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El Malpais Wilderness Suitability Study

By Ken Mabery and Dave Kenney

On Dec. 31, 1987, Congress established El Malpais National Monument (NM) on the southeastern edge of the Colorado Plateau. "The bad country" (EL-MAL-pie-EES) was aptly named by Spanish explorers for the trackless, broken lava flows covering about 230 square miles in northwestern New Mexico (75 miles west of Albuquerque). The 114,848-acre monument contains one of the more recent lava flows in continental United States and has kipukas, cinder cones and other craters, spattercones, pressure ridges, important lava edge ecotones, and more than 50 miles of lava tube systems, some with unusual ice formations and flora and fauna species.

Other features include archeological sites dating from the Archaic (5000 B.C.) through Anasazi (A.D. 1350) periods and continuing to modern Navajo and Pueblo cultures and pristine vegetation associations such as aspen and Douglas-fir stands of pinon and juniper.

The El Malpais legislation also created a 262,600-acre BLM national conservation area (NCA), which almost surrounds the monument and within which are two designated wilderness areas. These areas (totaling 102,400 acres) border the monument on the south and east. The legislation required the development of simultaneous management plans for the NPS monument and the BLM conservation area.

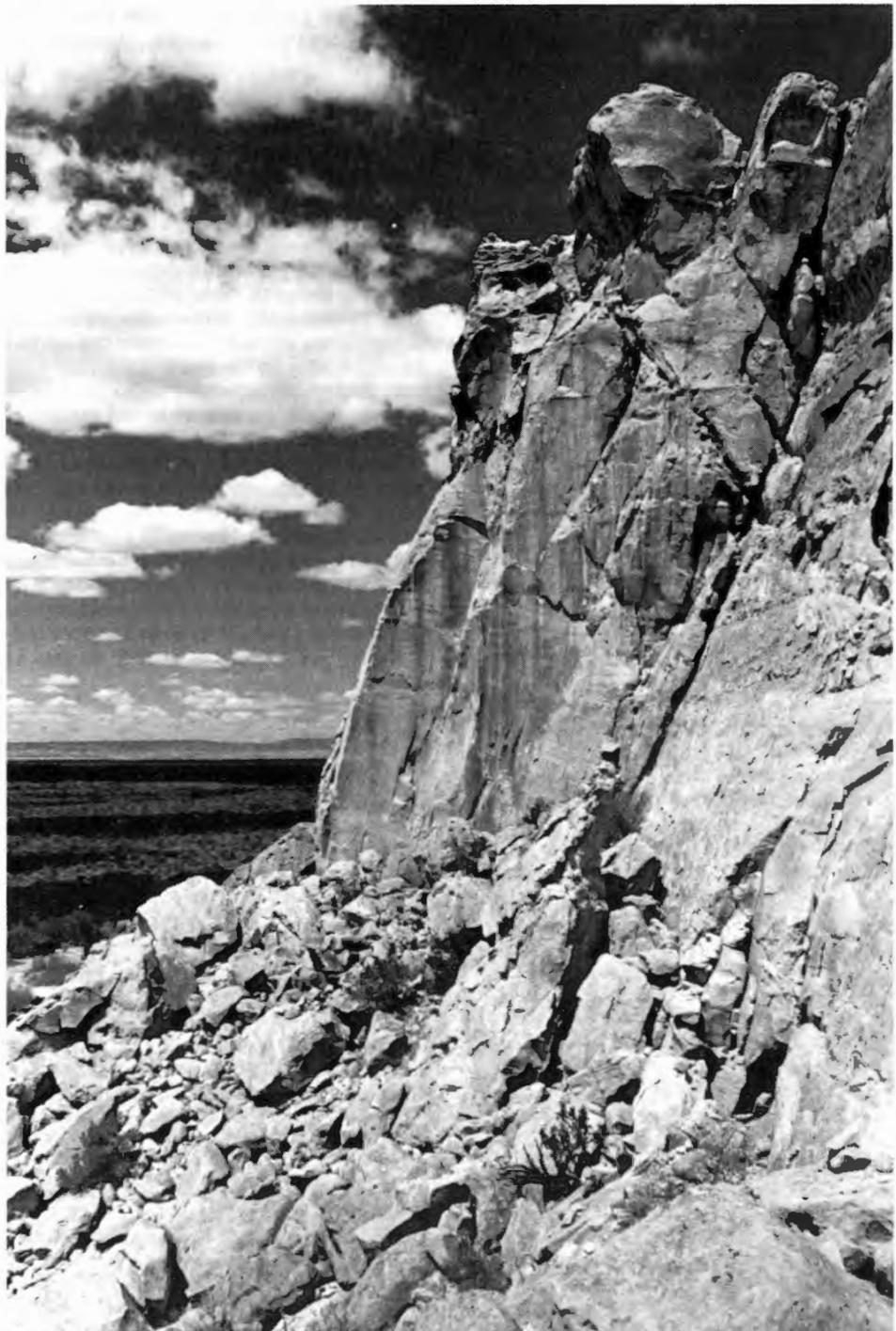
A further legislative requirement was a wilderness suitability study – an inventory of lands suitable for wilderness designation. This article deals with the NPS approach to and conclusion of that study and the problems encountered.

Background

Legislative provisions that influenced the mandated wilderness study are: (1) the general management plan (GMP) "shall review and recommend the suitability or nonsuitability for preservation as wilderness of all roadless lands within the boundaries" (hearing language defined "roads"); (2) a map of potential development zones that did not have to be inventoried; (3) development of two visitor centers and traditional NPS facilities to provide for the enjoyment of ...; (4) phaseout of grazing by 1998 (eliminating many existing roads and other incompatible intrusions); and (5) continuance of traditional American Indian practices and access consistent with the Wilderness Act.

Because of simultaneous deadlines, only one week was allowed for wilderness fieldwork. Topo maps and air photos were essential for locations of roads and other major intrusions. Most intrusions were adjacent to the lava flows and associated with past lumbering and grazing activities. Field inventory and evaluation concentrated on applying the Wilderness Act criteria,

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Cliff at Sandstone Bluff, with McCarty Crater flows in the background. Photo by Dennis Daily.

PARK SCIENCE

NATIONAL PARK SERVICE

SPRING 1991

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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Authors, Please Note!

It has come to our attention recently that several manuscripts mailed to *Park Science* over the past year have not reached our editorial office. In October 1989, that office moved from Oregon State University's Forestry Sciences Lab to the address that has since then appeared in our masthead:

Jean Matthews
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The University no longer forwards mail directed to the old address, so if you have been wondering what happened to your deathless prose, chances are it never reached us. If it can be updated and still deserves dissemination, try us again.

editorial

Editor's Note: *In the serendipitous way that things often happen, editorially, for Park Science, a veritable spate of cave-related articles appeared in our mailbox. That this occurred at the same time that WASO was pre-empting the Southwestern Region's Chief Scientist for help in establishing a national node for cave research and management, provided this issue of Park Science with a focus that is herewith introduced by SWR Chief Scientist Milford Fletcher in the following guest editorial.*

* * *

During the week of Feb. 11, 1991, I met with NPS Deputy Assoc. Director Denny Fenn to outline the tasks related to the recently passed Act directing the NPS to accomplish two tasks:

(1) Establishment of a Cave Research Program "to provide for the orderly and scholarly collection, analysis, and dissemination of research material related to caves in lands managed by the NPS including, but not limited to, Carlsbad Caverns NP and the Capitan Reef area" (a geological formation), and

(2) Transmission to Congress of a report on the feasibility of establishing a Cave Research Institute. The report shall consist of a study covering "the need for such a facility, its costs, its purposes, what the facility should include, and where it should be located. Analysis of potential sites for the Institute should include, but not be limited to, Carlsbad Caverns NP."

The Division of Natural Resources and Science in the NPS Southwest Region has agreed to be the main contact for the first task. The second task will be completed by one of the various planning organizations, pending funding for the study.

We are currently formulating a work plan for approval by the Directorate in Washington which will outline, in general terms, the main thrust and direction of such a nationwide cave research program and what it would look like.

The exciting thing about this legislation is that finally we are getting a chance to look at cave research needs on a nationwide basis. An initial list of these needs will be obtained from the recently submitted Tables and Charts, updating the resource management plan from each park area. This legislation has the potential to gather an information base on cave-related research, open lines of communication among a diverse group of cave researchers, and formalize a nationwide program of cave research and management based on the most recent knowledge of karst processes.

Since caves represent a priceless source of information on paleontology and anthropology, the participation of a wide variety of research directions and disciplines is virtually assured.

(See Kerbo's "Caves and the NPS" on page 5.)

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El Malpais Study Poses Problems

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the "road" definition, and evaluation of other intrusions. All identifiable roads and ways were field checked and evaluated for need and intrusiveness. The latter proved very difficult; many determinations were changed as planning progressed and additional consultations occurred with tribal groups. Data were circulated between NPS and BLM planning teams for additional review and comment. Finally, all pertinent data were transferred onto a permanent base map.

Crystal Ball Needed

Because the El Malpais wilderness study was part of the GMP process, an integrated team was assembled to determine the most appropriate potential land uses. This was critical to the wilderness study because NPS management of the monument had begun only a few months prior to starting the GMP and there was very limited visitor use and resource data base (first field staff were hired in July 1988; GMP fieldwork started that August). To balance wilderness preservation and other legislative requirements, it was necessary first to determine development and access needs for resource protection, and visitor, administrative, American Indian, and private uses. Because of limited data, this required some crystal ball type work.

Although El Malpais' legislative map designated some potential development zones that did not have to be evaluated for wilderness suitability, these were inventoried anyway; those suitable (after planning needs were met) were included as wilderness-suitable lands.

The authors found some unique circumstances during this study. The lava flows show almost no evidence of modern humankind. For the most part, the rugged lava flows preclude developments, and no further exploration was required on a sizeable portion of the monument. For approximately 58 of the 131 linear miles of monument boundary, many lava flow edges roughly coincide with monument boundaries, making ecosystem and physiographic boundary identification and protection relatively easy. A strong desire to simplify management with the adjacent BLM West Malpais Wilderness Area made analysis along approximately 33 miles of common boundary less complex. This left about 40 linear miles that presented the difficulties discussed here.

Lack of Guidance

The NPS's *Management Policies* devotes a chapter to wilderness; however, the chapter primarily addresses operational management rather than the study process. Another potential guidance source, NPS-2, *Planning Process Guidelines*, lacks any reference to wilderness studies. A review of other, older NPS wilderness studies proved to be the best overall guidance, as discussed here later.

The Senate report mandated the use of the BLM's definition of road – "a vehicle route which has been improved and maintained by mechanical means to ensure relatively regular and continuous use." A way, on the other hand, was "a vehicle route which has not been improved and maintained by mechanical means." For this wilderness study, "maintained" and "relatively regular and continuous use" needed further definition. Fortunately, BLM was wrestling with the same criteria on its nearby Chain of Craters Wilderness Study Area; we shared each other's ideas and thoughts. Still, what evidence of maintenance will you find on a road in an open grassy flat? In a remote, isolated, rugged area, what is "relatively regular" use?



Inside Bandera Crater within El Malpais National Monument. Photo by Dennis Daily for the Cibola County Beacon.

Once a month? Once a year?

Obtaining the Needed Data

Numerous vehicular routes were not on topo maps or range inventories, and some were not even apparent on aerial photographs. Up to a year after the fieldwork, at least six vehicular routes were discovered, which made keeping up with acreage calculations and determining wilderness boundaries very difficult.

Do We Evaluate Private Lands for Wilderness Suitability?

Another problem was how to deal with private lands within the monument. Should they be evaluated before being acquired? No guidance is given for evaluating these private lands. In our final analysis, the private lands were evaluated and when those private lands that meet wilderness criteria are acquired, they will be considered as wilderness-suitable lands. (For purposes of the study, these lands were called potential wilderness additions.)

How Do We Determine Wilderness Boundaries?

Perhaps the biggest problem was the lack of guidance as to how to determine wilderness boundaries. The lack of clear guidance was evident in several areas.

Definitions: While applying the Wilderness Act and NPS policy to this study, most often the authors found the law and policy too loosely worded to provide enough guidance. Neither policy nor law defines basic terms like "solitude," "untrammeled by man," or "primitive and unconfined recreation." Also, neither gives guidance on determining wilderness boundaries.

Solitude: Solitude from what? When is solitude achieved in terms of user experience or physiography? What are the elements that make up solitude? Are there opportunities for solitude on open flats or broken lava fields (with few trees) adjacent to roads? How do developed areas affect solitude? Where do wilderness

users begin to experience solitude and how is it measured – when they are out of sight of roads, or sound of vehicles, or both?

In heavily vegetated areas it seems easier to identify where a sense of solitude begins, but human perceptions vary through time, geographic area, and by individual. The recreation opportunity spectrum (ROS), developed by the USFS and adopted by BLM, was a valuable tool and helped with this identification.

Primitive and unconfined recreation: What is primitive in terms of trail standards and other wilderness developments? Does unconfined mean that management cannot take any confining actions such as gating caves to reduce resource impacts or closing areas that may be hazardous for visitors? How is unconfined reconciled with American Indian access issues?

On one hand, dealing with primitive and unconfined recreation wasn't as complex: El Malpais has no major developments. On the other hand, there are no established visitor use patterns or public use needs either. What demands on the resource and management will future visitation bring? There are no direct baseline data to model, so the GMP team used other parks similar to El Malpais to project overall visitation trends. This wasn't much help in wilderness planning. Visitation levels affect the quality of wilderness. What developments/facilities are necessary to protect the resource and accommodate an estimated potential annual visitation of 276,100 by the year 2000 without compromising wilderness values? Where and how do we provide for the enjoyment of those visitors and maintain wilderness? Again, an ROS system helped to provide a framework.

Untrammeled by man: Currently, there are many private inholdings in the northwestern quarter of the monument; access must be provided and developments will continue. What is the resiliency of this land and environment to the effects of people? How much restoration can we economically and realistically do to give the feeling of "untrammeled by man" (not to mention woman)?

Multiple Problems with Existing Ways Of Determining Wilderness Boundaries

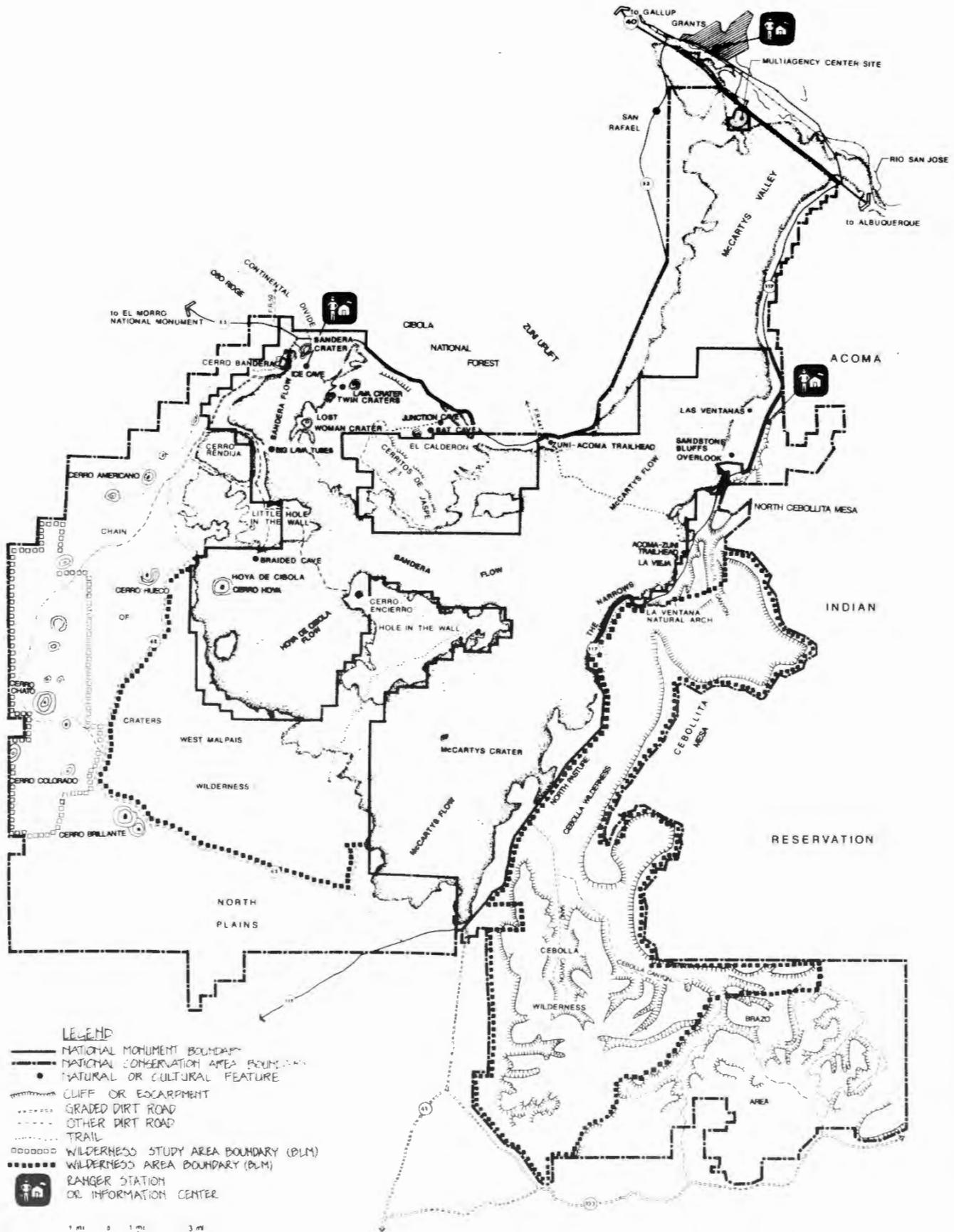
Basically, there are three broad parameters or methods for determining wilderness boundaries:

(1) *Using standard setbacks* (BLM's preferred method). For NPS this method already presents a problem ... the Park Service does not define a standard setback. (At least one NPS study, Big Bend, used a 660' setback from developments). In general, this method provides for maximum acreage, although it is inflexible to terrain and vegetation variations. With standard setbacks (a) solitude and law enforcement trespass problems are created in open terrain; (b) future options for road realignments for safety factors (landslides, floods, etc.) are limited to a narrow corridor, which often creates more expensive realignments than might have been necessary; and (c) options for developing facilities to access wilderness (parking, trailheads, etc.) are much more limited.

(2) *Using physiographic boundaries:* This is apparently the favored NPS method, judging from past studies. This method works well where landforms provide identifiable boundaries. The public can easily identify and understand the boundary, and management can easily enforce and maintain the boundary. Where landforms are indistinct, this method presents problems.

(3) *Using surveyed boundaries:* This method may

(Continued on pages 4 and 5)



EL MALPAIS NATIONAL MONUMENT AND CONSERVATION AREA

U.S. DEPARTMENT OF THE INTERIOR

El Malpais Wilderness Study Poses Problems

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follow section lines, Universal Transverse Mercator (UTM) coordinates, or other artificial lines. This seems to be the NPS and BLM second favorite method. Acreages are easy to calculate and areas are easy to establish on maps, but they also are incredibly difficult for visitors (and managers) to locate on the ground without intrusive signs. Also, surveyed boundaries are expensive to establish formally.

Conclusions and Proposals

The NPS planning team studied BLM's resource and management problems that related to using standard setbacks from roads, looked at other NPS wilderness documents, and looked at issues at other NPS wilderness areas. The approach that seemed most closely to follow past NPS practice was the use of physiographic boundaries where possible and practical, and survey lines where physiography could not be used. Every attempt was made by the NPS team to define manageable boundaries that could easily be identified on the ground. Boundaries were drawn that (1) maximized wilderness values and met other legislative requirements, (2) made maximum use of physical boundaries for ease in public identification and management, (3) prevented potential problems of ORV and other trespass, and (4) enhanced long-term management. In other words, all three methods were used in the NPS El Malpais wilderness study – BLM standard setbacks from most roads, physiographic boundaries where they reflected wilderness criteria, and surveyed boundaries in remote areas where lava flows could not be used.

Approximately 97,025 acres (86,011 instant; 11,014 potential additions) or almost 85 percent of the monument was found to possess wilderness characteristics and values, including most of the major lava flows and ecotones and grasslands adjacent to the lava flows and especially land adjoining BLM wilderness (forming a 136,625-acre NPS/BLM wilderness area). Approximately 17,823 acres in 14 separate monument areas were not suitable for wilderness due to proposed development access routes, and other effects of people. In accord with NPS *Management Policies*, once the suitability study was approved, the monument began managing those lands as wilderness.

If policy and guidelines such as NPS *Management Policies* and the *Planning Process Guideline* (NPS-2) defined the broad parameters of acceptable means/methods for determining wilderness boundaries and had definitions for setbacks, solitude, and primitive and unconfined recreation (two of the three major terms in the Wilderness Act), some of the aforementioned problems could be avoided. Defining wilderness boundaries for those 40 linear miles would have gone just as smoothly as the defining of boundaries for the rest of the monument. However, because of the lack of clear guidance, an unnecessarily large amount of time and effort were spent defining and justifying the wilderness boundary for those 40 miles.

Mabery is Chief Ranger at El Malpais NM; Kenney is a Natural Resource Planner at the Denver Service Center.

Caves and the NPS

By Ronal Kerbo

The U.S. National Park Service has the responsibility to manage more than 350 units, which include historic, cultural, recreational, and natural areas. Within natural areas are seven units that have been designated specifically to protect caves. However, well over 50 other units contain caves and cave systems that must be considered as integral segments of overall management schemes. Examples include Grand Canyon NP (which contains more known caves than any other park in the System); Ozark National Scenic Riverway, with many caves important to the regional hydrological system; and Hawaii Volcanoes NP, where large lava tube systems exist that are important cultural resource sites and that still serve as religious shrines for the Hawaiian people.

Each park must have a general management plan with a section that deals with management of natural resources, which may include caves or other karst features. In the past it was difficult for managers to think of caves, except as possible hazards to the public's wellbeing. Because of perceived difficulty in accessing caves, and the misunderstanding of their importance and relevance to ecosystems, they were not often thought of as assets except in those cases where they could be developed for general public entry. Only developed caves were managed with any degree of great concern, and most of that was aimed at personal safety and allowing the visiting public close proximity to major scenic features.

Misplaced Facilities

Even with these concerns for ready accessibility, many of the developed caves suffered from a management style that was inadequate for the long-term protection of the cave resources. An example is the large number of facilities that exist over such caves as Mammoth and Carlsbad Cavern. These facilities most often provide for visitor comfort and safety, NPS administration offices, and employee residences. The most important concerns here are the attendant gas and sewer lines that may overlie cave passages. With the passage of time, buried lines and fuel tanks located over caves can result in negative impacts. Leaks from any of these sources can go undetected for months, perhaps years. Legislation has been introduced to deal with underground fuel tanks, and parks have been taking critical looks at lines running in close proximity to caves.

A number of recent events have had, and will continue to have, positive effects on cave management. Within the last decade most of the major cave parks have either begun drafting cave management plans or already have approved such plans. As an example, Carlsbad Caverns NP's cave management plan addresses the following topics: cave permit programs; visitor use monitoring; resource protection techniques; and such items as cave gates, maintenance standards, research guidelines, and exploration guidelines. Other items included in separate action plans for specific caves, cover survey standards, disposal of bodily wastes, route marking, and concern for surface or subsurface activities that might directly impact natural systems.

Other important and positive actions relevant to caves include the passage of the Federal Cave Resources Protection Act in October 1988. This Act states that caves on Federal lands are an invaluable and irreplaceable part of the nation's natural heritage.

Caves also are addressed in the recently drafted NPS Resource Management Guidelines (NPS 77). Other provisions for cave management include the Wilderness Act, the Management Policies of the NPS, and the Endangered Species Act.

New Mexico Initiatives

The most recent step taken to insure a legitimate and positive image for caves in the scientific community was the passage of an act to conduct certain studies in the State of New Mexico, which, under Title 11 of the Act, provides for establishment of a Cave Research Institute and a Cave Research Program, both to be administered by the National Park Service, but not limited in its scope to that agency or lands under its jurisdiction.

This Institute and Program would allow for addressing such research topics as modern and paleo groundwater movement through carbonate rocks, the monitoring of global climate change, environmental monitoring, strategies for the recovery of oil and gas reserves, biological and microbiological community relationships, and the protection of subterranean resources from possible intrusion by oil and gas production leaks. The Institute could become the repository and exchange agency for worldwide speleological baseline data.

As sensitivity to and understanding of spelean resources continue to expand, perhaps we can prevent such things as the changing of cave airflow patterns, drastic modifications to a cave's microclimate, the alteration of surface water flow patterns in karst regions, the blocking or pollution of water infiltration routes, the introduction of foreign and harmful elements into a cave, disturbance of cave biota, and altering of natural cave ecosystems. Caves may finally come to be considered in their proper perspective – as an integral part of our land management mandate and ethic.

Educating the Public

The Cave Institute and Program could also play a vital role in educating the general public about the importance of caves and karstic landforms. It could afford the opportunity to investigate the cave environment, and provide educational tools for learning more about bats, other cave fauna, paleontology (many caves act as natural traps), and hydrology (dye tracing of karstic water courses has been a valuable tool in protecting park areas from the negative impacts of poorly placed landfills). The Program also could introduce people to other programs where speleological and karst research are being used to assist in the management of public and private lands.

Another important function of caves that could be explored through the Cave Research Program is their use as natural laboratories where paleoclimatic evidence has been stored, awaiting our discovery. The Grand Canyon packrat middens in caves have yielded pollen up to 4000 years old. The dry, dusty caves of the west side of Guadalupe Mountains NP have been great storehouses of pollen and sloth dung. Coring carefully selected speleothems in Carlsbad Cavern has given up indicators of paleomagnetism and paleoclimatic conditions. In the Devils Hole, a submerged cave system in Death Valley National Monument, researchers have produced a regional paleoclimate record by sampling travertine from the cave.

A last item that has enhanced the image of caves in the National Park System, has been recent discoveries

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Mapping Jewel Cave – From the Surface

By Arthur L. Lange and Mike Wiles

Natural caves are extremely sensitive to disturbances of the ground surface and drainage. Cave resources are subject to destruction by blasting, and alterations in the percolating water supply can affect the development of speleothems and other structures. Even more susceptible to influence is the unique subterranean biota, whose survival can be endangered by changes in cave temperature and moisture. Thus, in planning new roads, buildings, wells, and waste facilities, it is important to ensure that an underlying cavern environment will not be jeopardized.

Toward this end, we tested a promising geophysical technique in Jewel Cave National Monument (JCNM) – a technique that could assess the possible existence of undiscovered caverns beneath a proposed construction area. Earlier surveys using the natural-potential (N-P) method had demonstrated its effectiveness in areas of low relief; the much more severe terrain of the Black Hills provided an especially rigorous test of this procedure.

Geologic and Hydrologic Background

JCNM is situated 21 km west of Custer, SD. The known cave – over 132 km (82 miles) – lies beneath a 5 km² area (2 land sections) of a broad plateau, dissected by steep-walled Lithograph and Hell Canyons (Fig. 1). Average elevation is 1600 meters (5200 feet), with about 120 m of relief. Hilltops form broad, flat meadows, while the slopes are typically forested with Ponderosa pine. Neither canyon maintains a stream flow, even during the heaviest rains.

The cave-bearing formation is a buff, massive dolomitic limestone (Pahasapa of Mississippian age), about 120 m thick. Unconformably overlying this unit is the lower third of the Pennsylvanian Minnelusa formation, containing 60 m of red sandstone, limestone, and thin beds of chert and shale. Both units occupy the vadose zone.

Jewel Cave is a 3-dimensional rectilinear maze (Fig. 2) of phreatic origin (pertaining to that layer of rock or soil through which water may enter wells or from which



Figure 1. Reading the natural potential on a slope of Hell Canyon directly outside the natural portal of Jewel Cave.

springs and seeps may emerge). Its 5 distinct levels have developed generally within the upper half of the limestone. Most of the known passages lie beneath the Minnelusa cap and are completely dry. The Minnelusa apparently prevents or retards direct seepage of rain and snow melt. Erosion has removed the Minnelusa from portions of Hell and Lithograph Canyons, exposing the Pahasapa. Galleries beneath these areas usually are dry, though dripstone testifies to past infiltration. Present-day seepage is occasional, sporadic, and extremely localized. Most water enters the cave in areas directly below the contact of the Pahasapa and Minnelusa. There, dripping generally occurs year round, although drip rates vary seasonally.

Natural-Potential Phenomena

Just as our atmosphere everywhere is filled with invisible electromagnetic waves – from radio and TV broadcasts as well as emissions of our sun and stars, so the ground contains both a.c. and d.c. electric currents. Electromagnetic signals generated by worldwide lightning and solar storms penetrate the ground to depths dependent on their frequencies.

Likewise, d.c. currents circulate through the ground from causes as diverse as chemical reactions around mineral deposits, volcanic heating, and moving groundwater. The individual sources form an assemblage of “geo-batteries” of all different sizes and orientations. The natural-potential method measures the voltages generated by these currents along surface profiles, using a roving electrode tied through a long cable and meter to a fixed base electrode.

At this point, one might wonder how a cave can produce a battery-like current. Actually there are several ways a cave can affect the natural electrical environment. In one of these, an empty cave gallery provides a locally more permeable path for infiltrating water, with the result that greater infiltration occurs over the cave roof than the surrounding rock. Because of the electrokinetic, or streaming, phenomenon (Ishido and Mizutani, 1981), the cave ceiling becomes positively charged relative to the ground surface, while the surface zone overlying the cavern becomes more

negatively charged than its surroundings (when the fluid chemistry is basic). Thus, a negative potential anomaly develops locally over the cavern (Lange and Quintan, 1988). In Jewel Cave, where drippage pH averaged 8.35 (Bakalowicz et al. 1987), the cave ceiling measured almost 250 millivolts (mV) more positive than its corresponding point on the surface, 40 m overhead.

Because the voltage anomalies observed over caverns can be small – on the order of 5 to 50mV, meticulous data collection procedures and precision instrumentation are required. The end result is a computer-drawn graph of voltage and elevation vs. horizontal distance along each profile (Fig.3) and where lines are closely spaced, a plan map of potential contours.

The Jewel Cave Survey

Prior to using any geophysical method as an exploration tool for extending a cavern system beyond its known limits, one should test the method over at least one mapped passage, to see whether the technique can resolve the underlying void. Fortunately, at Jewel Cave a detailed map of the system was available, and passage depths had been established. Thus, four lines, ranging up to 840 m in length, were laid out in a NNE direction so as to cross the “grain” of the maze at nearly right angles (Fig.2).

Representative portions and depths of cave system were selected. On each line, a base station was established near a road, and a long, color-calibrated wire was spooled out to the ends of the line. Multiple potential readings were made at station intervals ranging from 1 to 7.5 m, as data warranted, and corrections were made to remove drift due to temperature fluctuations in the soil and electrodes (Fig.1).

Jewel Cave Anomalies

Definitive negative anomalies coincided with the cave passages, wherever the test lines crossed over cave passages. Line B is typical of this correlation (Fig.3). Here, the edges of the broad central low response correspond to the north/south limits of the mapped cave. Except for the northern ends of the profile, the remainder of the line is positive. The exception occurs around the main highway junction, where a nearly east/west fault crosses the line (Deal, 1962). Although N-P expressions of faults are common, it also is possible that additional undiscovered cave galleries underlie this feature.

It is instructive to ask what would be the result of placing a drilling target over the maximum negative value of the profile. On Line B, such a drill hole would intercept a major lower level of the cave system at an estimated depth of 140 m.

The three other profiles likewise showed a definitive correlation of millivolt lows with mapped cavern. As on Line B, negative readings also expressed fault zones. All in all, the natural-potential profiles delineated more than 90 percent of the mapped cavern crossed by the lines. As mentioned above in the section on hydrology, much of the cave today remains dry, suggesting that mechanisms other than downward filtration are contributing to the anomalies observed over the cavern.

Exploration Scenario

In practice, one would not necessarily target a test hole on the negative peak. For one thing, the N-P response can express voids situated on either side of the line. In order to better resolve the target, several short potential lines would be run offset from the first to

Caves and the NPS

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in Lechuguilla Cave, within Carlsbad Caverns NP. Scientists within the NPS, the USGS, other government agencies, and the private sector, are excited about the possibilities of using the cave to gather baseline data that will give us new insights into global warming theories. The passage leading into the major portions of the cave was blocked with loosely compacted rubble for perhaps many thousands of years. Now, recent explorations have led explorers and scientists “through the looking glass” into a world that has been relatively unaffected by the impacts of 20th Century life ... a real wonderland, where even Alice hasn't been.

Kerbo is Southwest Regional Cave Specialist. He was formerly Cave Specialist at Carlsbad Caverns NP.

Sources

“Cave Management in the National Park Service” by Dr. Millford Fletcher, (notes for a presentation at the 1st NPS Cave Management Seminar, March 1990.)

“Caves of the National Park Service” by Ronal Kerbo (ibid.)Kiyim Cunningham (pers comm), Science Director for the Lechuguilla Cave Project.

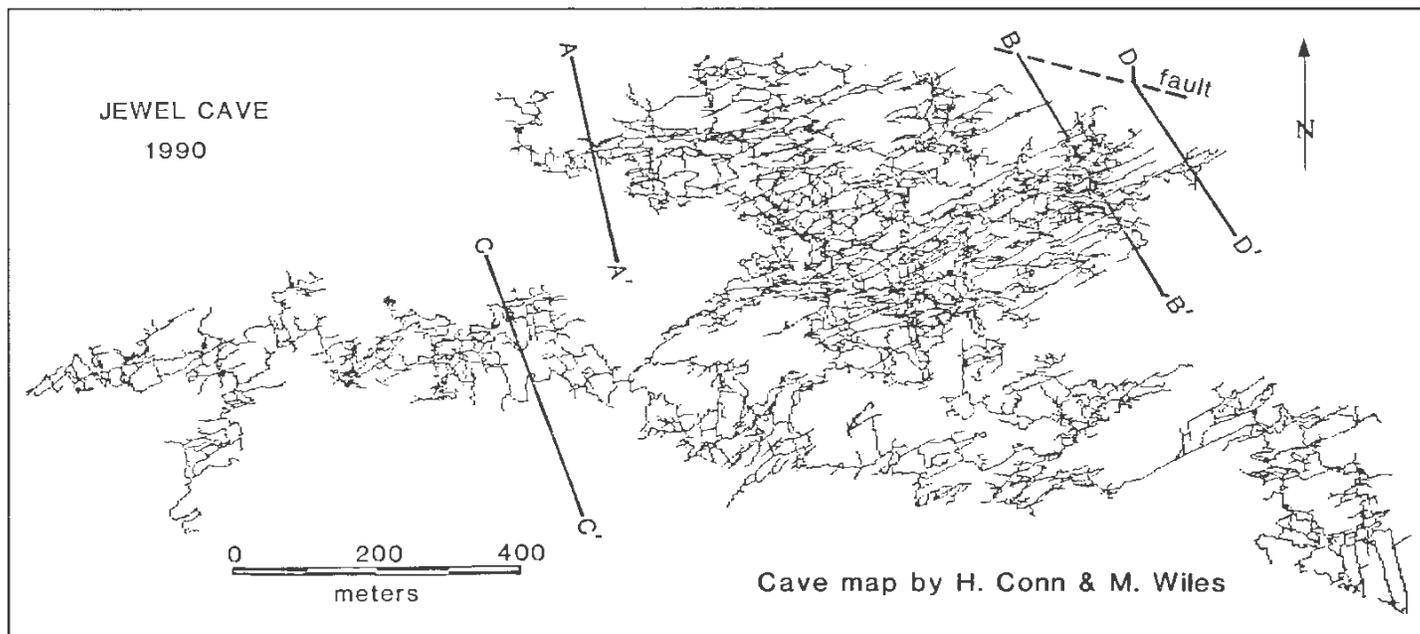


Figure 2. Computer-drawn map of the known 132-km extent of the Jewel Cave labyrinth, showing the natural-potential lines and a segment of a major fault that intercepts two of the lines.

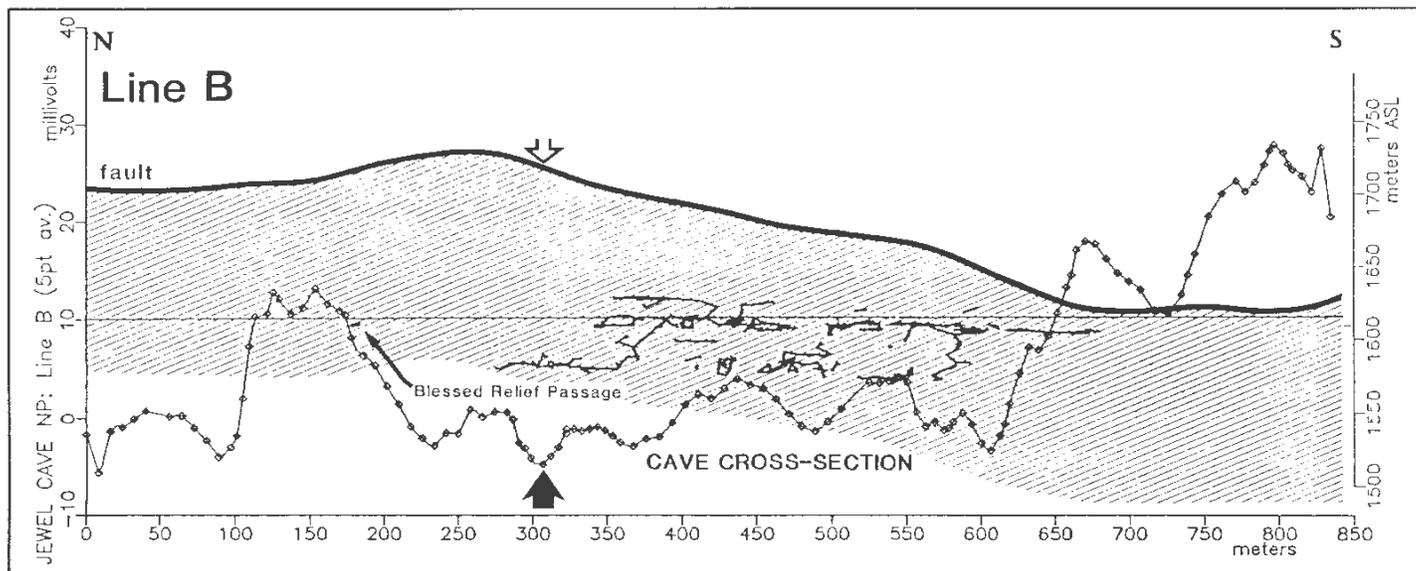


Figure 3. Natural-potential profile of Line B superimposed on a cross section of topography and cave. The major N-P low coincides closely with the region of mapped cave; a secondary low is associated with a major fault zone, which may possibly contain voids. A drill hole sighted at the open arrow, corresponding to the lowest potential value of the line (solid arrow), would intercept a cave passage at a depth of about 140 m (~460 ft).

map the response on either side.

Because N-P anomalies, both positive and negative, can arise from processes other than water movement around voids, it is advisable to test the N-P targets by means of another geophysical method. The gravity method is most appropriate since it responds directly to low density zones and voids underground (Neumann, 1967). Unfortunately, the method requires precise surveying of ground elevations, and mapping of nearby topography. In addition, it loses resolution as the target depth exceeds the width of the void, so that the deeper passages may not be resolvable. For these reasons, one would confine the gravity measurements to the N-P target zones, rather than attempting to sample the entire area.

Other Natural-Potential Tests Over Caves

The senior author began applying N-P techniques to caves in 1986 over the Ozark Underground Laboratory,

Protom, MO. Three test lines produced a strong correlation of negative anomalies with mapped cavern. Since that first trial, tests have been made in environments as diverse as the Mammoth Cave area in Kentucky (Lange and Quinlan, 1988), the Edwards aquifer of Texas, the Great Basin of eastern Nevada and desert outcrop of Kartchner Caverns State Park, AZ (Lange et al., 1990). Especially pronounced anomalies have been observed over underground streams, making "natural-potential" the logical targeting tool for siting monitor wells over groundwater conduits in carbonate terrains. Ongoing research is focusing on the electrochemical processes that generate cavern anomalies.

The Jewel Cave N-P study was funded by the University of Wyoming National Park Research Center and JCNM and conducted by The Geophysics Group in conjunction with San Diego State U. Foundation.

Lange is a geophysicist with the San Diego State

University Foundation; Wiles is a JCNM Park Ranger.

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Reclamation of Abandoned Mines At New River Gorge, Gauley River, and Bluestone

By Carol A. Pollio

"Smokeless" coal from the New River Gorge once fueled the navies and steamships of the world. America's steelmills and industries depended on this clean burning coal to meet their energy needs. Today, all that remains of this industrial heritage is an abundance of abandoned mine sites, including hundreds of mine openings, refuse piles, deteriorating structures, and dangerous highwalls.

The National Park Service administers three units in southeastern West Virginia: New River Gorge National River (NR), Gauley River National Recreation Area (NRA), and Bluestone National Scenic River (NSR). This part of West Virginia was mined extensively in the past – for coal in the New and Gauley River areas, and for oil and gas near the Bluestone and Gauley Rivers. This past mining activity created a wide range of safety and environmental problems, which NPS managers must now address.

Abandoned underground mines have serious potential health and safety hazards and environmental problems in New River Gorge NR and Gauley River NRA. The greatest threat is from open or partially open mine portals (entries), especially those mined out areas that are extremely unstable and easily accessible to park visitors and area residents.

Because of the geologic formation of coal seams in this part of West Virginia, coal was primarily "deep mined." (Diagram 1). Deep mine portals present serious hazards to visitors, including the danger of roof falls (loose, falling rock), the presence of poisonous and explosive gases (methane), and deep pools of water. In addition, numerous partially collapsed buildings and unstable walls, conveyors, rail lines, bridges, hazardous equipment, and debris are associated with deep mines. Specific environmental problems that go with underground mines include mine drainage, subsidence of mine voids (creating sink-holes), and unvegetated, eroding mounds of waste materials and coal refuse.

Unreclaimed surface mines are a source of significant landscape disturbances in all three of the NPS areas. Hundreds of acres of unvegetated or partially vegetated bench areas with steep unstable spoils piles and slides subject to slippage and erosion still remain. Major associated problems include erosion and runoff from highwalls, haulroad and spoil areas, rock falls, slippage and slope failures, and lack of vegetation on many sites.

In addition, many reclaimed surface mines within park boundaries present problems. Surface mines, reclaimed as contemporary standards require, are often returned to grasslands, creating areas devoid of woody vegetation surrounded by climax forest. Typical reclamation seed mixtures often contain species of grasses, e.g. rye, now known to be allelopathic (plants which produce toxins that prevent other plants from becoming established.)

Other types of abandoned mine sites in the three park units include oil and gas operations – capped wells and clear areas with sparse vegetation. The Bluestone NSR contains the bulk of these abandoned operations.

In 1988, an inventory of abandoned mine lands (AML Inventory) was conducted through a Cooperative Agreement with West Virginia University (Armstrong and Yuill, 1988). Potential abandoned mine sites were

identified first by conducting thorough searches of historical geological data; historical aerial photos; USGS topographic maps; coal, oil, and gas permit and exploration records, and numerous interviews with state and local experts. The most difficult task was ground truthing the sites. The New River Gorge, often referred to as the Grand Canyon of the East, contains rugged terrain and few access roads. The gorge walls are steep, in some places rising 1500 feet from river edge to ridge top in as little as 100 yards.

The AML Inventory revealed 115 areas with abandoned mines located in the park or within a 1/2 mile of the boundary. Each abandoned mine may contain numerous hazards, including multiple open portals, deteriorating structures, and scattered debris. Once located, the sites were rated to determine which ones presented the most serious problems, using the following hazard rating system.

Health and Safety

High – likely danger to exposed visitors/residents including features such as portals, unstable structures, subsidence holes, dangerous equipment.

Medium – moderate potential for hazard if site is visited – structures, unstable highwalls, slides, partially accessible portals.

Low – potential for hazard but low likelihood based on site conditions – unstable trail, low highwall, etc.

None – minimal or no hazard potential observed.

Environmental

High – observed significant problem including active slides, major polluted drainage discharges, etc.

Medium – high potential for significant future problems – unstable slide areas, impounded water in unstable areas or moderate problems observed such as erosion and sedimentation.

Low – minor problems identified such as minor drainage with no visual evidence of pollution or limited erosion and sedimentation.

None – no problems observed with minimal potential for future problems.

Eyesores

Identified based on qualitative judgments in the field. Unvegetated slides, refuse areas, dead vegetation, coal piles and trash and debris were examples of areas noted in this category. The visibility of mine features from the river, trails, and major and minor roads also was estimated and described.

Site Accessibility

Ease of access (vehicle, pedestrian, difficult pedestrian) and site visitation levels (based on physical evidence, such as tire tracks, road use, trash, and personal interviews) were rated and described.

In addition, the Office of Surface Mining Reclamation Priority System was used. It categorizes sites into six levels that determine priorities for reclamation: Priority 1 represents a threat of substantial physical harm to

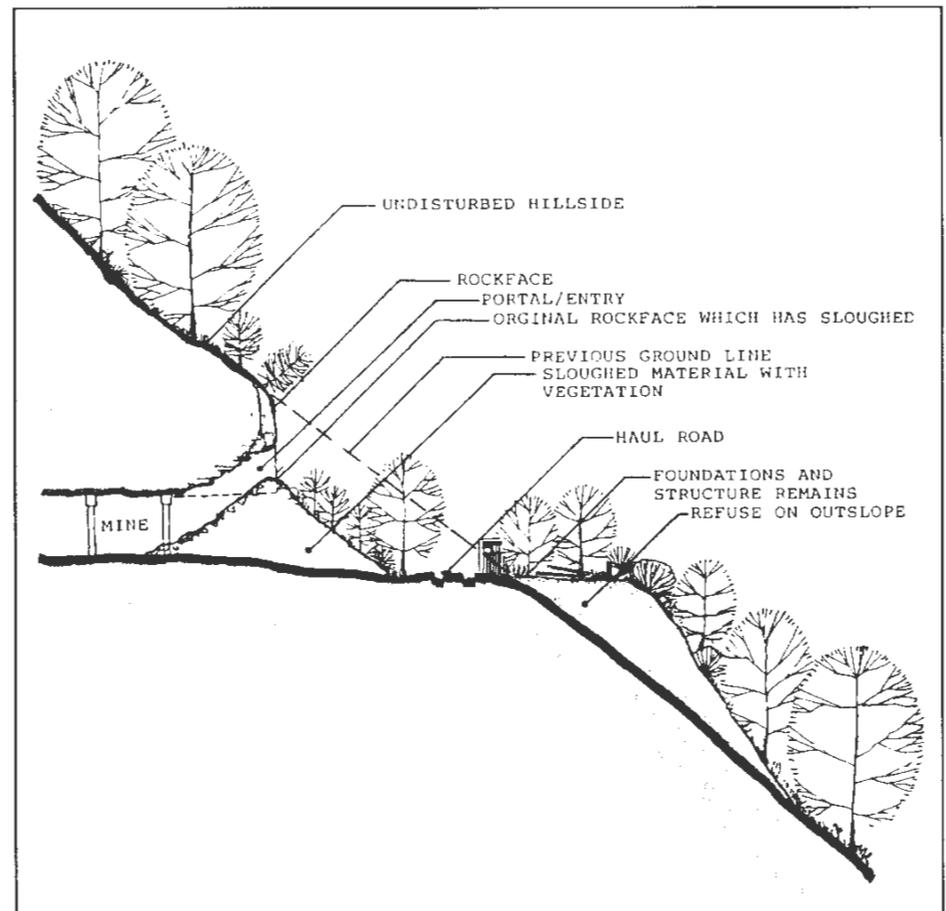


Diagram 1. Typical Abandoned Deep Mine Site

Abandoned Mines

(Continued from page 8)

the public; Priority 2 is the protection of the public from adverse effects of mining practices; Priority 3 deals with restoring environmental damage; Priority 4 represents research project areas for reclamation techniques; Priority 5 deals with repair or replacement of public facilities, such as roads, utilities, or recreation areas adversely affected by mine operations; and Priority 6 deals with public lands adversely affected by coal mining. During the inventory, numerous sites were categorized as Priorities 1, 2, and 3. (USDI Abandoned Mine Update).

Using this rating system, 62 sites were identified as possessing severe potential health and safety problems, 31 were rated moderately severe, and only 22 received a low or no-hazard rating. Environmental problems were considered severe at only 3 mine sites; another 38 sites were rated moderately severe, and 31 sites were categorized as eyesores (Table 1).

The information gathered was then rated a second time to establish priorities for reclamation. The most critical potential health and safety hazards were determined in terms of:

1. Problem Severity – the most severe health and safety and environmental problems; and
2. Area Sensitivity – potential impacts on present or planned park developments.

The ultimate goal of the AML Inventory at New River Gorge NR was to establish a priority list of sites in need of reclamation. The Surface Mining and Reclamation Act, passed in 1977, required reclamation of existing mining operations and created a fund source for the reclamation of mines abandoned prior to passage of the Act. This funding, administered by the Office of Surface Mining, has been used to reclaim 5 of the worst areas identified. To date, 50 mine portals have been closed, 3 mine structures have been fenced off, 600 feet of highwalls have been filled, and a large landslide area has been stabilized.

The reclamation projects, coordinated through New River Gorge NR Resource Management section, were designed carefully, taking into account federal threatened and endangered species, state rare and endangered species, wetlands considerations, wildlife habitat, and the significance of cultural resources at the mines. An independent threatened and endangered species (T&E) study was done by the West Virginia DNR to determine the presence of potential habitat of such species, although it focused primarily on bat habitat (Bryan 1988). The park Cultural Resource Specialist coordinated with the West Virginia State Historic Preservation Office to ensure Section 106 compliance. Using this information, 3 types of mine closures were developed that minimized the impact of mine closures on park natural and cultural resources.

The first was a simple soil closure, where soil was backfilled into an opening and a corrugated pipe was placed at ground level to allow for Eastern woodrat (*Neotoma floridana magister*) access. The Eastern woodrat, while still fairly common in West Virginia, is being considered for threatened status in Pennsylvania due to population declines.

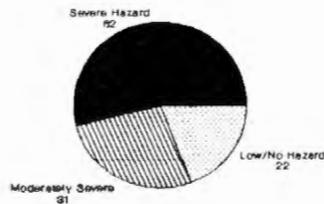
The second type of closure consisted of steel bars anchored in surrounding rock – wide enough for bat access yet narrow enough to exclude people. The T&E survey had indicated the presence of bats (*Pipistrellus subflavus* Eastern pipistrelles, *Myotis lucifugus* Little brown bats, and *Epescicus fuscus* Big brown bats) in

(Continued on page 10)

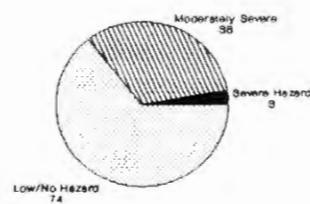
Table 1.

New River Gorge National River Abandoned Mine Inventory

Health and Safety Hazards Associated with Mines



Environmental Hazards of Mines



Resource Management Ranger Robert Sullivan looks into the main portal at the Ames Mine, scheduled to be reclaimed this year. Photo by Robert Sullivan.



Open portal at Ames Mine. Photo by Robert Sullivan.

Reclamation of Abandoned Mines in West Virginia

(Continued from page 9)

several mine openings that were a top reclamation priority. The study also identified portals that represented good potential habitat for federally endangered species, such as the Indiana bat (*Myotis sodalis*) and Virginia big-eared bat (*Plecotus townsendii virginianus*). Each of these steel closures, known as "bat gates," was custom made to fit individual mine openings securely.

The last type of mine closure was designed to allow for its possible removal at a later date. It consisted of a foam plug, blown into the opening and then covered with soil. The mine openings where this closure was used were the main portals of the Kaymoor Mine, one of the finest examples of an old coal mine and town in the entire gorge. A foam closure allows management the option of removing the plug when the site is developed, so that visitors will be able to experience the operation of a historic coal mine.

As long as funding is available, more cooperative projects with the Office of Surface Mining will be planned. Of the remaining abandoned mines in New River Gorge, 5 rated as most hazardous to both visitors and the environment would then be reclaimed.

Native Seed Banking

The New River Gorge NR staff also has undertaken the task of reclaiming some of the smaller disturbed sites using an experimental process known as native seed banking. This process involves covering disturbed areas, such as coal refuse piles, with lime, fertilizer, and a 2-inch layer of soil taken from the forest floor. This encourages the germination of native species. Three replications of 20' x 20' experimental plots have been established on a large coal refuse pile near the abandoned Brooklyn mine site. The plots were installed in June, August, October, and the following year's June, to determine if time of year is linked to emergence of desirable species.

In August, Resource Management rangers identified all vegetation on the plots and currently are preparing a formal report for the native seed bank project. Initial data indicate that woody species present are primarily



Natural Resource Specialist Margaret Weesner looks at a "bat gate" installed at the now reclaimed Kaymoor Mine. Photo by Margaret Weesner.



Deteriorating stone wall from the Ames Mine site. Photo by Robert Sullivan.



Deteriorating structure hides a large, 6' x 10' open portal. Photo by Robert Sullivan.

native species, having successfully crowded out some invasive non-natives. Herbaceous species present are a mix of both native and non-native species with very few takeover species present. On an annual basis, resource management staff will return to the site and monitor successional changes in vegetation to determine success over time.

It may be many years before all the scars that remain from mining of the Gorge are healed, but the Abandoned Mine Land Inventory for New River represents an excellent start in speeding the process. This year the Office of Surface Mining has awarded the park \$50,000 to conduct identical surveys on the Gauley River NRA and Bluestone NSR, two areas added in 1988 and administered by New River Gorge NR. NPS Resource Management personnel will identify and prioritize abandoned coal, oil, and gas operations along the Gauley and Bluestone Rivers and will include a T&E species study of the sites inventoried. Results will be used to determine funding levels necessary to

reclaim abandoned mine sites within the Gauley River NRA and Bluestone NSR.

In our search to make a safe and enjoyable experience for park visitors, it is important not to overlook the cultural history and significance of these areas. Abandoned coal mining towns, like Kaymoor and Nuttalburg, are considered by many to be invaluable vestiges of Appalachian heritage. As they are reclaimed, many historic features of these sites will be preserved for visitors to discover and explore ... safely.

Pollio is Natural Resource Specialist at New River Gorge NR.

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New Perspectives in Science

By William E. Brown

Editor's Note: The following essay appeared first in Proceedings of the Second Glacier Bay Science Symposium, Sept. 19-22, 1988 and is here reprinted with permission of the author and of Jim Wood, Proceedings co-editor. Brown is currently SWR Coordinator of the Columbus Quincentenary, stationed in the Santa Fe SWRO. He plans to retire in April 1991 and devote himself to the activities of the Glacier Bay NP Science Advisory Board and the Friends of Glacier Bay ... all from the rocking chair on the front porch of his home at Gustavus, AK.

In the beginning, the national parks were anthropocentric. When Phineas T. Barnum visited Yosemite in 1870, he conveyed the sense of the age with this comment:

"Unsurpassed and unsurpassable. Look around with pleasure and upward with gratitude."

A century later, the founding anthropocentric purpose still informed the creed of lifetime ranger Lon Garrison – with the added insights of a century:

"Parks are for the understanding of nature and ourselves; they are for the inspiration that comes from lonely commune with nature and the forces that shape our environment; they are for solace for those troubled by the turbulence of modern civilization."

From this modern turbulence, with its specter of human species run amok, emerged a biocentric reaction; that nature – particularly in those last untrammelled vestiges of it, the national parks – was intrinsically valuable, independent of conventional measures of human utility. In its most profound statement this philosophy maintained that plants, animals, and mountains had rights and souls of their own. This was a Deep Ecology version of the pantheism and spiritual union with nature that once moved us all. It called back to Eden, to the garden before its violation, to the human innocence and integration that preceded the violation.

The founding ideal of the National Park Service can be viewed as a three-part esthetic: The Wonders of Nature, in both its emotive and intellectual beauties; the health and virility gained from wildlands experience, the Rooseveltian perpetuation of the frontier mythos; and the pure esthetics of artistic and literary expression. Somehow, in the crush of the late 20th Century, that ideal had become inadequate. The environmental ethic had crept in.

While public thought and perception evolved, the people of the Park Service doggedly pursued the management of their congressionally mandated dilemma: preservation and use ... without impairment. But they began to see that parks were more than the pleasuring grounds and mythic landscapes of the founders' vision. For the environmental ethic was contagious. They began to view parks as laboratories and models whence that ethic could be broadcast to the larger society. They began to see that parks could not long endure as refuges from troublous times and encroaching despoliation, lacking public conversion to the environmental ethic.

On another front, as early as the late 1920s, with the advent of George Wright's influence, the Park Service began to glimpse the need for science-based management if these marvelous areas were to be preserved. But the Depression, Wright's untimely death, wars, then postwar expansion of the Park System and the deluge of visitors to it, and the Park Service's response

In the long view of history, what can be attributed only to an accident of cultural altruism – this setting aside of parklands for the benefit of the people – has become a pragmatic treasure of the utmost current significance.

to that deluge, combined to shrivel the enlightened beginning. Then came criticism of the hiatus in park science, followed by a series of studies beginning with the Leopold and Robbins reports of the early 1960s, all calling for order-of-magnitude expansions of scientific research in the parks, and for the sake of their own preservation.

Social studies began to make the tie between environmental conditions and human health – physical, mental, social. An earth mortgaged by the parents faced the children yet to come.

Today the expanding horizons of thought have met each other coming around. Now the ecosystem affecting and affected by human beings is clearly seen to be the entire biosphere.

And still, here is the Park Service preserving the natural and cultural environments of the past. In the long view of history, what can be attributed only to an accident of cultural altruism – this setting aside of parklands for the benefit of the people – has become a pragmatic treasure of the utmost current significance. The adventure in cultural edification first embodied in the early parks has held in trust relatively unaltered ecosystems or parts thereof in which, belatedly, we can attempt to discover the workings of this world ... in which we can measure environmental and cultural changes that threaten the environmental solvency and sanity of the world.

From such studies in the parks can come the communications – scientific reports, lectures, campfire and school programs, films – that can inform and move the public at large to those reforms of social and individual behavior that may yet save us, and the parks that give us inspiration.

This traditionalistic institution, which has always fought within itself whether to go along with public demand or to take on the duty of edifying and guiding that demand, has, through its prescient congressional mandate, unwittingly positioned itself and the landscapes it manages for transcendent contribution to this society and the world at large. Its very conservatism, its being a kind of model of cultural lag, finding solace in the past, has fortuitously been its greatest strength. For despite the Service's human foibles, the System stands today relatively intact for the great social purpose of the coming decades. It would seem that social experiments as well as scientific ones can produce unforeseen benefits.

Now opportunity beckons. Through scientific studies using the vast assemblage of natural laboratories preserved by the terms of an earlier vision, the restrictively managed parklands of this Nation – and from that inspiration, of the world – stand ready to synthesize the anthropocentric and biocentric visions so that man can return to the fold as a functioning rather than destructive part of the biosphere. Man in nature, beholden to it for nurture – and reciprocating that care – is no longer an ecofreak.

In this expansion of the meaning and purpose of the National Park System, with its evolving bureaucracy trying to catch up with the evolving world ecosystem, the older mission cannot be lost. Nor indeed should we presume to change the words of the Organic Act that in 1916 launched the Service and cohered the System. In its wisdom, the Congress gave us a broad charter, which, like the Constitution, responds elastically to the needs of an evolving society:

"The Service thus established shall promote and regulate the use of the Federal areas known as national parks, national monuments, and reservations ... by such means and measures as conform to the fundamental purpose of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

Immanent in this charge is the authority to meet the necessities of a changing world, to marshal the resources and ideas necessary to save the parks, to build upon the founders' philosophy – as a tree grows and extends its branches in its maturity. We must intelligently explicate the evolving mission and purpose, and seek congressional sanction for the tools and wherewithal to carry them out. But this added nourishment should flow through the roots that have sustained us all these years. This is no new planting. It is the growth of the original institution.

From the beginning the parks have been a mosaic of values and functions. These parks, these cultural creations, can and should – through enlightened zoning and land-use dedication – combine traditional public access to beautiful and instructive parklands with scientific utility for social understanding and survival. Environmental standards and aspirations gained from parkland experiences – along with the scientific knowledge derived from parkland study zones – can help guide the larger decisions and reforms that our society must make in the coming decades.

Thus, the founding concept of public use and enjoyment need only be adaptively expanded to accommodate modern socio-scientific imperatives. To the extent that America's parklands contribute to that larger reform, they can save themselves from encroachment and further justify their value to the public. In a world ever more straitened for resources, the park ideal and the parklands themselves will escape exploitative predation only because of their more profound social utility as parklands.

correction

A clarification is in order for the article "Olympic NP Mountain Goat Removal Project Subject of Risk Assessment Report" (*Park Science*, Winter 1991, vol.11(1):14-15). The principal investigator of the social risk assessment reviewed in the article was Dr. Gary E. Machlis, Sociology Project, Cooperative Park Studies Unit, U/ID, Moscow. In addition, Dr. Roger E. Kasperson, Professor of Geography and Director of the Center for Technology, Environment, and Development, Clark University, Worcester, MA, was co-investigator on the project.

Also the institutional association of Seth Tuler was unclear. He is a graduate student in the Environment, Technology, and Society Program at Clark University, Worcester, MA and served as a Research Associate for the University of Idaho CPSU on this project.

regional highlights

Pacific Northwest

Edward Starkey, research biologist with the NPS CPSU at Oregon State University, has been named by Interior Secretary Manuel Lujan Jr. to the 16-member team charged with developing "a plan that will lead to the conservation and survival of the northern spotted owl." The Secretary told the team to "exercise the full range of its creative abilities" in seeking a plan that would lead to removal of the owl from the threatened species list, but he also directed them to build a plan that would limit job losses in the Pacific Northwest.

The owl, which lives in old-growth conifer forests of the Northwest, was declared a threatened species last June. Proposals to set aside large tracts of public forest land to protect the bird would result in a sharp drop in logging.

Marvin L. Plenert, Pacific regional director of the USFWS, was named team leader. A draft plan is slated for presentation by Dec. 31, 1991. Donald R. Knowles, deputy under-secretary of the Interior and Lujan's representative on the team, said it will take about six months after a draft is released for final adoption of the plan.

Fender's blue butterfly, a relic of the ice ages and thought to be extinct since 1937, has been rediscovered, living a precarious existence in remote sites of the Willamette Valley, Oregon. A petition is being prepared requesting the USFWS to list the butterfly as threatened under the federal Endangered Species Act. Another native of Oregon – the silverspot butterfly – already is listed as threatened.

The butterfly's brush with near-extinction is linked directly to destruction of the native prairie ecosystems and the one flowering plant vital to the insect's existence, according to Paul Hammond, entomologist and butterfly expert, who discovered the relict population in Oregon State University's experimental forest. Kincaid's lupine is the only acceptable food for the larvae of this butterfly, and between agriculture and urbanization, the native prairies that contain the plant have been reduced to one percent of what they once were.

A North Cascades grizzly bear technical group has been formed to review the research and vegetation mapping efforts that have been on-going in the North Cascades for about five years. The group's charter is to establish the process and criteria for jointly determining the North Cascades' ability to support grizzly bears. The technical group then will make a recommendation to the Northwest Ecosystem Grizzly Bear Management Subcommittee about whether or not the North Cascades is a viable ecosystem for grizzly bear recovery.

The Northwest Ecosystem Grizzly Bear Management Subcommittee reports to the Interagency Grizzly Bear Committee, which will make recommendations to the USFWS.

Bill Gaines, Jon Almack, Dan Davis, Jon Jarvis, Gregg Servheen, Chris Servheen, and Rodd Richardson are members of the technical team. Rick Mace, Richard Knight, Tony Hamilton, and Bruce McLellan are reviewers and Peter Morrison, Jim Eby and Bart Butterfield are advisors.

The National Parks and Conservation Association (NPCA) is working to increase local participation and citizen involvement in park management issues by establishing a Pacific Northwest Regional NPCA office in Seattle, WA. Its director, Dale Crane, has 37 years of parks and conservation experience, the last 12 of which were with the U.S. House of Representatives as professional staff and as Staff Director for the Interior Committee responsible for National Parks and Public Lands policy. Two new members to the NPCA Board of Directors from the Northwest are Dr. John Miles, dean of the Huxley College of Environmental Studies at Western Washington University, and Russell Cahill, former NPS Park Ranger and Director of California State Parks.

Wildlife & Vegetation Division

Projects to be funded under the FY91 Director's Special Initiatives portion of the Natural Resources Preservation Program (NRPP) were to be selected March 22. Issues emphasized this year are Effects of Urbanization and/or Boundary Development on Park Environments, Management of Animal Populations, and Managing Human-Natural Resource Conflicts and Issues. Of the 66 pre-proposals received, 15 were selected for full proposals.

Park biological inventories are a major focus of the I&M program this year and next. First, the gaps in park flora and fauna lists will be assessed. Then a strategy for filling gaps (such as mammals first Systemwide or basic data sets park-by-park) will be devised and implemented. The goal – Phase I of the I&M program – is basic data sets Systemwide within 10 years. The monitoring side of the I&M program is stressing development of pilot park programs. Denny Fenn, Deputy Associate Director, Natural Resources, is overseeing the total I&M program; the Wildlife and Vegetation Division is handling the biological component.

Pete Comanor, NPS Global Change Coordinator, chaired a meeting of the NPS Global Change Committee in Reno, NV Jan. 29-Feb. 1. (See Global Change Update, this issue).

The Division is producing various print and audio-visual materials this year. Vol. 27, No. 4 of *Trends*, guest edited by Mike Ruggiero, came out in January. Titled *Preserving Natural Resources*, it contains articles by NPS people in natural resource work as well as by Laurie Wayburn of the Point Reyes Bird Observatory.

NPS-77, the Natural Resources Management Guideline, appears headed for spring printing. This has been a huge collective effort of several hundred people, shepherded by Anne Frondorf.

A report on the NPS Recreational Fisheries program, coordinated by Mike Coffey, should be out this summer. A 4-color folder for the public, *Endangered Species in the National Parks*, was due from the printer in February. Copies were shipped to all regional offices and WASO for further distribution.

The Division also has on the 1991 docket folders on research opportunities in the national parks and the Watchable Wildlife program, as well as an IPM training videotape on rodent management, and workbooks to accompany 5 existing IPM videotapes. The Division also will produce and distribute the 1990 Servicewide Research Inventory this summer and a Servicewide summary of the FY91 RMP update information.

Mike Coffey changed hats on February 11 when he moved into the Science Branch of the WVD as Wildlife Biologist. Part of his former work will be done by a Consumptive Uses Specialist, a position advertised in January.

Rocky Mountain

The Beaver Creek Shelter (39CU779) is a north facing rock shelter in Wind Cave NP. Excavations were conducted by the South Dakota (SD) School of Mines and Technology in 1985 and again by that institution and the SD Archaeological Research Center in 1985 and 1987. This work penetrated 4.77m of vertical rock shelter sediments. The excavations defined 22 stratigraphic horizons, many of which contain archeological materials, and produced a sequence of 12 radiocarbon dates covering most of the Holocene.

The archeological specimens, the stratification, and the radiocarbon dates indicate the shelter has the potential of providing information on the transition from Early to Middle Archaic periods, a poorly known interval in the northern Great Plains, and of elucidating the interrelationship between climatic trends and human prehistory throughout the Holocene.

A report on the archeological remains of the Beaver Creek Shelter has been completed by Lynn Alex. In addition to the archeology, the shelter is important for its nearly complete paleoenvironmental sequence for the Holocene in the Black Hills. The paleofauna, soils, snails, and other environmental indicators have been partially reported in a number of papers and masters' theses.

Plans by a Golden, CO company to build a hazardous waste incinerator adjacent to Pipe Springs National Monument apparently have been halted. The facility was to be located on the Kaibab-Paiute Indian reservation and was to process 100 to 200 thousand tons of petroleum and related wastes per year. An on-site landfill for the waste ash was to be included. Negotiations came to an impasse over environmental protection measures desired by the Indian tribe. The NPS was concerned about potential effects on air quality at Pipe Springs, Zion, Bryce Canyon, and Grand Canyon, and about effects on water quality at Pipe Springs.

The investigator for a project monitoring sound levels at Rainbow Bridge, Glen Canyon, and Dinosaur, reported that sound levels at these parks were comparable to that of a "very quiet concert hall" during most periods, and were routinely at the lower limit of detection of the monitoring equipment (10 to 20 dBA). This, along with other sound monitoring efforts in the region, indicate that the Colorado Plateau is one of the "quietest" places left in the country.

Similar results have been documented for air quality in this corridor. Primary sources of "unnatural noise" at the sites monitored were visitors and motorboats. Main sources of "natural noise" were wind, insects, and birds.

In compliance with a Congressional mandate, a draft Impact Analysis and Risk Assessment report concerning the Corwin Springs Known Geothermal Resource Area (KGRA) has been completed. Potential exists for private geothermal development in the Corwin Springs area, which may impact Yellowstone's geothermal features.

regional highlights

Research conducted to determine if there are cross-boundary connections between Yellowstone geothermal resources and those in the Corwin Springs area found no evidence of any such geologic barrier, and that there is evidence of geothermal fluid movement between the two areas. The report recommends alternatives for Congressional consideration to avoid impacts to Yellowstone's geothermal resources. Final report will be submitted to Congress by April 15, 1991.

The Colorado Mine Land Reclamation Division recently used a relatively new technique to close the Kodel Mine at Colorado National Monument. The project was funded through a cooperative agreement between NPS and the State of Colorado. Two "winzes," vertical opening dropping off the main level, were bulkheaded using a polyurethane foam (PUF). This was the first time a closure was attempted using PUF mixed by hand in winter ambient air conditions. The project was successful. The foam sealed the openings thoroughly and its density, although not optimum, was in the good range. The project was done by backpacking all equipment, chemicals, and other supplies approximately one mile to the mine. Its significance lies in demonstrating the practicality of using backpack techniques to close hazardous mine openings.

Glen Canyon NRA recently hosted the annual Colorado Plateau Workshop, held late in January at the Wahweap Lodge near Page, AZ. Over 50 resource managers, superintendents, scientists, rangers, interpreters, planners, and public information staff from the Rocky Mountain, Southwest, and Western Regions attended, together with representatives of CPSUs, contractors, and private organizations such as the Grand Canyon Trust.

The conference included updates on park research, reptile and small mammal populations studies, and NRPP projects concerning peregrine falcons, desert bighorn, insular populations, and Quaternary studies. CPSU activities at both U-WY and Northern AZU were presented. Briefings were provided on the 1989 Clean Air amendment, the Navajo Generating Station, the status of EISs for Glen Canyon Dam and Western Area Power Administration, and the reclamation of abandoned mineral lands. Collections management and ethnographic responsibilities were discussed and an overview of the Native American Graves Protection and Repatriation Act was presented.

The Federal Noxious Weed Act of 1974 (7 USC 2801 et seq) has been amended by Sec. 1453 of the Food, Agriculture, Conservation, and Trade Act of 1990 (Public Law 101-624). Among other things, the act states that Federal agencies "shall enter into cooperative agreements with State agencies to coordinate the management of undesirable plant species on Federal lands." "Undesirable plants" cannot include endangered species or plants indigenous to the area where control measures are to be taken.

Zion NP resource management rangers, with collat-

eral law enforcement and paraprofessional archeology duties, assisted Big Hole National Battlefield (BIHO) in the retrieval of a priceless artifact stolen from the BIHO Visitor Center in 1972. The artifact is the peace pipe that belonged to Chief Joseph of the Nez Perce - one of the tribe's greatest leaders. BIHO initiated the case in September 1990, with the development of local informants, who revealed that the artifact presently was in St. George, UT, near Zion. Zion resource rangers investigated, in conjunction with the FBI, and recovered the peace pipe from the suspect in December. Criminal and civil charges currently are pending, and the pipe has been returned to BIHO.

Yellowstone NP's report to Congress on the grazing question for the northern elk winter range will be completed by July 16, 1991. Comprising approximately 25 sections in 3 volumes, the report will summarize work conducted between 1986 and 1990. For more information on the report, contact John Varley, Chief of Research, Box 168, Yellowstone NP, WY 82190.

Glacier NP has been selected as one of several NPS areas where studies will be funded for global climate change research. The Glacier Biogeographic Area provides ideal conditions for testing climate change hypotheses. The geographic location, topographic features, and prominent ecotones allow the study of ecological processes that influence composition, distribution, and sensitivities of biotic communities. If the planet is warming, all living things will be affected, but neither the capacity for rapid adaptation nor tolerance levels for change is known. It is hoped that through the studies at Glacier, models can be developed that will predict more general effects. A new position, Global Climate Change Coordinator, and support funds, have been granted and specific research proposals are being developed.

Natural Resource personnel from the Region's Great Plains parks, the U/WY CPSU, and the USFS Experimental Station in Rapid City met at Wind Cave NP February 26-27 for a first annual Great Plains Resource Management Workshop. Included were updates on park research, bighorn sheep, the regional GIS plan, the Global Warming proposal for Prairie Parks, IPM (Canadian thistle, Japanese brome, and other alien species), prairie restoration, insular population studies, resource management plans, NRPP funding, and the on-going I&M program. Representatives of the USGS Experimental Station and the Wyoming CPSU discussed their programs; Boise Interagency Fire Center Prescribed Fire Specialists discussed fire management issues.

The Region's GIS plan, nearing completion, is being reviewed in the Regional Office and WASO GIS Division. It will be available for park review by April.

The plan sets forth as its first priority the need to

Zandy Hillis, Resource Management Specialist at Buck Island Reef National Monument (BUIS), is looking for radio telemetry equipment to use on a hawksbill turtle tracking project. If anyone has receivers, antennas, headsets or other tracking equipment they would be willing to loan or transfer to BUIS, please contact Zandy at 809 773-1460.

concentrate on database construction. It also identifies parks that are logical candidates to develop individual capability as well as parks that will be designated as "node" parks for clusters of parks. These node parks will develop a GIS database construction and analysis capability for themselves and the other parks in their cluster. Whereas larger parks will want to purchase UNIX workstations, the expectation is that smaller parks that are part of the clusters eventually will be able to purchase smaller systems that meet their data processing needs and at the same time will be user friendly. These systems are expected to be functional in 3 to 5 years or less.

The Rocky Mountain Wolf Restoration Committee, authorized by Congress in the FY91 Appropriations Bill, has begun putting together a plan for restoration of the species in the Central Idaho wilderness and the Greater Yellowstone Ecosystem. The 10-member committee is composed of the state game and fish directors from Montana, Wyoming, and Idaho and representatives from USFS, NPS, USFWS, the Wyoming livestock industry, the sport hunting industry, and the Defenders of Wildlife. Meetings have been held in Denver and Cheyenne; others will follow in Helena and Boise. Public workshops are being held in conjunction with the committee work sessions. Additional work in April will complete the plan due to the Secretary of the Interior by May 1 for review and transmittal to the Hill.

Southeast Region

USFWS Regional Director James Pulliam Jr. signed a Finding of No Significant Impact (FONSI) based on a final environmental assessment of the Florida panther captive breeding program. This clears the way for the USFWS to issue permits which will allow panthers to be captured and held for captive breeding purposes. Permit issuance was anticipated 30 days after the December 19 publication of the FONSI in the *Federal Register*. However, the process was delayed when the Fund for Animals filed suit to suspend permit issuance until completion of a full environmental impact statement. A meeting of the Technical Subcommittee of the Florida Panther Interagency Committee was held in mid-January to plan implementation of the first phases of the captive breeding program.

The first annual Mammoth Cave Karst Research Conference was held on December 17 and 18 at Mammoth Cave NP. Sixteen people, including Joe Meiman and Martin Ryan of the MACA staff, presented papers on various subjects relating to Karst hydrology. At the close, the group recommended topics and format for future conferences.

The endangered red wolf has returned to the Great Smokies after being extirpated from the area nearly a century ago. In a joint NPS/USFWS project, two pairs of red wolves have been brought to the Cades Cove area of Great Smoky Mountains NP and placed in an acclimation compound. They were expected to breed in February and have pups in April or May. In August one wolf family will be fitted with radio transmitters and released; the second family will be held in reserve. NPS Director James Ridenour, Supt. Randall Pope and USFWS officials were present when the wolves arrived, and held a formal press conference to announce the event. Wildlife artist Steve Jackson presented Director Ridenour with the first print of his new red wolf painting, and donated the proceeds from the first 500 prints to the recovery project.

Global Change Program Update

By David Figlio

The Global Change Program Committee (GCPC) met in Reno, NV, the week of January 28 to review Global Change Capabilities and Interest Statements from 14 biogeographic areas. The GCPC identified 10 of these as being significant to a national global change research program.

Of these 10 areas, Big Thicket, Central Grasslands, Channel Islands, Hawaiian Islands, South Florida, and Upper Rio Grande Basin, were regarded as particularly important additions to the existing NPS global change network; these will be invited to submit Global Change Operations and Conceptual Research Plans (GCP), according to target schedules in official Washington Office (WASO) memoranda.

These schedules are being developed so that lower ranked biogeographic areas won't be putting out a lot of effort chasing the limited dollars in the program at this time. In order to provide preparers additional time, this next round of GCPs will be due to WASO by Sept. 3, 1991, rather than in May as previously indicated. The other 4 areas – Central California Coast, Chihuahuan Desert, Colorado Plateau, and Greater Yellowstone – will be invited to submit GCPs as additional funding becomes available.

At the request of biogeographic area coordinators currently preparing full research proposals, the Associate Director, Natural Resources, provided guidance on selection of technical peer reviewers. Full research proposals were due to be WASO by March 15 and the due date for peer reviews was March 29. The GCPC met in Boulder, CO, the week of April 8 to review these proposals.

All of this is being written in February, so if any questions arise between my writing and your reading, they can be answered by Pete Comanor at 202-343-8126.

Figlio is a staff member of the NPS Wildlife and Vegetation Division, WASO.

letters

Hi Jean: Thanks so much for starting up my subscription to *Park Science* again. It wasn't until I read the recent issue that I realized how much I have been missing.

I have started four volumes on *Birds of the U.S. National Parks* and the first volume on the East Coast parks is slated to be out in early 1993. I hope to produce a manuscript yearly, and the next three will be the Rocky Mountain states, West Coast, and Central states. The up-to-date issues of *Park Science* contain good stuff which I can use in these books.

The audience is the average person going to the parks who notices wildlife and would be interested in learning more about the park's birdlife. The idea is to hook that person on a common bird and entice him/her into the next step of getting interested in other park birds and habitats. Research, resource management, and interpretive activities will all be included. You can understand the value of *Park Science* to me.

Ro Wauer
202 Padre Lane
Victoria, TX 77901

meetings of interest

1991

May 14-19, INTERNATIONAL CONFERENCE ON SCIENCE AND THE MANAGEMENT OF PROTECTED AREAS, at Acadia University, Wolfville, N.S. Canada. To serve as a forum for examining current perspectives on the role of science in managing protected areas and the role of protected areas in the conduct, support and promotion of scientific research, and as a lead-up to the IUCN World Parks Conference, 1992. Contact Neil Munro, Director, Policy Planning & Research, Canadian Parks Service, Atlantic Region, Environment Canada, Historic Properties, Halifax, Nova Scotia, Canada, B3J1S9.

May 19-23, THIRD ANNUAL SOCIETY FOR ECOLOGICAL RESTORATION CONFERENCE, in Orlando, FL. Contact SER, 1207 Seminole Highway, Madison, WI 53711; (608) 262-9547.

May 29-31, 12TH ANNUAL MEETING OF THE SOCIETY OF WETLAND SCIENTISTS, at Ann Arbor, MI, covering wetlands research and management from many different disciplinary approaches. Contact: Douglas A. Wilcox, USFWS, National Fisheries Research Center-Great Lakes, 1451 Green Rd., Ann Arbor, MI 48105; 303/994-3331.

Oct. 16-20, 45TH NATIONAL PRESERVATION CONFERENCE, "Historic Preservation for the Next 25 Years," at the St. Francis Hotel, San Francisco; sponsored by the National Trust for Historic Preservation, the NPS, and the Advisory Council on Historic Preservation. Contact: Vice President, Programs Service and Information, National Trust for Historic Preservation, 1785 Massachusetts Ave., NW, Washington, DC 20036.

October (no date given in initial announcement), SOCIAL ASPECTS AND RECREATION RESEARCH SYMPOSIUM, Theme, "Wildland/Urban Interface," at Lake Tahoe, interfacing resource managers and scientists in small group discussions of research findings. Sponsored by USFS, BLM, Society of American Foresters and others. For information write Debbie Chavez, SARR Symposium Coordinator, USDA Forest Service, 4955 Canyon Crest Drive, Riverside, CA 92507.

Nov. 3-8, THIRD GLOBAL CONGRESS OF HERITAGE INTERPRETATION INTERNATIONAL – JOINING HANDS FOR QUALITY TOURISM, to be held in Honolulu, to explore how effective interpretation can help protect natural and cultural heritage while providing meaningful and memorable experiences for residents and visitors. Registration and travel/housing information available in April. Contact: Ray Tabata, UH Sea Grant, 1000 Pope Rd., MSB 226, Honolulu, HI 96822 USA; (808) 956-2866; FAX (808) 956-2858.

1992

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

Arbor Day Foundation Sets Training Institute Dates

From Dr. James R. Fazio, former department head of Resource Recreation and Tourism at U-ID and now on loan to the National Arbor Day Foundation, comes word of establishment of the Foundation's new Institute, created to serve as a training, continuing education and professional development arm of the Foundation. Designed to help close the gap between what is known about trees and what is practiced, the following 1991 event schedule has been established, with Fazio as contact.

May 2-3, MODERN ARBORCULTURE – A SYSTEMS APPROACH TO PRACTICAL TREE CARE, by Dr. Alex Shigo, at Nebraska City, NE.

May 7-8 and 9-10, TREE INVENTORY WORKSHOP and COMPUTER SOFTWARE FOR STREET/PARK TREE INVENTORY AND MANAGEMENT, by ACTR, Inc., Kent, OH, with the Arbor Day Institute. Workshops may be taken together or separately, and are repeated Oct. 15-18.

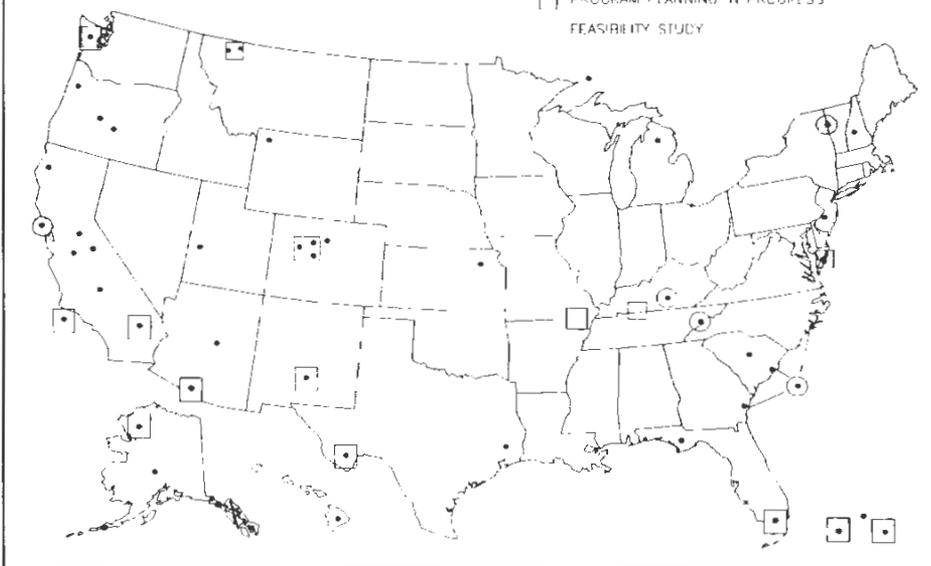
Sept. 8-12, SKOG TUREN – THE TREES AND FORESTS OF SCANDINAVIA, a travel course that includes a look at environmental problems and research in Iceland, Norway, and Sweden.

Nov. 22-23, NATIONAL FUELWOOD CONFERENCE, with focus on technology available for using wood as an alternative to non-renewable energy sources, Lincoln, NE.

For more information or a complete course catalog, contact Dr. Fazio at The Arbor Day Institute, PO Box 81415, Lincoln, NE 68501; (402) 474-5655.

STATUS OF U. S. BIOSPHERE RESERVE PROGRAMS

- DESIGNATED AREAS
- PROGRAM COORDINATION STRUCTURE
- PROGRAM PLANNING IN PROGRESS
- ◻ FEASIBILITY STUDY



The map above summarizes the status of U.S. Biosphere Reserve programs. BRs with a program coordination structure include the Southern Appalachians (established MAB cooperative) and the Carolinian-South Atlantic, Central California Coast, Champlain Basin-Adirondack Mountains, and Mammoth Cave Area (all with informal structures including a coordinator and/or program committee). Program planning is underway at Catskill Mountains, Channel Islands, Chihuahuan Desert, Colorado Rockies, Glacier NP Area, Land Between the Lakes Area, Mojave and Colorado Deserts, and Northwest Alaska. Feasibility studies for regional BR programs are underway at Central California Coast, Champlain Basin-Adirondack Mountains, Guanica Area (Puerto Rico), Ozark Highlands, South Florida, Sonoran Desert, and Virgin Islands. Most of these study reports are due in 1991. Not all the areas above include designated BRs.

publications

Another handsome new addition to the ranks of environmentally-oriented publications is **Earth Work**, product of The Student Conservation Association, Inc., with editorial headquarters at 1800 N. Kent St., Suite 913, Arlington, VA 22209 (703) 524-2441.

The monthly describes itself as being for you who "don't just want a job, you want a career protecting the Earth." The introductory issue came to **Park Science** from Destry Jarvis, executive vice-president of the SCA. **Earth Work's** special feature, "Job Scan," provides the most comprehensive listing of natural resource and environmental job opportunities anywhere, and its articles focus on the people, the agencies, and the nonprofit organizations that protect parks, refuges, forests, and other such lands.

Subscriptions are \$29.95 for 12 issues; single issues, \$6.00. More information about SCA charter membership savings may be had from the Student Conservation Assoc., Inc., PO Box 550, Charlestown, NH 03603-0550.

Natural Science, Conservation Biology Books, Catalogue 38, 1991, is now out, from Patricia Ledlie Book-seller, Inc., One Bean Rd., PO Box 90, Buckfield, ME 04220; (207) 336-2778. The company issues five catalogues a year and features different subject areas in each one. The initial 1991 catalogue contains 586 titles, covering birds, botany (including cryptogams), and miscellany (including mammals, insects and other invertebrates, reptiles, amphibians, and fishes).

The Wetland Training Institute, Inc., of Poolesville, MD 20837-0099, (PO Box 1022), has issued a 12-page pub-

lication entitled **Wetland & Water Resource Training**, announcing its 1991 course schedule and featuring 53 sessions of 19 different courses - 11 of them new (not offered in 1990).

A new set of guidelines to help manage State-owned and federally-owned shipwrecks has been issued by the NPS. The final version, entitled **Abandoned Shipwreck Act Guidelines**, was published in the **Federal Register** on Dec. 4, 1990. Copies are available free, from the Department Consulting Archeologist, NPS, US Dept. of the Interior, PO Box 37127, Washington, DC 20013-7127.

A brochure announces formation of an ambitious new foundation - the Denali Foundation of Alaska: "to benefit our planet, the state of Alaska, and Denali National Park through research, education, and communication."

Michael Cobbold, executive director, with headquarters at P.O. Box 212, Denali Park, AK 99755, disclosed plans for a 1991 Science Conference (no dates given) "to bring together a wide range of experts to develop scientific consensus for research at Denali NP that meets the needs of park management, provides greater understanding of global environmental change, and that can serve as a model for other equivalent preserves."

Donated land adjoining Denali NP will be used by the Foundation for a research center.

The Foundation is being established with part of the royalties from the sale of **Grizzly Cub**, written by Rick McIntyre and published by Alaska Northwest Books.

Bill Gregg, NPS MAB Coordinator, sees growing support for the biosphere reserve/MAB regional program idea.

"There is more activity now than ever before," he says. "But the push is coming as much from outside groups as from government agencies. For instance, the Grand Canyon Trust is exploring a regional program for the Colorado Plateau; Friends of ProNatura for the Sonoran Desert, and informal private interests for the Sierra Nevada and Upper Rio Grande Valley. For the sake of pursuing worthwhile regional and international goals, our biggest need now is a more structured program and more guidance for participation in BR programs. Those should be well spelled out when the Action Plan for Biosphere Reserves and operational guidelines are completed.

Napier Shelton
NPS Washington Office

Revegetation Efforts Using Native Species

A number of Rocky Mountain Region parks are using native vegetation to rehabilitate Federal Lands Highways Program (FLHP) road corridor disturbance. Extensive programs are beginning or continuing at Grand Teton, Bryce Canyon, Mesa Verde, Yellowstone, and Glacier. Each of these parks has selected native species believed to be environmentally appropriate and genetically acceptable for its particular rehab needs.

Native seed or cuttings are collected from the parks to be propagated at a Soil Conservation Service (SCS) plant materials center. Here, native grass seed is propagated over several seasons to produce large quantities of seed which, in turn, is returned to the park. SCS also will propagate shrubs from cuttings or seeds to be returned to parks for planting at the appropriate time. FLHP funds have paid for the SCS plant propagation for these 5 parks.

NPS revegetation/restoration expertise is available from the NPS Plant Materials program, staffed by Rocky Beavers and Wendell Hassel, and located in Professional Support at the Denver Service Center. Both these individuals are available to advise parks which species to use for reveg efforts and how to develop them through the SCS plant material centers. Sarah Wynn is Vegetation Restoration Coordinator for the Rocky Mountain Region.

In order to develop as much information as possible about how to revegetate disturbed areas using native vegetation, the Branch of Science asks those parks involved in such efforts to monitor all ongoing projects and if possible to establish a research plan.

Society and Resource Management

The Fourth North American Symposium on Society and Resource Management has been scheduled for Madison, WI, on May 17-20, 1992. The Symposium will focus on the integration of social and biological sciences as they address, together, natural resource and environmental issues.

For further information, contact Donald R. Field, Program Chair; School of Natural Resources; 1450 Linden Drive, Madison, WI 53706.

Search for Cave Swallow's Winter Range Underway

By Larry W. Johnson

Carlsbad Caverns, long known for its tremendous rooms and incredible formations, also houses the last bird species on the North American continent for which the winter range is unknown. The Cave Swallow, a close relative of the Cliff Swallow, makes its summer home nesting just inside the entrance to Carlsbad Cavern. Scientists at Carlsbad Caverns NP currently are engaged in one of the region's largest ornithological banding projects in an effort to learn more about this bird and ultimately to discover its winter range.

The Cave Swallow is a regular summer resident of Mexico, the West Indies, and northern South America, and currently is expanding its range northward and eastward into the United States. A relative newcomer to Carlsbad Caverns, the birds were first sighted in the cave in 1966, when two or three pairs arrived and built their nests just inside the cave entrance. Prior to 1966, the birds were known to roost only in a few very isolated locations in remote canyons nearby. Since then, the colony inside Carlsbad Cavern has increased to upwards of 4000 birds – the largest and northernmost active colony known to exist.

Cave Swallows (*Petrochelidon fulva*) are easily distinguished from the more familiar Cliff Swallows by their buff-colored throat and their practice of building a small, half-cup nest of mud, grass, and feathers instead of the fully enclosed, gourd-shaped nest of the Cliff Swallow. The primary nesting sites chosen by the birds are caves, although the birds have been seen occupying adobe buildings, silos, and similar structures.

Carlsbad Caverns is one of the few locations in the United States where the species can be seen readily by the general public, so park visitors get an extra treat when they come to see the caves. The swallows are interesting and fun to watch as they chatter, swoop, and make spectacular dives and maneuvers into and around the cave mouth.

Like the famous bats of Carlsbad Caverns, the Cave Swallows are predictable migrators. They usually



Cave Swallow

arrive at Carlsbad in February and depart for unknown wintering grounds by November. Soon after arrival of the first nesting pairs in 1966, a massive banding and study project was undertaken in an effort to learn more about the birds. Steve West, a local school teacher and NPS volunteer, heads the project. Project volunteers include park rangers and students from West's school, who get hands-on experience in netting, handling, measuring, and weighing the swallows.

Thousands of birds have been banded in the hope that some day a band will be recovered and returned to give a clue to the species' winter range. So far, no bands have been recovered outside Carlsbad Caverns, but the research indicates that the same birds do indeed return yearly to nest in the cave. There has been one reported sighting of a Cave Swallow in northern South America (Aruba) during the winter months, but whether that bird was part of the Carlsbad colony was not determined. One of the project's most unusual findings so far was the discovery of an albino Cave Swallow nesting in the cave.

While two or three bird species in North America may have questionable winter ranges, ornithologists generally agree that the Cave Swallow is the last and only species for which the winter range is virtually unknown.

Johnson is a Park Ranger at Carlsbad Caverns NP.

NPS Projects Underway At U/WY Research Center

Three projects of some general interest now underway at the NPS U/WY Research Center are:

(1) **Changes in Geomorphic Processes in the Snake River Following Impoundment of Jackson Lake.** (Richard A. Marston). Findings from the second year of a 3-year project in Grand Teton NP are helping identify potential conflicts over management strategies for the Snake River. An inverse relationship has been discovered between geomorphic stability (channel bar migration, lateral shifting of channels, aggradation/degradation) of the Snake River, and the diversity (relative richness) of floodplain communities.

Commercial river runners would prefer a stable, single-thread, meandering channel for improved navigation and safety. This contrasts with the desires of wildlife biologists, who would prefer a multiple-thread (braided or compound), unstable channel, which condition is associated with maximum diversity of floodplain vegetation. Channel stability and vegetation diversity, in turn, have been affected by the operation of Jackson Lake Dam. Lower peak flows and higher late summer flows in the Snake River since 1957, when the Jackson Dam release schedule was changed, have accelerated succession by eliminating destructive early summer flows and by elevating the late summer water table.

Work in the third year of the project will involve compilation of a sediment budget for the Snake River watershed, using GIS technology to develop a predictive model of river channel response.

(2) **An Evaluation of Earthquake Hazards of the Grand Teton Fault.** (Robert B. Smith, John O. Byrd, David D. Susong, Arthur G. Sylvester, Ronald L. Bruhn, and John W. Geissman). The Teton fault is a major, range-front normal fault that bounds the east side of the Teton Range, located in northwestern Wyoming. This fault is the primary structure responsible for producing more than 2100 meters of vertical topographic relief and is the single most important factor contributing to the spectacular topography and scenery of Grand Teton NP.

Dr. Smith and his team are conducting a multi-year investigation of the Quaternary faulting of the Teton Fault, including timing of faulting, earthquake induced ground deformation, and paleomagnetic measurements of fault deformation. On the basis of the long term record, Dr. Smith's team believes that future earthquakes of magnitude 6.3 M_s <math>< 7.5</math> are expected to continue in the Hebgen Lake-Yellowstone-Teton region, with expected recurrence intervals on the order of once every 1000 years.

(3) **Feral Horse Distribution, Habitat Use, and Population Dynamics in Theodore Roosevelt NP.** (Clayton B. Marlow, Leonard C. Gagnon, Elena Hovland, and Lynn R. Irby.) Description of the ecological niche filled by feral horses in Theodore Roosevelt NP requires information on reproductive rates, home range size, individual and band affinity to home ranges, food and shelter requirements, and seasonal diets. The information will be used to integrate horse requirements with those of elk, bison, and vegetation to determine the ungulate carrying capacity.

To date, Dr. Marlow's research team believes that long term stability of individual bands and high fidelity to certain areas suggests the likelihood of overgrazing, especially when the concurrent patterns of elk and bison are included. Based on preliminary results, they believe that horse management might have to be more intensive than that for elk or bison.

revegetation notes

Brooklyn Native Seed Bank Project Near Completion

In June 1989, a joint effort at abandoned mine-lands reclamation was launched between the USFS Research Station in Princeton, WV, and New River Gorge NR. The project, known as the Brooklyn Reclamation Project, involved using layers of topsoil and leaf litter as a source of seed – a method known as native seed banking, and moving it to disturbed unvegetated sites.

The project site consisted of a 40+ year old half-acre coal refuse pile that was subject to washouts and gullyng and completely bare of vegetation. The 20' x 20' plots were installed in June, October, April, and the following June, and were replicated 3 times. The plots were treated with lime and fertilizer, and the seed bank source area was selected based on the quality of topsoil, density of leaf litter,

and presence of desirable native species.

By installing the plots during different times of the year, we hoped to determine whether there would be a significant difference in the emergence of native vs. alien species and which time frame resulted in the quickest growth. The resource management staff is currently collecting final data and a formal research report, co-authored by the NPS and USFS, will be published this summer (1991).

It is hoped that the results will provide us with a low cost method of disturbed site revegetation that encourages the emergence of native species. Anyone interested in the project can obtain more information from Carol A. Pollio, Natural Resource Specialist, New River Gorge NR, at (304) 465-0508.

A Commentary on Visitor Statistics

Editor's Note: It takes all kinds of people to make up a world, and some of them seem to be 2 or 3 different individuals wrapped into one outer covering. Crusty, cantankerous, gun-toting poets aren't your run-of-the-mill park visitor (or your usual hunter, either). But listen to one of them, and it could surprise you into reexamining some of your own comfortable ruts.

By Al Lovaas

Recently, Dick Briceland announced visitation figures for September 1990. There were 25,775,338 recreation visits to the National Park System that month, of which Alaska Region had 148,909, or a little more than half of 1 percent, while 56 urban parks alone scored 7,050,180. For the year to date, Alaska recorded 1,089,906 of the total 210,397,573. While these are important statistics, obviously they are not intended to, nor do they, tell the whole story about visitor use of NPS areas.

Toward the end of that very month I made one of my infrequent recreational visits to an NPS area. There, 130 miles north of Nome, I reveled in the silence, the loneliness, the empty, roadless, sweepingly-open vistas of a truly wild place. I exulted in being alive: in the interplay and flex of my muscles; in the pleasant exer-

tion of hiking hillsides where mosses, lichens and forbs displayed pastel autumnal abstractions reminiscent of a Jackson Pollock paint-dribbled canvas (although I doubt the artist ever saw nature's originals).

I marveled at the soaring, flashing speed of a gyrfalcon; a near straight-line trek to nowhere by a ponderous lone musk-ox; large flocks of ptarmigan wheeling in flight, their whiteness stark against sienna tundra and willow. I was enraptured by the mysterious, undulating, glowing beauty of northern lights in the clear night sky. I was struck by the purity and silence of freshly falling snow, creating its mood of timelessness and antiquity. I was lulled by the musical murmuring of clean water flowing endlessly over ancient stones in a tiny brook.

I shot and killed a fine bull moose. I made a longish shot, but one well within the range of my .300 Win. magnum and he fell in his tracks to a 200-grain hand-loaded bullet, although I had to stick a finisher in his ear. He was sleek and fat and beautiful; I may have been the only human he ever saw. I venture to say not any of the 7,050,180 legitimate recreation visits to 56 urban park area in September, nor the 1,065,333 to Yellowstone, Olympic, and Zion that month resulted in the deliberate killing of a large wild animal.

I gutted and quartered my moose and with help from three companions packed the meat to the tiny airstrip and loaded it into a small plane to begin the journey to my home in Eagle River, Alaska. I did not depart, myself, for several days because of inclement flying weather and the need to assist companions in getting out two more moose. While we saw tracks, we did not get a chance to kill any grizzly bears.

The delicious, low in cholesterol, unadulterated, tender, and very expensive meat was stored respectfully and carefully in my freezer alongside packaged filets from 23 sockeyes I dip-netted in June from a river forming part of the boundary of another NPS area. Injuries from orcas, seals and commercial fishermen's nets on a few of those bright, handsome fish were reminders of the incalculable odds they faced during a lifetime of peril, and of their dauntless determination to surmount any obstacles in returning to their natal streams to reproduce their kind. My dip net finally snuffed out that determination so close to their final goal, with only a few fish wheels and predators left between them and their spawning streams. I do not waste their succulent flesh.

I made my September recreational visit to a 2,785,000-acre national preserve, which by law is administered exactly as a national park except that sport and subsistence hunting and trapping are permitted and, in that particular preserve only, reindeer herding. The salmon were taken from a 13,188,000 acre park and preserve. In the early 1980s, I killed three caribou on the preserve, but not qualifying as a local rural resident, I could not participate in subsistence hunting in the park. My hunts were accessed by small planes on marginally short, narrow, rocky, and in one instance tree-girl, landing strips that barely qualified for that designation. On one flight, I saw a gorgeous, rollicking grizzly bear, but never was fortunate enough to find one while hunting.

Consumptive uses present problems, but they also present opportunities foreclosed by complete protection: "The National Park Service recognizes and the Committee agrees, that subsistence uses by local rural residents have been, and are now, a natural part of the ecosystem serving as a primary consumer in the

food chain" (Legislative History, Alaska National Interest Lands Conservation Act). We are mandated also "to insure that consumptive uses of fish and wildlife populations within NPS units not be allowed to adversely disrupt that natural balance which has been maintained for thousands of years" (ibid.).

But how much consumptive use is natural and not adversely disruptive? Research, inventory and monitoring can provide guidance; comparisons with research results from totally protected parks are essential. And how much effect, if any, on the biological processes are we mandated to continue unimpaired by adverse human activity is coming from arctic haze, global climate change, reindeer herding, fire protection/management, special Alaska provisions for ready visitor access and transportation, missing or unnaturally reduced life forms, development of world-class mines near parks, changes in life styles by indigenous people, desires of suburbanites like me to become natural parts of ecosystems, and increasing human populations?

Are the answers to these questions really important? I believe they are essential, not just to manage national parks and preserves in Alaska, but to help at least a little in guiding humankind into an uncertain future. How can we tell what direction we are going if we don't know where we began?

Whether visitors are merely looking at something of interest in an NPS area or whether they are shooting, trapping, or netting something must obviously be considered in management formulas along with the numbers of recreation visits.

Visitor expectations are important. If cost is dependent largely upon comparative scarcity, Dr. Briceland's figures indicate recreation visits to the Alaska Region approach pricelessness. Many of the visits are once-in-a-lifetime experiences: all are expensive and time-consuming. Discriminating buyers expect top value when they pay top dollar and they deserve to get it. While the word "great" has become hackneyed, Alaska deserves its title, "The Great Land." To meet great expectations of visitors while preserving great but often fragile resources and wilderness ambiances requires sophisticated management and decision making dependent upon expensive information. Chip Dennerlien, in a 1988 *George Wright Forum* (Vol. 5, No. 4) paper eloquently and succinctly described the challenges of managing northern and remote parks.

A national park manager from the simpler, less crowded, less knowledgeable world of not all that long ago would be amazed if he could look in on the Alaska Regional Office of today. There are divisions of Protection and Ranger Activities, Budget and Finance, Planning, Concessions, Personnel, Environmental Compliance, Facility Design and Maintenance, Contracting and Property, Cultural Resources, Interpretation and Visitor Services, Subsistence, Land Resources, Information Management, Minerals Management, Natural Resources, and an Office of Oil Spill Coordination.

All are essential or they wouldn't exist in these times of tight budgets, and all are bustling to try to turn concepts into reality in this modern world. I'm sure though that the old timer had plenty of problems to contend with, and probably if anything a more negative ratio of resources to needs. Nobody ever said it was, is, or will be easy, but for sure it will get even more complicated, which must be recognized by the American people if we are to continue to receive their support.

Lovaas is Chief Scientist in the NPS Alaska Region.

Colonial Mowing Pattern Changes Paying Off

The changes in mowing patterns at Colonial NHP described by Chuck Rafkin on page 16 of the Fall 1990 issue of *Park Science* already are paying off in 2 park fields. Word from Rafkin is that natural vegetation, including wildflowers, are suppressing the johnson grass in these fields.

"With this in mind," he writes, "we have developed and initiated a plan with the local Colonial Water and Conservation District to conduct a cooperative experimental demonstration project to suppress johnson grass in the park, employing selective vegetative management techniques without the use of herbicides."

The Colonial Soil and Water Conservation District is providing technical assistance, financing, and the use of a no-till seeder to the park. Additional technical support is being provided by Jeff Marion, Mid-Atlantic Regional research scientist.

The park is benefitting from the work of graduate students in the course entitled Federal Jurisdictional Wetlands Delineation at the Virginia Institute of Marine Sciences, College of William and Mary. Their class project is to survey for non-tidal wetlands the open fields of the park's Yorktown Battlefield unit. Areas meeting the Federal guidelines have been delineated and mapped. The park will be supplied with the maps and reports on each area and the information will be added to the park GIS.

With regard to the water resource management plan for the park, a change of cooperators now has the park working with the William and Mary Virginia Institute of Marine Science under a cooperative agreement. Dr. Carl Herschner, head of the Wetland Ecology department, and Dr. Suzette Kimball, geologist in the Division of Geological and Benthic Oceanography and co-director of the Virginia Coastal Inventory program, are the principal investigators.

Chiricahua Mountains Annotated Bird Checklist

By Kathy L. Hiett, R. Roy Johnson, and Michael R. Kunzmann

Southeastern Arizona may be the premiere inland bird watching locality for the United States, and is considered by many ornithologists and birders to be excelled by few other places in the world, but only in recent years has the popularity of the area become apparent. Portal, a small community on the eastern fringe of the range caters to birding groups and dispenses information on local attractions. The U.S. Forest Service provides local information, maps and a checklist (1989) of birds in the Chiricahuas and operates recreational facilities throughout the range that are heavily used by birdwatchers from around the world.

Many come seeking to add to life lists and search for specialty birds from this region, with the most sought after birds being those from the Sierra Madre Occidental of northern Mexico. Examples of Madrean birds that regularly summer and breed in the Chiricahuas include: the Elegant Trogon (*Trogon elegans*), Sulphur-bellied Flycatcher (*Myiodynastes luteiventris*), Red-faced Warbler (*Cardellina rubrifrons*), and Painted Redstart (*Myioborus pictus*), to name a few of the more colorful species. Numerous other "Mexican species" are permanent residents, reaching their northernmost limits in the extreme southwestern United States. These include the Strickland's Woodpecker (*Picoides stricklandi*), Gray-breasted (Mexican) Jay (*Aphelocoma ultramarina*), and Mexican Chickadee (*Parus sclateri*).

For the past three years, scientists at the Cooperative Park Studies Unit at the University of Arizona (CPSU/UA) have conducted an inventory of the Chiricahuas. The method for collecting information and determining species annotated accounts was designed by R. Roy Johnson. Computerized information management and compilation of observation and breeding data were coordinated by Michael R. Kunzmann. The related project for the vegetation and habitat classification system was contributed by Peter S. Bennett.

Since the establishment of the American Museum of Natural History's Southwestern Research Station (SWRS) near Portal in 1955, researchers have come in increasing numbers to explore the biological riches of the Chiricahuas. This research has greatly expanded the knowledge of the mountain's flora and fauna and resulted in the compilation and publication of field checklists for Chiricahua NM as well as for the rest of the range. Previous to the work of the CPSU/UA, however, no annotated checklist has been available for this area. The CPSU/UA project gathered records from the past 20 years as well as new data and provides information, verification, and references on approximately 350 avian species, found in this area.

The area studied covers the entire Chiricahua Mountain range from Ft. Bowie NHS south toward the city of Douglas, encompassing approximately 700 square miles of public land including: Chiricahua NM, Ft. Bowie, Coronado NF, and some privately owned lands. Lower elevation limits on the eastern side were set at 4,200' and for the western side at 5,000'. Data and photographs were gathered from all major habitat types (see Fig. 1) from the desert floor to montane meadows, and to Engelmann spruce forests at the summit of Chiricahua Peak (elev. 9759'). Plant community structure is illustrated with photographs.

During the avian and floristic studies conducted by CPSU/UA scientists, the mountain island diversity theory was examined as well as the biological diversity of the range. The high avian species richness, and floral and vegetative diversity is largely due to the ecotonal nature of the region. Lowland diversity is derived from the convergence of species from the Chihuahuan Desert to the southeast and plains grasslands to the northeast, with those from the Sonoran Desert to the west. Species richness for montane forest and woodland diversity derives from Rocky Mountain vegetation to the north blending with vegetation from Mexico's Sierra Madrean vegetation to the south.

Publication Components and Information Management

Prominent ornithologists and others who have studied the Chiricahua Mountains were invited to submit essays that provide the reader with a broader perspective of the cultural and natural history of the area and birds found here. Dr. Jerram Brown, SUN, the top authority on Gray-breasted Jays (formerly Mexican Jay), has authored an essay on the value of long-term observations and the stability of the jay population during his 20 year study in the Chiricahuas. Alden Hayes, a resident of Portal and author of several Chaco Culture NHP reports, described the area's cul-

Classical Checklist Categories	Breedings Birds	Brown, Lowe & Pase Categories	Merriam's Life Zones
Forest Spruce-Fir Forest Spruce-Fir-Aspen Pine-Fir Ponderosa Pine	Mexican Chickadee Red Crossbill Golden-crowned Kinglet Steller's Jay	Madrean Subalpine Forest 121.5	Hudsonian Zone
	Olive Warbler Red-faced Warbler Flammulated Owl Grace's Warbler Hepatic Tanager Greater Pewee	Madrean Mixed Conifer 122.61	Canadian Zone
	Magnificent Hummingbird Strickland's Woodpecker Whiskered Screech-Owl Gray-breasted Jay Montezuma's Quail Black-throated Gray Warble	Madrean Pine Series 122.62	Transition Zone
Woodland Pine-Oak Woodland Pinyon-Juniper Oak Woodland	Strickland's Woodpecker Whiskered Screech-Owl Gray-breasted Jay Montezuma's Quail Black-throated Gray Warble	Madrean Oak-Pine Series 123.32 Madrean Encinal (Oak) Series 123.31	Upper Sonoran Zone
Brush Interior Chaparral	Bushlit Black-chinned Sparrow Scrub Jay Crissal Thrasher Poor-will	Scrubland Interior Chap 133.3	
Desert Chihuahuan Semidesert Grassland Chihuahuan Desertscrub	Scaled Quail Cassin's Sparrow Chihuahuan Raven Verdin Cactus Wren White-winged Dove Greater Roadrunner	Semidesert Grassland 143.1 Chihuahuan Desertscrub 153.2	Lower Sonoran Zone
Montane Meadows Montane Meadow	Yellow-eyed Junco American Robin Chipping Sparrow Broad-tailed Hummingbird	Madrean Sub-Alpine Grassland 141.6 Madrean Montane Grassland 142.6	Hudsonian Zone Canadian Zone and Transition Zone
Wetlands/ Riparian Areas Mixed Deciduous Canyon Mixed Deciduous Wash Desert Arroyo (Wash)	Elegant Trogon Blue-throated Hummingbird Sulfur-bellied Flycatcher Painted Redstart Bridled Titmouse Dusky-capped Flycatcher Lucy's Warbler Ladder-backed Woodpecker Black-chinned Hummingbird Black-tailed Gnatcatcher	Mixed Broadleaf Series 223.2211 Sycamore/Ash/Pine Mixed Broadleaf Series 223.2212 Xeroriparian Series 233.23	Higher Zones Upper Sonoran and Lower Sonoran Zone
Water Areas Madrean Marsh Lakes/Ponds/Stock Tanks	Black Phoebe Vermilion Flycatcher	Madrean Marshland N/A 243.5	Most Zones
Cultural Rural Areas	Hooded Oriole Bronzed Cowbird	N/A	Lower Zones

Figure 1. Chiricahua habitat classifications.

Scheduled for Publication Early This Year

tural and political history. Robert Morse, a local Portal retired engineer and ornithological enthusiast, suggests birding tips and etiquette.

Dr. Steve Russell, professor of ornithology at U/AZ, contributed an essay on mountain island diversity. He also was co-author of "Birds in Southeastern Arizona" with William Davis. Drs. Noel and Helen Snyder discuss the restoration efforts for the extirpated Thick-billed Parrot (*Rhynchopsitta pachyrhyncha*) in the Chiricahuas begun by the USFWS in the mid-1980s. Drs. Walter and Sally Spofford, retired Cornell Lab of Ornithology researchers and permanent residents of Portal, provided professional advice in their essay on observations, keeping good records, and on specialty birds in the area. The Spoffords and Robert Morse were especially effective in contributing critical information and observation records that have greatly assisted in producing an accurate checklist.

GIS technology has largely replaced paper and mylar maps, traditionally used to spatially locate natural resources. Computerized databases linked to GIS workstations retrieve and map resource information more efficiently than traditional methods. With an eye towards the future, a standardized database has been developed to collect locality information on all 350 plus species of birds in our study area. The program, written in Foxbase Pro, operates in an IBM/DOS 3.31 environment with at least 1.5 megabytes of hard disk storage.

By standardizing the information collected, different researchers can enter data in a consistent, defined format which is searchable by key fields, species, locality, habitat, date, and numerous other combinations. The program is linked with two related databases, one that references all 941 species of North American birds (including Hawaii) and another database referencing typical habitats found throughout the range. Future efforts will be directed toward linking UTM locality data with GIS, so species distribution maps can be produced directly.

Maps produced by Lois Kain, U/AZ, depict the study area boundary and show the Chiricahuas in relation to surrounding ranges involved in our mountain island diversity studies. The reader's understanding of the mountain's cultural history is enhanced by the adaptation of a Cochise County map from the 1890s. A schematic cross section of the range shows spatial relationships of vegetation types discussed by Peter Bennett in relation to avian distribution.

BERYLLINE HUMMINGBIRD (*Amazilia beryllina*) Erratic summer resident throughout range. Nesting: SWRS, 1976 (unsuccessful, Monson & Phillips 1981); Chiricahua Nat. Mon., Natural Bridge trailhead, 18 August to 15 September 1984 was the 3rd U.S. Nesting Record and 3rd for Arizona (Amer. Birds 39:86-90, 1985). Additional sightings: Cave Creek Canyon 30 June to 1 August 1970 (H. Snyder et al.); SWRS 26 June 1981 (Pimm et al.); Portal 9 June 1983 (P.S. Boyd); South Fork 29 June 1984 (B. Zimmer et al.); Silver Creek Spring 2 July 1984 (R. Morse); Rustler Park trail near Barfoot crossing 18 July 1984 (D. Horn); SWRS 5 August 1986 (T. Mack). Photographs, nest collected 29 September 1984.

Figure 2. Sample of species annotated account.

Species	National Geographic	Peterson Guide (1989 edition)	Golden Guide
White-throated Swift	252	246	184
Broad-tailed Hummingbird	260	218	184
White-eared Hummingbird	256	218	190
Berylline Hummingbird	254	220	N/A
Violet-crowned Hummingbird	256	220	190
Blue-throated Hummingbird	256	218	190
Magnificent Hummingbird	256	218	190
Plain-capped Starthroat	256	220	N/A
Lucifer Hummingbird	254	220	190
Black-chinned Hummingbird	258	220	188
Anna's Hummingbird	258	216	186
Costa's Hummingbird	258	220	188
Calliope Hummingbird	260	220	186
Broad-tailed Hummingbird	260	216	186
Rufous Hummingbird	260	216	188
Allen's Hummingbird	260	216	188
Elegant Trogon	232	206	192
Eared Trogon	232	206	192
Belted Kingfisher	262	206	192
Lewis' Woodpecker	266	222	198
Red-headed Woodpecker	266	222	198
Acorn Woodpecker	266	222	198
Gila Woodpecker	264	228	196
Red-naped Sapsucker	268	226	N/A
Williamson's Sapsucker	268	226	198
Ladder-backed Woodpecker	272	228	196
Downy Woodpecker	270	224	200
Hairy Woodpecker	270	224	200
Stickland's Woodpecker	272	228	200
Northern Flicker	264	226	194

Figure 3. Sample of Chiricahua Mountains cross-referenced checklist.

Species occurring in the Chiricahuas are discussed in the species account portion of the checklist (Fig. 2). Abundance and status information for preparing species accounts was determined by analyzing observation records from CPSU/UA and other field data, Chiricahua NM and Ft. Bowie NHS wildlife observation records. USFS "Birds of the Chiricahua Mountains" field checklist (1989), SWRS records, and museum specimens from various collections, especially the University of Arizona. More than 100 articles from journals and other publications provided additional avifaunal data. A list of all species recorded from the range is keyed to pages from the three most widely used field guides (Fig. 3) for the benefit of birders visiting the Chiricahuas.

Summary

The Chiricahua annotated checklist has been patterned after two annotated checklists previously produced by CPSU/UA biologists, one for Grand Canyon NP and the other for Organ Pipe Cactus NM. The coverage of this checklist has been expanded to make it more usable for both resource managers and visitors. It is scheduled to be published early in 1991 as a CPSU/UA Technical Report, after which it will be submitted to Southwest Parks and Monument Association for publication as a sale item at area visitor centers.

Hiett, Johnson, and Kunzmann are all associated with the NPS/CPSU at U/AZ, Tucson 85717.

Interagency Neotropical Migratory Bird Program

The Service is participating with the Fish and Wildlife Service, Forest Service, Bureau of Land Management, Smithsonian Institution, Agency for International Development, and Environmental Protection Agency in developing a Memorandum of Agreement for a program of research, population monitoring, information/outreach, and international cooperation. The purpose of this cooperative program will be to prevent further declines in populations of neotropical migratory birds.

The Service also is identifying representatives to a steering committee and to 8 working groups that the interagency program is establishing. In addition to coordinating efforts of the federal agencies involved, the Neotropical Migratory Bird Conservation Program will rely heavily on participation by a large number of state, international, and non-governmental organizations. Contact Mike Coffey, Wildlife Biologist, WASO, for more information (FTS/202 343-8135).

Sea-Kayakers At Apostle Islands National Lakeshore Summary of a 1989 Exploratory Study

By Carolyn C. Phelps and David W. Lime

Sea-kayaking is an emerging use that has grown dramatically over the past few years at Apostles Islands National Lakeshore (APIS) on the western shore of Lake Superior near Bayfield, WI, as well as in other parts of the country. The NPS reports that sea-kayaking use at the Lakeshore has grown from about 150 visitors in early- to mid-1980s to over 2000 in 1989.

To gather baseline information on sea-kayakers use, a study was undertaken by researchers at University of Minnesota's NPS/CPSU in conjunction with Lakeshore staff. This information will be used as background for more detailed studies in the Lakeshore and perhaps elsewhere in the Midwest Region.

Increased knowledge of sea-kayakers will help the NPS to better understand the needs of these recreationists, as well as their impact on the resource, and will facilitate the formulation of management plans and educational, interpretive, and safety programs. Data sought by researchers included characteristics of the trip and geographic travel patterns, visitor profiles, visitor satisfaction, and problems encountered by sea-kayakers.

Survey Method

Sea-kayakers were asked to register name, address, and age, on a "group information form" when contacted at either of two APIS visitor centers. Most contacts were made during issuance of the mandatory camping permit. Some contacts also were made by NPS personnel at 3 lake access points. A local sea-kayaking outfitter assisted researchers by asking patrons, both day use and campers, to complete the group information form.

While camping permits are required at the Lakeshore, day use permits are not. Because of this, day users – particularly those who did not use outfitter services, may be slightly underrepresented in the sample. However, due to the long distance of the Lakeshore from large population centers (e.g. Madison, Duluth, and Minneapolis/St. Paul), researchers do not believe the number of nonoutfitted day users is high.

All persons 16 or older who registered with us were sent mail-back questionnaires following their visits to the Lakeshore. In all, 234 surveys were mailed, most within 2 weeks of the visits. Two mail follow-ups were employed to increase participation. Of these, 203 usable surveys were returned, resulting in an 87 percent response.

Selected Survey Results

The average age of sea-kayak visitors who returned the questionnaire is 36 years, with a range from 16 to 63. Thirty percent of the visitors were from the Minneapolis/St. Paul area; an additional 12 percent were from other areas in Minnesota. Six percent were local (less than a 2-hour drive to APIS); 20 percent were from other areas in Wisconsin. Thirty-five percent were from other parts of the U.S.; 1 percent were foreign. Three-fourths of the sea-kayakers had no previous sea-kayaking experience at APIS. Of those who did, about half (47%) had sea-kayaked at the Lakeshore only once before.

The proportion of day and overnight visitors was nearly equal. Three-fourths of the visitors used an outfitter for some or all of their services/supplies. Non-outfitted groups reported a median group size of 3.

Table 1. Degree of problem encountered by sea-kayakers (1989).¹

Potential Problem	Not a Problem	A Problem		Respondents
		Slight/Moderate	Serious/Very Serious	
	percent	percent	percent	number
Insect bites	49	43	8 ²	187
Inadequate toilet facilities at launch site	56	35	8	190
Finding a high quality campsite ³	52	45	3	67
Finding an unoccupied campsite ³	59	35	6	65
Rough seas made travel difficult	66	29	5	187
Bad weather	67	30	4	192
Meeting too many other watercraft	67	30	3	192
Too few launch sites	77	20	3	190
Not enough hiking trails	77	21	2	164
Soil erosion at campsites ³	78	21	1	79
Damage to beach vegetation caused by visitors	79	20	1	188
Litter	80	19	1	192
Finding safe drinking water	78	21	1	188
Insufficient information about things to see and do in the islands	87	10	3	188
Availability of navigational maps	88	11	2	185
People being inconsiderate	86	13	2	191
Poor quality launch sites	87	13	1	193
Someone in group received an injury	88	10	2	194
Not enough firewood	88	12	0	178
Human body waste	91	7	2	191
Too many rules and regulations	91	8	1	185
Too few rules and regulations	93	6	1	186
Loss or damage to personal property	94	5	1	194
Navigating among the islands	93	7	0	176
Overall maintenance of the area	94	6	0	189
Not enough law enforcement	94	6	0	188
Too much law enforcement	97	2	1	188
Black bears	98	2	0	191

¹ Ranked by mean score.

² Row totals may not equal 100 percent due to rounding.

³ For overnight campers only.

Outfitted groups show a higher median group size, but it is not reflective of actual conditions because many outfitted respondents reported the total outfitted group size rather than their own personal group size. Three-fourths of the visitors traveled with family or friends. Respondents reported hiking/exploring (53%), paddling/kayaking (34%), swimming/surfing/snorkeling (30%), and camping (28%) as primary activities engaged in.

Overall, visitor satisfaction was very high. Seventy-two percent of all respondents reported their visit as "very good," on a 5-point Likert scale ranging from "very good" to "very poor;" an additional 22 percent reported their visit as "good." Only 3 respondents (2%) rated their visit as "poor" or "very poor." Visitors also

were asked to list up to 3 "high points" and "low points" of their trip – things that were most and least satisfying. Scenery/scenic beauty was reported by 36 percent as "high points," followed by visits to the sea caves (35%), absence of other people (15%), and good weather (15%). Low points listing was headed by bad weather (13%), not enough time for the visit (12%), and insects (10%). No low points were reported by 8 percent of the respondents. Low points for campers focused on problems associated with finding a campsite or with the condition of campsites (15%), insects (14%), and presence/activities of motorboaters (14%).

The mail-back questionnaire asked respondents to rate 28 potential problems on a 5-point Likert scale, ranging from "not a problem" to "a very serious prob-

Sea-Kayakers

(Continued from page 20)

lem." Most issues or topics were found **not** to be a problem (Table 1). Among all problems listed, insect bites (reported by 51%) was the top-rated. Forty-four percent complained of inadequate toilet facilities at launch sites. About a third of all respondents reported each of 3 issues as a problem—rough seas that made travel difficult, bad weather, and meeting too many other watercraft. Too few launch sites on Lake Superior were cited by nearly one fourth of all visitors. In addition to insect bites (60%) and meeting too many other watercraft (54%), campers reported finding a high quality campsite (48%) and finding an unoccupied campsite (41%) as problems.

Even among the problems identified as relatively important, virtually none was rated as serious or very serious (Table 1). For example, while 51 percent of the respondents reported insect bites as a problem, only 8 percent of all respondents rated them as "serious" or "very serious." Most rated them as "a slight problem" (23%) or "a moderate problem" (20%).

Some of the issues identified as problems (insect bites, bad weather, rough seas) would seem not to be management oriented. However, managers *can* help mitigate these problems through the use of brochures, interpretive programs, and other information and education activities, making visitors aware of, and prepared to contend with, these conditions as they arise. A brochure for sea-kayakers, developed in 1988, identified these concerns and is currently being distributed. It also may be advisable to use local outfitters to dispense educational information to clients before they arrive at APIS for their sea-kayaking experience.

A major finding of the study is that nearly half the respondents never left the mainland shore to venture out among the 18 islands comprising the Lakeshore. For visitors who used the Meyers Beach entry point (103 respondents), for example, 75 percent used the shoreline only. For those entering at Little Sand Bay (49 respondents), 25 percent visited the shoreline only. All but one of the visitors launching at Bayfield/Red Cliff (45 respondents) visited at least one island. Shoreline-only visitors typically used the services of an outfitter and were day users. Many visited the popular Squaw Bay sea caves. Because the mainland shore, not the islands, is the destination for many sea-kayakers, different information, education, and interpretation programs may be needed for shoreline visitors and for sea-kayakers who explore the island resources.

For those visitors who did stop on at least one island, nearly all made at least one stop in the 6 inner islands; half stopped in the 7 middle islands, and nearly 20 percent visited at least one of the 5 outer islands. It also is important to note that use appears to be concentrated on only a few of the islands in each zone.

This project was an exploratory step on the way to designing and implementing a program to monitor sea-kayaking, as well as other watercraft use, in the Lakeshore. Monitoring is an important management activity, letting managers know over time whether physical and social conditions are getting better, getting worse, or staying about the same. While no particular issue appears to be a big problem *now* for sea-kayakers at the Lakeshore, managers are well advised to monitor change and be responsive to it.

Phelps is a Research Assistant and Lime is a Research Associate and NPS/CPSU Leader in the Department of Forest Resources, College of Natural Resources, U:MN, St. Paul 55108.

notes from abroad

Editor's Note: From time to time we get reports from scientists who have attended conferences abroad. In order to encourage submissions of this kind of news, a "standing head" will be used to cover these accounts. Recently David L. Peterson, research scientist with the NPS/CPSU at UIWA, presented papers at the International Symposium on Tree Rings and the Environment in Ystad, Sweden, and at the International Conference on Acidic Deposition in Glasgow, UK. Following are highlights from his report and a listing of the papers he presented.

By David L. Peterson

The International Symposium on Tree Rings and the Environment was the second major meeting for dendrochronologists and was a follow-up to the conference held in New York in 1986... truly an international meeting with 120 participants from 25 countries, only 8 from the U.S. I was the sole NPS representative at the conference.

Subject matter was wide-ranging, with many papers presented on dendroclimatology, most of these from Europe. There is increasing interest in this subject because of its connection to global climate change through evaluation of past climatic conditions.

Most papers focused on the relationship between annual growth and individual climate parameters (such as monthly precipitation), as well as reconstruction of past climate. However, 3 papers, including mine, focused on long term growth patterns. I presented the results of a study of whitebark pine and lodgepole pine in the Sierra Nevada of California. These high elevation species have had increasing basal area increment growth since about 1850, a pattern also found at a few other North American subalpine sites. One of these papers, presented by Keith Briffa of East Anglia, UK, showed there has been a similar growth increase at many sites in mountainous areas of Europe. These results created a great stir of interest and helped encourage discussions about additional studies of subalpine species.

The session on methodology revealed there have not been many new developments in analytical capability. Disagreement still exists as to what statistical approaches to use for time series analysis of tree growth data. A movement is growing to look at individual tree growth patterns, in contrast to the traditional approach of aggregating data by groups of trees. This approach is better for examining the variance in any particular dataset. Some progress has been made in the technology of measuring tree cores, particularly in the areas of image analysis and densitometry. Both technologies are still very expensive, although image analysis may be a viable alternative if the resolution of discriminating among tree rings improves.

A number of "applied" topics were discussed, such as the use of tree ring analysis to date old European structures (e.g. churches) as well as structures at a number of archeological sites.

The International Conference on Acidic Deposition in Glasgow attracted 800 people from 25 countries, mostly Europe and the US. Again, I was the only NPS representative. This meeting provided a forum for synthesizing much of the information collected on this topic over the past decade. It may well be one of the last meetings of its kind because of reduced funding in this area and a shift of interest in global climate

change.

Considerable debate continues over the effects of acidic precipitation and other pollutants on terrestrial ecosystems. Many of the "declines" that received a lot of publicity in the early '80s have now been explained in terms of other phenomena or have not been linked conclusively to pollutants. The forest decline issue in central Europe is hardly even mentioned anymore: many trees studied on permanent plots have reverted to a more healthy condition in the last few years.

The condition of red spruce in the eastern US continues to command much attention. Experimental evidence with seedlings has shown a weak link at best with pollution. Establishing cause-and-effect relationships between trees and pollutants has not been very successful because of the difficulty (or lack of interest) in working with mature trees. I presented a similar paper to the one I gave in Sweden; the results on tree growth increases in the Sierra Nevada contrasted with most of the other papers that focused on damage and declines.

The best presentations were on the effects of acidic deposition on aquatic systems and soils. There appears to be a great deal of evidence that acidification of lakes and some streams is occurring at least in some locations. This seems most prevalent in areas that have the highest sulfur and nitrogen inputs and the ecosystems with the lowest buffer capacity. There also seems to be good evidence of the potential for soils to have increased acidity and decreased nutrient content under long term acid deposition. This has not been manifested on a large scale, but may be in the next 50-100 years if deposition is not reduced or mitigated.

The conference also revealed some of the usual prejudices in this field. The Canadians were upset with the US for supposedly acidifying their lakes and damaging sugar maple. Many US scientists think the Canadians use their research and publications mainly as environmentalist propaganda. The Scandinavians continue to complain about pollution from continental Europe and Great Britain. Unfortunately there were few eastern Europeans there to discuss what really severe pollution damage is like. Many of the studies were inadequately designed to link pollutants with effects in a realistic context, or were somewhat biased in their interpretation (usually in favor of pollutant damage.)

I visited some of the parks in Norway and Sweden and did quite a bit of hiking in Hardangervidda National Park in central Norway. This park is at about 62 deg. latitude and entirely above treeline. It contains a wide variety of alpine plants in both wet and dry habitats, lots of lakes and streams, and some spectacular glaciers.

Park management in Norway is relatively passive. The trails are well-marked, but that is about the only sign of management presence. There are no visitor centers, parking lots, campgrounds, interpretive material, or park personnel. Everyone seems accustomed to this and they just put on their backpacks and take off for a hike.

The parks also are used extensively for grazing, mostly by sheep, and have been used for this purpose for hundreds of years. Obviously, this has affected the local plant communities. I also visited some natural areas in southern Sweden, the largest of which was Skaralid NP. Again, management is passive in most

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Tree Line Research in Gates of the Arctic NP A Follow-up to Robert Marshall's Research

By Terry Droessler and Judy Alderson

When wilderness explorer Robert Marshall travelled in the central Brooks Range in the 1930s, he combined his enthusiasm for the scenic and wilderness values of the area with a scientific interest in the ecological relationships there. As a result, Marshall undertook tree growth studies in the North Fork of the Koyukuk, Alatna, and John River drainages in what today is Gates of the Arctic National Park and Preserve (Retzlaf and Marshall 1931, Marshall 1933, 1970, 1979, Glover 1986, Brown 1988).

Current interest in global change and the need for long-term data relating to climate change have led two agencies to investigate the potential use of Marshall's data for determining change at tree line in the central Alaskan arctic. Tree line is defined in this study as the northernmost trees that were located.

During summer 1990, the U.S. Environmental Protection Agency and NPS combined resources to sample sites at tree line within Gates of the Arctic NP. White spruce (*Picea glauca*, Voss) at tree line is sensitive to climate and may respond to global climate change. To detect field evidence of white spruce tree growth and tree line responses to climate, tree line location was mapped and tree cores were extracted to determine tree age and annual increment. Previous work by Marshall helped identify specific research sites. The tree increment cores collected, together with observations of tree line migration, should enable quantitative statements of tree growth and tree line migration response to recent past (post 1900) climate. The tree cores currently are being analyzed and results as well as observations will be published when completed.

The relationship between tree line location and climate has been based on correlational studies. There are several temperature-based guidelines that correlate with tree line location. For example, correspondence between the 10 deg. C. July isotherm and tree line location is discussed in Tranquillini (1979),



Boreal Mountain (left) and Frigid Crags Mountain (right) form the namesake "gates" in Gates of the Arctic NP. In this photo, looking south, the North Fork of the Koyukuk River flows in from the left and Ernie Creek flows in from the right. Tree lines on both waterway drainages were sampled, as shown on the map.

Arno (1984), Larsen (1988), and Young (1989).

The greatest climate warming is expected to occur at higher latitudes. According to predictions from General Circulation Models (GCMs) warming in the higher latitudes may be at least twice the global average (Houghton and Woodwell 1989). An increase in temperature would shift the 10 deg. C. July isotherm higher in latitude and altitude. If temperatures do increase and moisture is not limiting, tree line may advance in latitude and altitude at a faster rate, or advance where it previously was limited by climate. Previous studies of

tree line in other areas in Gates of the Arctic have shown stable to advancing tree lines (Densmore 1980, Goldstein 1981, Odasz 1983, Cooper 1986, Lev 1987).

White spruce at tree line on the south slope of the Brooks Range and isolated clusters of balsam poplar (*Populus balsamifera*, L.) trees on the north slope commonly reproduce by vegetative means only (Lev 1987, Edwards and Dunwiddie 1985). Increased temperature may allow trees to flower and set viable seed. Migration rates could increase dramatically because seed dispersal distances are far greater than branch or root vegetative reproduction dispersal distances.

Marshall's Historical Records

The Robert Marshall Papers, archived at the Bancroft Library, U/Cal/Berkeley, contain ecological observations and tree growth data that Marshall collected on field trips. Marshall kept detailed field journals, including time and distance records and descriptions of where data were collected. The data include various ecological observations in addition to increment core tracings and diameter distribution and stocking information.

Marshall collected tree growth and sample plot information at and "below" tree line. He hypothesized tree growth to be limited by moisture, solar radiation, or temperature, and that tree line was not exclusively constrained by climate. Rather, he thought spruce trees may not have had sufficient time since the last glaciation to migrate to a climate controlled tree line.

Marshall attempted to advance tree line by planting white spruce seed plots beyond tree line (Marshall 1970). Paired plots were planted in 3 drainages, Grizzly, Kinnorutin and Baronland Creeks (located in Gates of the Arctic NP), to see if seeds would germinate and grow. Seed was sown on mineral soil (all vegetation removed) on one plot and on existing vegetation on a paired plot. For example, the 1930 Grizzly Creek planting (about 12 miles north of tree line) used

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areas except for some recreational areas used for picnicking and group activities.

I saw heathlands as well as hardwood and conifer forests. The heathlands and other nonforested areas are used extensively for sheep grazing. The forested areas are managed for timber production as well as esthetic purposes. Intensive forest management is expected in most areas and there are as many as 8 thinnings prior to final stand harvest. Forest composition has changed a great deal over the years, with Norway spruce commonly planted in areas where it is not native. North American species are represented, particularly Douglas-fir.

I had the opportunity to see forest management practices in Great Britain, ranging from southern England to Scotland. Great Britain originally was 90 percent forested, a percentage now down to 10. In addition to the native Scots pine, a large number of non-native species have been planted. The most common are from North America: Sitka spruce, Douglas-fir, lodgepole pine, and noble fir. There is some effort by the British Forestry Commission to increase the amount of land containing forest, with an emphasis on plantations. This has some public support, but a lot of

opposition too. Many people apparently prefer a more "open" landscape that is traditionally used for grazing. Reprints of the following two papers are available from Peterson at NPS/CPSU; College of Forest Resources, AR-10; University of Washington, Seattle, WA 98195.

"High elevation tree growth trends in the Sierra Nevada, California, USA," by David L. Peterson, Michael J. Arbaugh, and Lindsay J. Robinson, IN *Proceedings of the International Symposium on Tree Rings and the Environment*. University of Lund, Sweden, 1990.

"Growth trends of whitebark pine and lodgepole pine in a subalpine Sierra Nevada forest, California, USA," by David L. Peterson, Michael J. Arbaugh, Lindsay J. Robinson, and Berg R. Derderian, *Arctic and Alpine Research*, Vol. 22, No. 3, 233-243.

* * *

Dave Parsons, Research Scientist at Sequoia/Kings Canyon NPs, attended the international workshop "Earth System Responses to Global Change - Northern and Southern Hemisphere Contrasts" in La Serena, Chile Nov. 30-Dec. 4, 1990. Highlights of his report will appear in the Summer issue Notes From Abroad.

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seed collected approximately 4 miles south of tree line. Marshall suggested that if the seeds germinated and grew, he was advancing tree line by about 3000 years (based on the estimated 50 years to reach seed bearing age and a seed dispersal distance of 1000 to 1200 feet, roughly a migration rate of one mile in 250 years).

The Grizzly Creek planting site was revisited in 1938 by Marshall and no sign of seed germination was found. Sam Wright visited the Kinnorutin Creek and Barrenland Creek sites in August 1966 and again found no sign of trees (Wright 1969, 1973, 1988). A likely explanation is that the seed origin was inappropriate (Minnesota and Michigan) and seed viability was unknown for 2 of the 3 seed sources. The seed also may have been sown above climate controlled tree line.

The Barrenland Creek planting site was revisited by Sam and Billie Wright in 1968. They obtained 100 4-year-old white spruce seedlings from Dr. Leslie Viereck at the Forestry Sciences Lab in Fairbanks (Wright 1973, 1988) and planted them in one of Marshall's original Barrenland Creek plots. Sam Wright revisited the planting site in August 1989 and found 5 living seedlings, approximately 2 inches taller than at planting (S. Wright personal communication, Wright 1988). That there were any surviving seedlings after 21 years indicates the potential for trees to survive north of current tree line (the planting site is approximately 3 miles north of current tree line). That the trees were essentially the same size as at planting indicates a physiological limitation on photosynthesis. Wright (1988) ends a chapter entitled "Tree Planting" with the following:

"At present, in the arctic wilderness north of timberline, there is now a small grove of seedlings which have jumped three thousand years."

Tree Line Sample Locations

Marshall provided detailed descriptions of tree line locations where he extracted tree cores. Figure 1 shows 6 of Marshall's tree line sites chosen for this study.

Data Collection

For the 1990 field work, tree line sampling sites were located from a helicopter and by hiking. The helicopter was used to hover at low altitude and circle up drainages beyond tree line to help insure that the northernmost trees were located. Hiking from both the north and south helped insure that trees hidden by alder and willow brush were located.

Once located, the tree line position was recorded on topographic maps and photographs of trees were taken. Approximately 20 trees, 5 cm or larger at 1.5 m above the base, were cored at each site. Cores were extracted at the base and at 1.5 m height, stored in straws, and labeled for later measurement. The increment cores are currently being measured and analyzed; results will be published upon completion.

Management Implications

Baseline tree growth and tree line location data will help advance our understanding of a unique resource, the forest-tundra ecotone. It will also be important for monitoring future climate-induced tree growth and migration changes. Current and recent past white spruce demographics will be essential for interpreting response to recent past climate and for predicting possible future changes. Marshall's descriptions of tree line position in the 1930s provide one baseline for



Looking north at the northernmost trees on Loon Creek.

comparison. The data collected in the summer of 1990 will provide a current baseline for comparison.

Tree data may be useful as part of the international effort to study global change. The importance of arctic areas for global change research is becoming recognized. Regional assessments and studies can be coordinated and correlated through tree line work such as this, and through work planned in the Noatak National Preserve to the west of Gates of the Arctic. Predictions of tree growth and tree line migration response to future climate scenarios throughout the region may be possible.

Tree line information may be useful for park specific or regional retrospective analyses and future resource management interpretative efforts. The potential impact on wildlife that show preference for forested versus brush/tundra areas exemplifies the use of tree line location information. In the near future, sparsely forested areas at the south of tree line may become heavily forested, thereby enlarging habitat ranges for northern woodland wildlife species.

Future Research and Monitoring

The acquisition of a portable Global Positioning Sys-

tem (GPS) would allow mapping of tree line and other features of the park in 3 dimensions and provide precise measurements for tree line advances or retreats. Because tree core information already has been collected, this would involve revisiting the sites with a portable GPS unit, standing next to each tree or feature of interest, and locking in the position with a GPS receiver. A single GPS unit will determine position within approximately 15 meters, multiple units within one meter. The accuracy of GPS equipment depends on the grade of the satellite signals available for civilian use at a given time (controlled by the Department of Defense and called selective availability.)

Many factors acting separately or synergistically have been hypothesized as controlling tree line location. Identifying the physiological limitation(s) for sexual reproduction, seed germination, seedling survival, and tree growth and maturation at sites varying in slope, aspect, drainage, etc., is critical for modeling the response of tree line in specific drainages and regions to climate change.

The tree line environment is subject to natural cycles on various time scales and to anthropogenic influences that may confound the effect of global warming. Determining the effect of rising CO₂ levels from rising temperature levels may prove challenging. If temperature is a critical factor, tree line may advance beyond the continental divide to the north slope, reducing tundra areas to the higher elevations of the continental divide.

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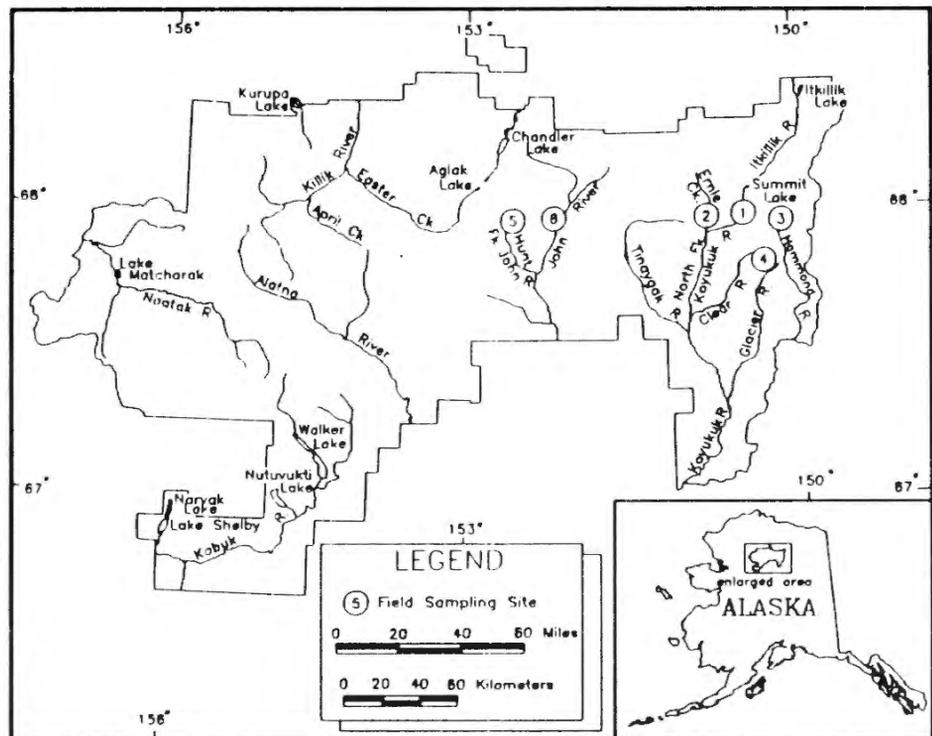


Figure 1. Map of Gates of the Arctic National Park and Preserve showing the position of tree line study sites in the park. 1) North Fork of the Koyukuk River, 2) Ernie Creek, 3) Hammond River, 4) Clear River, 5) Loon Creek and 6) John River.

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New Plant Species Discovered in Guadalupe Mountains National Park



A "group picture" of the new find - *Viola guadalupensis*, clinging to a limestone cliff in Guadalupe Mountains NP.