals) and completion of the second assessment, the park began a goat management program that stipulated continued live-capture removals, with an option of shooting by park rangers to be considered in 1991. This program was terminated a year early, due to unacceptably high risk to park personnel and a rising mortality rate for goats during the capture operations. Practically speaking, the program had reached the limits of population reductions that could be achieved through live capture.

Current Status

In 1991 the Olympic National Forest (NF) and Washington State Department of Wildlife (WDW) joined with the park to form the Interagency Goat Management Team (IGMT). Within the park, NPS has sole management jurisdiction over all wildlife. On adjacent goat range in Olympic NF, the

USFS manages the habitat, while the State manages the wildlife. The team's goal was to cooperate in writing a Draft Environmental Impact Statement (EIS) for mountain goat management on the entire Olympic Peninsula.

In January 1992, the IGMT sponsored a series of four scoping meetings, soliciting public comment on concerns and ideas that should be incorporated into a draft EIS. Alternatives for the park include no action, control (reduction) of sub-populations, and total elimination from the park.

At this date, problems have arisen with the differing agency mandates and policies, and although the State and Forest Service will continue to assist in the planning process, the EIS will apply only within the park.

Scientific issues related to the mountain goat program have undergone thorough academic scrutiny. The park's long-term study of goats and their effects on plants and soils was submitted for peer review last spring, was revised to reflect the reviewers' comments, and has been completed in final form. A peer review of sterilization and contraception techniques conducted in October 1991 determined that none of the techniques is feasible at this time. A thorough search of historical and archeological records has been conducted to answer any lingering doubts about the exotic status of the goats. The information from this records search also will undergo technical evaluation by subject matter experts.

Scrutiny in the print and broadcast media has been exhaustive, both locally and nationally, with recent articles in the *Wall Street Journal*, *National Geographic*, and *Reader's Digest*. There is strong and rapidly growing interest in this issue, with opposition being voiced by animal rights groups and strong support for goat elimination coming from conservation organizations.

Finally, the NPS Pacific Northwest Regional Office and the Washington Office have reviewed the research, policy, operational constraints, and law, and have accepted the park's analysis of the issue and recommended that it proceed with developing a DES. The matter is being viewed as a major test of NPS policies on exotic species management.

Crawford is a Resource Management Specialist at Olympic NP.

Dump truck shown here is unloading fill material onto a canal plug. (Photo by D. Weeks)



By George L. San Miguel

The Turner River is a small meandering stream that emanates from the cypress swamps of southwestern Big Cypress National Preserve (BICY). The 9 mile long river empties into the Chokoloskee Bay estuary among the mangrove swamps of northwestern Everglades NP. The primary significance of the Turner River stems from the scarcity of such streams in south Florida. Its upper course is the only natural channel of fresh water available for recreational fishing and canoeing. At its south end, the Turner River Canoe Trail joins Everglades NP's 100 mile long Wilderness Waterway boat trail.

Prior to the 1960 construction of the Turner, Birdon, and Wagon Wheel roads, the river attracted tourists to Turner River Jungle Gardens, which offered boat trips along its course. After construction reduced the river's flow stages, small boat and fishing activities became limited to the dull, straight channel of Turner Canal. The canal was dug to provide elevating fill material for the road.

Construction of Turner Road and Turner Canal severed the Turner River from its upper drainage basin. Similar impacts were suggested for the Deep Lake Strand drainage in the northern part of the Turner Road and Canal construction area. Surface water, which normally contributed to the river's natural stages and discharges, bypassed the river, making much of the natural stream virtually unusable. River waters became shallow and stagnant. The stream bed began filling with detritus, promoting the growth of emergent thickets of giant cutgrass (*Zizaniopsis miliacea*) and cattail (*Typha domingensis*) and subsurface tangles of exot-

ic hydrilla (*Hydrilla verticillata*), while surface waters became clogged with floating mats of water lettuce (*Pistia stratiotes*).

Congress authorized BICY in 1974. Peter Rosendahl and David Sikkema, hydrologists from Everglades NP, began field investigations in 1978 to determine the possible hydrologic consequences of restoring Turner River. Their 1981 final report became the driving force behind restoration efforts.

The excavation of Turner Canal and the filling of Turner Road resulted in several undesirable hydrological and biological consequences, affecting about 18,000 acres of wetlands. The area's canals lowered the groundwater table by up to a foot for about 600' on either side of the canals by draining groundwater during the dry season. Even such seemingly minor alterations in water tables can lead to major vegetation changes in a less wetland-oriented community and shift the local fire regime to a more flammable condition.

The area's canals shunt surface waters from north to south during the rainy season, thus raising southern area water levels and lowering northern area water levels during the summer and fall. Surface waters that naturally flowed into the Deep Lake Strand and Turner River were quickly diverted down the Turner Canal. The damming effect of the roads caused higher than natural stages to the east and lower than natural stages to the west. These new local conditions would lead to opposite long-term changes in vegetative communities and fire regimes on either side of the canal.

By cutting off much of the Turner River's water sources, the channel's depth was decreased. Shallower waters experienced high-

Turner River Restoration

er temperatures, less dissolved oxygen, and different successional processes in and along the river. All of these consequences also influenced the river's aquatic fauna.

So little water was reaching the Turner River's channel that there was virtually no discharge from December through May and the otherwise diminished flow was measurable only 38 percent of the year. Reduced fresh water discharging into the river's distributary system would have a local effect of favoring salt tolerant species in an area where such had not been the case.

Diminished flows and lower velocities caused the otherwise suspended sediments to settle out of the water column and build up on the stream bed. In combination with changing water quality and quantity, the stream channel was colonized by plants atypical of the normally free river channel. As the river became choked with vegetation, flows began backing out of the river and into the canal during the high water season even after flow restoration was completed in 1989.

The hydrostatic head of fresh water flowing to the southwest normally prevents salt water from infiltrating much closer than a few miles from Tamiami Trail. After the construction of Turner Canal, the migrating wedge of salinity was able to reach the hydrological monitoring stations along this highway during the spring low water season. The stage recorder at the intersection of Tamiami Trail and Turner Canal even recorded a slight tidal effect! Water quality tests detected salt water at the station during about 12 percent of the days in a year, resulting in drastic changes in fish populations including periodic displacement or mass die-off of fresh water species.

All these effects tended to feed back on one another and worsen conditions. It was feared that the Turner River was dying and eventually would fill in and become shrouded by vegetation. The river's ability to serve as a recreational and natural resource in BICY and Everglades NP was in jeopardy.

The goal of the restoration project was to reverse the negative impacts caused by the Turner Road and Canal and allow natural processes to return conditions in the river to a state more closely resembling preconstruction. It was predicted that year-round discharge could be returned to the river with a measurable flow 88 percent of the year and about a 35 percent increase in the channel's depth.

From 1986 to 1989, a combination of federal, state, and county funds was used to modify the surface water flows that meet the Turner, Birdon, and Wagon Wheel roads

at Big Cypress Preserve

The "Aquamog" clears vegetation from Turner River. (Photo by T. Pemas).

and their respective borrow ditch canals. Early estimates ranged up to \$1 million as the price for restoration. The cooperative venture was able to keep the federal costs to about one quarter of this.

Each of these dirt roads is owned and maintained by Collier County. Little thought was given at the time of construction to the environmental repercussions of the design used. The priority in 1960 was to encourage homesteading, recreation, and commercial and industrial activities in this huge "worthless" swamp. In time, even the inadequate set of culverts that were emplaced were neglected and allowed to become clogged with debris and hidden by vegetation. As part of the restoration project, the county agreed to clear the old culverts.

The main component of the project was the installation of 21 canal plugs and 23 new culverts along 28 miles of county roads and canals. The work was performed in-house by the BICY maintenance staff. The plugs were designed to back up water flowing down the canals and build up the hydrostatic head behind these small earthen dams. The greater pressure provides the water with enough force to be flushed through the culverts that were installed behind the plugs. The culverts direct the water under the roads, where it then disperses back into sheet flow and finds natural channels such as Deep Lake Strand and Turner River.

The plugs were constructed of native limestone. Minerals then precipitated from the calcium-rich swamp waters into the pores of the plugs. This natural cementing process changed the loose fill into a concrete-like substance known as caliche, greatly increasing the impermeability of the structures. Vegetation was planted and large boulders were placed on top of the plugs to discourage off-road vehicles.

Numerous piles of rock were left over from the excavation of the canals. These artificial "uplands" and the filled road shoulders had been invaded by dense thickets of Brazilian pepper (*Schinus terebinthifolius*), an invasive exotic shrub. No one was able to see over or through the dense pepper hedges to view the natural Big Cypress landscape. BICY obtained \$70,000 of wetlands violation fine funds from the Florida Department of Environmental Regulation, which paid for labor and heavy machinery to scrape the pepper hedges into piles for drying and burning. Debris left over from the burns, together with 800,000 cubic yards of spoil rock, were more or less evenly spread out and dumped back into the canals. The outcome was dramatic; these road segments are becoming the finest scenic and wildlife viewing drive in BICY.



While flows improved in Turner River and subsided in the area's canals, the river channel remained clogged with aquatic vegetation. The river's obstructed condition limited the success of previous restoration efforts and severely inhibited its capacity as a recreational resource.

In 1992, the South Florida Water Management District volunteered the use of its "aquamog" and operator for several weeks. The aquamog was essentially a floating backhoe with interchangeable tool heads. It scooped up aquatic and emergent vegetation by the roots and chopped overhanging branches of encroaching woody vegetation. With the river's channel opened up to the mangrove fringe, the stream's greater velocity will keep the channel clear and halt or even reverse the sedimentation problem.

More urgent needs currently take priority, but quantitative hydrological analysis of the restoration project is likely in the near future. Some impediments to surface flow still exist in the Turner River area including small canals and abandoned roads. None of these structures has been mitigated, though they are on a long list of currently unfunded reclamation needs. An assessment also is needed of the effects that changing stages may be having on the various inhabited inholdings along Birdon Road and Turner Road.

There will continue to be dry season fish kills in the now stagnant canal waters. These fish kills are not considered to be a serious resource issue since the canal habitats are artificial, as are the fish populations that live in them. Additionally, as long as the terminus of Turner Canal remains unplugged it will continue to experience seasonal incursions of salt water.

Due to the persistent problem of exotic vegetation, there may need to be periodic retreatment of the area. Monitoring the condition of the plugs, culverts, water level, water quality, biota, and private properties will be an ongoing responsibility.

The Turner River restoration was the first project to be completed in the State of Florida's "Save Our Everglades Program." The project earned BICY's restoration crew a unit citation for excellence of service.

San Miguel is a Resource Management Trainee with the Resource Management Division at Big Cypress National Preserve.

Supporting Literature

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Predation of Yellowstone Elk Calves

By Francis J. Singer, Kate K. Symonds,
and Bill Berger

A 4-year elk calf mortality study on the Yellowstone northern range, undertaken to determine the causes and rates of mortality during the first year of elk life, has now been completed. Ever since adoption of the natural regulation policy in 1969, NPS has received considerable criticism for apparent lack of controls on the elk population. Douglas Houston, in his book on Yellowstone's elk, contended that the herd was regulated primarily by juvenile mortality in a density-dependent fashion; elk calves died at higher rates during winters when elk densities were high (based on drops in calf/cow ratios). Fall calf/cow ratios also are typically low in the population, suggesting significant mortality must also occur during summer.

Newly-born elk calves were captured each spring between 1987 and 1990 from horseback and helicopter. The calves were instrumented with motion-sensitive radio collars and released. Motion-sensitive collars double their signal pulse rate when no motion occurs for a specific period of time, indicating a likely mortality. When this occurred, field crews rode or skied into the backcountry and inspected the kill or carcass site.

More elk calves died during summer (32% of 127 marked calves) than winter (21% of marked calves). Nearly all mortality during summer was due to predation, whereas mortality in winter was primarily related to malnutrition. Almost all the winter deaths occurred during the severe winter of 1988-89, following the drought and fires of 1988. Winter elk calf mortality was relatively insignificant in the winters of 1989-90 and 1990-91, when elk numbers were reduced (supporting Houston's contention). Summer elk predation on calves, however, increased in 1989 and 1990 in spite of lower elk densities, in a density-independent fashion.

Heavier elk calves tended to survive better than lighter calves. Not surprisingly, more light calves were born following the drought and fires of 1988 and the severe winter of 1988-89. The scientific literature on many other ungulates such as red deer, caribou, and white-tailed deer also suggests progeny are lighter following severe winters or during periods of food shortage. Lighter weights at birth result in higher mortality from all causes. On Isle Royale, moose born to dams stressed by a severe winter are more vulnerable to predators throughout their lives.

Grizzly bears were one of the most significant predators on elk calves. Grizzlies killed about as many calves as coyotes and black bears combined. Based on our marking study

and elk population estimates, grizzlies killed about 950 elk calves on the northern range each year. Wolf restoration has been proposed for Yellowstone Park. If summer predation on elk calves is density-independent (see double-outlined box), then wolf predation on elk calves would likely be additive to current predation levels, i.e. the total effect of predation likely will be greater following wolf recovery.

Our study discovered that summer predation on elk calves was far more significant than had previously been suspected. Our observations of winter mortality, although limited to 4 winters, tended to corroborate the contention of Houston that winter elk calf mortality was density-dependent and a potential regulatory force on the northern winter range.

Singer and Symonds are Research Ecologist and Wildlife Biologist, respectively, with the NPS; Berger is with Telonics, Inc.

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Bears Found to be Significant Predators of Neonatal Ungulates Across North America

The advent of expandable, motion-sensitive radio-collar packages in the late 1970s and early 1980s resulted in discovery that both grizzly and black bears killed more neonatal ungulates than previously had been suspected. In 3 areas in Alaska and the Yukon, grizzlies killed 41%, 76%, and 84% of all marked moose calves, while black bears killed 57% in a fourth study. These areas are considered to have high predation levels. Wolves were present in all these areas, but in each case, bears killed more young calves than did wolves. In one of these areas near Tok, Alaska, grizzlies also chased down and killed more adult moose than did wolves.

The senior author worked in Denali NP in 1984 and 1985, when grizzlies also killed more neonatal calves than did wolves. (Wolves have since increased nearly 2-fold and they now kill more calves than do grizzlies according to Dave Mech and Lane Adams). Predators in Denali killed caribou calves at the more moderate rate of 46% (of 96 marked caribou calves) in 1984 and 1985, similar to

Motion-Sensitive Collars: A Technological Breakthrough

Motion-sensitive radio collars were first developed and used on wild neonatal ungulates in the late 1970s. The mechanism involved in their use is an interval timer, which doubles the pulse rate whenever the motion-free time equals that interval. For the Yellowstone study, the interval timer was set for 2 hours of inactivity.

The first collars often were clumsy packages whose useable life span was only a few weeks. Development of a sturdier package with a longer life span however, presented a trade-off with the potential of the collar to constrict the neck of a rapidly growing calf.

In 1989, the senior author initiated one of the first studies of neonatal caribou mortality in Denali NP, involving the use of the collars with a 1-year life span. The design used on Yellowstone elk calves is the culmination of advances in design. These collars are light, the material is elastic, 2 rip-out folds allow for rapid expansion, and a cotton section of the collar provides for deterioration and an eventual breakaway mechanism.

Yellowstone elk calves wore working collars for 1.5 to 2.0 years with no evidence of chafing or discomfort. At the end of that time, the collars deteriorated and dropped off. We compared survival rates of collared and un-marked calves (from calf/cow ratios) and found that radio-collared calf survival rates were higher, indicating that collaring of calves does not lower their probability of survival over that of un-marked calves.

Yellowstone's moderate rate of 32%. In more temperate northern Idaho, predators—mostly black bears—killed 65% of all marked elk calves.

French and French documented 3 major hunting strategies for grizzlies:

(1) **The search**, where the bear hunted sagebrush patches in a zig-zag fashion with nose to the ground. Elk calves were caught in this fashion even when no adult cows were present to suggest calves were in the area.

(2) **The chase**, when grizzlies charged groups of cows and calves and sought to separate and run down an individual calf. Grizzlies rarely caught straight-running calves, but cutting off the angle on calves running in an arc often proved successful.

(3) **The ambush**, when grizzlies charged out from the treeline at groups of elk in open sagebrush or meadows. Gunther and Renkin, grizzly bear researchers in the park, observed a high level of motivation by grizzlies to hunt calves; grizzlies chased elk in 26% of all May sightings and grizzlies chased elk for an average of 8.7 minutes. Forty-five percent of 130 chases observed by Gunter and Renkin and the Frenches resulted in capture of at least one elk calf.

Book Review

By Jean Matthews

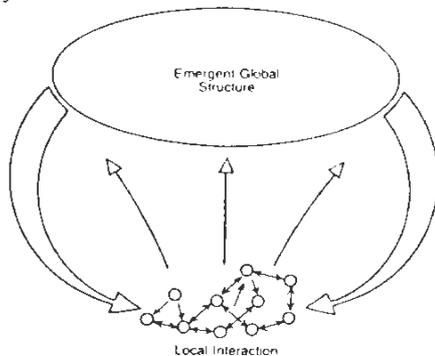
Complexity: Life at the Edge of Chaos, by Roger Lewin (Macmillan, 1992) is a spell-binding journey through the fields and laboratories of those who are pushing toward a set of rules that some day may provide a grand unification of the life sciences. Their various approaches to these elusive rules have landed them at the core of the current struggle to redefine evolution—or at least to rewrite the Darwinian version of it.

Lewin's story begins in Chaco Canyon, NM, the center almost a millenium ago of the complex, sophisticated Anasazi culture. Although it disappeared like steam from a boiling kettle, the Anasazis' economic, political, and religious web, which covered more than a hundred thousand square miles, is referred to by today's archeologists as the Chaco phenomenon.

From that bleak, arid terrain on the Colorado Plateau, the story moves to consideration of how such complex systems as the Anasazi culture might have arisen from a simple set of organizational rules. For someone who has read James Gleick's absorbing best-seller, *Chaos*, it may be hard to imagine a more enthralling journey through the frontiers of scientific discovery, but Lewin has provided a worthy sequel.

The theory of chaos is described early on in Lewin's book by Chris Langton of the Santa Fe Institute as a subset of complexity "in that you are dealing with nonlinear dynamical systems." In the case of chaos, he explains, a few things are interacting, producing tremendously divergent behavior—what he calls "deterministic chaos." It looks random, he says, but it's not, because it results from "often quite simple equations that you can specify." In the case of complexity, Langton continues, "interactions in a dynamical system give you an emergent global order, with a whole set of fascinating properties" leading to what the Complexity theorists call "emergence."

Langton's view of emergence in complex systems looks like this:



The interaction of the components at the bottom of the diagram give rise to properties that could not have been predicted from what you know of the component parts. And the emergent properties then feed back, to influence the behavior of the individual interactors that produced them.

Lewin then jumps back to the beginning of the story—in the early 1960s when a bright young scholar, Stuart Kauffman (now of the University of Pennsylvania) began playing around very seriously with random Boolean networks. Kauffman's ignorance of mathematics served him well; he accomplished something no knowledgeable mathematician would have attempted. By incredible luck, early in his computer runs, his modest network stumbled into an emergence of order of a sort. His first thought was "Oh my God, I've found something profound," and he told Lewin "I still think so. It's the crystallization of order out of massively disordered systems. It's order for free." This "accident," born of intuition and nurtured by diligence and luck, is one of the first building blocks in an edifice that has arisen from similarly serendipitous starting points in a scientific landscape ranging from geology and biology to archeology and evolution. The names of contributors to this new scientific adventure include Murray Gell-Mann, Warren McCulloch, John Maynard Smith, Per Bak, James Lovelock, Stuart Pimm, Richard Dawkins, John Cowan, Edward O. Wilson, Stephen Jay Gould, and Brian Goodwin.

Lewin describes the debate between Gould and Goodwin as to whether complexity and the edge of chaos reveal a sort of progress in the random flow of Darwinian selection. When Goodwin is challenged about his definition of the idea of "quality" in an organism, he replies that by "quality" he means "the organism as the cause and effect of itself, its own intrinsic order and organization." Goodwin asks us to think of organisms as the result of a biological attractor—a sort of whirlpool in the sea of a complex dynamical system. Then, he says, "you begin to approach what I mean by quality."

In addition to the gripping story of how complexity theory has grown, by leaps of faith and intuition simultaneously in different disciplines and farflung geographic locations, I found most compelling the idea of Darwinian adaptation being only the surface manifestation of evolution, riding on the deeper structure of rules that seem to govern nonlinear dynamical systems of all kinds, throughout the universe.

The "emergentists" (as the seekers of these rules have been called) seem to have reached a tentative definition of "progress" in the evolution of systems: the ability to process more and more information. What should interest readers of *Park Science* is the possible role of this new theory as a push toward a holistic view of nature. The Santa Fe Institute people talk of "self-organization in complex systems, the emergence of patterns in evolutionary models that mimic patterns in nature, and the idea that living systems, as complex dynamical systems, are driven to these same patterns. They are saying there is a deep theory to the order of nature."

When they are accused of straying from mechanics and "looking for the meaning of life," they reply (in the words of Goodwin): "We're not looking for the meaning of life, more the meaning *in* life, the generation of order, the generation of pattern, the quality of the organism."

Kauffman adds: "Pure Darwinism leaves you without an explanation of the generation of biological form. In the Darwinian view, organisms are just cobbled-together products of random mutation and natural selection, mindlessly following adaptation first in one direction, then the other. I find that deeply unsatisfying and I don't think that's because I want there to be some purpose in evolution." Kauffman would reformulate Darwinian theory to include self-organization. "We have no theory in chemistry, physics, biology, or beyond, that marries self-organization and selection. To do so, as I think we must, brings a new view of life." In effect, he says, it extends self-organization from the realm of physics, where it's accepted, into biology, where it is still viewed as mystical at best and heretical at worst.

Lewin is a Ph.D. in biochemistry from the University of Liverpool. His most recent book, *Bones of Contention*, has been named the U.K.'s top science book for a general audience, besting both Stephen Hawking's *A Brief History of Time*, and James Gleick's *Chaos*. In May 1989, Lewin received the first Lewis Thomas Award for Excellence in Communicating Life Science.

From Complexity

"... if the concept of the edge of chaos does indeed translate from computer models to the real world, as Stu Kauffman, Chris Langton, and others firmly believe it will, then there will be nothing trivial about it at all. Stu's cocvolutionary model systems get

Continued on page 22

Regional Highlights

Rocky Mountain Region

The Region's biannual Science and Resource Management conference, to be combined in 1993 with Interpretation's biannual Alliances conference, will be held Dec. 6-10 in Denver. The regionwide Alliances VI Conference will focus on improving coordination and information exchange among interpretation, resource management, and research. The conference will explore ways in which interpretation can better be utilized in resource management and ways interpretation can better incorporate information from resource management and research. Coordinators are Dave Dunatchik, Laura Joss, Bob Schiller, and Janet Wise (303) 969-2000.

* * *

Planning has begun for the Fourth Conference on Fossil Resources, to be held in Colorado Springs in Fall 1994. The Fourth Conference will be sponsored by NPS and BLM. Florissant Fossil Beds NM and BLM's Canon City District Office will be hosts, in partnership with Friends of Florissant Fossil Beds and the Garden Park Paleontological Society. Assistance is needed in developing a program to address major issues affecting paleontological resources on public lands. Program development questionnaires have been mailed out. For a questionnaire or information on the conference, contact Dale Ditmason or Maggie Johnston at (719) 748-3253.

* * *

The Region has initiated an ethnographic research project in Bighorn Canyon NRA, with Dr. Larry Loendorf—an independent researcher in Tucson, AZ—heading the study in collaboration with the Crow Tribe. The study will identify areas and resources of cultural significance to the Crow and results will be used in environmental assessments. The Crow Tribe will also help determine ways to protect areas in the park used for traditional cultural purposes. The USFS has requested the NPS to expand the work scope to include study areas within the Custer NF. BLM and the State of Montana also have expressed interest in having the project address their land and resource management responsibilities.

* * *

Glen Canyon NRA is funding a survey for northern leopard frogs (*Rana pipiens*) along the Colorado River corridor from Glen Canyon Dam to Lees Ferry. The frog surveys will be coordinated and conducted by Charles

Drost (Zoologist, CPSU/UC) and Mark Sogge (Ecologist, CPSU/NAU), and will document abundance, distribution, and habitat utilization.

* * *

The Colorado Plateau Vegetation Advisory Committee (CPVAC) in conjunction with the NPS CPSU/NAU sponsored a field training session at Mesa Verde NP on June 16-17. Participants received hands-on instruction in the use of the Brown, Lowe and Pase vegetation classification system. Anyone interested in what transpired at the session can contact either Steve Budd-Jack (MEVE) at (303) 529-4510 or Elena Deshler (CPSU/NAU) at (602) 523-9090.

Southeast Region

SER Chief Scientist Dominic Dottavio has accepted a position as the dean at Ohio State University in Marion. His extensive research record and administrative background were cited as factors in his selection. Dottavio, a native of Ohio, was the first choice of the selection committee after a year long search that attracted 200 applicants. He begins his new work in August.

* * *

A draft coastal park inventory and monitoring handbook has been completed and distributed to coastal parks from Acadia to Padre Island. The handbook contains draft protocols developed as a result of the I&M workshop held at U/VA in August 1992.

* * *

The second annual Big Cypress Wildlife Research Colloquium was held Feb. 4, 1993, at the Oasis Visitor Center. Presentations were made by representatives from NPS, the U/FL, and the Florida Game and Fresh Water Fish Commission.

* * *

William Loftus, Research Ecologist at Everglades NP, began a collaborative project with Dr. Horton Hobbs of the U.S. National Museum to redescribe the Mianu Cave Crayfish (*Procambarus milleri*), a subterranean species with very localized range. Life history information also will be presented for the first time.

* * *

U/GA CPSU Director Bob Warren travelled to Mexico at the invitation of the University of Veracruz in Xalapa. He presented four seminars to faculty and graduate students, toured their Tropical Rain Forest Park

for Wild Plants and Animals, and met with administrators to discuss future joint research and graduate education efforts. University researchers and park administrators were interested in the bobcat reintroduction research Dr. Warren has directed on Cumberland Island National Seashore (NS), his research on raccoon ecology and sea turtles at Canaveral NS, and his research on white-tailed deer.

* * *

Recently published reports include:

Van Cleave, R. 1993. *Trail Use in the Cades Cove and Abrams Creek Area of Great Smoky Mountains NP*. NPS/SERGRSM/NRTR 93/03.

Cole, A., and K. Turner (eds.). 1993. *Barrier Island Ecology of the Mid-Atlantic Coast: A Symposium*. NPS/SERCAHA/NRTR-93/04.

Articles published:

Jodice, Patrick G.R. 1993. *Movement patterns of translocated Big Cypress Fox squirrels (Sciurus niger avicennia)*. Florida Scientist 56(1):1-6.

North Atlantic Region

"Is commercial shellfish harvesting compatible within an urban national wildlife refuge?" This question is the title of an article published in *Fresenius Environmental Bulletin* 2:174-178 (1993) Birkhauser Verlag, Basel/Switzerland, by John Tanacredi of Gateway NRA. Tanacredi concludes that such shellfishing is incompatible with the wildlife protection mandates of the urban national park concept, and that such programs based solely on bacteriological monitoring are inappropriate.

Midwest Region

David Figlio, a PhD. candidate at U/WI-Madison, conducted a cost/benefit analysis of Pictured Rocks National Lakeshore (NL) as part of an internship program sponsored by the Great Lakes CPSU at U/WI-Madison.

For a 30 year time frame, Figlio determined the benefits to the local economy accrued from tourism spending, park salaries and expenditures, and payments in lieu of taxes. He then compared these benefits to costs due to loss of logging opportunities and lakeshore development. Results showed that economic benefits of the park's establishment greatly outweigh the costs, even when maximum lakeshore development and liquidation logging practices are considered.

The results will be used to counter local perceptions that the park has negatively impacted the local economy. Other parks may find Figlio's methodologies useful for showing how resource preservation makes economic sense. Copies of the complete report are available from Pictured Rocks. A less technical version is available in the park's series of Resource Reports. For more information, contact Resource Management Specialist Brian Kenner, Pictured Rocks NL, P.O. Box 40, Munising, MI 49862; (906) 387-2607.

* * *

From Jack Oelfke, Natural Resource Specialist at Isle Royale NP, and Rolf O. Peterson, Michigan Technological University at Houghton, comes word of the 35th annual winter study program of wolf/moose monitoring at Isle Royale. The program, a cooperative effort with the park and Dr. Peterson at MI/Tech/U, ran from Jan. 14 to March 2, 1993. Previous trends were maintained—the wolf population remained at 12 animals while moose population continued to grow to its highest level in 60 years—close to 1500 animals.

Two wolf pups born in 1992 countered the loss of two adult loners (one was never found, the second was killed by other wolves when it strayed into that pack's territory). The present 12 animals are organized into three packs; the single reproducing pack has increased to seven members; the other two packs consist of two wolves each. Only one lone wolf is present. Three females, one from each pack, were in breeding condition and courted in 1993, however only one pack has successfully raised young since 1988.

Chronic wolf population decline led to more intensive studies beginning in 1988. Disease may have played a role in the population decline, but the current belief is that genetic loss is primarily responsible for lack of recovery. Genetic analysis of several Island wolves indicates that all are descended from a single female, probably a founder of the population. Substantial genetic variability has been lost, leading to inbreeding depression or reduced reproductive success arising from genetic isolation of a small breeding population.

Current expectation is that the wolf population will die out on the Island, although when is not known. Of the 10 animals of known sex, only three are female. Live-trapping and collaring of animals continued in 1993, raising the number of collared animals to six. Monitoring continues throughout the summer and early fall.

National Capital Region

The Rachel Carson House in Silver Spring, MD was dedicated as a National Historic Landmark on April 18. Dr. James L. Sherald, Research Plant Pathologist and IPM Coordinator for NCR represented the NPS at the dedication. Sherald spoke of the advances made in IPM in the NPS and on Rachel Carson's influence on pest management throughout the world.

Western Region

Recent evidence indicates that amphibians are declining on a global basis. Healthy, seemingly well-protected populations have disappeared for no obvious reason, even from parks and large wilderness areas. At the same time, the status of amphibians has been poorly documented and little research has specifically addressed these issues. Dr. Gary Fellers, Research Biologist at Point Reyes NS, has begun a three year study of declining amphibians in California parks, to:

- Assess the status and distribution of selected amphibians in nine park areas.
- Evaluate possible causes of amphibian declines.
- Determine the feasibility of experimentally reestablishing frog populations that have been lost.
- Determine the genetic diversity of selected amphibians that might be used in reintroductions.
- Develop a monitoring program that will allow the NPS to monitor key populations.

* * *

The Second Biennial Conference on Research in Colorado Plateau NPs will be held on the campus of Northern Arizona University, Flagstaff, AZ, Oct. 25-28, 1993. Hosted by the University and the NPS/CPSU at NAU, the conference will highlight biological, cultural, social, and physical science research in national parks and related areas on the Colorado Plateau.

* * *

Charles van Riper III, Unit Leader and Mark Sogge, Ecologist, both of the NPS/CPSU at NAU, are authors of a new publication, *Changing nest placement of Hawaiian Common Amakihi during the breeding cycle*, in Wilson Bulletin Vol. 105. Sogge attended a meeting of the Cooper Ornithological Society in Sacramento and delivered a paper on *Status of the Southwestern Willow Flycatcher along the Colorado River in Grand Canyon*; Van Riper, at the same meeting, gave a paper titled *A comparison*

of avian hematozoan epizootiology in two California coastal scrub communities. Research Ecologist Peter G. Rowlands, also of the NAU/CPSU, has had accepted for publication in Southwestern Naturalist a paper on *Climatic factors and the distribution of woodland vegetation in the Southwest*.

* * *

Six Technical Reports (Nos. 45 through 50) were published by the NPS/CPSU at U/CA Davis in October 1992, and five 1993 Technical Reports (Nos. 4 through 8) are currently in preparation. For titles of the reports, which range widely over subject matter from Bighorn Sheep reintroduction in the Sierra Nevada to Great Grey Owl Hunting Behavior in Yosemite, from kelp forest monitoring in the Channel Islands to characteristics of nine forest stands in Sequoia NP, write to the NPS/CPSU, Wickson Hall, U/CA, Davis, CA 95616, or call Unit Leader Stephen Veirs at (916) 752-6086.

* * *

Sequoia and Kings Canyon NPs were represented at the conference on "Fire in Wilderness and Park Management: Past Lessons and Future Opportunities," held in Missoula, MT March 30-April 1. Poster presentations were made by Tom Ritter, David Parsons, Mark Finney, and MaryBeth Keifer.

In late May, Sequoia/Kings Canyon hosted a Principal Investigators' workshop for all PIs working on the Sierra Nevada global change research program. Also, Research Scientists David Parsons, David Graber, and Nate Stephenson are cooperating with the USFS in developing a proposal for in-depth analysis of the status of old growth forest and associated ecosystems in the Sierra Nevada.

* * *

In March, 1993, the Division of Humanities and the Environmental Studies program at U/CA Santa Cruz co-hosted the second in a series of University conferences with the common title "Reinventing Nature." According to David Graber, Research Biologist at Sequoia/Kings Canyon NPs and the NPS/CPSU at U/CA, the intentionally ambiguous title refers to powerful concepts of invention and deconstruction applied to nature, wilderness—even the science of ecology.

To what extent is "nature" a cultural determination? How possible is it to know the actual structure of nature? How durable is the American myth of wilderness in the light of revelations about the long-term plasticity of the continent and interactions of

(Continued on page 22)

native Americans with the pre-Columbian landscape? The way these questions are answered, Graber suggest, may have profound consequences on the way national parks are managed in the future.

Graber's invited paper was entitled *Resolute biocentrism: managing for wildness in national parks* and he has promised *Park Science* an article in a future issue based on what he terms "the most important scholarly meeting I have attended in my NPS career."

* * *

4 NP Videos Win Awards

K.R. Cranson, with Lansing Community College's science department, alerts *Park Science* to four new videos made in national parks that won awards at the 30th National Outdoor-Travel Film Festival sponsored by the Michigan Outdoor Writers Association. Cranson's review of the videos will be carried in the Fall issue of *Park Science*.

Southwest Region

A three-year study, a cooperative effort by the NPS/CPSU at NAU and the AZ Game and Fish Department, will examine the physical and biological factors influencing Arizona pronghorn habitat use. Objectives are to determine pronghorn movements within, into, and out of park boundaries, to identify home ranges of the pronghorn herds and core use areas within and outside the park, and to

determine pronghorn fawn behavior and the influence of vegetation structure on pronghorn fawn mortality.

The study also is being conducted in Petrified Forest NP, to compare to Wupatki NM data. The project is being supervised and administered by Van Riper and NPS/CPSU Wildlife Research Biologist Henry E. McCutchen.

Pacific Northwest

A superbly conceived and executed 14-panel folder, *Wildflowers of Craters of the Moon National Monument*, has been produced and is on sale for \$2 by the Craters of the Moon Natural History Assn. The full color folder is pocket size, with photos of the Monument and 14 of the plants to be found there. Portions of the text are adapted from *Common Plants of Craters of the Moon NM*, by Karl A. Urban. Each plant photograph has a check-off box beside its description, for easy record-keeping.

* * *

The NPS held its annual Rivers, Trails, and Conservation Assistance (RTCA) training in Portland, OR April 18-23, 1993. This year's training focused on environmental negotiation and upon involving culturally diverse and economically depressed communities in the care and management of their natural resources. PNR Director Charles Odegaard has committed to providing staff

resources for planning and developing the Evergreen Agenda, an initiative underway in Washington State to create a community-based statewide system of natural and open space lands.

* * *

The first ever biological survey of the Oregon Caves was carried out in 1992 by Rod Crawford, an invertebrate specialist at U/WA's Burke Museum. This initial effort found more than 20 species inhabiting the cave. Two, and possibly three, of the species had never before been known and occur nowhere else in the world. One is a millipede of the genus *Speoseya*, a species represented elsewhere by only two specimens. The second is a water mite, likely parasitic on a yet-unknown species occurring in the cave.

A third specimen, a grylloblatid, is suspected to be a new species but this cannot be confirmed until a male is found. Grylloblatids are primitive insects found mostly in ice fields and in lava caves. They have always been found in glaciated or formerly glaciated areas. The current find conforms to this pattern. Glaciation has occurred within 2,000 meters of Oregon Caves, and the grylloblatid is believed to be a glacial relict. The pit-traps, baited with limburger cheese, are still set in the cave and are checked by park staff every 20 days. The survey is continuing in 1993 and will be tied to a five-months-long Earthwatch project.

Book Review

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themselves to the edge of chaos, and so too do Stuart Pimm's and Jim Drake's ecological models. No one can say yet whether individual ecosystems do the same thing, but the data from mass extinctions at least suggest that, globally, they do. "That's a powerful message of a powerful intrinsic dynamic," said Chris. "Systems poised at the edge of chaos achieve exquisite control, and I believe you see that right the way up to Gaia."

"If it's true that, for instance, ecological communities move toward the edge of chaos, where novel properties emerge (such as foodwebs and the ability of a long-established community to resist invasion by alien species), then it seems legitimate to talk about such communities as real systems. It

may even be legitimate to think of them as behaving and evolving as a whole, analogous with the superorganism concept that Ed Wilson talked about in connection with social insect colonies. Coevolving communities act in concert as a result of the dynamics of the system; they do so as a result of individuals within the community myopically optimizing their own ends and not as collective agreement toward a common goal; and the communities really do come to know their world in a way that was quite unpredictable before the science of Complexity began to illuminate that world."

* * *

Troubling complexities is the title of an article by I. Peterson in the Sept. 5, 1992 issue of *Science News* (p. 157). In it, Peterson states:

In studies of the dynamics of biological systems, researchers face the dilemma of determining from experimental data whether observed variations represent random fluctuations or the chaotic state of a deterministic system. If they can demonstrate that the system is chaotic rather than random, they have a better chance of developing a strategy to understand and control this erratic behavior.

Peterson quotes Leon M. Glass of McGill University in Montreal: "Complex aperiodic rhythms that are observed in natural systems might be due to deterministic chaos, random 'noise,' or some combination of the two different mechanisms. Thus, the interpretation of the dynamical basis of complex aperiodic rhythms in natural systems is a difficult and hotly debated topic."

Information Crossfile

The June 10, 1993 issue of *NATURE* announces the successful cloning of DNA from a previously unknown species of weevil that was preserved in fossilized amber (hardened treesap for at least 120 million years. George Poinar, Jr., an entomologist at U/CA Berkeley and four other scientists have now pushed back the earliest known date for cloning DNA to 120 to 135 million years ago.

* * *

The April 1993 issue of Florida DNR's *Resource Management Notes* contains an account of how Hurricane Andrew devastated exotics, exultantly headlined "Native Victory Garden." Renate Skinner, Florida Region 7 biologist, describes Australian pines (*Casuarina equisetifolia*) over 60 feet tall—some four to five feet in diameter at the base—downed, scattered, and "stacked on the ground as if they were mere saplings." Triumphantly still standing. ("wedged between the fallen giants,") were native strangler figs (*Ficus aurea*), seagrapes (*Cocoloba uvifera*), and sabal palms (*Sabal palmetto*). Sea oats (*Uniola paniculata*) still thrived; four known endangered plant species at Cape Florida survived; "and then there was the gratifying discovery that the native vegetation in the designated 'Natural Zone' still existed, doubly gratifying, since in the early 1980s the area was on the way to becoming a parking lot. Park and regional staff efforts prevented this by pointing out the spontaneous, prolific growth of native plants which had occurred there after Australian pines had been toppled in a minor windthrow."

* * *

Runoff Report is the name of a new publication started by the National NonPoint Source Federation, P.O. Box 30101, Kansas City, MO 64112. Billed as "a watershed information network news," *Runoff Report's* Spring 1993 (Vol. 1, No. 1) issue, welcomes "corporate, environmental, governmental, and grass roots interests from all sections of the country." Incorporated in Missouri as a not-for-profit organization, the Federation is headquartered in Kansas City, with membership regions corresponding to ecoregions. An electronic bulletin board will be on-line within several months and planning is underway for a regional workshop and national conference.

* * *

Sinauer Associates, Inc. of Sunderland, MA (01375-0407) announce publication of *Ecology and Our Endangered Life-Support Systems*, Second Edition, by Eugene P. Odum. The 300+ page soft cover volume, with 91

illustrations (\$18.95), presents a "big picture" look at ecology. It includes updated, expanded coverage of experimental life-support systems, ecotones, diversity, energetics, agroecology, succession, mutualism, evolution, ecological economics (!), waste reduction, global concerns (such as ozone holes and climate change) and ecosystem types, especially wetlands. Charles van Riper III will review it for the Fall issue of *Park Science*.

* * *

State of the World, 1993, the 10th annual edition of the Worldwatch Institute Report on progress toward a sustainable society is now available in both hardcover (\$19.95) and paperback (\$10.95). The Institute's *Vital Signs 1992: The Trends that are Shaping Our Future*, (same prices as *State of the World*) tracks environmental, economic, social and health trends plus significant new patterns that are emerging. When ordering (from Worldwatch, 1776 Massachusetts Ave., N.W., Washington DC 20036-1904) include payment and Worldwatch will pay the shipping charges.

* * *

A Memo from the GWS Executive office, introducing the Vol. 10, No. 1, 1993 issue of the *George Wright FORUM*, discusses "A National Biological Survey: Some Issues, Concerns, and Historical Background." Without taking sides, the authors consider the mechanics of creating a separate agency and the series of questions thus raised: "Will the NBS increase or decrease U.S. NPS direct access to scientific expertise for dealing with resource issues? Will the U.S. NPS have to pay NBS to do the research?"

"Will the current trend within U.S. NPS... toward the use of research information in decision-making and the emphasis on resource management... be reversed if U.S. NPS scientists are removed as internal advocates? Who would be left within the U.S. NPS to advocate research?"

"Where will national parks and other protected areas fit into the NBS's priorities? Since parks and other protected areas are such a small part of the country's land base, and because there may be a perception that they are not as much at risk as multiple-use lands, how much attention will they receive in a national inventory?"

"How will the NBS react to changing politics in the Secretary of the Interior's office? Could a future, less supportive Administration undermine long-term projects? Could such an Administration manipulate the results?"

"Might a career ladder develop in which junior scientists cut their teeth in the U.S. NPS, only to move on to the NBS to address national level biological concerns?"

* * *

Richard West Sellars, U.S. NPS historian based in Santa Fe, NM at the NPS SW Regional headquarters, is the author of a forthcoming history of natural resource management in U.S. national parks. A three-part series of excerpts from the book began in the *George Wright FORUM*, Vol. 10, No. 1, pp. 55-77. The series is dedicated to Victor H. Cahalane, who headed the programs from the mid-1930s to 1955. Part I is entitled "The Rise and Decline of Ecological Attitudes in National Park Management, 1929-1940."

* * *

William H. Rodgers Jr., a professor of law at U/WA, Seattle and chair of a National Research Council committee on federal land acquisition, is quoted in the *Gazette-Times* (Corvallis, OR) May 20 editorial page in favor of the development of a common information base on the part of the four different agencies that hold the most federal land—BLM (270 million acres), USFS (191 million acres), USFWS (89 million acres), and NPS (76 million acres).

"Each agency has its own criteria and procedures to buy new land... but the agencies' priorities are poorly coordinated, and the process used to submit their proposals to Congress makes the problem worse... [The method used] forces wildlife refuges in the Florida Keys to compete with the Civil War Battlefield at Gettysburg. It does not address larger goals or long-term plans, such as protecting entire ecosystems," Rodgers said. "... the four agencies and the OMB need to develop a new approach. They should begin by separating the current ranking system into at least three categories: outdoor recreation resources, natural resources, and cultural resources... They then need to develop a common interagency information base. Amazingly, the government now has no comprehensive source of information on privately held lands that it might want to buy. It does not even have such a data base for the land it already owns."

* * *

"Any close reading of the past 12 years forces us to the tragic conclusion that politics within the natural resources agencies has, for all practical purposes, driven science out of the decision-making process whenever science comes into conflict with any opportuni-

Albright Expands Leadership and Management Course

By Mark J. Maciha and Jim Corless

ty for private profit from the public lands. Until there is a much better public understanding of the major public lands issues and conflicts, we will continue stumbling blindly along the same destructive course."

Thus spoke former Sen. Gaylord Nelson (now with The Wilderness Society, Washington, D.C.) at the George Wright Society's 7th Conference on Research and Resource Management in Parks and on Public Lands in Jacksonville, FL in November 1992. The address is carried in the *GWSFORUM*, Vol. 9, Nos. 3 and 4, pp. 8-16. Bill Brown's Letter from Gustavus, "A New Day Dawning," leads off the volume, the rest of which is devoted to papers from a workshop organized by the GWS and IUCN at the 4th World Congress on National Parks and Protected Areas, Caracas, Venezuela, February 1992.

* * *

An 88-page full color book, *A Protected Areas Vision for Canada*, produced by the Canadian Environmental Advisory Council and forwarded to *Park Science* by its principal author, Kevin McNamee, is available free from Publication Centre, Environment Canada, Ottawa, Canada, K1A 0H3.

* * *

Report of a Workshop for National Park Service Ecological Research Program, edited by Drs. Paul G. Risser and Jane Lubchenco, is available from Mike Ruggiero, NPS Division of Wildlife and Vegetation, P.O. Box 37127, Washington, DC 20013-7127. The report discusses findings from the workshop sponsored by the W&V Division and the Southwest Region, held in February 1992.

* * *

Planning for the Future: A Strategic Plan for Improving the Natural Resource Program of the NPS, is an illustrated description of four overall goals to direct the actions of the natural resource program and of the several objectives contained in each goal. Copies of the 16-page publication, edited by Lissa Fox and Jen Coffey and designed by Todd Hampson, may be had by calling (202) 343-1000.

In January 1993, the Facility Manager Development course at Albright Employee Development Center became the NPS Leadership and Management Course. The former course had, for five years, been instrumental in meeting the call for highly trained managers in the maintenance field. The new version was developed through the efforts of NPS managers in four fields, to include trainees in maintenance, interpretation, law enforcement, and administration.

Thirty-six personnel, mostly supervisors—some line, some division chiefs—from these four disciplines attended the first session of this course and chose to name their class after newly appointed Secretary of the Interior Bruce Babbitt. They felt that Secretary Babbitt exemplifies the revitalization of the Department and of the NPS that class participants are striving for.

The five-weeks course was made possible through efforts of the Employee Development Office, the WASO Divisions of Interpretation, Maintenance, and Ranger Activities, and the regional administrative offices. Countless opportunities were provided for the group to approach problems from a multidisciplinary perspective, using the diversity of the group's knowledge and skills. The result was a coming-together not only in locality, but intellectually.

A team approach developed quickly, as participants became first roommates, then as co-workers to solve case studies and exercises, and finally as friends, who discussed creative solutions for addressing their park concerns. They came to recognize the different perspectives of the disciplines and capitalized on those differences in preparing class assignments, in addressing their own park issues, and in resolving misunderstandings about different divisions.

It became apparent how diversity in personal and work styles could be used in a complementary way to produce a more excit-

ing and productive work environment. Decision making, time and risk management, communications, negotiation, media relations, and managing change—all were components of the curriculum. Sessions on planning interfaced well with presentations on resource management issues.

Participants, who said they often were at odds with other divisions in the parks, found they were able to meet management objectives far better when they worked with other disciplines from the very start of planning or problem solving. This training will be reinforced when the participants go on their individual four week details to other park areas, primarily with different divisions, to broaden their experience and put their new learning to the test. A counselor, selected for each participant, helped trainees develop goals and objectives and project assignments.

A perceived shortfall of the course was the scarcity of the trainees' resource management expertise compared to their experience in their principal disciplines. Although the course agenda included resource management topics and case studies, all exercises shared by the class would have been more meaningful with representation of resource management specialists' perspectives. An integrated approach to resource management and protection is critical, not only between cultural and natural resources, but among all park divisions. This course contributed to awareness of resource issues among all participants and will facilitate integrated approaches and solutions to resource management issues.

Class members adopted a plan—a set of objectives and actions—to further their self-defined mission: "To strengthen the pride and vision of the NPS by empowering people through creative leadership and an interdisciplinary team approach."

Maciha is South District Ranger at Death Valley NM; Corless is Chief, I&RM, at Hopewell Furnace NIS.

Crater Lake Final Report

Limnological studies of Crater Lake were initiated by NPS in 1982 in response to the suggestion that characteristics of the lake were changing because of human activities around the lake. The final report of these studies is in the final stages of preparation

under the direction of Gary Larson, a Research Scientist with the CPSU at Oregon State University.

A draft of the report, which describes a wide array of studies of biological and physical properties of the lake, was distributed for review in December 1992. On Feb. 27, 1993 a panel of scientists met at OSU to discuss the report. Members of this peer review panel

were Stanford Loeb, chairman, U/KS; Raymond Herrmann, with NPS at CO/State/U; Hiram Li with the Oregon Cooperative Fishery Research Unit of USFWS; Manuel Nathenson, with USGS in Menlo Park, CA; Richard Peterson, with Portland State/U, OR; and John Stoddard, with the U.S. EPA, Corvallis Environmental Research Laboratory.

High Altitude Mountaineering: Visitor Types and Management Preferences

By Alan Ewert

A recent study at Denali NP identified some of the characteristics of the mountaineering visitor, the climbers' perception of the mountain environment, and certain preferred management options affecting the mountain environment and the mountaineer on Mt. McKinley and adjacent Alaska Range peaks. To date, the research community has paid little attention to such areas in terms of who the participants are, what are the underlying reasons for their visits, and what types of management issues are at stake.

Approximately 360 registered climbers were asked to complete a 26 item questionnaire as they checked out at the ranger station in Talkeetna. Response rate for the questionnaires was close to 100 percent; 84 percent attempted the West Buttress route and the remaining 16 percent climbed the Muldrow, West Rib, or Cassin. Since this study was exploratory in nature, the questionnaire was printed only in English. The sampling began in June and was concluded in August. It covered approximately 36 percent of the total number of climbers registered to climb McKinley in 1992.

Who Is the Climber?

Of the climbers responding to the questionnaire, the average age was 32 (range=18-62). Within this group more than 90 percent were male. Climbers reported an average of 10 years of mountaineering experience. It should be noted that the sample was skewed toward the low end of numbers of years of

mountaineering, with over 40 percent of the sample reporting six or fewer years of experience.

Within the sample, 67 percent indicated that they made the summit or completed their route. Of these, the reasons for their success included (in descending order of importance): Preparation, experience, acclimatization, food, good weather, patience/perseverance. The primary reasons given for not summiting or completing the route included: Bad weather and sickness/medical problems. The majority of the people (66%) were classified as independent climbers (not a member of a guided party), with 32 percent being part of a guided party and 2 percent being solo climbers.

The Mountain Environment

By a wide margin, the majority of climbers utilized the Southeast Fork Kahiltna landing strip. As depicted in Figure 1, levels of trash were perceived differently at various locations. Of all the locations reported in the study, the campsite at 17,200 feet on the West Buttress was the only consistently reported area to have trash problems.

In dealing with trash, the vast majority of climbers reported carrying out their trash. This was followed by dropping it in a crevasse (14%), and burying (1%). A note of caution here: Carrying out garbage is the administratively correct thing to do; without an actual behavior observation there is no way to ascertain the accuracy of these "reported" actions. On the other hand, it should be noted that filling out the questionnaires was voluntary and anonymous.

A number of suggestions were made by climbers on how to handle trash. The more popular ones included: Carrying it out, education, establishing collection sites and using helicopters to remove it, and burning it. Currently, NPS policy emphasizes a carry-out procedure; burning trash is not allowed.

Regarding human sanitation on the mountain, human waste disposal was not a problem at base camp for most climbers (72%). In camp locations, only 3 percent reported that disposing of human waste was a problem that detracted from their mountaineering experience. On their climbing route, 30 percent reported that human waste disposal was a problem.

Ninety percent of respondents reported they used plastic bags for human waste disposal in crevasses; however, the questionnaire did not determine whether climbers used this method all the time or interspersed it with other techniques. Problems in disposing of human waste included: Not enough latrines, inadequate directions on how to dispose of human waste, too severe environment to adequately use plastic bags or build latrines, and latrines inadequately placed. Possible solutions listed by climbers were: Limit number of parties, have more plastic bags available and enforce a human waste disposal policy, furnish more latrines, dump stations, and chemical toilets. Currently, NPS recommends using plastic bags as latrines and then disposing of the bags in deep crevasses.

Continued on page 27

Figure 1. Levels of Trash at Various Locations (in percent).

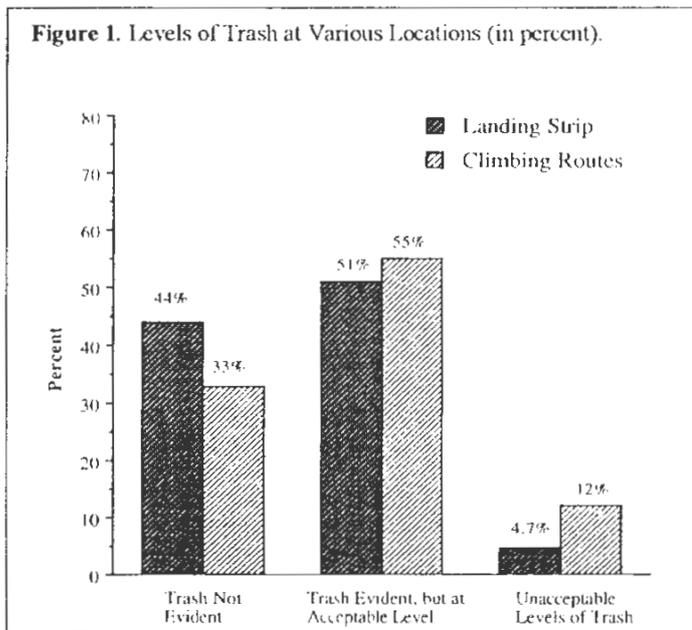
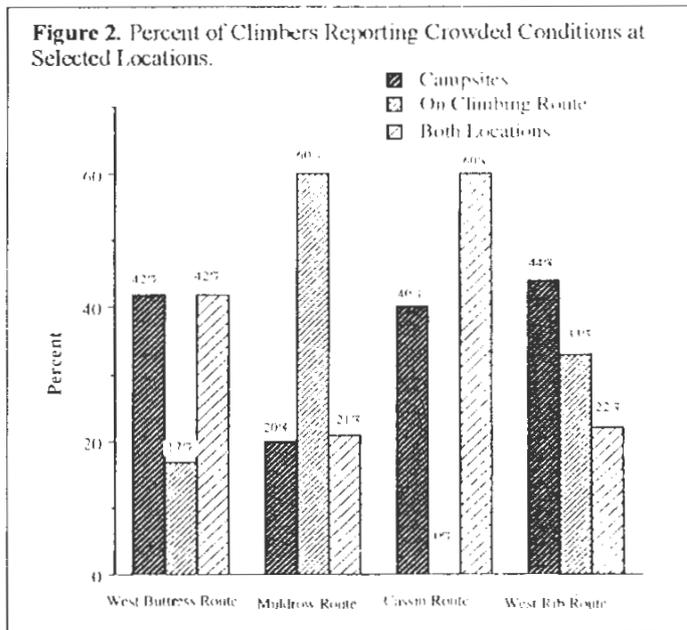


Figure 2. Percent of Climbers Reporting Crowded Conditions at Selected Locations.



Wildland Fire Management at Carlsbad Caverns NP

By Tim Stubbs

Carlsbad Caverns NP in the Guadalupe Mountains of Southeast New Mexico is widely known for its ornate caves, but not for its 47,000 acres of nearly pristine wilderness. The vegetation is mostly representative of the Chihuahuan Desert biome. It can be characterized as a plant community normally dominated by grasslands and interspersed with areas of shrubs and agavaceous succulents and cacti.

Surface water is scarce; riparian areas are limited to a few places along normally dry washes. Both pinon-juniper (*Pinus edulis* and *Juniperus scopulorum*) and forested areas are found in the park's higher elevations (generally above 6000'). The latter are found only on the extreme west end of the park and are composed of disjunct timber species such as ponderosa pine (*Pinus ponderosa*), douglas fir (*Pseudotsuga mensziesii*), and white pine (*Pinus strobus*), more widely found to the north in the Southern Rocky Mountains.

Periodic and sometimes large prairie and timber fires are well documented in both written and verbal records from the 19th and the early part of the 20th centuries. Considerable evidence, both in historical accounts and in tree ring studies, indicates that most of what now is Guadalupe Mountains NP to the west of Carlsbad Caverns burned in one large fire around the turn of the century. A few large (around 10-33 thousand acres) wildfires also occurred in this century, most caused by summer lightning.

Prevention and suppression of vegetation fires has taken place throughout most of this century; the great majority of detected natural lightning ignitions have been quickly suppressed. Heavy grazing of the herbaceous vegetation by cattle, sheep, and goats has taken place concurrently. This substitution of sustained unnatural disturbance (grazing) for the periodic natural disturbance (fire) has allowed the colonization of many areas with various fire sensitive and unpalatable shrubs such as spreading juniper (*Juniper pinchotti*), catclaw (*Mimosa biuncifera*), and creosote (*Larrea tridentata*), and the unpalatable succulents lechuguilla (*Agave lechuguilla*), Sotol (*Dasylirion leiophyllum*), and prickly pear (*Opuntia spp.*).

Beginning several years ago, park managers endeavored to exclude trespass livestock that was migrating into the park from adjacent private and federal lands by fencing the perimeters of both parks. This sudden cessation of heavy grazing, coupled with abnormally wet years, produced a bumper crop of grass and other herbaceous vegetation intermingled with the aforementioned shrub and

succulent vegetation. The resulting fuel situation has been shown by several recent fires in and around to readily sustain almost any ignition not immediately rained out or suppressed. Successful suppression in these fuel conditions has been shown by woeful experience to be unlikely in view of the hot, dry, and windy weather typical of spring and early summer months. Fuel reduction is clearly called for in many areas if any subsequent suppression efforts are to be successful.

The park also contains a substantial wilderness area within its boundaries. The mandates of the Wilderness Act of 1964 and of NPS policies governing management of wilderness areas have dictated that we consider reintroduction of naturally ignited vegetation fires as a natural resource management tool.

The Park Fire Management Program

A Fire Management Plan has been drafted and approved for Carlsbad Caverns that includes both "prescribed natural fire" and "management ignited prescribed fire" as tools for achieving certain natural resource management and fuels management goals.

A prescribed natural fire (PNF) is defined as a wildland fire ignited by natural means (usually lightning), which is permitted to burn under specific prescribed conditions, in a preplanned location, and with adequate fire management personnel and equipment available to achieve certain defined resource management objectives. A management ignited prescribed fire (MIPF) is similarly defined except that MIPF is intentionally ignited by park management, where specific prescribed conditions and fire location usually are more precisely defined.

The introduction of this program to park neighbors and neighbor agencies has not been without substantial resistance. Land adjacent to the park is sparsely populated but contains valuable gas and oil facilities and ranchlands, and memories are still fresh of the Cottonwood Fire (1974, 16,000 acres) and the Big Fire (1990, 33,000 acres). Neither of these wildfires had regard for park boundaries and both presented major threats to outlying ranches and gas/oil facilities. The specter of prescribed natural fires becoming similar raging wildfires is unacceptable, and every attempt has been made to coordinate park planning with that of all adjacent property owners and jurisdictional agencies around these relatively small tracts of NPS land.

The park's fire management plan describes strict prescription limits for prescribed natural fire behavior. Since the park is surrounded on most of its boundary by Bureau of

Land Management (BLM) and U.S. Forest Service (USFS) lands, the park's plan delineates a conditional suppression strategy zone for its boundary area. The strategy for this buffer zone is identical to that specified by neighbor agency fire management planning documents. Any ignition in the boundary areas of the park/BLM/USFS (or any PNF that approaches this area from the interior of the park) will be managed in an appropriate suppression strategy (confine, contain, or control) as determined by a unified command of all involved/concerned agencies. MIPF is proposed for natural resource management purposes in lieu of PNF in the proximity of park boundaries and around high visitor use areas of the park. In these areas an increased degree of control is necessary and the uncertainties of PNF (i.e. the timing of the treatment vs. the availability of control forces) are unacceptable. MIPF in these areas also will create "defensible space" of reduced fuels in the likely event of a PNF or wildfire in these areas.

Wildland Fire Research Needs

Research in the form of intensive fire effects monitoring must be involved in every step of the implementation of this program. Some examples of current research needs are:

- The effects of fire in the park on flora and fauna have been qualitatively researched only cursorily; there is scant information as to the effects of fire on hydrology, cultural resources, etc. Quantitative baseline data on species composition and density need to be established and monitored through several burn/recover cycles under the strictly controlled and monitored conditions of MIPF. With this data we can ascertain the effects of fire on the park's natural and cultural environment in general and on affected flora, fauna, and watershed in particular.
- Current theories concerning fire frequency for the park are based largely on incomplete historical records or on suppression-era ignition data. Tree ring, charcoal deposit, or similar studies could ascertain more correctly the fire frequency in the Guadalupe Mountains, particularly in the Carlsbad Caverns area.
- The current vegetation composition is almost certainly unnatural, as complete fire suppression and heavy grazing have been the rule throughout most of this century. Photographic reviews, pollen and opal phytolith, or similar studies would help park managers ascertain the "natural" vegetation composition of the park.



Resource Management SCA student Amy Rusk monitors fire behavior during a Management Ignited Prescribed Fire in the park. Vegetation transects were laid out prior to the burn and monitored during the burn and will be monitored in the years to come.

All known colonies of the nationally listed cacti Lee's Pincushion (*Corypanthus sneedi* var. *leei*) in Carlsbad Caverns NP are currently protected in full suppression zones because the effects of fire on this species are largely unknown. The USFS and USFWS have conducted recent studies adjacent to the park to determine the effects of wildfire on this species. Preliminary reports are that intense broadcast fire not only seems to have little long-term effect on individual specimens but may

even aid in the plant's propagation. Several of our known populations are in easily accessed areas in which it would be relatively easy to execute MIPFs. We should establish interagency ties to study the effects of fire of various intensities on this federally protected plant.

Fire Management's Future at Carlsbad

Prescribed natural fires will be allowed to burn, with extreme sensitivity to the concerns of neighboring agencies, park visitors, and park neighbors. These fires will be

carefully monitored to learn the effects of fire on natural resources and to ascertain and certify the capabilities of park management at deploying this inexpensive but powerful natural resource management tool.

Management ignited prescribed burns will be conducted to ascertain both the direct and the indirect effects of fire on all aspects of the park's natural environment. Various academic institutions will be encouraged to address the park's fire research needs, possibly through subsidized research funds currently available through FIREPRO (NPS wildland fire management funding) sources. Through MIPS we will continue to establish research-based goals and objectives derived from properly conducted research, which will include documentation of fire effects in various intensities, and the validation of prescriptions necessary for achieving these goals/objectives.

Suppression of all fires that do not qualify as PNFs (including all non-MIPF human-caused fires) will continue. The park will maintain a cadre of highly trained wildland fire personnel to properly monitor prescribed fires and to professionally supervise wildfire suppression efforts when these become necessary.

Stubbs is Fire Management Officer at Carlsbad Caverns NP.

High Altitude Mountaineering continued from page 25

Sociological Factors

Given the international popularity of Mt. McKinley and the increasing numbers of climbers over the past decade, the issue of crowding was considered an important study element. Although the size and complexity of Mt. McKinley would seem to preclude a crowding problem, only a few routes receive the majority of use. In this study, 32 percent of the climbers reported crowding as a problem. As shown in Figure 2, perceived crowding varied with the location. For example, crowding was prevalent on the Muldrow route and non-existent on the Cassin route.

On the issue of limiting the number of climbers, a slight majority of respondents were against limitation (57% to 43%). These numbers might change if climbers were actually faced with being denied a climbing opportunity on the more heavily traveled routes. When asked about ways to deal with the crowding problem, two responses were most often given: Establish a permit system, and limit group sizes.

The literature now is fairly consistent in differentiating between solitude, user-density, and crowding (Patterson and Hammitt, 1990; Stewart and Carpenter, 1989). While density can be an actual physical measure-

ment (numbers of climbers in a given location), solitude and crowding are psychologically determined. In the case of crowding, how "crowded" an area is depends in part on the expectations and past experience of the individual. At Mt. McKinley, climbers (particularly on the more popular routes) may be expecting to see larger numbers of other climbers and consequently feel less "crowding" even though a relatively high user-density obtains.

Conclusions

Drawing conclusions from a one-time snapshot of people and time can be a risky business. Some information from this study bears up under the weight of common sense, experience, and past findings from the literature. The demographics from this study's sample are congruent with the general population of climbers visiting Mt. McKinley. To the extent that this is true, it would seem reasonable that they reflect many of the views and demographics of most McKinley climbers. It should be noted however, that the study did not sample those climbing in the earlier part of the season—April and May. The variables of age, gender, and years of mountaineering experience do seem in line with

the overall climbing population of Mt. McKinley.

Trash and human waste are problems in some areas but not overwhelming for most climbers. Most-offered solutions, such as crevasse dumping or helicopter-assisted removal, either are not new, or represent a significant increase in maintenance and personnel costs.

The study showed that trash, sanitation, and crowding still are within acceptable limits for most Mt. McKinley users. If problems eventually do occur in these or other areas related to management of the climbing environment, future studies should strive to determine what types of solutions or management options would be most acceptable to the user.

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Effects of Fire on Cultural Resources at Mesa Verde NP

By William H. Romme, Lisa Floyd-Hanna and Melissa Connor

On Oct. 20-21, 1992, twenty-five archeologists, ecologists, and fire managers met in Mesa Verde National Park (MVNP) to evaluate and predict the effects of fire on the park's cultural resources. Our goal is to develop a risk model—incorporating parameters of potential damage to sites and artifacts, vegetation/fuels conditions, and weather conditions—that will be useful to managers in predicting and managing fire effects in Mesa Verde and similar parks in the southwest. This report addresses the first component of the risk model, namely the differential susceptibility of various types of cultural sites and materials to damage from high intensity fire effects.

Three general questions were: (1) What are the major types of cultural sites and materials in MVNP and what are the direct and indirect effects of high intensity fires on each type? (2) What kinds of monitoring and damage evaluation should be conducted before, during, and following high intensity fires? (3) What kinds of pre-suppression activities can be taken to reduce damage to cultural resources?

We focused only on high intensity fires because these are potentially most damaging and difficult to control. Following is a summary of our conclusions and recommendations for further studies.

Effects of Fire on Different Kinds of Cultural Resources

The several types of historic and prehistoric cultural sites identified are listed below in approximately descending order of susceptibility to direct damage by fire. Additional details and evaluation of fire impacts on these kinds of cultural resources can be found in the assessment of the Long Mesa fire that occurred in MVNP in 1989 (Eininger 1990, Fish 1990) and the annotated bibliography compiled by Duncan (1990).

A. Sites with high vulnerability:

1. Native American historic structures: These include sweat lodges, corrals, and similar structures. Wooden structures are destroyed by fire and leave little trace. Protection during fire is nearly impossible. Many of these structures are sacred for the people who use or used them.

2. Alcoves and cliff dwellings: Combustible materials—e.g. packrat middens, wooden beams, corn cobs—are consumed by fire. Many alcove sites are relatively protected from fire because they are surrounded by expanses of bare rock with no fuel. But

organic materials can be ignited by firebrands or spontaneous combustion through pre-heating from an intense fire burning all around the alcove.

3. Rock art panels: Rock art occurs in MVNP, but no known panels were within the boundaries of the Long Mesa fire. A comprehensive inventory of rock art panels within MVNP does not exist and undocumented panels may have been affected by the fire. Studies in upper Salt Creek in the Needles District of Canyonlands NP indicate that exfoliation of the rock face occurs during high intensity fires (Noxon and Marcus 1983 a,b). Prevention measures include clearing brush from areas around the rock face. Other methods, including application of a stone strengthener (organo-silicon compounds in a ketone carrier), also may help prevent exfoliation (Grisafe and Nickens 1991).

4. Scarred trees: Several old trees in the park were scarred by Native Americans, probably Ute people, who stripped the bark for food some time prior to park establishment in 1906. These trees could be killed by high intensity fires and their tree ring record lost.

B. Sites with moderate vulnerability:

1. Euro-American historic structures: Most of these structures are associated with park management, e.g. the Recreation Hall and Museum on Chapin Mesa. Some of these may be defensible in moderate intensity fires, but several cannot be protected from high intensity fires.

2. Lithic scatter with shallow hearth: Due to its ephemeral nature and the emphasis on structural features, this site type may be under-recorded within MVNP. As the effects of fire are strongest at the surface, artifacts here will be vulnerable to damage by fire. Surficial lithic materials within the Long Mesa fire boundary showed color alteration due to heating. This would not impair analysis of their technological attributes or their function based on morphology. Studies on silica-rich stone suggest that low fire temperatures are responsible for minor morphological change in surface cherts at Long Mesa. Beyond about 700F (350C) stone will spall, crack, and shatter (Mandeville 1973; Purdy and Brooks 1971). In a hotter fire or on a different type of stone, the potential exists for changes to stone artifacts that impair morphological analyses.

Due to the increased luster associated with heating of cherts, heating probably would impair microwear analysis, as it would im-

pair blood residue analysis. However, as neither of these analyses are routinely successful on surficial material, this is not a serious loss.

Effects of fire on a shallow hearth are more problematic. Common archeological analyses of hearths include studies of the way the hearth was made, their pollen, faunal, and macrobotanical contents, and dating techniques such as radiocarbon, thermoluminescence, and archeomagnetic dating. The study of hearth construction does not appear to be affected by fire.

Effects of fire on hearth contents have been studied. Fish (1990) conducted a study on effects of fire on pollen and found that even the surface samples marked by ash and charcoal from the Long Mesa fire yielded abundant, identifiable pollen. She found that pollen grains that appeared to be fire-altered by the Long Mesa fire "were darkened to a yellowish-brown color and would not absorb the stain used to enhance microscope viewing. Walls of these grains were thickened or swollen and fine morphological features were obscured, although identifications were still possible" (Fish 1990:2-3). Shipman and others (1984) document the effect of fire on bone, showing color change and calcining in surficial bone at lower temperatures. Ashing occurs at high temperatures. Calcined surficial bone was observed within the Long Mesa fire boundary. Ford (1990) found the Long Mesa fire did no damage to ethnobotanical material from hearths within the fire boundary. Thus, almost counterintuitively, it appears that wildfires such as the Long Mesa and La Mesa fires have little impact on study of the contents of shallowly buried hearths.

The third factor affecting the research potential of these hearths is dating. Although not studied as a result of the Long Mesa fire, wildfire burning over a shallow hearth probably would affect the potential for use of thermoluminescence and archeomagnetic dating. That wildfire affects both analyses was demonstrated in studies after the La Mesa fire in Bandelier NM (Rowlett and Johannessen 1990; DuBois 1990). No controlled studies on the effect of wildfire on radiocarbon dating exist. However, inclusion of recent charcoal from a wildfire into a radiocarbon sample would result in significantly younger date.

C. Sites with low vulnerability:

1. Deeply buried unexcavated pueblos: Fire produces discoloration and oxidation of surface ceramics and lithics. Eininger (1990)

Alcove containing a small Anasazi stone building. The Long Mesa fire in 1989 burned the forest above and around this alcove, but did minimal damage to the archeological site because of the lack of fuel directly within the alcove.



Boulders that were cracked by sudden and intense heating in the Long Mesa fire of 1989. Prehistoric rock walls could be damaged by cracking and spalling of this kind.



summarizes what is known about these effects and the temperature thresholds at which they occur. At very high temperatures (ca 600C), carbon may be burned out of sherds, leading potentially to misidentification. Fire also accelerates decomposition of sandstone blocks. Accelerated rock decomposition could create future difficulty in recognizing sites on the basis of surface components. Deep structures probably are unaffected by fire, since heat rarely penetrates more than a few cm even in intense fires (Chandler et al. 1989).

Fire apparently has little impact on the research value of deeply buried sites except in two circumstances. First is buried pueblos with large trees on or adjacent to the site; the roots may burn in a high intensity fire and carry heat down into the buried structures (Wettstead 1988), and the charred roots remaining in the soil may confuse charcoal dating and interpretation. The second potential effect occurs immediately below large logs that smolder, driving the heat as deep as 20 cm into the ground at that spot (Connor et al. 1989).

Fire retardant slurry could affect standing walls if it is dropped directly on the walls during suppression activities. Slurry weight could knock down walls, and geologist Mary Griffiths suggests the slurry may be incorporated into sandstone rock where it hastens decomposition.

2. Lithic scatter: See discussion on surficial lithic material under section dealing with lithic scatter with shallow hearths.

3. Check dams: Fire apparently has little or no effect on check dams.

Indirect Effects of Fire

Several indirect effects may occur either immediately or months after a fire. Potential-

ly important indirect effects include:

1. Rodent and insect populations may increase in response to increased succulent vegetation following the fire; rodent burrowing disturbs artifacts and alters their positions.

2. Bare soil exposed by fire is vulnerable to erosion and redeposition during the time period before vegetative cover becomes re-established (Connor and Cannon 1991, Swanson 1981). These processes may remove artifacts or bury them.

3. Microbial activity may increase after fire (Bissett and Parkinson 1990). Potential effects on cultural materials are unknown, but probably result in short-term accelerated decomposition of organic materials.

4. Application of fire retardant slurry during suppression activities may affect cultural artifacts; details are lacking. The U/CA at Riverside is conducting studies of slurry effects in Joshua Tree NP, but results are not yet published. The phosphorus in the retardant also may influence post-fire plant growth and composition, since phosphorus is a limiting plant nutrient in most ecosystems.

Pre-suppression Opportunities for Reducing Fire Damage

We started with the assumption that high intensity wildfires will occur in MVNP in the future: given the climate, fuels, and topography, occasional uncontrollable fires are inevitable. See Erdman (1970) and Omi and Emrick (1980) for discussion of fire history and future fire potential in the park. Below is a list of things that can be done to minimize damage to individual sites and materials before the next uncontrollable fire occurs.

Some of the actions are expensive; others may not be feasible immediately. Rather than embarking on a crash program to "harden" all cultural resources against fire, we suggest that park managers should incorporate these steps into their long-range planning and do each at an opportune time. Some damage to sites will occur even without fire: natural processes of weathering and erosion have been occurring for centuries and will continue, regardless of our actions. Suggested pre-suppression activities are listed in approximately descending order of urgency.

(1) Document sites and artifacts that cannot be protected from high intensity fire. Several kinds of cultural resources are highly vulnerable to wildfire and cannot be effectively protected. The only way to ensure that information they contain is not lost is to document them thoroughly. The park already has a program of inventory and analysis of these kinds of resources, but the program must be accelerated. We recommend the following specific actions:

(a) Contract a qualified persons(s) to inventory and estimate approximate age of packrat middens; then contract the same or another person to perform a thorough scientific analysis of a sample of the oldest middens. These contain among the best records available of variations in climate and vegetation over the last 20,000 years (e.g. Betancourt et al. 1990); and they are, obviously, irreplaceable.

(b) Locate and photograph the scarred trees throughout the park. Then contract a dendrochronologist to collect increment cores. The tree rings will reveal the date the tree was scarred and a record of climatic variation.

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(c) **Map, photograph, and describe** Native American and Euro-American historic structures and evaluate whether any additional pre-suppression activities, such as localized fuel reduction, would be practicable.

(2) **Reduce fuels selectively in localized, high value areas.** It is not feasible or necessarily even desirable to try to reduce fuel loads throughout the park; fuels are so great and variable and other resources would be damaged in the attempt. However, small but highly significant areas present opportunities to reduce fuels. The inventory of sensitive cultural resources should include evaluation of the feasibility and value of fuel reduction around each site. A risk analysis team then should review the list and select the sites for fuel reduction. They should have high cultural significance, high risk from fire, and a setting where fuel reduction is feasible.

Fuel reduction may be accomplished mechanically, by prescribed burning, or by a combination. The existing hazardous fuel reduction program could be expanded to accomplish this. Following is a list of some of the methods that may be practicable:

(a) **Removal of dead and down woody material, thinning of the forest canopy** (30-foot or 60-foot spacing), and thinning of brush around historic structures.

(b) **Removal of brush and trees** from the vicinity of alcoves and cliff dwellings (may need to be repeated periodically).

(c) **Removal of trees growing in or adjacent to buried pueblos or hearths.** Sites having standing walls would receive higher priority for this work than sites with only rubble on the surface.

(3) **Evaluate all the existing sites and interpretive facilities and assign each a priority rating for trying to save it in a high intensity fire.** Much of this kind of assessment already has been done, but it needs to be expanded to include all such structures in the park. The ranking system must be presented explicitly to all park workers to reduce confusion and controversy during a large fire. Each type of cultural resource should be evaluated independently, as well as in comparison with all other cultural resources. The assigning of a priority ranking should be carried out by a risk assessment team of both cultural and fire people. Priority assignments will call for value judgments and these should be stated explicitly by the risk assessment team and if necessary debated long before a large fire demands immediate decisions.

(4) **Build fire resistant features into new and existing park buildings and interpretive structures wherever possible.** This can

be accomplished over many years. Fire personnel should be involved in planning future construction and renovation, to see that fire resistant features are built in wherever those features are consistent with the primary purposes of the structure. Examples follow:

(a) **When roof repairs become necessary,** replace existing shake shingles with fiberglass or other reproductions that look similar but are vastly less flammable.

(b) **When the curtains on the ruins shelters need replacement,** use fire resistant material. In the event of a high intensity fire, the curtains then provide some protection for expensive interpretive features inside.

(c) **Install sprinkler systems** in or around highly significant but vulnerable structures.

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In the next issue...

- ✎ "New Fossil Mammals Found at Florissant Fossil Beds," by Emmet Evanoff and Peter M. de Toledo, indicating that the Florissant Formation was deposited at the same time as the Chadon Formation of Badlands NP
- ✎ "Seasonal and Diurnal Discharge Fluctuations in Neddano Creek, Great Sand Dunes NM in Southern Colorado," by James P. McCalpin
- ✎ "Evaluating Eastern Wild Turkey Restoration at Indiana Dunes National Lakeshore" (using GIS analysis), by Eddie L. Childers
- ✎ "Succession and Biological Invasion at Mesa Verde NP" (weed species invasions following hot fires), by Lisa Floyd-Hanna, William Romme, Deborah Kendall, Allan Loy, and Marilyn Colyer
- ✎ Part I of an overview of the "Shared Beringian Heritage Program," by Dale Taylor and Jeanne Schaaf

Curtis Bohlen, former Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs, has appointed Dr. Frank H. Talbot as the new chairman of the U.S. MAB National Committee. He will serve for three years, 1993-1995. Dr. Talbot is Director of the National Museum of Natural History at the Smithsonian Institution. He succeeds Dr. Thomas Lovejoy, who served for five years. Under Lovejoy's chairmanship, U.S. MAB streamlined its structure by reducing the 14 directorates to 5. It began core directorate projects, and concentrated MAB upon interdisciplinary social and natural science research. In leaving his MAB post, Dr. Lovejoy noted "that the greatest assets of U.S. MAB are the biosphere reserves themselves... [but] we have yet to come successfully to grips with how we can capitalize on this impressive network... The... biosphere reserve managers workshop currently being organized will be a significant step in that important direction."

Regional MAB and MAB-related programs are progressing all around the country. For example, planning activities are underway in the Sonoran Desert, Ozark Highlands, Champlain-Adirondack Area, Colorado Rockies, and western Lake Superior. Regional work on the ground continues in the Mammoth Cave Area, the Southern Appalachians, and the Central California Coast. Since these regional programs are working examples of cooperation in implementing biosphere reserve concepts, I will highlight one in each MAB Notes column.

The **Central California Coast Biosphere Reserve** (CCCBR) was established in 1988. The first biosphere reserve to involve a major urban area, it is culturally and ecologically extremely diverse, with an impressive array of management, research, and educational institutions. Its 13 public and private land and water units, centered in the San Francisco area, include Audubon Canyon Ranch; Bodega Reserve of the University of California, Davis; Cordell Bank and Gulf of the Farallones National Marine Sanctuaries; Farallon National Wildlife Refuge; Golden Gate National Recreation Area; Jasper Ridge Biological Preserve of Stanford University; Marin Municipal Water District; Mt. Tamalpais, Samuel P. Taylor, and Tomales Bay State Parks; Point Reyes National Seashore; and the San Francisco Water Department Peninsula Watershed Lands.

A feasibility study funded by U.S. MAB and a subsequent planning report funded by the Marin Community Foundation guided

development of the CCCBR structure and operating procedures.

The work of the CCCBR is planned by councils; three—Managers, Science, and Education—have been established. Two others—Sustainable Economic Development and Public Participation—will be created when leadership is identified. The councils' activities are facilitated by the non-profit CCCBR Association.

The Association's Board of Trustees consists of the Chairs of each Council and additional representatives from science, education, and other communities. The Board reviews Council proposals for the Association's endorsement and support. The Association receives funds from government agencies and private sources for carrying out projects of the biosphere reserve.

A Memorandum of Understanding, signed in 1992-93 by agencies and organizations participating in the biosphere reserve, sets forth the background and objectives of the BR program. It is not surprising that getting the signatures of BR administrators and other interested parties took some time, as agencies and organizations had to be assured that the agreement would not conflict with their individual mandates. The CCCBR's office is at Fort Mason, in Golden Gate NRA. The CCCBR sees itself primarily as a coordinator, convener, and facilitator of communication for the many groups engaged in resource management, conservation, environmental education, and research on natural and human systems in the central California coastal region. Several projects are underway. One is organization of a symposium on biodiversity of the central California coast, including the greater San Francisco Bay region. The symposium, to be held in winter 1993-94, will look at the status of biodiversity in the region, the resources at risk, and strategies and tools for sustaining biodiversity. Another project is development of an integrated GIS system for the CCCBR. This involves determination of the present GIS capacities of the CCCBR member agencies, and development of a questionnaire to obtain information needed to identify objectives and assess opportunities for an integrated GIS system. The general goal is to improve the information base for multi-sector and cross-boundary resource management and restoration and to improve the utility and cost effectiveness of existing GISs.

With a dedicated, well-functioning Board, clear project goals, and a small but growing bank balance, the CCCBR appears to be off to a good and promising start.

Napier Shelton, NPS Wildlife and Vegetation Division, WASO.

A PhotoPoint Archival System

By Stephen V. Cofer-Shabica

Case and others (1982) describe a system of documenting natural and human-related physical changes in natural and cultural resources within units of the National Park System. The documentation system has multiple uses, is aesthetically unobtrusive, and sufficiently permanent to provide natural and cultural resource base information today and in the future.

The preservation of the photographic products (in this case, 35mm color transparencies, black and white negatives, and B&W color-separation negatives) is discussed. They suggest that metal cabinet-type slide storage files or metal slide storage boxes be used for the archival storage of original transparencies, and the B&W negatives. Regardless of the method used, they caution that the environment surrounding the storage area be temperature and humidity controlled, to ensure long-term preservation.

The maintenance of a constant temperature/humidity environment often is difficult in parks. Thus, in 50 to 75 years, as the color dyes fade, the recorded images will lose much of their information. Black and white color-separation negatives are costly, since three negatives are required for each preserved image. These negatives also need proper temperature/humidity control, although it is not as critical as with the color transparencies.

Advances in computer technology over the past five years have provided a means of archiving photographic products over long periods of time. The introduction by the Eastman Kodak Company of a compact disc (CD) photographic process provides photographers and resource managers with a relatively permanent, inexpensive, and easily stored means of archiving photographic slides, negatives, or prints. This system allows up to 100 color transparencies to be placed on one CD, at a current cost of less than \$20 per disc. The photographs may then be displayed either with a Kodak Photo CD Player connected to a television, or a CD ROM (XA) drive connected to a personal computer. In addition, duplicate copies of the photographs can be reproduced from the CD as well as additional discs made.

The use of the compact disc for storage of critical natural and cultural resource photographs and color transparencies should allow managers to archive such products permanently.

Cofer-Shabica is Resource Management Specialist at Cumberland Island National Seashore.

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The use of trade names does not imply U.S. Government endorsement of commercial products.

Letters

To the Editor:

I wanted to let you know that I was pleased with our recent articles on inventory and monitoring in *Park Science* (Fall 1992 and Winter 1993 issues). The layout was attractive and effective in conveying the rather lengthy discussion in the text.

I was amazed at the response that we had to these articles. We had requests for information and publications from many different agencies, universities, and other institutions. Our research program clearly gained a higher degree of visibility and credibility on a national basis because of these articles. The contact with non-NPS scientists has been particularly helpful in developing additional linkages for our program outside the agency.

I am not sure if all your articles get this much response, but *Park Science* was certainly an effective forum for getting the word out, both

within and outside the NPS. I appreciate your assistance with our articles and enjoy every issue of *Park Science*. Keep up the great work!

David L. Peterson
Assoc. Prof., Univ. of Washington
NPS Research Biologist, NPS/CPSU at U/WA

Editor's Note: A letter from Scott F. Poser of the Canadian Ministry of Natural Resources recently arrived, asking for missed copies of Park Science, (the result of a gigantic distribution snafu), and adding: "I am particularly interested in the series of articles dealing with the development of Inventory and Monitoring programmes in U.S. National Parks as I am working on a project with a similar aim for Ontario Provincial Parks."

These things are good to hear.

Biology Colloquium Explores Harmony With Nature

Ruth Jacobs, Research Assistant with the NPS/CPSU at Oregon State University, attended the 54th Annual Biology Colloquium held at OSU April 29, 1993, where the question explored from many angles was "How can humans live in harmony with nature?"

Speakers covered the subject matter from the abstract to the specific and applied—from "Three Philosophies of Conservation," (by Richard B. Norgaard with U/CA-Berkeley) to "The Concern for Human Population Growth in Conservation Issues" (Anne Ehrlich with the Center for Conservation Biology at Stanford).

Of particular concern in the Pacific Northwest were two lectures by Drs. E. Charles Meslow (USFWS) and David Ehrenfeld (Rutgers U Dept. of Natural Resources). Dr. Meslow addressed the controversy over logging in the Pacific Northwest and conservation of spotted owls. In 1987, he said, we assumed that 300 acres of land per pair of owls was sufficient. That judgment was based on the best data then available. Today, he

he said, we recognize that a pair of these owls uses several thousand acres of forest, with a strong dependency on old-growth systems. User groups and management agencies have struggled to deal with this changing base of knowledge at the same time that local and global demands for forest products have increased.

"In the case of the spotted owl," he said. "we have avoided decisions outright... when our knowledge warned us to do otherwise. In other instances, we have postponed reasonable decisions that would alter ongoing management programs pending more information."

We still have options for owl conservation, he noted, "but they are fewer and more limited."

Dr. Ehrenfeld argued that humans live in an increasingly artificial reality. "Many of us," he said, "don't even care about our natural world, although we are intricately tied to it, because we have lost touch with reality."

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