PARK SCIENCE

A RESOURCE MANAGEMENT BULLETIN

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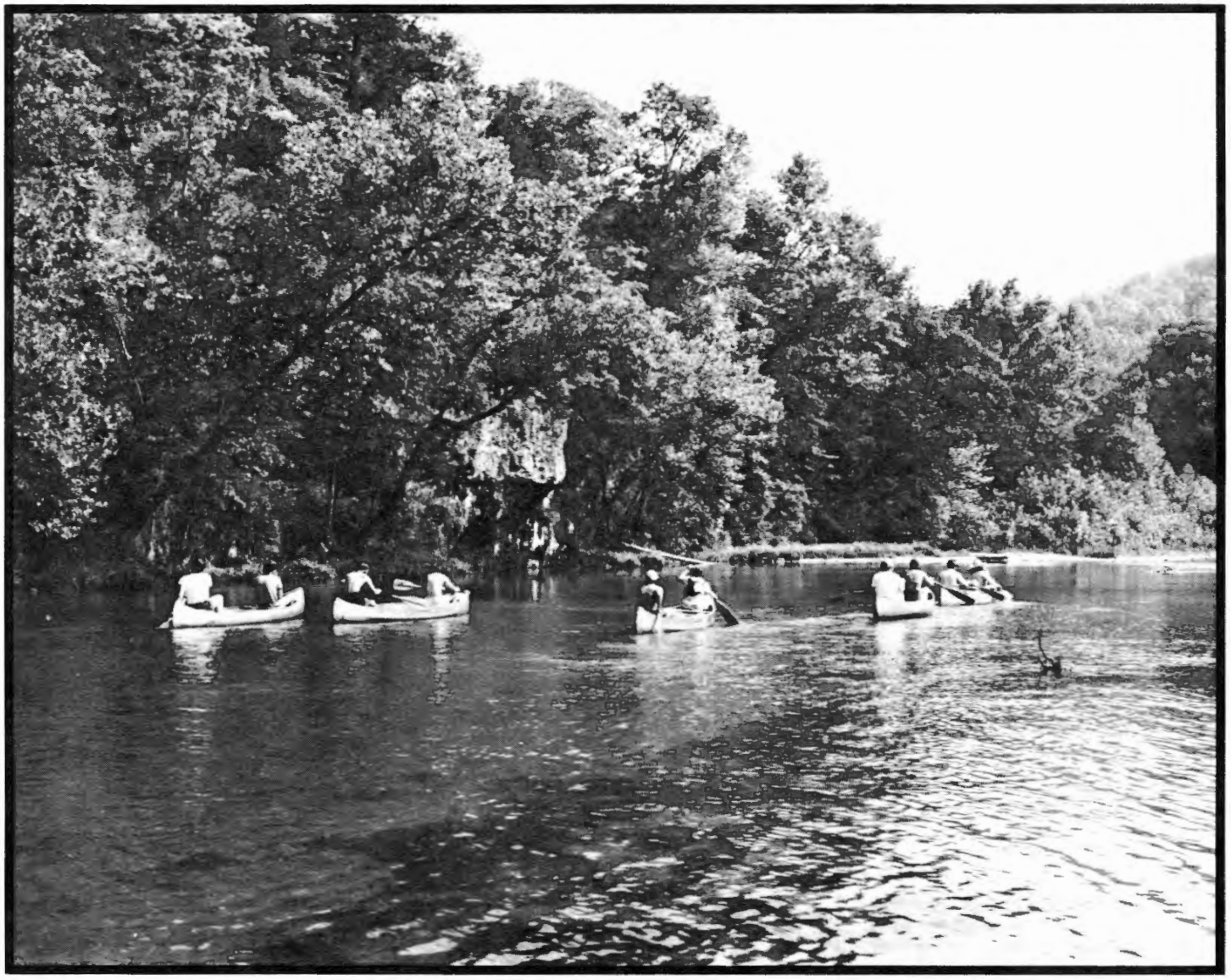

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A report to park managers of recent and ongoing research in parks with emphasis on its implications for planning and management

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Cover:
Canoeists using the Ozark National Scenic Riverways (the Current and Jack's Fork Rivers) are the subject of intensive sociological research. (Story page 3)

Newspapers come and go, television news programming expands, computer networks spread, grow and tighten into tough new teguments of information exchange – and in all this upheaving sea of human communication, small craft like Park Science *seek their proper levels and paths.*

Probably not the most notable journalistic event of 1984, but certainly a significant one in this editor's world, was the first meeting in February of the Park Science *editorial board. For the past two years, the board members had been receiving by mail, reading, and passing on all the material that went into each issue of* Park Science. *Editorial guidelines had been approved and disseminated to all NPS Regions through the Regional Chief Scientist. Many a sticky problem had been resolved via the telephone. But never had the group come together with an agenda that demanded definition of the overall role of* Park Science, *its article length limits, its policy with regard to letters to the editor, its tolerance for humor, its distribution practices, its editorial board composition and terms.*

The results have been communicated to the field in the form of a memo from the editor. Basically, the message is that Park Science *will continue to furnish as wide as possible a sampling of the various scientific research projects going on in the field, do so in short, concise style, in layman's terminology, and in the timeliest possible fashion.*

The board noted the usefulness of Park Science *as a tool for getting new findings into the mainstream of management, even while the more arduous route of scientific publication is grinding along. One of our board members, Bill Lukens, also serves on the editorial board for the NPS Monograph Series, now based in the Southeast Region. From his position as a member of both boards, Bill offered the view that Park Science's rapid dissemination – "keeping everyone up to date on what's going on" – satisfies a real management need in the System. After attending a Monograph board meeting, immediately following the* Park Science *gathering, he wrote that the two programs, together, amounted to "a very good, albeit lean publication progam dealing with the natural resources and the visitors' relationship to them."*

In the interests of keeping the distribution list spare and sharply targeted, a notice will shortly be included in all "single copies" on the list, asking recipients to re-request inclusion. If no reply is received, the names will be dropped.

The editor was grateful and, frankly, somewhat surprised at the level of interest and commitment shown by the hard-working board members, all of whom have their own demanding jobs with the Service. The energy and enthusiasm they displayed is a priceless boon to an editor and to the System we are all trying to serve.

Let this editorial also serve as an invitation to readers to contribute – articles, news notes, letters. It's your thoughts and feelings as well as the results of your research and applications that make up Park Science's *raison détre.*

RUSSELL E. DICKENSON, Director
National Park Service
U.S. Department of the Interior

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In the Next Issue:
"An Ecological Study of the Chellberg Forest at Indiana Dunes National Lakeshore," "Problem Analysis of Denali Caribou Herd Decline," "A Study of Cave Temperatures at Lava Bed NM," "Oil Spill Containment Training at Gateway NRA," "How RMPs Help Identify Baseline Information Needs in Midwest Region," and a Superintendent's Corner from Joe Kennedy of Dinosaur NM.

Combined Social/Biological Research Works Both in Park and in Court

By Kenneth Chilman and Dave Foster

Social research in national parks is an often discussed, but frequently confusing topic for park managers. This may be because social scientists use a specialized language not familiar to persons trained in natural resources management. It also may be because field methods for social sciences in park and wildland settings are relatively new and evolving.

An unusual social research program has been conducted at Ozark National Scenic Riverways (OZAR) in Missouri over the past 14 years. Its purposes were to identify and conduct visitor studies needed for recreational carrying capacity determination in a park setting. The program is unusual, first because of the long-term continuing research cooperation between a university social science researcher and the OZAR staff. This occurred because of OZAR's need and interest in having social research conducted, and the researcher's proximity (approximately 150 miles) and interest in working in a park setting. Second, the researcher had an unusual combination of natural science and social science training, and several years of experience in wildland resources management. This combination facilitated discussion of research needs, and interpretation of research results that would aid management. And, third, the social research at OZAR is unusual in aggressively seeking ways to obtain social science information in the face of severe budget constraints.

One hundred and forty miles of the Current and Jack's Fork rivers were designated as Ozark National Scenic Riverways in 1964. By 1970, rapidly increasing numbers of canoe floaters began to cause management concerns about recreational carrying capacities and effects of recreational use on OZAR natural environments. A balanced program of biological and social research addressing the carrying capacity concerns was designed by OZAR biologist Leo Marnell (now at Glacier NP) to gather data in the period 1972-1977. The rationale for the program and the search methods and results were reported in a 139-page summary publication *River Recreation Research at Ozark National Scenic Riverways 1970-1977* available from OZAR headquarters, P.O. Box 490, Van Buren, Missouri, 63965.

The social inputs needed for the program were identified by the participating social researcher through intensive discussions with OZAR staff, managers of other wildland areas, and other social researchers. Field methods for studies of wildland visitors were new, developing, and scattered. The concept of a series of visitor studies in one park, integrated with other research considerations, was unique.

The studies selected for implementation followed from a series of questions relating to the canoeist increases. A central concern was how many canoeists actually were using the river. An innovative time-lapse photography program was developed by Marnell to count canoes on various parts of the riverways; the counts were done in 1972 thru 1975, and again in 1977 to establish trend data. Several visitor interview studies were conducted concurrently. The first sought information about "where did first-time visitors learn about OZAR" and "what were their visit expectations." A series of "perceptions of crowding" studies began in 1972, and continued in 1977 and 1979, again for trend data.

***HOW MANY PADDLERS** does it take to "fill up a river" to the quality capacity level? At OZAR they decided to find out.*

Research on management alternatives began with studying the characteristics of large group (over 20 canoes) floaters, and implications of limiting group size. Another study investigated the effects of increasing numbers of canoeists on johnboat fishermen. (Johnboats are large, flat bottom, motorized boats). Characteristics of private canoe owners were surveyed. Safety concerns were explored through an examination of accident records and river conditions. Finally, a study was done to determine perceptions of comparable river floating opportunities in the region, and reasons for canoeists choosing OZAR.

Individually, these studies were rather small-scale and unsophisticated, although they used state-of-the-art social science research methods. But collectively, they began to form a data base for OZAR managers to use with biological research data (patterns of ecological site impacts, water quality studies, fisheries and wildlife studies, cave studies) for day-to-day decision making.

Then, two things happened. In 1978, research activities were put on hold during planning activities for a new master plan. But more importantly, legal action was initiated to prevent canoe rental businesses without NPS concession permits from operating on the riverways. OZAR managers had to establish river use capacities in order to show that control of numbers of canoes rented (approximately 87% of total canoe use) was necessary. At the federal court hearing in St. Louis in 1982, the research data played an important part. First, the 1978 summary research report provided strong evidence of the serious NPS efforts to develop a data base for decisions. Second, both the biological and social research documented the needs for maintaining use with certain constraining conditions.

Following appeals and some legal complications of the federal court's ruling favorable to NPS, research activities have been resumed. Some canoe counting was done in summer 1983 to learn the effects of restricting unlicensed canoe rentals (an estimated 40% of rental canoes available), and a use monitoring system was designed. As further changes occur in the recreation management situation at OZAR, new subjects for research and monitoring will be identified.

The question of OZAR recreational carrying capacity has not yet been answered definitively. The complexities of the OZAR river management situation have afforded opportunity for examination of various carrying capacity strategies over a time period of several years. We believe we have identified a carrying capacity strategy that will work for the OZAR river use plan to be developed in the next few months. That strategy also involves continuing research on monitoring the various aspects of carrying capacity for management purposes.

The concept of designing a park research program to combine social and biological inputs appears to have been the real key to utility of the research information. For OZAR, the data base obtained from the research program has been used frequently in daily decision-making, in planning activities, and in federal court. Although difficult to measure, the utility of the data base for daily decisions is probably its greatest advantage. For the cooperating researcher, the long-term series of studies has been an exceptional opportunity to learn more about the kinds of social information that managers need and how to devise ways to obtain them.

Chilman is Associate Professor, Department of Forestry, Southern Illinois University at Carbondale; Foster is Research Biologist, Ozark National Scenic Riverways.

Consortium Turns Flood Disaster Into Scientific Learning Experience

By Henry E. McCutchen
and David R. Stevens

On July 15, 1982, the Lawn Lake dam, a privately owned reservoir within Rocky Mountain National Park, failed, sending a 700-acre-feet torrent of water down the Roaring River into Fall River and into the town of Estes Park. The flood caused three fatalities and over $30 million damage to public and private property. The site was later declared a major disaster area by the President of the United States.

Impacts of the flood on the Park's natural resources were numerous. Lawn Lake was partially drained. About 8 miles of aquatic ecosystems and the adjacent riparian and other plant communities were inundated. The river channels were scoured to bedrock with cuts up to 50 feet deep. A 42-acre debris fan was deposited, damming the Fall River and creating a new lake.

Although the event was tragic in terms of loss of life and property, scientists in the area saw the site as a unique opportunity for research. Rarely does a high elevation perturbation of this magnitude and type, in an easily accessible area and protected in a national park, occur.

In May 1983, through the interest of Dr. Gustav Swanson of Colorado State University, the Lawn Lake Flood Research Consortium was formed. Its purpose is to share knowledge and resources in the course of conducting research on the physical, biotic and social impacts of the flood. The consortium is multidisciplinary, with about 15 scientists participating. Contributing individuals, agencies and colleges include: The National Park Service, Rocky Mountain National Park, Rocky Mountain Regional Office (via Jim Reid, Regional Chief Scientist), and Water Resource Field Support Laboratory at Fort Collins (via Dr. Raymond Herrmann, Director); Colorado State University; the University of Colorado; the Institute of Arctic and Alpine Research; the University of Northern Colorado; the U.S. Geological Survey; and the Bureau of Reclamation.

The park is seeking additional funding to meet the needs of an intensive 3-year base line research program. This will be fcllowed by a more limited long-term monitoring program. The research has basic and applied implications; data for interpretation and management direction will be provided relating to the natural recovery of high elevation ecosystems. The research also has implications as to mitigation and restoration of mining impacts, and in the development of predictive models of dam breaks, their impact and recovery rates. Such information applies to several hundred other high elevation dams in Colorado.

Stevens is the Research Biologist at Rocky Mountain NP; McCutchen is the Park Ecologist and Coordinator of the Consortium.

Revegetation Investigation

By Mark G. Noble
and Kenneth A. Barrick

The recovery of disturbed areas in the tundra environment has received much attention at Rocky Mountain NP, where strong mountain winds are an important factor in the process of revegetation. We have begun related work on the colonization of wind-destabilized flood deposits in an upper montane environment just a short distance below the tundra . . . an opportunity that arose as a consequence of the Lawn Lake Flood.

When the dam containing Lawn Lake failed, about 986,400 m^3 of water descended a mountain valley for 7.3 km with an average fall of 99.6 m in each kilometer. At the base of this valley an extensive outwash fan was deposited. Because the energy of the flood waters decreased rapidly with the abrupt reduction in slope, large boulders were deposited at the beginning of the fan while fine sands were deposited much farther downstream. Stream channel modification and the burial of the vegetation are two important consequences of this major flood.

Our study of the outwash is focused on four sites which range in stability from very little wind-related surface change to continuous deposition and shifting of wind-transported material. The revegetation rates differ greatly among these surfaces – the number of species and cover of vegetation are over 2.5 times greater on the most stable site compared with the others. Thirty-five species have become established among all of the sites after one full growing season. While 25 of these occur on the most stable site, only three are present where stability is least. Even greater disparities exist among density values. Available moisture, nutrient status, and proximity to a seed source are factors that can influence revegetation at these sites. However, the destabilizing effect of wind is clearly the most important factor at this time. Colonization and establishment have been greatly impeded where the outwash is subject to continuous microsite adjustment as particles are shifted by the wind.

A potential impact that might alter the rate and direction of succession is trampling by park visitors. The outwash fan is popular with visitors and readily accessible from the road. Although trampling is not a serious problem now, management of human impacts might be necessary if succession is to proceed unimpeded. On the other hand, the small extent of these unstable sites provides them with a scarcity value as a type of environmental surface. These early successional stages could be prolonged on the most unstable sites as part of a management strategy to maintain the current interpretive opportunities for future park visitors. It is evident that, on unsheltered sites in the upper montane, the erosive and destabilizing effects of the wind can be as great as in the tundra environment.

Noble and Barrick are scientists at the University of Colorado's Mountain Research Station.

Bird Population Effects

By Ronald A. Ryder

In 1983 two study sites were established, each 200 x 600 m. One was severely disturbed by the flood; a second area (the control), upstream on Fall River, was undisturbed. Boundaries of both areas were marked with stakes, as were random vegetation sampling points. Overstory and understory vegetation densities and structure were sampled using techniques described by James and Shugart (1970).

Six visits were made to the sites between Aug. 28 and Oct. 15 and terrestrial vertebrates noted. Fifty avian species, four mammals and one snake were seen. Breeding birds left the area by late August. Four birds were banded. Late nesting of Western Wood Pewee was observed.

Results of 11 breeding bird surveys of the "treated" area were obtained from Debra Bangs, who noted 16 species, 62 territorial males (194 territorial males/100 A). Her data are being compared with ours and those we summarized from five summers' counts (1976-1980) made in similar habitat in Moraine Park by Paula L. Hansley.

One winter survey of the plots was made Dec. 17, 1983. Regular censuses resumed in April 1984.

Ryder is on the faculty of the Department of Fishery and Wildlife Biolcgy, Colorado State University.

Dam Break Modeling Done

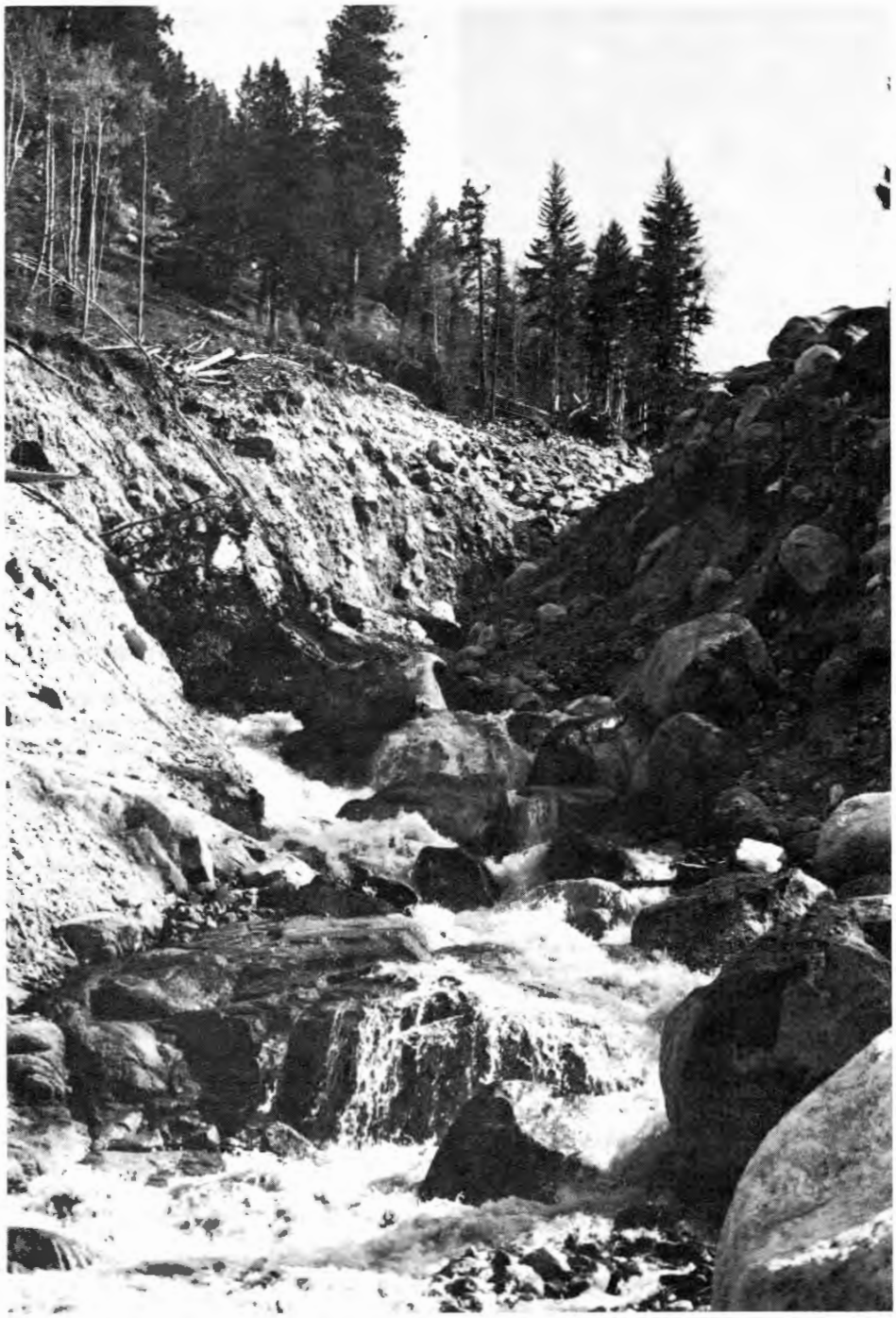
By Robert D. Jarrett and John E. Costa

On July 15, 1982, Lawn Lake Dam, a 26-foot high earthfill irrigation dam built in 1902 in Rocky Mountain National Park, failed due to piping. Cascade Dam, downstream on Roaring River from Lawn Lake Dam, subsequently failed as a result of the flood. Various methods were used to compute indirectly the peak discharge, attenuation of flow, and flood traveltime. Channel cross sections were surveyed and other pertinent hydrologic data collected.

Immediately downstream from Lawn Lake Dam the flood was a wall of water 25 to 30 feet high, but as the flood wave progressed downstream, it attenuated so that approximately 20 minutes separated the leading edge and the flood peak. The channel slope ranged from approximately 0.4 to more than 20 percent. The streambed was scoured, as much as 50 feet deep and 300 feet wide, in the steepest 4.5-mile section of the Roaring River. All flood waters eventually were stored in Lake Estes 12.7 miles downstream from Lawn Lake.

A version of the National Weather Service dam break flood model was used to: (1) Evaluate the model's performance on steep-gradient streams; (2) provide supplemental hydrologic information for these dam failures; and (3) evaluate various scenarios of dam-breach development and the probable impact of the failure of Cascade Dam. Satisfactory results were obtained, but not without significant difficulties in getting the model to run properly. To calibrate the model, Manning n-values between 0.1 and 0.2 were required, and subcritical flow was assumed.

Jarrett is a Hydrologist and Costa is a Research Hydrologist for the U.S. Geological Survey, Denver.



Lawn Lake Flood in Rocky Mountain National Park cut the channel of the Roaring River as much as 50 feet.

Geomorphology, Sediment Transport, and Hydrology

By Colin Thorne, John Pitlick, David Biedenharn, Stanley Schumm, Samira Rais, Jeff Bradley, Mike Harvey, Lyle Zevenbergen, and Mark Siegenthaler

We have been studying the Fall River intensively since the Lawn Lake dam disaster. Work has been concentrated on the Horseshoe Park reach because the sedimentary impact of the flood was greatest there.

The 1983 results are preliminary and data reduction is incomplete. However, an initial examination of the data has yielded some interesting information and allowed some immediate conclusions. To present these findings, each project is briefly reviewed in turn.

Stage-Discharge Curve for Gauging Station

Discharge, the most important single flow parameter in any river study, is difficult to estimate and time-consuming to measure. Therefore, the first step in the study was to locate a stable section and establish a relationship between water surface elevation (stage) and flow rate (discharge).

At Horseshoe Park the best stable section is at the Trail Ridge Road (Highway 34) bridge . . . a concrete culvert structure. A stage board and continuous recorder have been installed and a stage-discharge curve developed by stream gauging. At present this is the only gauging station on the Fall River.

Mapping and Surveying of Fall River Channel

The channel of the Fall River in Horseshoe Park has been monitored throughout the snowmelt hydrograph for 1983. The data show remarkable differences in channel response to the influx of sediment in different reaches.

In reach 1, the uppermost reach studied, the channel is braided. The original, meandering channel of the Fall River is completely buried in alluvial fan sediment. Deposition, mostly of gravel and cobbles, is spread over a wide area on the fan and consists of filling and tearing away of distributary channels together with erosion of new distributaries.

In reach 2, adjacent downstream, the sinuous channel has changed little from its pre-flood condition. The channel's lateral stability can be attributed to almost nonerodible banks of cohesive meander belt deposits bound by dense vegetation.

In complete contrast, the highly sinuous, meandering channel in Reach 3, further downstream, has not been able to transport the sediment input from upstream. The channel here has been filled with sand, leading to a complete loss of channel capacity. Downstream in Reach 4, little has changed so far. The sediment wave in Reach 3 has not yet arrived, although it will do so early spring runoff 1984.

Measurements of Bedload and Suspended Load

Direct measurements at two sites explain in process terms the results of the channel surveys. At the upstream site (Reach 2), high rates of transport have been recorded all through the hydrograph. Unsteadiness is evident, probably associated with sporadic inputs of sediment by slump failures in the ravines on the Roaring River. These unstable slopes could provide significant sediment supply for many years to come.

Transport rates at the downstream site (Reach 4) were very much lower, explaining the sediment accumulation in Reach 3. The "wave" of sediment is moving slowly downstream, and transport rates did begin to increase at the end of the snowmelt hydrograph.

No sediment comes from the Fall River upstream of Horseshoe Park because the new lake, caused by ponding behind the alluvial fan, traps all incoming sediment. This simplifies the task of isolating sediment sources that are confined to the Roaring River basin.

Bed Armoring

The size of bed material has been monitored in Reach 1. Transport of gravel and coarser bed material is strongly influenced by selective transport of finer grains, leaving a coarsening surface layer. This pro-

Flood Disaster (Continued)

A 42 acre alluvial fan, *deposited by the Lawn Lake Flood in Rocky Mountain National Park, contained an estimated 10 million cubic feet of material.*

cess is called armoring. In the lack of a coarse sediment input, armoring leads eventually to the formation of an immobile, coarse surface layer – a pavement. If there is a continuing supply of sediment from upstream, a coarse, mobile bed forms but paving does not occur. Armoring and paving have important effects on channel development in rivers with coarse beds and must be taken into account when modeling channel development.

The bed material data show progressive armoring throughout the reach. Initially the sediments were almost homogeneous with depth, but quickly a coarser layer developed. Upstream of the Roaring River-Fall River confluence, armoring progressed to paving because of the lack of sediment supply from the new lake. At the end of the summer an immobile paved bed had developed. Downstream of the confluence an armored, mobile bed developed, but phases of coarsening were interspersed by periods of fining, associated with large unsteady inputs of sediment from the Roaring River. Overall, though, the armoring trend was clear.

Bend Flow Measurements

Intensive studies of the flow and sedimentry processes in consecutive bends in the meandering Reach 4 are being made. The measurements show a "classic" flow pattern of primary and secondary velocities.

Secondary flow is dominated by a skew-induced cell taking surface water towards the outer bank, where there is a small cell of reverse rotation. At the inner bank, flow over the point bar is radially outwards.

The intent of this study is to continue these bend flow measurements in subsequent runoff seasons as the sediment stored in Reach 3 moves into Reach 4. Very few data sets for such situations exist even though bend response to high sediment supply is a topic of some interest.

Summary

The research at Horseshoe Park has shown the response of the Fall River to be variable and complex. The river is competent to transport the material being supplied and thus has the power to change its channel markedly. The intensive data being gathered will allow quantification of the response mechanism and the flow and sediment processes involved. The site is unique and deserves detailed, extensive study for the advancement of both pure and applied science.

Thorne, Schumm and Harvey are with the faculty at Colorado State University. Pitlick, Rau, Zevenbergen, Biedenharn, Bradley and Siegenthaler are graduate students.

Amphibian Recolonization

By C. Richard Tracy and Linda Zimmerman

The dimensions of this overall project include: (a) A survey of the possible amphibians in the Lawn Lake area and their breeding requirements: (b) A time-dependent survey of the percentage of river course (including all backwaters and ponds) that is usable for amphibian breeding; (c) A time-dependent survey of the water chemistry (especially with respect to heavy metals) of the water course; and (d) Bioassays of the potential of water in the Lawn Lake system to support successful reproduction.

We have begun a survey of the waters in the Lawn Lake system for heavy metals and have found dramatic increases in the amount of iron in the waters of the alluvial fan in Horseshoe Park. This is especially true in the backwaters that move slowly and accumulate a characteristic "surface scum." We have not completed all analyses of water sampled in 1983, but those analyses will be completed before the 1984 season. In 1984, we hope to expand the chemicals sampled to include O_2CO_2, Nitrites, Nitrates, Ammonia, pH, and other standard indicators of water quality.

We have initiated bioassays of the potential of water from various parts of the Lawn Lake system to sustain healthy survivorship in the aquatic eggs and larvae of amphibians. These laboratory experiments include preparing serial dilutions of water taken from the Lawn Lake system (along with a control), and testing for percent mortality in eggs and tadpoles raised in these sample waters. The experiments on waters collected in 1983 were completed in spring 1984. The problems encountered so far have centered around the difficulty of inducing oviposition in amphibians (of any species) in fall. Since our project could not begin until fall, we have had problems getting viable material for the bioassays. In 1984 we should not have any problems completing the bioassays during the normal breeding season for amphibians that can be found in the Lawn Lake system.

In 1984 we will establish transects on experimental and control stretches of stream, which will be censused regularly to get a long-term time course of recolonization by amphibians. In addition, we will be collecting data on the abiotic factors of the environment that can be correlated to the pattern of recolonization.

Our findings in 1983 suggested that water in the alluvial fan created by the Lawn Lake flood was different from that of older stream beds. This difference in water quality could inhibit successful invasion of the backwaters of the alluvial fan area by amphibians. We have reoriented and expanded our original research to investigate these possibilities.

Clearly if our research finds that chemical changes in the water quality of the Lawn Lake system can inhibit successful reproduction in amphibians, these results would have profound implications that go beyond the scope of our current project. It is also important that permanent, long-term transects are established before the natural time-dependent changes that occur in impacted ecosystems progress beyond points that should be documented in order to understand the natural succession of this flooded system.

Tracy is on the faculty of the Department of Zoology and Entomology, Colorado State University. Zimmerman is a graduate student.

Effects on Macroinvertebrates

By Nancy Jacobson

Evaluation of longitudinal effects of a single large flood wave on the macroinvertebrates was conducted through a summer season of 1983. Control sites were established and related chemical, physical and plant matter measurements and observations were made. The kick sampling method was used.

Roaring River

During low flows in the ice-covered Roaring River in April 1983, nine months after the flood, high conductivity and high iron levels were found. Anaerobic conditions, high turbidity, and suspended sediment were presumably due to the production of ferric hydroxide. Suspended sediment, oxygen depletion and fine bed material are unfavorable for the macroinvertebrate populations in winter.

Flood Disaster (Continued)

Snow melt flushed the high ionic concentrations and much sediment downstream. Macroinvertebrate density at a midway point on the Roaring River was only 0.3 percent of the density at a control site on the Ypsilon, a tributary stream, during high flow. This was due to pulsar high suspended sediment levels and a mobile bed and to a largely drifting population. In July a more stable armor layer was created on the riverbed. By August algae but no moss had re-established. The population rose to 3.2 percent of that at the control with a much higher percentage representation of Chironomidae (48.2% versus 4.6%). Drift decreased from 100 percent to 19.5 percent.

Sites upstream of this midway point on the Roaring River suffer less severe erosion and densities were slightly higher. The site below the confluence of the control stream showed a mixture of the densities and biotypes of the two streams but, by the lowest site on the Roaring River, the densities and biotypes were more typical of the Roaring River.

In general at flood-disturbed sites, macroinvertebrate density decreased during peak flow and then increased after peak flow more radically than non-disturbed sites.

Though diversity was not significantly different at flood-disturbed sites, the equitability component was higher and the species richness component was lower. However, both of these indices may be obscured by sample size. In the literature diversity as well as density are reported to decrease following floods.

The primary sources of macroinvertebrate repopulation during the period observed seem to be downstream drift from tributaries and adult egg-laying in the Roaring River, with larval upstream migration playing less, if any, role.

Until some degree of bank stabilization occurs, these trends can be expected to continue.

Fall River

Fall River, in the small section upstream of the confluence with the Roaring River and below the flood-formed lake, returned to a density equal to its control by early July because of the flushing of alluvial fan deposits and the construction of a stable armor.

The site below the confluence formed a less stable armor on top of a mobile bed, like that formed in the Roaring River, due to continuous pulses of new sediment from the Roaring River.

Macroinvertebrate densities, types and trends were similar at this site to observations in the Roaring River.

The downstream site in the Fall River initially served as a catch area for macroinvertebrates transported downstream during the flood. During the 1983 season, substrate at this site remained mobile as sediment from the snowmelt period, in the Roaring River, failed to flush through; gradients are very gentle in this section of Fall River. Consequently, macroinvertebrate densities continuously decreased and percentage drift continuously increased.

Though the downstream Fall River site was a baseline site for three past studies, it is difficult to draw conclusions about biotype because numbers are very small and natural variability is very high. Percentage representation of Chironomidae did not increase here as the season progressed as it did at other flood-disturbed sites.

Jacobson is a former graduate student at Colorado State University and seasonal research technican at Rocky Mountain National Park.

Editor's Note:
Because this project represents such an imaginative exploitation of disaster and wide scientific interest, directed toward management and interpretation of a unique situation, more than the usual space has been given to its coverage.

Park visitors appear tiny *in relation to the 42-acre debris fan of the Lawn Lake Flood in Rocky Mountain National Park.*

NPS Science Publications Transferred to SE Region

Beginning this fiscal year 1984, the NPS Servicewide Science Publications program was transferred from WASO to the Southeast Regional Office in Atlanta, with Jim Wood, technical writer/editor for the Southeast Region, in charge.

One function of the program is to produce high quality research publications in the Service's Scientific Monograph Series. An NPS Natural Resources Publications Review Board was established to assist Wood in reviewing manuscripts submitted for this Series. The following professionals constitute the board: Joe Abrell, Chief of Operations, Acadia National Park; Bill Anderson, Regional Chief Scientist, National Capital Region; Brian Harry, Superintendent, Hawaii Group; Dennis Fenn, Regional Chief Scientist, Western Region; G. Jay Gogue, Regional Chief Scientist, Southeast Region; Doug Houston, Research Biologist, Olympic National Park; Bill Lukens, Superintendent, Padre Island National Seashore.

On March 6, 1984, a workshop of the NPS Natural Resources Publications Review Board was held in Atlanta to (1) review the history and background of the Servicewide Scientific Monograph Series, (2) establish new criteria and standards for the acceptance of manuscripts in the Series, (3) formulate new guidelines to authors, and (4) establish new procedures for the Board's review of manuscripts submitted for publication. The workshop resulted in numerous suggestions for improving both the quality and management of the Series. New revised guidelines to authors and review procedures for the Scientific Monograph Series now are available from Jim Wood through the NPS Science Publications Office, 75 Spring Street, S.W., Atlanta, GA 30303.

It has been brought to my attention that NPS scientists who publish the results of their research in the Servicewide Scientific Monograph Series may not be receiving proper consideration for such publication in their research Grade Evaluations.

I would like to stress that the Scientific Monograph Series is an important publication outlet of the National Park Service. Manuscripts published in the Scientific Monograph Series can have multi-regional, national, and international appeal. They can be valuable in informing the public of the important resource management concerns of the Service and of the "problem-solving" scientific research undertaken to guide the Service in fulfilling its mission.

I recommend that your scientists give consideration, as appropriate, to publications in the Scientific Monograph Series when evaluating individuals under the Research Grade Evaluation Program. The weighting applied to such publications must depend on the quality of the work as measured in terms of its scientific value and contribution, and as judged by the level of scientific peer review and acceptance that the publication has received.

Dick Briceland
Assoc. Dir. for Natural Resources, WASO

In addition to the Scientific Monograph Series, the NPS Science Publications Office will:

1. Provide editorial, design, layout, and printing services for the MAB Reference Series for Bisophere Reserves in the National Park System;
2. Compile, edit, and publish annual proceedings and transactions of park, regional, and Servicewide science conferences, meetings, symposia, etc.;
3. Provide editorial, design, layout, and printing services for "in-house" research publications (such as Research/Resources Management Reports, CPSU and park/laboratory unit reports, etc.) for the 10 NPS Regional Offices;
4. Provide general grammatical review and editorial assistance to Servicewide field scientists in the preparation of reports and articles intended for publication in outside professional scientific and technical journals.

Glacier Bay Affords Management Textbook Example of Interaction

Editor's Note:
The following unsolicited article was submitted to Park Science *by a former participant in the University of Washington NPS/CPSU as "partial payment of the debt I owe NPS" and with the hope that it will "at the very least convey my feelings of appreciation."*

By David O. Duggins

Glacier Bay National Park and Preserve (GBNPP) provides a unique opportunity to observe an ecosystem dominated by the dynamic ebb and flow of gigantic mountain and valley glaciers. Over the past 50 years, GBNPP has served as a field laboratory for scientists in such diverse disciplines as glaciology, plan ecology, and ethology. For example, early models relating to plant succession were derived in part from research along the 80 mile (200 year) path of glacial retreat. In fact it was this type of research that in the 1930's led the Ecological Society of America to lobby vehemently for the park's creation; the park's original mandate emphasizes its unique research values.

A large section of the park is, however, rarely observed by park visitors or researchers. Situated along the park's Gulf of Alaska boundary is a remote coastline, dominated by wave-swept headlands, high-energy sandy beaches, and deeply cut fjords. While physical disturbances such as violent winter storms and landslides are a common occurrence, this coastline has remained virtually untouched by man's frequently disturbing influence. This portion of GBNPP remains the only example of wave-exposed, outer coast habitat under the protection of park or preserve designation along the approximately 2000 miles between southern British Columbia and the northern Gulf of Alaska.

In the 1960s, two events occurred which led park biologists and resource managers to believe that the outer coast of GBNPP could undergo significant ecological change resulting directly from the activities of man. First was the discovery of a very large mineral deposit (nickel-copper) in the region. Under certain circumstances, mining is allowed in GBNPP; if developed, production levels from this deposit could reach 10,000 tons per day, and extend over about 30 years. In addition to potential biological impacts from the mining operation, a large community would have to be built to accommodate mine personnel and their families – all this in a remote natural area, rarely even visited by man.

The second potential human-generated disturbance event, virtually guaranteed to take place in this area, is very different in character. At the turn of the century, the northern sea otter *(Enhydra lutris)* was hunted by man to near extinction. Once common from northern Japan and the Aleutian Islands to Baja California, by the 1920s only small populations in central California and the Aleutian Islands remained. In the mid 1960s, a small number of otters (about 40) were transplanted from the Aleutians to an area just south of GBNPP. Since then, this southeast Alaskan population has grown and taken up residence within park boundaries. The elimination or re-introduction of sea otters has dramatic, wide-ranging, long-term, and predictable ramifications throughout the entire near-shore marine ecosystem. Thus, while otter reintroduction represents the "correction" of an earlier human disturbance, it will also produce major changes in the area.

Concern over these potential events led to establishment of a research program on the outer coast of GBNPP. The work involved scientists from the Universities of Alaska, Washington, Ohio, and Vermont, and included limnologists, fisheries and avian biologists, mammologists, geologists, terrestrial plant ecologists, and marine ecologists. As a group, our goal was to gather natural history and ecological information on resident organisms in order to 1) provide a basis from which to predict potential impacts of disturbance, and 2) provide a baseline against which to evaluate changes in the various biological communities in the event that a man-made disturbance took place.

The data gathered between 1973 and 1975 were published in a series of volumes entitled *The Dixon Harbor Biological Survey* (NPS, Juneau, AK). My own work, in the area of marine ecology, has continued until the present and constituted the majority of my PhD thesis (1980, University of Washington) and subsequent published journal articles. Cooperative Park Studies Units at the Universities of Alaska and Washington played a major role in the project.

My research was designed to address several questions relating to the communities of plants and animals found in the intertidal and shallow subtidal zones along wave-swept, rocky shorelines. I was particularly interested in 1) the biological factors determining the species assemblages observed, 2) the types and frequency of natural disturbance (biological and physical) in these communities, and 3) the response of the communities to disturbance.

The rationale behind this type of ecological approach is as follows. If we know how communities are organized biologically (for example, how predator-prey or competitive interations produce the community's patterns of distribution and abundance), then we may be able to predict how disturbance at some level in that organization will affect the community as a whole.

The methods we used to determine community structure are relatively straightforward and surprisingly powerful. On a very small scale, we (the scientists) create disturbances in a well-controlled manner and observe the community's response. We may remove or add a species or group of species, or we may remove all species and observe whether the community returns to its original configuration and how long it takes to do so. While time doesn't allow the manipulation of all possible species within a community, existing ecological literature and theory make predictions as to which organisms are likely to be most important, and this is where we begin.

For example, in the study area along GBNPP's western boundary, giant seaweeds (up to 130 feet long) called kelps are a common component of near-

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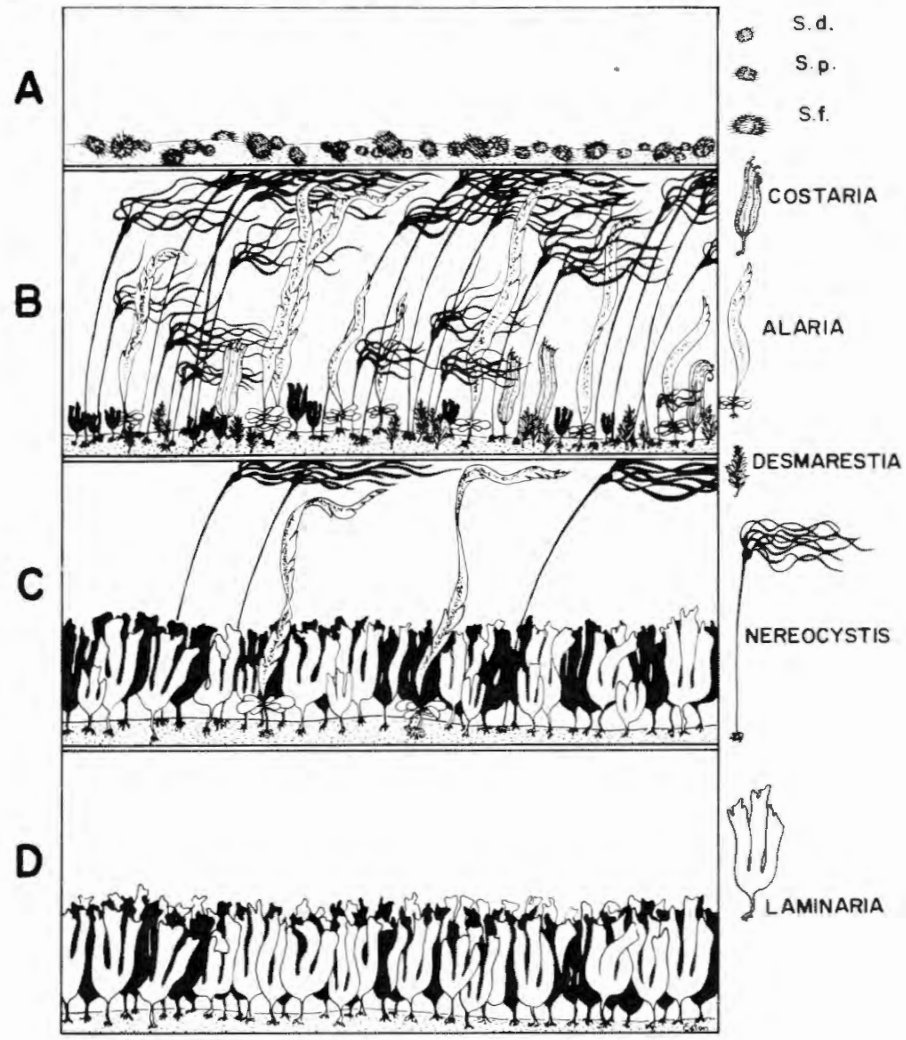


shore communities (down to a depth of about 50 feet below the 0 tidal datum). These kelps are grazed by a number of herbivores, the most conspicuous of which are the sea urchins. Sea urchins are, in turn, preyed upon by a species of very large (up to 3 feet in diameter) starfish. How do sea urchins affect seaweed biomass, species diversity, and distribution? How important are the seaweeds to the primary productivity of the community? By performing experiments in which these components of the community were manipulated, these questions were answered.

I learned that sea urchins essentially control the distribution and abundance of kelps. Normally, large urchin populations consume virtually all benthic algae. In the absence of urchins, kelp biomass (and hence productivity) reaches very high values (as high a productivity as has been measured in any system, terrestrial or marine). When sea urchins are removed for long periods of time, kelp species diversity drops to very low values as a single species of kelp outcompetes all the others – producing monospecific stands of plants. Starfish seem to have their major effect on urchin populations not so much by direct predation but by moving urchins around in space. When starfish abundance becomes high at a given site, urchins wll leave the area and kelps will flourish (at least temporarily).

It is well known that sea urchins are a favorite food of the sea otter. Based on results like those above, we would predict that areas with a large population of sea otters would have few sea urchins and consequently would have dense kelp beds composed of a few competitively superior species. This is exactly what I found when I visited the area south of GBNPP where sea otters were originally transplanted. The reappearance of sea otters caused the growth of giant kelp beds, leading to greatly increased benthic primary productivity. This productivity can be utilized by higher trophic levels both directy (by grazers) and indirectly (by pelagic zooplankton, when the kelp has degraded to particulate detritus). Futhermore, kelp beds are thought to serve as important habitats for pelagic organisms such as fish and shrimp by providing habitat heterogeneity and shelter from predators.

Knowing what we now know about sea otter, sea urchin, and kelp interactions, we are in a good position to make strong predictions about the consequences of removing sea otters from communities where they are established. Inasmuch as otters are particularly sensitive to certain types of disturbance (such as oil spills – there are no fat layers under their skin, so when their pelts become soiled, they cannot thermoregulate), and since they will play such an important role in GBNPP's marine ecosystem, they probably represent the single most important marine species for resource managers to monitor.

Using these same types of techniques, many questions regarding the structure or organization of different benthic marine communities in the study area have been addressed. I learned, for instance, that the intertidal appears to be much less structured by the types of biological interactions so important in subtidal kelp beds and as a result, the response to disturbance in the intertidal zone seems much less predictable. Furthermore, following a disturbance, the intertidal community seems to take much longer to return to its original configuration. This may have to do with infrequent and variable recruitment of juvenile organisms and high year to year variation in reproductive success. Thus, were a large-scale disturbance to take place along GBNPP's outer coast, it would probably take many years for the area to return to its pre-disturbance appearance.

In addition to doing experiments on the organization of marine communities, we have attempted to gather a long-term set of baseline data. It is only with such background data that park resource managers will be able to determine if the marine communities are changing over time. Since most communities vary to some extent from place to place and time to time, this type of data must be gathered at the same locations and over as long a period as possible, in order to distinguish normal ecological variation from ecological response to some hypothetical disturbance. In the future, we hope to train Park Service personnel in the gathering of these data.

The structure and organization of rocky intertidal and subtidal communities along this section of coastline is now well enough understood that we can being to make reasonable predictions regarding community response to certain types of disturbance. The NPS has made our research possible with its financial and logistical support. We hope that the results of our efforts will help park managers address future environmental problems which might arise along this pristine and dramatically beautiful coastline.

Duggins has a post-doctoral appointment at the University of Washington and is on the permanent staff at the Friday Harbor Lab.

Mapping Barrier Island Vegetation

By Beau McCaffray

Barrier islands are some of the earth's most dynamic landforms; consequently, maps of the coastal barriers can become abruptly antiquated. Barrier island mapping techniques must accommodate the natural forces that constantly shape these coastal barriers. A mapping technique sensititive to the dynamics of coastal barriers has been developed at North Carolina State University's (NCSU) School of Forest Resources for Ocracoke Island, Cape Hatteras National Seashore (CHNS). Two features of this technique, the use of computer mapping and the available NCDOT aerial photography, combined, provide the capability to update and reproduce barrier island maps frequently and inexpensively.

First, by using a computer, island map data may be easily stored, retrieved and changed. In addition, different scales and a wide variety of data, such as fire history and wildlife nesting locations, can be added easily to the base data and graphically portrayed on a map. Perhaps the greatest benefit of using computer maps is that they are inexpensive to reproduce at multiple scales, shading configurations and overlays.

Second, by using NCDOT aerial photographs, a resource base becomes available on a frequently updated and inexpensive basis. The Department frequently takes aerial photos of its roads and highways. When severe weather events threaten or damage highways on barrier islands, the NCDOT takes aerial photos of the area to assess road status and to develop and analyze alternatives to correct problems. The low attitude/large scale photography preferred by Department professionals is inexpensive and useful for interpreting vegetation communities, making NCDOT photography ideal for inexpensive diagnosis of changes in vegetation and other features wrought by storms, road rerouting and other events.

For the Ocracoke vegetation map, Physiognomic - floristic vegetation zones were: defined with the assistance of Kent Turner (CHNS) and E.D. Seneca (NCSU Botany Dept.), identified (interpreted) on 1:12000 black and white aerial photographs, and then delineated on acetate overlays. Using a Bausch and Lomb stereo zoom transfer scope, the vegetation zones were transferred onto the base maps, USGS 7.5 minute topo sheets covering Ocracoke Island. The 1:24,000 vegetation map of NPS land displays 140 zones of 11 different vegetation communities for a total of 5,118 acres. The minimum mapping area was .19 acre. The State Plan Coordinate System frames the map; fire occurrence can be precisely located. A separate map report also is produced by the computer, which sequentially numbers each zone as it is plotted, giving the acreage and vegetation type of each zone. These sequence numbers also are printed in each zone on the map itself for easy reference to the map report.

A sampling procedure was developed to test photointerpretation accuracy by stratitying all data into boundary and interior vegetation. These two strata were created based on their assumed differing levels of difficulty of classification. That is, boundary points, by virtue of their close proximity to differently identified zones, were considered harder to identify correctly than interior points. Additionally, the vegetative successional nature of many boundary areas could contribute to interpretation error, especially when the photos are more than a few years old. Interior points were considered to be less difficult to identify since these areas' texture, shading and patterns were often uniform for some distance. Sampling results revealed the overall photointerpretation accuracy to be 76%. As expected, boundary points were more difficult to correctly identify (67% accuracy rate) than were interior points (90% accuracy rate).

This mapping system provides a flexible capability to inventory data needed to manage some of the most dynamic landforms on earth.

McCaffray is a research assistant working under the direction of Prof. Hugh A. Devine, Recreation Resource Administration, North Carolina University School of Forestry.

Ruckelshaus on Science

William D. Ruckelshaus, administrator of the U.S. Environmental Protection Agency, appeared in a recent issue of *Renewable Resources Journal* (5410 Grosvenor Lane, Bethesda, MD 20814), as author of "Science, Risk and Public Policy."

"I believe," he wrote, "that part of the solution to our distress lies with the idea of science. We will not recover our equilibrium without a concerted effort to more effectively engage the scientific community."

superintendent's corner

By John E. Cook, Superintendent, Great Smoky Mountains NP

At Great Smoky Mountains National Park, we believe there is an urgent need to place greater emphasis on reducing adverse impacts on park resources. In a modern setting of technology and change, we are taking some unprecedented steps to address this need.

Many more people are visiting the park than ever before, hiking into the backcountry, camping overnight, and creating impacts obviously detrimental to the Smoky Mountains ecosystem. A myriad of exotic plant and animal species is adversely affecting the park's natural and cultural resources. External forces are at work, damaging the park environment in ways we do not yet fully comprehend.

To meet these real and potential threats to park values we have established an integrated research and resources management unit under the supervision of an assistant superintendent for resources management and science. This comprehensive unit includes two newly formed divisions. The divisions of administration, maintenance, interpretation and ranger activities have been retained under the supervision of an assistant superintendent for management and operations.

This revised organizational format is designed to form a cohesive and integrated program for full protection of the park's natural and cultural resources. It will assure constant attention to these most important responsibilities. As the Director pointed out in a speech to the Association of National Park Rangers, "The park ranger, resource specialist, maintenance personnel, scientist, and interpreter must function as a well oiled machine if we are to fulfill our proper mandates." Ranger and maintenance personnel will continue to be implementers. Scientists will gather information and analyze it, and they must provide me with alternative courses of action to deal with problems identified. The resource specialist will be the facilitator and act as liaison between the scientist and management. It is the interpreter's job to sell the program to the various publics.

Paramount in dealing with the mitigation of adverse impacts is a management plan, whose ingredients and priorities are arrived at jointly. The park's reorganization actions will permit better communication between researchers and resource managers, who share in the identification of resource problems. They will jointly agree on information needed before corrective measures can begin. But these two groups will still be only part of the team dealing with resource problems. Field rangers, maintenance personnel and interpreters must be strong supporters and participants in the total package.

Resource management strategies in the General Management Plan are the principal projects needed to combat threats to the park's ecosystem and to human life and safety. The document for dealing with these projects is the Resource Management Plan. Project statements are prepared for each resource related problem. The specific actions to be taken are identified. Actions are carefully assessed. Any that are controversial will be reviewed by the public before implementing. Typical resource management actions are as follows:

The park's Fraser fir forest has been heavily infested by the balsam wooly aphid and numerous trees killed. In order to preserve a few of the species in the highly visual sensitive area of Clingmans Dome, spraying operations are being conducted on a twice annual basis. Early monitoring indicates success in controlling the insects in this area. A somewhat unique aspect of our program is the melding of both natural and historic resource management. Cades Cove is well populated with turn-of-the-century pioneer structures, including homes, outbuildings, churches and a grist mill. This 2,000 acre area is kept in a meadowlike condition as a backdrop to these remnants of 19th century pioneer life. Cattle raising and haying activities performed to maintain the meadow condition provide, artificially, a good habitat for deer. Turkey, black bear, fish and other aquatic life also are affected. The new division is prepared to deal with these conflicts and others associated with this challenging relationship.

It has been evident for a long time that visitor impacts have created unnatural ecosystem changes; changes that must be minimized as much as possible. For example, people camping in the backcountry come in close contact with black bears. Frequent contact results in bears panhandling for food. The new division is applying principles of management derived from information compiled from people/bear social relationship studies. Progress is being made to reduce confrontation, injuries, property damage, and to retain the animals' natural character.

It is with great pride and expectation that we move forward with this newly organized research and resource management unit. It is made up of talented individuals, dedicated to furthering the interests of the National Park Service and to the pursuit of scientific truths and their applications in the preservation of the natural and cultural resources of the System.

To the Editor:

This past April I had the opportunity to serve as an instructor at Albright Training Center for the week-long "Natural Resources Management" training courses for Superintendents and for Mid-Level Managers. As a typical NPS scientist who'd never had the opportunity to *receive* any training at Albright, I was more excited about what I could learn from the other instructors, staff, and "students" than about my 3-hour opportunity to try to convince managers that there was an appropriate and effective role for research in the Park Service.

The experience exceeded my most optimistic expectations. Most striking was the serious and professional approach taken by all participants. Training Specialist Doug Morris had seen to it that the course content was meaty, but the interest and concern of attending managers was an attitude that they brought with them. Chalkboards filled, pencils churned, and students and instructors debated one another in an amicable but energetic fashion. For someone like me whose orientation to the Park Service is almost single-mindedly fixated on natural resources while it oftens feels that everyone else is more interested in budget, personnel, and visitor services, it was exhilarating to be reassured that we have not lost sight of our mission.

I walked into my own session with a small chip on my shoulder, the consequence of feeling that most managers view NPS science as either an extravagance or an expensive nuisance. I was provocative, even confrontational in my argument that high-quality scientific research is an essential element of responsible resources management. I said that if managers were unhappy with the quality or the relevance of scientific work performed in their Parks, it was their own fault for not stating what they wanted in advance and then following through with enough interest to get what they had paid for. The challenges and conversations that ensued from my presentation were stimulating and educational for me, and went far to persuade me that resources management in the National Park Service is viable and in increasingly supportive hands. The whole experience made be proud to be a part of this organization, and optimistic about its future.

David Graber
Research Scientist

To the Editor:

I would like to suggest that *Park Science* do an article discussing the rationale behind the recent revisions to 36 CFR 2.5. This involves a considerable change in how parks administer collecting permits. Although I am in complete agreement with stricter standards and a stronger system for managerial accountability in protecting park resources, I feel there may be some misinterpretation of legislative intent in this revision. If nothing else, an explanation of the rationale will help managers explain to researchers the reasons for denying collecting permits.

My specific concern is with 36 CFR 2.5(f): "In park areas where the enabling legislation prohibits the killing of wildlife, issuance of a collecting permit for wildlife or fish or plants is prohibited."

This is a major change from past policy. Questions I have are:

1. Why are plants included when the legislation only specifies wildlife?
2. Why is any "taking" prohibited when the legislation only specifies "killing?" (Taking is the term used in 2.5(a) and defined in 1.4 that applies to specimen collection permits. And taking is defined as not only killing but any pursuing, harm, capture, harassing, etc., in other words, any handling.)
3. Why do the regulations only specify restrictions on biota? After all, the same enabling legislation that prohibits killing of wildlife often instructs managers to protect other resources too. For example, the 1917 enabling act of Mount McKinley (now Denali) says, in addition to a killing prohibition, "preservation of the natural curiosities and scenic beauties." I think similar language can be found for many parks. Thus why not prevent collection of such items as rock samples by geological researchers? It seems to me that the same reasoning that extends a prohibition of killing to any handling of biota should also extend a prohibition to damaging of nonliving resources.

As now written the regulations will prohibit, in some parks, any researchers not part of NPS projects, from handling specimens of any biota. As such, this topic should be interest to *Park Science* readers.

John Dalle-Molle
Resource Management Ranger
Denali NP

Editor's Note:
The editorial board agrees that clarification of these questions is called for, and has asked the Washington office to prepare a policy statement in response to the questions raised in the foregoing letter.

Agate Beds Story Reads More Like Agatha Christie

By Jean Matthews

Mystery fans who like their thrillers laced with a dash of the ancient and exotic will find these tastes well served at Agate Fossil Beds National Monument in Nebraska. There, a 20 million year old story of the carnivorous "bear dog" is being unearthed and pieced together by means of modern research effort that spans eight decades.

The scientific Sherlock Holmes in this remarkable unraveling of the ages is played by Dr. Robert M. Hunt, Jr., Department of Geology and State Museum at the University of Nebraska. Dr. Hunt began to suspect in 1977 that he might have found, on Beardog Hill within the park, the location of Carnegie Quarry 3 – discovered in 1905 by O.A. Peterson and then lost again in the mists of intervening time and waning paleontological interest.

The Agate Spring Quarries, as they have been known for 80 years, constitute one of the greatest fossil mammal deposits in North America – a 20 million year old bone bed buried in stream-laid sandstone of Miocene age and exposed in two hills (Carnegie and University) overlooking the Niobrara River valley of northwest Nebraska.

"So abundant are the fossil bones of mammals," Dr. Hunt was written, "that a man could walk on a pavement of bones without touching the sediment in some areas in these quarries."

What constituted the mystery was the significantly atypical distribution of numerous carnivore bones compared to the rare and fragmentary bones of herbivores in one particular site – the site dubbed in 1905 Carnegie Quarry 3. Olaf Peterson of the Carnegie Museum, who discovered the site, had reported it to be in the same Miocene stream channel deposit as the quarries in the main hills, but unfortunately he had left no pictorial or written record of the Quarry's exact location. A photograph published in 1910 indicated it was somewhere on Beardog Hill.

Intrigued by the record of what he considered this unusual aggregation of extinct carnivores, Dr. Hunt applied in 1981 for National Park Service permission to do a preliminary excavation at Beardog Hill. A complete and detailed description of the search – its trials, errors, failures and eventual success, of the logic behind each move, and of the evidential reasons for the moves – can be found in the Winter 1984 issue of the George Wright Society FORUM.

Eventually, after repeated attempts and the reluctant conclusion that "there was little probability of ever locating the exact site," Dr. Hunt adopted a routine procedure of field paleontology – screening the surface soil for bone fragments – that led to discovery of the elusive site.

The first two trenches worked produced nothing of interest, no bone or bone fragments, no sign of earlier digging. The third attempt led to a most amazing result. In Dr. Hunt's own words, this is what took place:

"Upon sieving the soil, carnivore bone fragments appeared on the screens; part of the pelvic bone, a partial arm bone, and the upper part of the shin bone or tibia. These were recognized as bear dog bones, in fact the same species found by Peterson, and the work continued in some excitement. The probability that we had located the quarry was high, for since carnivore bones are scarce in most field settings, bear dog bones of the kind found by Peterson in Quarry 3 were an improbable and thus a strongly confirming find . . .

"When we sieved the surface dirt and recovered the fragmentary bear dog bones we had no thoughts that one of these pieces would match one of the Carnegie bone fragments found in 1905. One of the most exciting moments of the work was Carl Swisher's match of the partial tibia with one of the Carnegie fragments, proving that they were once part of the same bone . . . The two pieces were collected 76 years apart!"

On the third day of the 1981 excavation, two large burrows were discovered, each filled with a fine gray ash-rich sediment that contrasted sharply with white sandstone bedrock intruded by the burrows. When the scientists examined the bedrock below the burrows, to their surprise there appeared a shallow depression similar in shape to pits left by professional paleontologists.

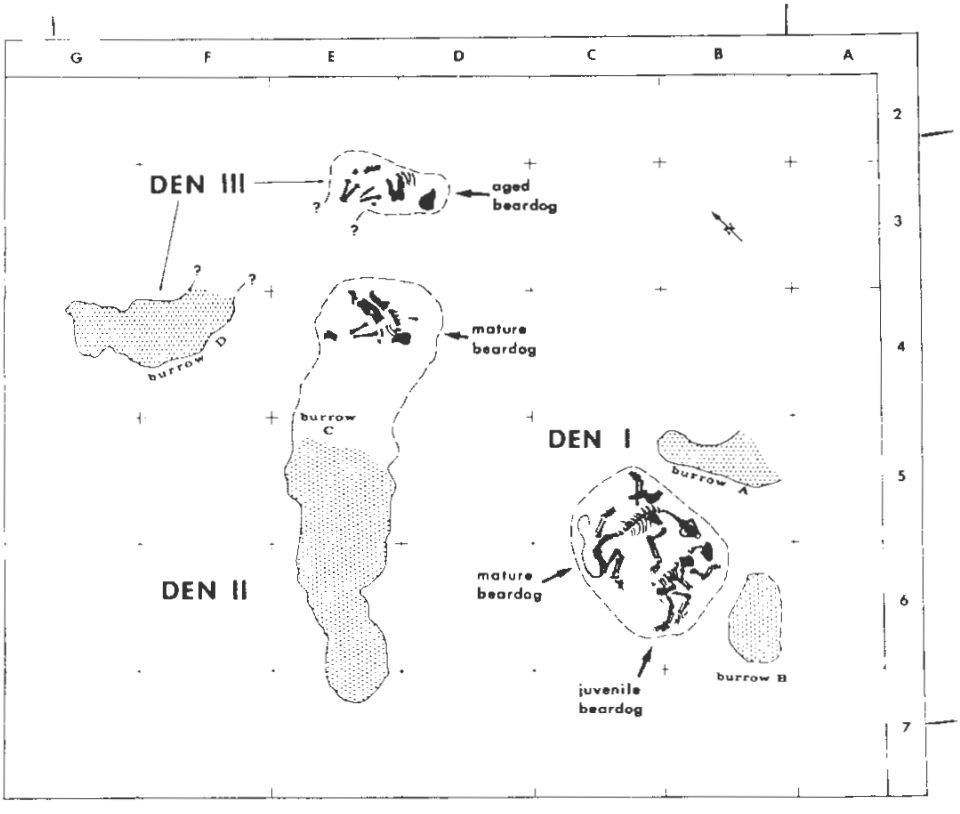
"Immediately, we remembered that Peterson had removed the two nearly complete skeletons of the rare bear dog (which he named *Daphoenodon superbus*) in a single large block of sandstone," Hunt recalled. "If this was the place from which the sandstone block had been collected, the two nearby burrows could explain why the two skeletons had been found together – one an adult female, the other a juvenile male about 6 months to 1 year old. Proof was lacking, but the circumstantial evidence seemed compelling."

The burrows discovery provided the scientist with their first hypothesis for why Quarry 3 had produced so many carnivores. Possibly it had breached an ancient den complex. The professional thoroughness with which the group went ahead to confirm this hunch makes up the rest of the story. The significance of the den complex lies not only in the wealth of extinct Carnivora found there but also in what was learned about the way of life of these animals. In addition to throwing new light on the ability of amphicyonids (bear dogs) to burrow and use dens as long as 20 million years ago, the research confirms that species members of two diverse lineages used the burrows and suggests that many amphicyonids could burrow and use dens upon occasion.

Work on Quarry 3 is continuing, with high probability that more dens will come to light. The hope is to discover the extent of the dens, and thus come to an understanding of their content and manner of filling. The results of these research efforts – the hardwon understanding of the fossils at Agate – are contributing to the overall comprehension of the prehistory of this plains site and to the larger picture of the evolution of life on Earth.

An article on "Miocene Burrows of Extinct Bear Dogs: Indication of Early Denning Behavior of Large Mammalian Carnivores," by Dr. Hunt, Jr., Xue Xiang-Xu, and Joshua Kaufman appeared in the July 22, 1983 issue of Science, *pp. 364-6.*

***PLAN MAP** of early Miocene carnivore dens, Quarry 3, Agate Beds National Monument. Stipple pattern indicates Miocene burrow fill that also surrounds beardog skeletons. Dens I and III contained the beardog* Daphoenodon; *Den II produced a rare temnocyonine beardog. Excavation grid is in square meters.*

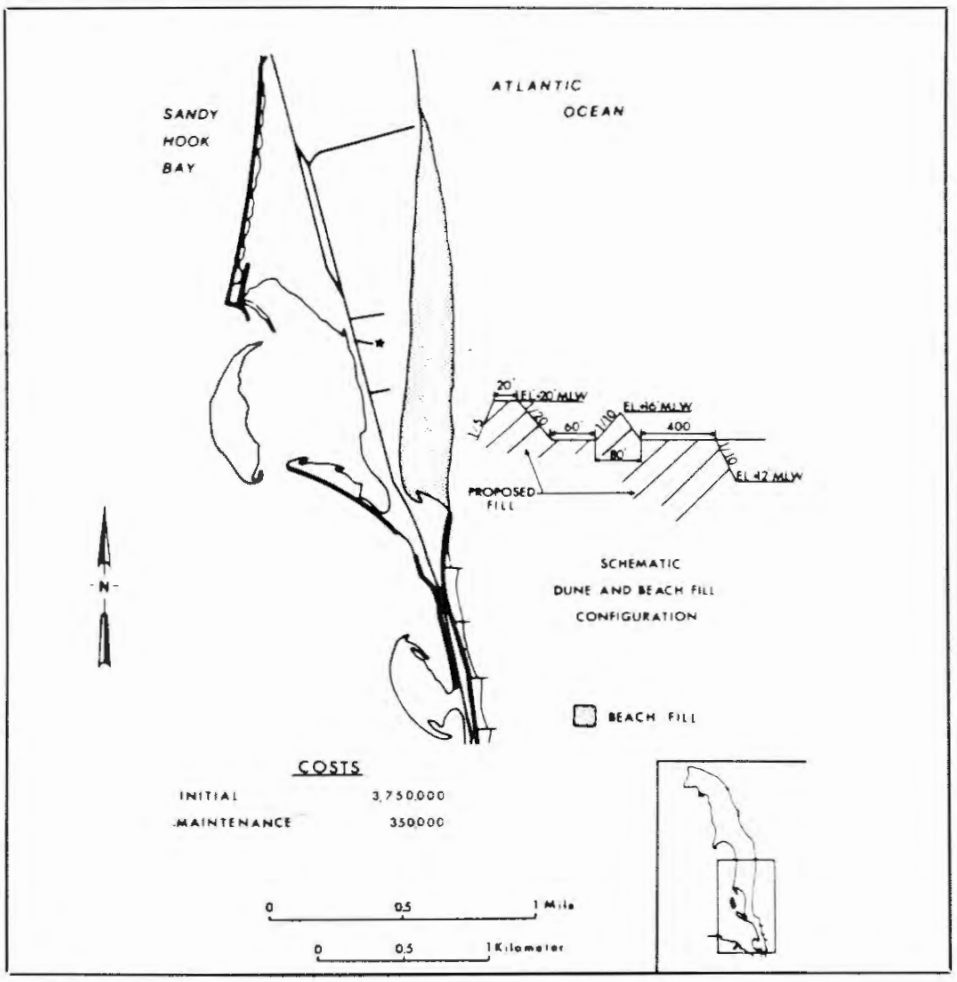


Mimicking Nature Through Dune Building

By John T. Tanacredi and Al Farrugio

Figure 5 PLANTING

Figure 2 BEACH NOURISHMENT



The dynamic geomorphological processes that shape our coastline are testimony to nature's landscaping abilities. Erosion and accretion of our coastal barriers has both plagued and nurtured man's desire to settle closer and closer to our rising seas. At the Sandy Hook Unit of Gateway National Recreation Area, a natural sand spit exists where the shoreline dynamics have separated the tip area (a spit in geological definition) from the mainland time after time over the last several hundred years.

Considerable effort on the part of many federal and state agencies has gone into evaluating alternatives for solving the potential breaching of the "critical zone." (Figs. 1 and 3) Erosion was leading to the separation of the spit from the mainland. A single access route to the tip is the only way facilities such as the U.S. Coast Guard, the National Oceanographic and Atmospheric Administration, New Jersey Marine Science Consortium, and American Littoral Society continued to operate, as well as being the only access for over 2 million beach users annually. A special Congressional appropriation of $12 million, to be reimbursed to the Federal Government by charging beach user fees, was allotted to help restore the original 1954 Sandy Hook shoreline profile.

The plan called for some 4 million cubic yards of sand material dredged from Sandy Hook and Ambrose Channels to be placed by hydraulic pumps up into the critical zone, beginning in March 1983. In addition to the sand material, an attempt at dune construction and stabilization would be made along a 1.5 mile strip of beach once the sand had been placed establishing the original shoreline. (Fig. 2) Three hundred thousand culms of dune grass, *Ammophila breviligulata* (Fig. 4) would be purchased, planted and fertilized over a two month period beginning in November 1983. Aerial photographs of the entire planted area are being made, coupled with an on-site ground evaluation of the survivorship of the culms.

The process is surprisingly simple. The plant species is dependent upon the location along the coastline. Only a handful of species is tolerant of the stresses associated with the beach environment. The plants must be able to survive sand blasting, burial by sand, salt spray, saltwater flooding, drought, heat and low nutrient supply. A perennial grass such as *Ammophila breviligulata* (American beachgrass) fits the Sandy Hook bill. This species is a cool-season dune grass, vigorous, and grows in dense clumps spreading laterally by rhizomes; it is easy to propagate, harvest, and store, and is readily available from commercial nurseries. The grass is extremely easy to transplant: (Fig. 5) it establishes and grows rapidly to begin trapping sand by the middle of the first growing season. The rhizomes may spread as much as 10 to 12 feet per year while accumulating as much as four feet of sand in the one growing season.

The work force for this project consisted of the Sandy Hook maintenance staff equipped with a tractor and an agricultural transplanter, and 50 volunteers. The volunteers included representatives of the NPS, NOAA, USCG, local Sierra, Audubon and Garden Clubs, Boy Scouts, Camping Clubs, and others. The planting went quickly to total approximately 150 rows, each with somewhere in the neighborhood of 1200 plants. To encourage rapid establishment of the beach grass, a complete fertilizer was applied shortly after planting in the fall of 1983 and then re-applied in the Spring of 1984.

Figure 1 SANDY HOOK

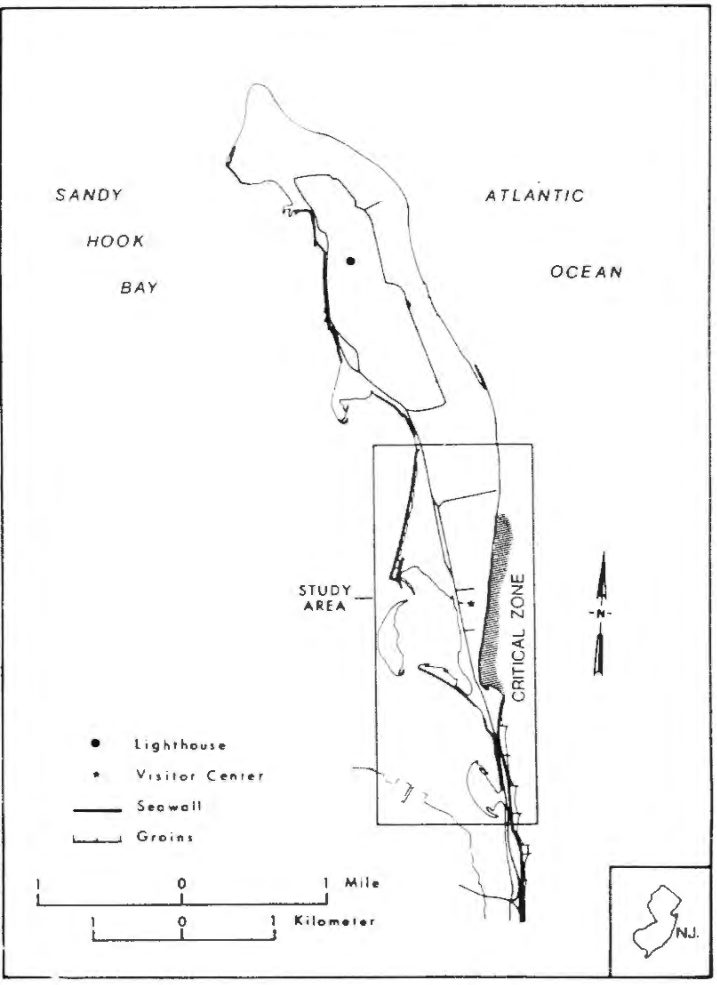


Figure 3 CRITICAL ZONE

Figure 4 BEACH GRASS

As the new dune system takes shape, powered by natural processes, other plant species will be introduced both naturally and with the help of the park. To do this, Gateway has begun a nursery system with the prime objective of growing coastal plant species that often are unavailable from commercial sources. A nursery site at Sandy Hook and one at Floyd Bennett Field in Brooklyn, along with a 24′ x 36′ free-standing greenhouse, will provide transplants of such plants as *Artemisia stellaria* (Dusty Miller), *Solidago sempervirens* (Seaside Goldenrod), *Myrica pensylvanica* (Northern Bayberry), *Coreopsis lanceolata* (Lance-leaved Coreopsis), *Opuntia compressa* (Prickly Pear), *Prunus maritima* (Beach Plum), and *Juniperus virginiana* (Eastern Red Cedar.)

The dune planting exercise at Sandy Hook is by no stretch of the imagination intended to stop erosional processes there. What is anticipated is that the grass will aid in stabilizing a new dune system, reduce the rate of erosion at the critical zone as the dunes become stabilized, increase coastal habitat diversity thereby providing for additional passive recreational opportunities, and continue to maintain the connection that provides access to Sandy Hook.

In the long term, other multi-purpose habitat development activities such as this one will be fostered at Gateway NRA, as well as at other coastal barrier parks. This habitat improvement, however, should not be achieved at the cost of elimination or substitution for "natural or virgin" habitat. A considerable period of time must elapse before any newly established habitat area can approach the level of diversity, complexity, and equilibrium a natural system develops over time.

Tanacredi is Natural Resource Management Specialist and Farrugio is Park Agronomist at Gateway NRA.

regional highlights

Southwest Region

From Milford Fletcher, SWR Chief Scientist, comes word of a three-day workshop in March, primarily for Resource Management Specialists, covering a wide range of topics and engendering "frequent, lively discussions." Of particular interest to the 28 who attended was the prioritization workshop, where resource management needs and funding capabilities were discussed and long-term strategies were plotted for resolving problems.

Also of interest was the ADP section, since the SWR is moving forward to computerize natural resource data in connection with geographic information systems used to computerize archeological data. In June, the Region hosted the first of several workshops with the Remote Sensing Division of the Denver Service Center, southwest Cultural Resources Center, WASO personnel, and Regional field users – "to determine our direction in computerization of natural resource data for the future."

The success of the March workshop has given rise to plans for a follow-up workshop this coming winter.

Rocky Mountain Region

The 239-page Proceedings of the International Symposium held at Kalispell, Mont., in June 1982, is now available from Glacier NP. *Towards the Biosphere Reserve: Exploring Relationships Between Parks and Adjacent Lands* is the outgrowth of a conference co-sponsored by Parks Canada and the U.S. National Park Service.

A background paper, "Biosphere Reserves in Concept and Practice," by U Michigan's Kenton R. Miller, sets the stage for six papers on issues and problems in applying the biosphere reserve concept; seven papers on research, monitoring, and education in parks and adjacent lands; four papers on the search for solutions; four papers on international experiences; and three papers on the future of the biosphere reserve in North America and abroad: opportunities for cooperation.

Western Region

Proceedings of the First Biennial Conference of Research in California's National Parks is now available from Charles van Ripper III, Unit Leader at the NPS CPSU, U Cal, Davis, 95616. The document contains 35 of the research papers presented at the conference held in September 1982.

* * *

Recently issued publications or reprints of articles by Charles van Riper III include the following: "The Influence of Nectar Resources on Nesting Success and Movement Patterns of the Common Amakihi" in *The Auk*, January 1984; "Basal Metabolism of the Apapane: Comparison of Freshly Caught Birds with Long-term Captives," (with Wesley W. and Debra L. Weathers) in the October 1983 issue of *The Auk*; "Censuses and Breeding Observations of the Birds on Kohala Mountain, Hawaii," in the *Wilson Bulletin* 94(4) 1982; "Within-Territory Division of Foraging Space by Male and Female Amakihi," (with Alan C. Kamil) in *Condor* 84:117-119, 1982; "Temperature Regulation in Two Endangered Hawaiian Honeycreepers: the Palila and the Laysan Finch," (with Wesley W. Weathers) in *The Auk* 99: 667-674, October 1982; and Tech. Report 44 of the CPSU at University of Hawaii, Manoa, "Avifauna of Kohala Mountain, Hawaii."

* * *

Two Technical Reports just off the presses from the NPS/CPSU at U Cal, Davis, are #16, *Management of an Endangered Species in a National Park: The Peregrine Falcon in Yosemite*, by Christopher E. Asay and William E. Davis, and #17, *Sensitive Plant Species of Sequoia and Kings Canyon National Parks*. The latter is an update to Technical Report #8. The former is a 142-page, illustrated study, with recommendations, of the peregrine falcon program conducted at Yosemite from 1981-83.

* * *

A symposium entitled Protection and Management of Terrestrial Hawaiian Ecosystems was held at Hawaii Volcanoes NP June 5-6, 1984. With 133 paid registrants in attendance, the meeting was convened by NPS and the U.S. Fish and Wildlife Service to (1) encourage cooperative efforts in resource planning, management, and research; (2) identify successes and bottlenecks in working together; (3) bring together people with diverse interests such as ranching, timber harvest, education, protected area management, hunting, native Hawaiian culture, and legislation; and (4) move forward with the job of wise stewardship of the natural resources for which we all share responsibility.

The sessions were structured to present overviews of the status, research, and management needs for native and alien (introduced) biota and to discuss concepts useful in managing ecosystems for and against these components. Such topics as preserve design, moitoring, genetic considerations, and restoration were considered.

At the final session, entitled Current and Future Roles of Agencies, Conservation Groups, Legislation, and the Public in Preserving and Managing Hawaiian Ecosystems, representatives from the State Senate, conservation groups, a native Hawaiian group, the ranching community, State and Federal agencies, and others, were heard from.

* * *

The ecological status of the tidewater goby, *Eucyclogobius newberryi*, (a small salt water fish), is discussed in Technical Report No. 15 from the Cooperative NP Resources Studies Unit at the University of California, Davis. The report, by Johnson C.S. Wang describes Rodeo Lagoon, an artifically detached lake in the San Francisco Bay area – the only place in that area where the tidewater goby has been found recently. The yellowfin goby, an introduced species thought to be a serious competitor of the tidewater goby, was abundant in the lagoon in 1980, but its population declined drastically in 1981 and 1982, when the water in the lagoon was less saline. Wang recommends that salinity in Rodeo Lagoon be controlled to protect the tidewater goby.

* * *

The Second Biennial Conference on Research in California's National Parks will be held Sept. 5-7, 1984, at the University of California, Davis, for presentation and discussion of research related to the biological and sociological resources of California's National Parks. Two days of paper presentations with keynote speakers are planned; evenings will feature poster sessions and one social gathering. Selected papers will be published.

Dr. Charles van Riper III, unit leader of the U/Cal Davis CPSU, is in charge of the program. All inquiries concerning arrangements should be addressed to Marsha Murphy, CPSU - Institute of Ecology, University of California, Davis, CA 95616.

Pacific Northwest

The 1983 Annual Reports, one for each of the three CPSU's in the Pacific Northwest Region, are available now. The Oregon State University Unit's report contact is Ed Starkey, Peavy Hall, OSU, Corvallis, OR 97331; the University of Washington Unit report contact is Jim Agee, College of Forest Resources, AR-10, University of Washington, Seattle, WA 98195; the University of Idaho Unit report contact is Gerald Wright, College of Forestry, University of Idaho, Moscow, ID 83843.

* * *

Historic Landscapes of San Juan Island National Historical Park is the title of a 45-page document by Jim Agee, published as a Winter 1984 report (CPSU/UW 84-2) of the University of Washington CPSU. This report defines historic landscapes of English and American Camps at the Park, discusses desired alterations to existing landscapes in order to restore the historic look of the area, and is one of the source documents for the San Juan Interdisciplinary Team, whose report is scheduled for publication this summer.

* * *

From R. Gerald Wright and Bart Butterfield of the NPS/CPSU at the University of Idaho, Moscow 83843, comes CPSU 83-4 – a publication entitled *Great Blue Heron Nesting Habitat on the North Fork of the Flathead River, Montana*.

* * *

A study comparing prehistoric and modern smoke production from forest fires in Western Washington, aimed at facilitating air quality planning and management, is described in an article by George R. Fahnestock and James K. Agee in the October 1983 issue of the *Journal of Forestry*. "Biomass Consumption and Smoke Production by Prehistoric and Modern Forest Fires in Western Washington" concludes that total fuel consumption and smoke production has declined by about 22 percent since prehistoric times.

Agee is sole author of "Fuel Weights of Understory-grown Conifers in Southern Oregon," which appeared in the *Canadian Journal of Forest Research*, Vol. 13, No. 4, 1983.

* * *

Don Field and Darryll Johnson have completed a manuscript entitled "Rural Communities and Natural Resources," which will be published as part of a collection of readings by Penn State University Press. The article outlines the contributions of early rural sociologists to the understanding of settlement patterns and resource development in rural America.

Continued on next page

Midwest Region

Isle Royale NP has completed an updated research bibliography which includes over 600 citations pertaining to the natural history and archeology of Isle Royale and the Lake Superior basin.

* * *

A continuing cooperative education and research program between George Washington Carver National Monument and Missouri Southern State College has resulted in the publication of Vol. 2, No. 1 of the *George Washington Carver National Monument Research Bulletin.* Although primarily a natural history publication the current issue includes two articles on George Washington Carver's ancestry and personal letters.

* * *

The Ninth North American Prairie Conference will be held July 27 through Aug. 1, 1984, in Moorhead, Minn., and will continue the series of biannual prairie conferences held since 1968. Papers on a variety of topics relating to prairie including prairie conservation, ecology, restoration, management and interpretation will be presented.

North Atlantic Region

Len Bobinchock is the new Regional Resource and Visitor Protection Specialist; Nora Mitchell has been named Resource Management Specialist for the Region. Both work in the Division of Management and Operations.

Southeast Region

Proceedings of the Workshop on Biosphere Reserves and Other Protected Areas for Sustainable Development of Small Caribbean Islands is the title of a 190-page publication now available, from Jim Wood of the Southeast Regional Office. Paper copies are $17.50; microfiche from the National Technical Information Service, is $4.50. NTIS acquisition number is PB84 – 189869; the address is NTIS, 5285 Port Royal, Springfield, VA 22161.

* * *

Research/Resources Management Report SER-66, *The Vegetation History of Fort Frederica, Saint Simons Island, Georgia,* by Susan P. Bratton, examines historical colonial records of the landscape and vegetation of the fort and finds the present landscape bears little resemblance to the actual forest composition during the colonial period. Copies of the report can be obtained from Bratton at the NPS/CPSU, Institute of Ecology, University of Georgia, Athens, GA 30602.

* * *

The final report from Arthur T. Leitheuser and John R. Holsinger of Old Dominion University, Norfolk, Va., entitled *Ecological Analysis of the Kentucky Cave Shrimp, at Mammoth Cave NP,* found that the park's boat concession operation had no impact on populations of the endangered shrimp. The boat concession will therefore continue to operate.

A one-year contract extension will allow Leitheuser and Holsinger to conduct systematic sampling of the microfauna within the cave system, addressing management-related questions.

Grizzly Bear Recovery Notes Update IGBC Plan Efforts

The March issue of *Grizzly Bear Recovery Notes* [No. 2 of an ongoing series published by the Interagency Grizzly Bear Committee (IGBC)] announced availability of the Population Review Task Force Report of data on grizzly bear population size and trend in the Northern Continental Divide Grizzly Bear Ecosystem. The authors conclude that available data (1) do not permit an estimate of population, and (2) do not allow a quantitative population trend estimate, as no indicator provided unequivocal evidence of increase, decrease, or stability.

The IGBC has selected future research priorities based on what managers said they needed to know in order to better manage grizzlies and grizzly habitat for population recovery.

Research topics selected by the IGBC included development of a population trend monitoring system; development of a population augmentation system; quantification of the effects of oil and gas exploration and development on grizzly behavior and habitat use; quantification of the effects of road access and associated activity on grizzly behavior and habitat use; quantification of the effects of non-motorized recreation in backcountry areas on grizzly behavior and habitat use; development of a habitat suitability standard or index; and compilation of a single source state-of-the-art compendium of all research results and management techniques information for North America. The research subcommittee is developing scope of work statements and detailed research proposals for these topics.

What a Difference A Digit Makes

"OOPS" read the headline in the Seattle Post-Intelligencer.

Who goofed?

A one-digit error made in compiling the population statistics on Yellowstone NP's grizzly bear population led to an erroneous report published in January 1983, stating that there was no significant trend in grizzly numbers.

A recheck of the statistics showed that someone mistook a four for a nine, when figuring the number of female grizzlies with cubs. By figuring the population trend on the faulty basis of a more than doubled number of grizzly bear mothers, the conclusion had been reached that grizzly numbers might be improving. The newspaper quotes wildlife advocates as commenting: "The revised findings make it clear that Yellowstone's grizzlies are indeed in trouble."

The item was forwarded to *Park Science* by Gary Machlis (of the University of Idaho CPSU) as "an example of how proofreading can never be taken for granted!"

* * *

Peter S. White, Plant Ecologist at the Uplands Field Research Lab, Great Smoky Mountains NP, has been elected vice-chairman of the Vegetation Section of the Ecological Society of America. Purpose of the Section is to encourage research and to sponsor meetings for communicating results of all phases of vegetation science. The second annual meeting of the group will be held Aug. 6-9, 1984, at Fort Collins and will feature a pre-meeting field trip similar to the one held last year at Grand Forks, ND. at the first annual meeting. For more information, contact White at the Uplands Lab, at (615) 436-7120.

Smokies Conference Eyes Management of MAB Reserves

National Park Service managers, scientists, and others including several from elsewhere in the world, will gather at Great Smoky Mountains NP Nov. 27-29, 1984 to talk about the implications of managing Biosphere Reserves. Coordinators are designing a conference to improve the understanding of the multiple roles of Biosphere Reserves and to introduce new ideas and techniques.

The concept of Biosphere Reserves is one in which a national park is one portion of a larger zone of cooperation that may include other Federal and State lands as well as private holdings. The park usually serves as the core of the Biosphere Reserve and provides the "control" for comparisons with the less protected and more manipulated portions of the reserve. Management of a Biosphere Reserve Park therefore differs somewhat from that of a park without Biosphere Reserve designation. It is this difference that will be discussed at the Smokies' conference.

The first conference day will feature six presentations on topics designed to set the stage for the next day's workshops. The first day presentations are: (1) The Biosphere Reserve in Concept and in Practice, Dr. Harold Eidsvik, Senior Policy Advisor, Parks Canada; (2) The Roles of Biosphere Reserves in Developed Countries, Dr. William Gregg, Jr., Co-chairman, U.S.–MAB Project Directorate on Biosphere Reserves, NPS; (3) Research, Technology Development, and Information Transfer, Dr. Jerry Franklin, Project Director, Forestry Sciences Laboratory, Corvalis, Ore. USFS; (4) Public Communications and Development of a Conservation Ethic, Dr. Gabriel Cherem, Interp General, Inc., Ann Arbor, Mich.; (5) Resources Management in Biosphere Reserves, Asst. Supt., Roland Wauer, Great Smoky Mountains NP; and (6) Strategies for Cooperative Programs, a three-part presentation, chaired by Dr. John McCrone, Dean, School of Arts and Sciences, Western Carolina University.

The second day's workshops will be co-chaired by Biosphere Reserve managers and scientists. Topics and chairmen include: (1) Air Pollutants, John Christiano, Field Coordinator, NPS Air and Water Quality Division, and Supt. Boyd Evison, Sequoia and Kings Canyon NPs; (2) Development of Nonrenewable Resources, Tom Lucke, Chief, NPS Branch of Water Resources, and Supt. Robert Haraden, Glacier NP; (3) Use of Renewable Resources, Dr. Stanley Krugman, Director, Timber Management Research, USFS, and Supt. Robert Barbee, Yellowstone NP; (4) Problem Species, Dr. Michael Ruggerio, NPS Pest Management Program Coordinator, and Supt. David Ames, Hawaii NP; and (5) Visitor Activities, Dr. Don Field, Senior Social Scientist, Oregon State University CPSU, and Supt. Don Brown, Isle Royale NP.

Reports on each of the five workshops will be made the morning of the third day. These topics will then be summarized by Supt. Jack Morehead, Everglades NP.

A special committee will develop suggestions that evolve from the workshops and can be utilized by Biosphere Reserve managers.

For further conference details write to Dr. John Peine, Uplands Research Station, Great Smoky Mountains NP, Gatlinburg, TN 37738.

Fire Management Data Gathered

by Dean Simon

Canaveral National Seashore (NS) has long been troubled by lightning-caused wildfires. Though these fires are considered part of the natural fire regime, suppression activities (both intentional and non-intentional) have led to heavy accumulations of fuels.

Currently, the U.S. Fish and Wildlife Service (USFWS) and the National Park Service are cooperating to extinguish wildfires throughout government properties at Canaveral including Merritt Island National Wildlife Refuge and NASA's Kennedy Space Center, but as both agencies have recognized, suppression alone will only intensify present fire management problems.

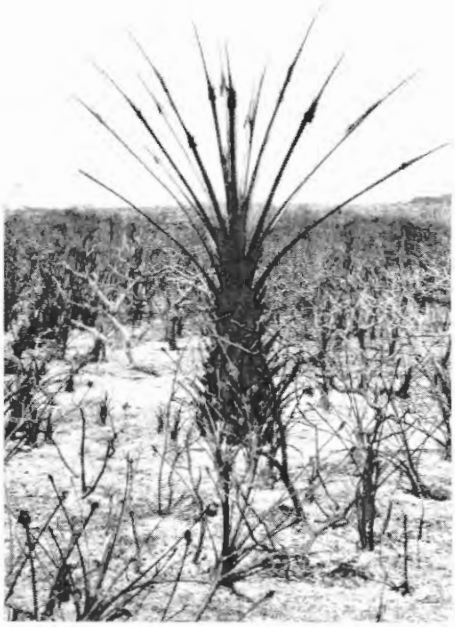
Since 1981, the USFWS has used prescribed burning to reduce heavy fuel accumulations in lands adjoining the seashore. Very little information has been gathered on fuel dynamics, however, and the impacts of present prescribed burning rotations are poorly documented. Hazardous fuel situations still exist within the park.

In Spring, 1983, the NPS Cooperative Wildlife Research Unit at the University of Georgia began working with the Canaveral staff to document fire effects on birds, plants, soils, and fuels in the important fire-adapted habitats of the National Seashore. Major objectives of the study are: 1) to determine how post-fire plant recovery correlates to resident bird species composition; 2) to determine how post-fire plant recovery correlates to soil nutrient levels; 3) to gather baseline data on fire behavior; 4) to develop a fuels model for use in a prescribed burning program at the Seashore, and 5) to provide a basis for long term monitoring. Since there is a lack of pre-burn data from areas where lightning-caused fires have occurred, it was desirable to plan three controlled research burns between May and October, the primary lightning-caused fire season.

Study sites were established in each of the three main fire-adapted community types at Canaveral NS: the coastal strand, the slash pine (*Pinus elliottii* variety *densa*) flatwoods, and the oak scrub. The size of the coastal strand and slash pine flatwoods study sites are about 60 ha and 80 ha respectively, and each was divided into a "burn" and "non-burn" half. The oak scrub study site was chosen primarily because of the presence of an immature Australian pine (*Casuarina equisetifolia*) stand. Australian pine is an undesirable exotic that is difficult to eradicate. The stand was cut down in 1979 and in its rejuvenating stage covers approximately 0.5 ha of the surrounding 4 ha oak scrub study site.

Pre-burn sampling of vegetation, soils, and fuels was conducted during the month of August. Twenty-two permanent 15m transects were established over the three study sites on which percent cover per plant species was measured and recorded. Close to each transect, a lysimeter was placed to measure for soil water nutrient content. Also, a pair of soil samples was collected near each transect. Fuels were measured by biomass collection and separation into various size classes for live and dead-standing and litter.

In preparing for the burns, an effort was made to utilize existing natural and man-made fire breaks, including roads, canals, and trails, some of which were widened to improve the margin of safety. The USFWS assisted by using a small bulldozer to roll over vegetation and push it aside along an old trail, widening the break while causing as little disturbance as possible to the soil surface.



The once thickly accumulated *fuels of the coastal strand are quickly reduced after the passage of fire.*

National Seashore staff conducted two burns in September: one on the oak scrub study site and one on the coastal strand study site. Weather conditions were not conducive to safely burn the slash pine flatwoods, so the third fire was delayed until next season.

Though weather conditions were nearly identical on the two days of burning, fire behavior varied greatly, primarily because of the great variation in community structure between the two study sites. Due to the consistent nature of its saw palmetto cover, the coastal strand burned much more quickly and cleanly than the oak scrub. Immediate post-fire observation on the oak scrub revealed that the young Australian pine stand was not affected significantly by the burning.

Post-fire data collection for vegetation, fuels, and soils began immediately following the burns and will proceed at two month intervals for the next year. Timed bird species diversity counts will be made in mid-winter, early summer, and late summer, along with measurements of saw palmetto fruit production, an important wildlife food.

All data yielded from this study and from continued monitoring of the study sites will be incorporated into the development of a fuels model and prescribed burning program for Canaveral. Eventually, the study will reduce dependence upon extrapolations of data from outside studies. The ultimate goal of the project is to help Canaveral develop a fire management plan that allows fire adapted communities to burn, while reducing safety hazards and maintaining natural disturbance regimes in native ecosystems.

Simon is a graduate student at the University of Georgia School of Forest Resources, working with the NPS/CRU and the USFWS/CWRU.

Spirit Lake Water Management Studied

Public concern that large releases of Spirit Lake water will threaten domestic water supplies, fish, and other valuable downstream resources in the Mount St. Helens (WA) area led to the recent publication of an Army Corps of Engineers study, *Water Quality Investigations – Spirit Lake Stabilization Project*, a 74-page document (NPPEN-HH-R), complete with 18 figures (some in full color) and 16 tables.

Specific evidence of severe water quality degradation in the lake included (1) total depletion of dissolved oxygen during summer months; (2) substantial generation of methane in lake bottom sediments; (3) high concentrations of phenolic compounds; (4) extremely discolored (blackish) water; and (5) an abundance of various reduced elements, including iron, manganese, and sulfur. These reduced metals gave rise to chemotrophic bacteria in aggregations two or three orders of magnitude above those reported for lakes unaffected by the eruption. *Legionella* sp., a pathogenic bacterium, was found in significant concentrations, and was given as the cause of a puzzling respiratory illness which had been contracted by several scientists working in the Spirit Lake vicinity.

Study objective was to provide a water quality assessment of the various alternatives for stabilizing Spirit Lake, which presently presents the potential for failure of the natural debris dam restraining the lake's outflow. The study describes the baseline limnological characteristics of Spirit Lake and the changes leading to lake recovery, considers the public health significance of bacteria in the lake and in alternative receiving waters, and evaluates the potential for stream channel disturbance by streamflow augmentation from the lake.

A limited number of the reports is available at no cost from the U.S. Army Corps, P.O. Box 2946, Portland, OR 97208.

Restoration Ecology Conference Slated

A half century of restoration research at the University of Wisconsin Arboretum will be commemorated Oct. 11 and 12, 1984, with a symposium to explore the value of ecological restoration as a technique for basic research Entitled "Restoration Ecology: Theory and Practice," the symposium also will examine the role of experimental and theoretical ecology in the development of "the science and art of community and ecosystem restoration."

The registration fee of $40 (through Sept. 28) covers admission to all sessions, two lunches, an evening banquet, and a tour of the UW Arboretum. Speaker come from Michigan, Wisconsin, California, Minnesota, Florida, Liverpool, England, and North Wales, and will address basic questions on the role of soil and climate in community development, introduction of species, community structure and species diversity, assembly of communities, plant-soil interactions, nutrient cycling and mycorrhizae, competition, succession, and the role of fire and other disturbances.

The presentation is designed for scientists, managers, administrators, and others interested in ecosystem restoration and development. Contact is Nancy Dopkins, UW Arboretum, 1207 Seminole Highway, Madison, WI 53711, or (608) 262-2746.

The RMT Program . . . One Perspective

By Johnathan B. Jarvis

Two years ago this September I met for the first of several times with the other Natural Resource Management trainees in Fort Collins, Colorado. Our backgrounds were diverse, some sporting Masters degrees, some PhD.'s, all at least a BS or BA. Some hailed from backgrounds in resource management, some from interpretation, and some from law enforcement. All regions were represented and most of the trainees already had a number of years in the NPS under their belts. Those few from other agencies seemed relieved that they finally had made it into the NPS. All the trainees were elated at being chosen for the program.

As we listened to our charge from Roland Wauer, I could not help feeling a sense of pride and an awareness of building electricity. The group meshed well, minds were sharp, ideas came quickly, and there was an overall sense of purpose – an advocacy for the protection of park resources. We were challenged by Ro that the two years would not be easy, that it would require dedication and self-sacrifice. He said some would not make it. Looking back, he was right on all counts. I recall feeling that in some ways the NPS would never be the same after this program.

As we left for our respective training parks that September, each of us was well aware that the NPS had made a very expensive investment in us. We were paid to learn everything we possibly could in two years about resource management. We were to build on our existing knowledge through formal and on-the-job training, conferences, reading, and independent study. We were granted the funding and (theoretically) the time to accomplish a laundry list of actions outlined in a lengthly IDP (individual development plan). In my own case, practicality and park priorities often interrupted the IDP schedule and specifics. However, built-in flexibility of the program allowed me to achieve each component in one manner or another. The travel training budget provided me the freedom to attend necessary courses without competing for slots from within park staff. Integration into the park operation allowed me to tailor IDP components to park needs so that both would benefit. The end result is that the park accomplished programs it never before had the time to do, while I developed expertise and reference materials over a broad range of resource management issues – assets I can apply to future problems.

Over the two yeras, I have communicated frequently with the other trainees and I can attest that the enthusiasm has only heightened. There is a sense of comradery in that we have all faced similar frustrations in our respective parks. There is, too, a sense of professionalism as we recognize the position of Resource Management Specialist and see it rising to its proper place of influence on park management.

I believe that the program has been a success and subsequent programs of its kind will be successes because they sow seeds within the System that will invevitably grow into a group of managers with strong resource management backgrounds. It is this group that will lead the NPS, or perhaps drag it, kicking and screaming, into the 21st Century of natural resource management.

First RMT Class Graduation Slated

By Bob Gartner

Thirty-two trainees, who constitute the first class of the Natural Resource Management Training Program, will gather for the final time at Mather Training Center, Aug. 13-17, for a Remote Areas Management training course. A graduation ceremony will be held on Friday, Aug. 17, for the trainees, who have completed two years of intensive natural resource training.

Two of the trainees will be reassigned to new parks within their Regions, while the remaining 30 will stay in the parks where they trained. The trainees currently are assigned as follows:

Alaska: Brad Cella, Wrangell/St. Elias; Kathy Jope, Katmai; *Mid Atlantic:* Beth Johnson, Delaware Water Gap; Dave Reynolds, New River Gorge; Dave Haskell, Shenandoah; Bruce Rogers, Assateague Island; *Midwest:* John Townsend, Indiana Dunes; Garee Williamson, Cuyahoga Valley; Walter Loope, Pictured Rocks;

North Atlantic: Norm Fletcher, Acadia; Barbara Samora, Cape Cod; Allan O'Connell, Fire Island; Debra Buzzell, Morristown; *Western Region:* John Miller, Southern Arizona Group; Ron Nagata, Haleakala; Tim Tunison, Hawaii Volcanoes; Steve DeBenedetti, Sequoia/Kings Canyon;

Pacific Northwest: Jon Jarvis, Crater Lake; Ed Schreiner, Olympic; *Rocky Mountain:* Jeff Conner, Canyonlands; Larry Belli, Glen Canyon; Steve Budd-Jack, Mesa Verde; Jeff Bradybaugh, Theodore Roosevelt; Jack Gulvin, Yellowstone; *Southeast:* Bruce Freet, Big Cypress; Linda Dye, Biscayne;

Southwest: Frank Buono, Chaco Culture; Steve Chaney, Buffalo River; Steve Cinnamon, Wupatki; *National Capital Region:* Chris Bauman, C&O Canal; Keith Langdon, Catoctin; Gordon Olson, Antietam.

The second class of Natural Resource Trainees will begin in FY 1985. Currently the Regions are reviewing new recommendations to restructure and improve the program, based on the experiences of the present class.

Gartner is the Program Training Coordinator at WASO.

Computerized Library Increases Efficiency, Saves Time, Money

The NPS Pacific Northwest Regional Office has established a Regional Library System using computer technology to provide comprehensive information services to its staff and 17 field areas in the region. Using the Online Computer Library Center (OCLC), the Regional Library can order and catalog all publications for itself and park library collections in Washington, Oregon, and Idaho.

Located in the Westin Building in downtown Seattle, the library will contain the main catalog of all the parks in the region. Park employees no longer need worry about the technical aspects of collection management; they can provide catalog information for a new publication to the Regional Librarian. In most cases a set of catalog cards can be in the return mail.

In addition to a centralized catalog, staff members will be able to borrow from the 2,400 other libraries on the OCLC System, which includes some of the largest natural and cultural resource collections in the country, such as the Department of the Interior Library, other NPS libraries, Alaska Resources Library, Department of Agriculture Library, etc. The OCLC system uses a specially designed Beehive terminal with a dedicated line to the central computer located in Columbus, Ohio.

Computer reference services are an integral part of Regional Library services. The four services currently available are Lockheed Corp., DIALOG; System Development Corp., ORBIT; the Department of Energy, RECON systems; and Bibliographic Retrieval Service (BRS). Each of these systems provides access to approximately 200 databases on different subjects. By searching these databases, the Regional Librarian can produce a bibliography of recent publications or articles on almost any subject.

Managers, scientists, and researchers often conduct surveys of the available literature before they begin a project to avoid duplicating work already accomplished by others, and to study the most recent developments and trends before making decisions. Cost savings realized by using these systems are dramatic . . . on the order of 10 times less expensive than a manual search. These database systems are reached by dial-in through standard telecommunications utilities, such as TELENET, TYMSHARE, and UNINET, using any standard dumb terminal. The PNR Library uses the Hewlett-Packard 2645A terminal for this purpose.

Ellen Traxell, Librarian
Pacific Northwest Region

Regions Get Nod To Continue CPSUs

Cooperative Park Studies Units (CPSUs) passed their examinations with flying colors, according to recommendations of the evaluation team, which conducted a study of the concept and its actual workings as part of the Realignment Committee's Phase 2 operation.

Generally, CPSUs were found to be a productive and good use of a centralized work force to produce benefits for a number of field areas. They supplement the limited number of Service scientists with a wide diversity of professional disciplines and provide a cost-effective source of research. The Park Service benefits greatly, both in effectiveness and in efficiency, from having formal research facilities such as libraries, computers, and staff available to carry out the Service's needs in performing approved research, the Committee found.

The NPS has 17 active CPSUs in 8 Regions, employing 36 fulltime equivalents.

information crossfile

An article by Michael P. Kinch, "Online Information Retrieval for Biologists," in *BioScience* Vol. 34, no. 3, March 1984, discusses the principles and procedures of online searching, including the concepts of boolean search logic and searching strategies. Also discussed are data bases important to biologists and the future role of biologists as online searchers. For additional information, on online literature searching access, contact, Ellen Traxel, Pacific Northwest Regional Librarian at (206) 442-5202 or FTS 399-5202

From Gerry Wright at the University of Idaho CPSU comes the word of a report by L. W. Barnthouse *et al* in *Bioscience*, Vol. 34, No. 1, on the controversy that raged, largely in the courtroom, over the siting of nuclear power plants on the Hudson River, and the resultant effect of cooling water entrainment and impingement on the striped bass fishery. This issue, which spans more than a decade, focused on the development of a succession of increasingly complex mathematical simulation models. These models developed by industry and agency experts respectively, either predicted that cooling water use would have a negligible or substantial impact on the striped bass population (depending on viewpoint). In the long run, this controversy was not resolved through the use of such models. Rather, an accord was reached only after several years of intensive data gathering, which in turn allowed the development of relatively simple empirical models.

The authors therefore conclude that although complex simulation models can be useful for focusing long-term research and monitoring programs needed to solve the pressing environmental problems of the day, the models themselves do not present a shortcut to solutions to those problems. They further point out, this being the case, that biologists as well as the courts must recognize the limitations of their science and recognize that decisions relative to environmental impacts will often have to be made on the bases of incomplete information rather than being deferred indefinitely in the hope that scientists will come up with definitive solutions.

In *BioScience*, March 1984, Ralph E. and Norma F. Good analyze the prospects for fulfilling the land-use regulations endorsed by the Pinelands Commission to protect the New Jersey Pinelands National Reserve. The Goods find that "continued maintenance and enhancement of Pinelands ecosystems will depend on appropriate application of existing knowledge and future studies in such areas as nutrient transfer, the role of fire in nutrient dynamics, sustainable aquifer yields, and the effects of ecosystem fragmentation."

Consideration of a forest tree as a long-continuing entity that changes in form and function over time in its relation to the forest is the focus of a 56-page USDA Forest Service General Technical Report (PNW-164), *The Seen and Unseen World of the Fallen Tree*, recently published by the Pacific Northwest Forest and Range Experiment Station, P.O. Box 3890, Portland, OR 97208. Chris Maser and James M. Trappe suggest, in this report, that a new look at time considerations and at what is becoming known about the structure and function of large woody debris raises profound questions about forest management. The publication examines some new concepts in the light of current forest management practices.

In particular, the report discusses how fallen trees function in providing moisture, support microbial activity, and diversifying fresh water and estuarine habitats.

A companion paper, by the same two authors, entitled "The Fallen Tree – A Source of Diversity" will be contained in *New Forests for a Changing World*, the Proceedings of the Society of American Forestry's 1983 National Conference.

From Roland H. Wauer, assistant superintendent for Resource Management and Science at Great Smoky Mountains NP, comes a detailed look at changes in the NPS resource management thrust from 1979 to 1983 as presented in March at the Fourth Conference on Social Research in National Parks and Wildlands. "I interpret the recent emphasis on resource management within the PS as a trend and not as a fad. It is a grass-roots event that seems to be increasing in scope," Wauer said. The full text of his address will appear in a forthcoming issue of the George Wright FORUM.

Also to appear in FORUM will be an abstract of the keynote address by William E. (Bill) Brown, at the August 16-19 Sun Valley, Idaho, Conference on Parks in the West. Speaking on "Western Parks and the American Character," Brown discusses the "varying success" of our national parklands in allowing the "partly vicarious national experience" of our early heritage to continue. Brown is historian with the NPS Alaska Region and the author of *Islands of Hope*.

Don Johnstone, director of the National Parks and Wildlife Service of New South Wales, writing in the Comment section of the *Australian Ranger Bulletin* (Spring, 1983), suggests that "our organisations, our land managers and officers at all levels must give greater emphasis and play an even more active role in promoting public awareness if our wildlife and wildlands are to survive the increasing pressures that will be placed upon them in the coming years."

A literature review and abstracts of recent publications in the field of human:wildlife interactions are part of the publication *Human Dimensions in Wildlife Newsletter*, put out by the Yale School of Forestry and Environmental Studies. Editors Joyce Berry and Stephen R. Kellert invite material. Their address is 205 Prospect St., New Haven, CT 06511.

Bob Stottlemyer, at the NPS Great Lakes Area Research Studies Unit, sends us the Spring issue of *Bulletin of the Ecological Society of America*, containing an article by Sam Iker, reprinted from MOSAIC – the institutional publication of the National Science Foundation.

Entitled "A Lifetime of Listening," the article enumerates the advantages of long-term ecological research and makes the case for how these seemingly unrelated studies actually "are linked by a common thread." The scientists involved, Iker writes, "are among the handful who have spent decades seeking to decipher that 'vast, pulsing harmony' whose rhythms, as Aldo Leopold put it, span not only the seconds but also the centuries."

There are signs, according to Iker, that the importance of continuity in ecological research is now being recognized by the scientific establishment. He describes a newly launched pilot program sponsored by the NSF – a network of 11 long-term ecological study sites established across the United States and containing a variety of ecosystems, from alpine tundra to oak savanna to freshwater swamp. Each site has a coordinating investigator, a site director, and a number of researchers from various disciplines who will focus on key aspects of the particular ecosystem. Whether or not this "golden opportunity" is seized, says Iker, depends on how many young scientists come to believe in long-term ecological research as "a new frontier."

From Bruce Kennedy, manager of the Statewide Planning Section, California Department of Parks and Recreation, comes a just released study, *Stewardship – 1983*, summarizing statistical data on natural resource threats to California state parks and making a wide range of recommendations for remedial policies, programs and actions.

Inspired by the NPS *State of the Parks* study of 1980, the California study examines the number, nature, severity, and priority of threats to the natural and scenic resources of the state's 267 units. Focus is on threats to the five basic natural systems – air, water, soil, vegetation, and animal life. Aesthetic values are included and strong emphasis is given to threats to the agency's ability to properly manage its lands. Summary figures are provided for all threat categories and, based on measures of severity and priority, a dozen of the worst categories of threats are identified.

This report, along with a separate working appendix on methodology and on statistical analyses, is of general interest to managers of large, resource-based parks, reserves, or sanctuary systems. Copies of *Stewardship – 1983* are available for $3 (postage paid) from the California Dept. of Parks and Recreation, Distribution Center, P.O. Box 2390, Sacramento, CA 95811.

Cumulative Effects of Forest Practices on the Environment: A State of the Knowledge, is the title of a recent publication prepared for the State of Washington's Forest Practices Board and funded in part by the National Park Service. The 268-page publication was compiled and edited by Rollin R. Geppert, Charles W. Lorenz, and Arthur G. Larson and is available from the Washington Department of Natural Resources, Photos, Maps & Reports OW-21, Olympia, WA 98504, for $7 per copy.

The book's foreword describes the attempt to single out problems and solutions in terrestrial and aquatic ecosystems as "an on-going, reiterative process tempered by social economic perceptions. There are few absolute answers . . . What we know best is what happens today."

The report objectives are to "bring about progressive change in the way forest managers perceive their problems, cause researchers to work more closely

Information Crossfile

(Continued)

with forest managers and administrators to fill data and knowledge gaps, and provide administrators with new perspectives on environmental effects of forest practices."

Monitoring by "whole guild inventories" – a new approach to evaluating wildlife and wildlife habitat – is described in *Forestry Research West* (September 1983), published by the Western Forest Experiment Stations, USFS. Jared Verner, research wildlife biologist at the Pacific Northwest Station (809 N.E. 6th Ave., Portland, OR 97232) describes a wildlife guild as "a group of species that exploits the same class of environmental resources in a similar way."

Author Dennis G. Hanson makes an interesting connection between the term "guild" as it is used in the wildlife inventory approach, and the Anglo-Saxon root word "gild" – a penitent offering, a protection against the future. Hanson points out that the guilds can be grouped in a number of ways, depending on management needs. The plan, which is being tried by the Sierra National Forest in California, uses integrated monitoring at three levels: (1) Species – only those management indicator species required by law; (2) Management guilds – guilds of birds in three habitats especially vulnerable to change by human activities; and (3) Habitats – most wildlife species to be monitored by inference from trends in habitats based on knowledge of each species' habitat requirements.

Landscape architecture students at the Harvard Graduate School of Design took their act to Yosemite NP last fall and developed a program to evaluate environmental changes in the park, using a geographic information system. The project was written up in the March 30, 1984 issue of the *Harvard University Gazette*.

The system is a computer mapping program often used by natural resource managers, urban planners, and market strategists to process spatial data. The geographic software system can be used to create and display maps as well as to analyze problems in a given study area.

Jan van Wagtendonk, research scientist with the NPS/CPSU at U.Cal Davis, and based at Yosemite NP, is in charge of developing the Yosemite data base that will make such a system useful for resource management. Van Wagtendonk has his information down to 15-meter resolutation (compared to the "quick and dirty" 100-meter resolution of the graduate school project) and is currently working with Maury Nyquist and Harvey Fleet of the Denver Service Center, where the data sets for Yosemite are being created.

The popular press (*Newsweek*, Dec. 5, 1983) has taken note of the decades-long studies of wolf-moose, predator-prey relationships on Isle Royale and the fact that such studies are "of more than academic interest." In a signed article by Sharon Begley and John Carey, *Newsweek* described the unfolding information that only such lengthy research can hope to uncover. Much of this information turns out to be counter to "the conventional wisdom." Rolf Peterson of Michigan Tech University described the greatest surprise to emerge from the on-going study – that the wolf packs do not help "balance" nature, but instead cause moose numbers to fluctuate even more wildly than they would without the pressure of the packs.

Heavy Trace Metal Deposition Studied

Gary Larson, Regional Chief Scientist, and Robert Stottlemyer, Department of Biological Sciences, Michigan Technological University (MTU), are co-investigators in a new study of heavy and trace metal deposition in the Great Lakes Basin. This research involves national park units in Ohio, Indiana, Michigan, Wisconsin, and Minnesota.

The best available EPA and state deposition data suggest that across these states there exists a pronounced west to east gradient of increasing atmospheric metal inputs. Chief objectives of the research are to continue monitoring of atmospheric inputs; determine metal input-output budgets in small gaged watersheds in each park unit; determine concentration levels in selected ecosystem biotic and abiotic components; and see if correlations exist between past and present atmospheric inputs, ecosystem retention, and organic decomposition rates.

This research is designed to complement a Basin-wide study initiated last year on small gaged watersheds located in these national parks. Increasing from west to east across the Great Lakes Basin is one of the most pronounced gradients of acid deposition in the United States. Historical data suggest this gradient has been in place for some time. This provides an opportunity to undertake time-trend analyses on the responses of watershed ecosystems to anthropogenic atmospheric inputs. Stottlemyer is principal investigator for this study.

Spring 1984 also starts the third year of research on the long-term study of ecosystem responses to acidic precipitation on Isle Royale. This work is being carried out at the Boreal Research Station on Isle Royale and at MTU.

Objectives of this research are to look at long-term changes in critical plant mineral nutrient budgets and in selected biotic components which might indicate effects due to acid deposition. Three lake watershed ecosystems, representative of the diversity of perennial surface-flow systems in the Lake Superior Basin, are under study. They are thought to vary widely in their "sensitivity" (buffering capacity) to acidic deposition.

Isle Royale is one of four national parks involved in this research coordinated by Ray Herrmann of the Water Resources Field Support Laboratory in Ft. Collins, CO. The other national parks are Olympic, Rocky Mountain, and Sequoia.

This report was submitted by Stottlemyer and Larson.

In the hindsight afforded by the 1980 Mount St. Helens volcanic episode, geologists have been looking with new eyes at an old question: what event or events were responsible for the "dimpled hills" that make up the land area surrounding California's Mount Shasta? Piecing together the Mount St. Helens story and applying the information to the geologic evidence found around Mounta Shasta, five USGS scientists have concluded that the Shasta Valley represents the largest known landslide of the past 2 million years, according to an article by Richard A. Kerr in the April 20, 1984 issue of *Science*.

A recent study by Lee Siebert of the Smithsonian Institution found that only half a dozen of the world's more than 75 identified debris avalanche deposits are known to exceed the 2.8-cubic kilometer volume of the St. Helens event. "But the Shasta deposit's volume is a mammoth 26 cubic kilometers," Kerr writes, "and covers at least 450 square kilometers . . . The horseshoe shaped scar that the avalanche presumably left on the mountain had healed in the approximately 300,000 years since the slide, but the deposit itself closely resembled those at St. Helens and other volcanoes." Siebert's article, in press, will appear in the *Journal of Volcanic Geothermal Research*. The five USGS scientists who "discovered" the Shasta landslide, are D.R. Crandell, C.D. Miller, H.X. Glicken, R.L. Christiansen, and C.G. Newhall, and their article appears in *Geology*, 12, 143, 1984.

From Prof. Robert B. Ditton, Texas A & M Department of Recreation and Parks, comes word of the one-week training course dealing with visitor aspects of natural resources management, held last December at the University at College Station, Texas. The course provided a grounding in current understandings of the park visitor and stressed the importance of considering visitors in managing National Parks. It was part of the NPS's Natural Resources Management Training Program, involving approximately 35 NPS employees in a series of assignments running 24 months.

Faculty included Gary Machlis and Don Field, with NPS/CPSU's at the University of Idaho and Oregon State University respectively, plus 11 additional faculty members from Texas A & M, the University of Maryland, Purdue University, and Utah State University.

Mount Rainier Hosts Research Symposium

Approximately 50 men and women concerned with scientific research and resource management in the Pacific Northwest gathered on their own time at Mount Rainier National Park on the weekend of January 21-22 to exchange research findings and ideas for their application to park management.

Nearly a score of presentations were made in the course of the tightly programmed weekend. Most of them dealt with research in the host park, but they included two presentations from Olympic NP as well as reports on the general topic of air quality and sulfur baseline monitoring . . . concerns that cannot be compartmentalized or handled on a single park basis.

Subject matter ran the gamut from spotted owl habitat and goat surveys to rates and patterns of tree bole decay and included a lively discussion of the NPS mission to conserve and its relationship to basic research.

William Briggle, then superintendent of Mount Rainier NP and now Deputy Director of the Pacific Northwest Region, opened the meeting and welcomed participants. Abstracts of all the presentations were collected and compiled by Robert Dunnagan, Assistant Superintendent of Mount Rainier and host for the conference. Abstracts of many of the papers are available in duplicated form from Dunnagan, Mount Rainier NP, Tahoma Woods, Star Route, Ashford, WA 98304.

Transport Crate Facilitates Goat Removal

By Bruce B. Moorhead

Wildlife problems in parks can lead to need for safe and practical means of translocating animals. Crates or other enclosed containers, tend to quiet as well as secure captured animals in transit. Emphasis, however, is often on strength (and weight) more than portability and animal care. An experimental program to translocate non-native mountain goats from Olympic National Park has led to the development of a maneuverable, 90-pound crate that is easy to make and may be adaptable to other wildlife species.

In three years of capture operations, 25 of these crates have been used repeatedly in translocating more than 150 goats from the park. The crates have survived much wear and tear, requiring only minor repairs. Animals are placed in them as soon as possible after capture and transferred successively by helicopter and truck to release sites 100 – miles from the park.

The crate is scaled in design to goat dimensions, and measures 48 x 17 x 49 inches exteriorly. The narrow, rectangular shape encourages goats to remain upright and expel ruminant gases, and discourages them from twisting around and becoming injured in transit. The sides and top are constructed from a sheet of ½ inch exterior plywood. Sides also are reinforced at three locations with ¾ inch wide metal strapping; interior joints are reinforced with 1 inch chamfer strips. The floor is ¾ inch plywood; longitudinal treading is optional to improve footing and encourage internal drainage.

Animals are loaded through a vertically sliding gate at one end. Gates at both ends of the crate aid in unloading animals, but also require added reinforcement (and weight) to the crate. Openings are spaced along the sides, top, and on the floor to provide ventilation and to drain urine and melt water from crushed ice placed beneath the animal as a coolant and water source. A wooden cleat on the gate protects fingers when the gate is being lifted or closed. The gate is fastened, up or down, by lock bolts mounted atop the crate to fit through matching holes in the gate.

The crate exterior is painted with a light-colored latex to reflect sunlight and counter heat build-up within. A number code stenciled on the top, sides, and door, aids in keeping track of the animals. Vital information about each animal (size, medications, etc.) is stapled to the respective crate in a zip-lock bag. The empty weight of the crate is stenciled on the top and sides to assist in rapidly calculating helicopter loads.

Crates are moved to and from capture locations, 2 to 4 at a time, in helicopter slingloads. Loaded crates are maneuvered at helicopter landing sites by 2 to 4 people lifting them (like a sedan-chair) with lengths of plastic pipe suspended through nylon loops on the sides of the crate. Most goats weigh in the 75 to 200 pound range. Large males over 250 pounds have been successfully transported, but a bit confined by a crate of these dimensions.

This design was adapted from a standard crate for hooved animals described in the *Animal Restraint Handbook* by D. Jessup and W. Clark of the California Department of Fish and Game. The improvements are a collaborative effort by park rangers, scientists, veterinarian Jim Foster, and park carpenter Spence Thompson.

Moorhead is Management Biologist at Olympia NP.

Oregon Bighorn Transport

Fifty-two bighorn sheep from Hart Mountain National Antelope Refuge in Oregon are now in residence at new sites in Southeastern Oregon after the Fish and Wildlife Department's most successful sheep live-trapping effort ever. Success was largely due to a contracted helicopter pilot with "extreme flying agility and a sixth sense that tells him when to push the sheep and when to back off," according to a F&W Department press release.

The transplant is part of long-term department efforts to reestablish bighorn sheep in much of its historical range. The California subspecies of bighorn once inhabited most of the open rimrock desert, river canyons, and rugged mountains of southeastern Oregon. Their disappearance from the state by 1915 is believed by biologists to have been caused by early over-hunting, competition with domestic livestock for food, and diseases brought in by domestic sheep.

The transport operation was held during the fall "rut." The sheep were hauled in pickup trucks or horse trailers to three release sites after being herded by helicopter into previously established traps. The animals all were in good condition, "hauled well," and quickly dispersed upon release. Some of the animals were medicated to help them past the stress of transport.

Grand Canyon Assesses Effects on Beaches of 1983 Flooding

By Nancy Brian

Prior to completion of Glen Canyon Dam, the Colorado River through Grand Canyon experienced wide fluctuations in flow as a result of spring run-off and summer thunderstorms. The pre-dam spring floods were heavily silt laden and had a mean discharge of 86,000 cubic feet per second (cfs). As the floodwaters receded, terraces of fine-grained sediments were deposited on the banks of the river channel.

In 1963, Glen Canyon Dam was completed and Lake Powell began to fill. Since that time, normal dam controlled discharge has ranged between 1,000 and 31,000 cfs, with a median discharge of 12,200 cfs. Because of the retention of sand and silt in Lake Powell, the sandy terraces, (colloquially termed beaches), have been progressively eroded by wind deflation, sheet wash, flash floods, mass wasting, and reworking by fluctuating river flows. In 1976, sediment hydrologists predicted that beaches below Glen Canyon Dam will vanish within about 200 years. However, the rate of beach erosion has been slowed by the dense band of riparian (or streamside) vegetation which has become established in areas formerly scoured by the pre-dam floods. Since 1972, the beaches have been utilized by up to 15,000 river runners per year with use concentrated on approximately 100 popular beaches. Concomitantly, wildlife has colonized this newly vegetated streamside zone, a habitat which has become rare in the largely arid southwest (See *Park Science*, Vol. 4, No. 2 article "Effects of Colorado River Flooding on Riparian Nesting Birds Studied" by Brown and Johnson).

The public and park managers became concerned about the fate of the beaches during June 3 to August 11, 1983, when flows from Glen Canyon Dam exceeded the 1963-1982 levels. Unseasonal precipitation and rapid thaw in the Upper Colorado River Basin states during spring 1983, resulted in unprecedented inflow into a nearly full Lake Powell. In response, the Bureau of Reclamation released flows from Glen Canyon Dam which ranged from 38,000 cfs to over 90,000 cfs. The high flows, approximating the pre-dam floods, submerged campsites and inundated riparian vegetation. Beach sediments were either actively reworked on site, transported and redeposited downstream, or removed from the system to Lake Mead.

The receding floodwaters revealed an altered riverine environment. To assess the changes in size, number, and distribution of beaches, personnel from Grand Canyon National Park's Division of Resources Management and Planning made an inventory of the status of the beach campsites two months after the high flows. Results were compared to a similar beach inventory conducted in October, 1973. The rapid erosion that occurred at many sites is evidence that beaches are not yet in equilibrium.

Campsites in existence prior to the high flows had various fates: some were removed or reduced in size, others were replenished or scoured, and some showed no appreciable change in beach profile. New deposits not in existence prior to the high flows also were created. In areas where the current was accelerated by high river gradient and constricted channels, sediment was eroded; conversely, in areas with reduced velocity due to lower gradient and wider channels, sediment was deposited. In many straight stretches of the river, sediment was deposited *behind* the dense band of shoreline vegetation. The 1983 high water deposits range from ephemeral dunes undergoing rapid erosion by shoreline currents to persistant deposits protected by woody vegetation and or rock armoring.

Riparian vegetation inundated by the high water flows likewise experienced a range of impact: some stands showed little effect, while in other stands vegetation was damaged, killed, buried, or removed. It was observed that understory vegetation (grasses, herbs, and sub-shrubs) was more severely damaged than woody tree and shrub species, and native species were more severely impacted than exotic species. Post-dam riparian vegetation succession appears to have been set back to conditions existing 10 to 15 years ago. However, the pre-dam old high water line vegetation (honey mesquite and acacia zone) situated above the 90,000 cfs waterline benefitted from the high flows. New, vigorous growth is evidence that these species were well watered by the high flows.

Potential Colorado River beach campsites numbering 443 were identified between Lees Ferry and Diamond Creek (excluding areas closed to camping). Large campsites (capable of holding 35-40+ persons) comprised 38 percent, with medium camps (21-30 persons) 36 percent, and small camps (15-20 persons) 26 percent. A majority (44 percent) showed active erosion taking place, while 31 percent exhibited

MARBLE CANYON CAMPSITE, *located at River Mile 19.3 is shown here on three dates – before, during and after the flood event. The Before photo was taken in 1973; the During photo was taken in June 1983, with river flow at approximately 60,300 cubic feet per second; the After photo was taken October 1983.*

Before

During

After

no erosion and 25 percent showed inactive erosion. In areas along the river corridor critical to campsite selection due to a scarcity of camps, four campsites were removed, while numerous new sand beaches were deposited in non-critical sections.

The comparison between the post-high water campsite inventory and a 1973 beach inventory showed the variety of change. A total of 227 campsites was identified in both surveys. Forty-two percent exhibited no discernible size change; 30 percent increased in size (due to sand deposition and/or vegetation removal); 28 percent decreased in size. Twenty-four campsites were either removed by the 1983 high water or so depleted in size that they no longer qualify as campsites. Thirty-two campsites were lost prior to the 1983 high water flows due to overgrowth by vegetation, erosion by fluctuating river currents, or tributary canyon flash flooding. Eight-six pre-existing campsites were increased in size by sand deposition and/or by vegetation removal. Fifty new beaches were deposited where none existed previously.

The 1983 high water resulted in a net movement of sediment downstream as reflected in the general decrease in size and number of camps in the upper 140 river miles below the dam and an increase in size and number of campsites in the lower 140-209 river miles. Sediment from the river bed brought into the system from tributaries since the completion of Glen Canyon Dam may have contributed to the river's sediment load during the 1983 flood event. These river bottom sediments would have substantially contributed to the aggraded beach profiles.

Changes in campsite distribution brought about by the 1983 flood event have not required park managers to modify the level or pattern of river running. Sufficient camps remain throughout the canyon to accommodate established use levels. However, future change in number, size, and distribution of beaches is expected to occur. The Bureau of Reclamation began releasing 43,000 cfs on May 7, 1984, in anticipation of the predicted 178 percent of normal run-off. If the river bed has been substantially degraded by the 1983 high flows and there has been little input of sediment from tributaries, the 1984 high flows may result in a greater net loss of campsites than experienced in 1983, especially in the upper reaches.

The future of the Colorado River beach resource is difficult to predict even with normal post-dam flows. Fluctuating flow regimes affect not only erosion rates but also the vegetation communities, their associated fauna, and the river running industry. In December 1983, the National Park Service in cooperation with the Bureau of Reclamation, and the Arizona Department of Game and Fish initiated research to quantify the impact of Glen Canyon Dam release patterns on the natural and recreation resources. Areas of investigation include sediment transport and erosion, terrestrial and aquatic biology, and river recreation. Results of these projects, to be completed in October 1986, will identify dam operating procedures that may minimize impacts on downstream resources. However, any change in the operating criteria for Glen Canyon Dam will follow an environmental impact statement produced by the cooperating agencies.

The fate of the Grand Canyon riverine environment is dependent upon the interaction of dam management and the dynamic nature of the Colorado River. Preservation of downstream resources will be enhanced by cooperation between Government agencies, public input, and results of the on-going research.

Brian is a Park Technician at Grand Canyon NP.

Buffalo River Air Project Publicized

"A soft, steady whir emanates from a secluded ridgetop above Arkansas' Buffalo National River. A few drops of rain begin to fall. As if by magic, a pyramidal metal plate glides through the air. Not far away on a tall metal tower, a black box clicks. Is it an invasion from outer space? No just a routine data collection at Buffalo River's air quality sampling site."

This catchy lead, designed to lure the average reader into "the rest of the story," is the way Park Volunteer Connie Toops opened her May 23 news release describing Buffalo National River's air quality data collection work.

The release goes on to describe the fine particulate sampling station and how it works as one of approximately 100 such sites sponsored by the National Atmospheric Deposition Program (NADP), the way the park is conducting its visibility study, and the park's air quality monitoring site role as one of 38 collection points for the Arkansas Department of Ecology and Pollution Control.

"Although northwestern Arkansas is not heavily industrialized," the release concludes, "park studies reveal impact from emissions originating as far away as the Gulf Coast and the Ohio Valley. Resource management personnel at Buffalo NR . . . expect to benefit from the air quality data being collected for years to come."

***A resource management technician** at Buffalo National River replaces the drum graph in the NADP recording rain guage. The instrument charts the intensitv and duration of each rain or snow shower which falls on the sampling site.*

Editor's Note:
The Spring issue of Park Science *was devoted to computer news from all over the NP System. Every entry did not get in on time, and some that did make the deadline couldn't be squeezed into the 24 available pages. Here, then, is the "overset," as the first of a special section on computer news that will appear in the future as developments warrant.*

Air, Water Quality Computer Uses

The Air and Water Quality Division uses computers for four basic purposes: word processing and administration; data management; data analysis; and modeling. The types of equipment in each of the three divisional locations are determined by the functional needs of the office. WASO uses two Lexitron word processors, with communication capabilities, and a CPT word processor. Denver uses two Lexitrons with communications, a Tektronix 4052 interactive graphics plotter, and has access to the Bureau of Reclamation CYBER mainframe. In Fort Collins a Multi-Net multi-user computer supports a variety of word processing, communications, data management and data analysis software packages; a Data Point system and communications, in addition to access to the extensive Colorado State University CYBER systems, also are available.

For administrative purposes, the computer capabilities have grown very important. Telecommunications among all the word processors allows the transfer of text from office to office with a minimum of re-typing. It also provides access to the NPS Electronic Mail system and other service-wide data base management systems. The Lexitron RMS and the "Star programs" — CalcStar, DataStar and SuperSort, which are all compatible with the WordStar word processing package on the Fort Collins multi-user system — facilitate project management and routine administrative tasks.

Data management — the organization and reorganization of vast quantities of data — is handled on two of the Fort Collins and two of the Denver systems. Programs are being developed to handle a hydrological data base on the Data Point, while the Multi-Net supports a separate visibility data base. The status of permit reviews is maintained on the Tektronix in Denver. NPFLORA, which catalogs and sorts flora identified in park units, resides on the Denver CYBER.

Data analysis frequently requires fast computer systems, fondly called "number crunchers." Any of the programmable Air and Water Quality systems is capable of data analysis, but the very powerful CYBER systems are available for complex or extensive analyses.

Modeling is a predictive type of data analysis. The Tektronix in Denver plays a significant role in the permit review process by modeling the concentrations to be expected from sources of pollutants. Hydrological (river flow and water release) and air quality modeling are performed on the Colorado State University CYBER systems. A special application is the computerized imaging which generates photographs depicting visibility conditions arising from given pollutant concentrations at a vista.

A promising direction for future development of computer uses lies in field research. Already a portable computer (Atrona Attache) is used to control the ZAPS fumigation system developed to determine *in situ* air pollution sensitivities of vegetation in park units. The Atrona, with the appropriate interface, reads output from air quality monitoring and meteorological equipment, then stores and manipulates real-time data developed during fumigation models. Another growth area is the optical portion of the visibility monitoring program. Increasingly automatic monitoring sites are being used to collect greater amounts of data more efficiently and accurately. Electronics control the automatic equipment and transmit data to a satellite. A ground station collects these signals and transmits them to the Air and Water Quality Division for analysis. Computers control the system, from collection to transportation to analysis of the data.

The creativity and usefulness proven by the existing systems indicate that insufficient imagination may be the *only* limitation to the fruitful relationship between computers and air and water research.

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For more on computers see the following pages.

New Book Takes Look At How People Behave

On Interpretation: Sociology for Interpreters of Natural and Cultural History, Gary E. Machlis and Donald R. Field, editors, takes a sociological approach to the basic element of successful interpretation – namely, how people behave toward one another, how they live, how they work, how they enjoy themselves.

This 176-page paperback book, with a foreword by NPS Director Russell E. Dickenson, was published in 1984 by the Oregon State University Press in Corvallis. The book is divided into three sections: Toward Theory and Technique, Case Studies, and Essays: it even includes a "radical" (and dissenting) view – the paper by Kenneth L. Nyberg based on his 1977 presentation to the Association of Interpretive Naturalists.

Various authors examine a wide range of interpretive situations for useful strategies and approaches. Children, family camping, the elderly, the Japanese tourist, cruise ship travelers – these are just a few of the facets of interpretation covered in this collection. The overall thesis is that sociology and interpretation can be useful partners.

Machlis is an assistant professor in the departments of forest resources and sociology at the University of Idaho and is sociology project leader for the NPS Cooperative Park Studies Unit there. He co-edits the *Journal of Interpretation.* Field is senior scientist (sociology) for the NPS/CPSU at Oregon State University, a professor of resource recreation management there, and co-editor of the journal *Leisure Sciences.*

On Interpretation is available for $11.95 from the Oregon State University Press, 101 Waldo Hall, Corvallis, OR 97331.

Uplands Research Lab Computers Versatile

By John Peine

What a difference a year makes! Uplands Field Research Laboratory at Great Smoky Mountains NP purchased an IBM PC with all the standard accouterments early last year. Just as importantly, we hired Mark MacKenzie, a Ph.D. candidate in plant ecology from the University of Tennessee, to computerize as many of our program functions as possible. As a result, the computer plays a role in all laboratory functions now.

Our primary computer application is, of course, research data entry and analysis. The computer has been programmed to be self prompting, allowing anyone with or without computer experience to enter data. We have developed a system for data management that includes clear documentation, duplicate sets for storage, and realistic programming of resources for data entry and analysis. We also advertise that the data are available for outside scientists to use – data marketing, if you will, to get as much mileage out of it as we can. Eight different field studies were being conducted simultaneously last summer, involving over 40 people. Within six weeks of the end of the field season, all data were entered and proofed, and within four months, all data analysis was complete. Our high-speed printer and phone modem has allowed us to hook up with the University of Tennessee main frame computer to analyze our data using the larger, more sophisticated statistical packages.

We have also used the IBM PC to write a number of programs which allow us to perform analysis other than statistics. Programs have been written to estimate fish population size from electroshocking data, summarize vegetation data collected from field sampling, and to randomize creel surveys. We hope to develop a program to estimate mast crops.

In Great Smoky Mountains NP, the vascular plant checklist has been automated and developed into a series of expanded data bases. Each of the separate data bases concerns a particular theme. For example, one data base includes the status of the plants on state and national rare endangered species lists. Another data base includes the geographic and habitat distributions of the species. We have developed a data base from information about wildlife food habits and have expanded information about exotic status to record country of origin and current status in the park's flora. In all, there are seven separate themes: life history and growth form, phenology and floral biology, habitat distribution, geographic distribution and rarity, exotic status, wildlife food habits, and air pollution sensitivity. The seven themes include a total of 50 variables. With some 1500 vascular plant taxa in the GRSM flora, this makes 75,000 individual pieces of information. Additional useful themes can be envisioned – for example, suitability of the native species for use in cultivation around park visitor centers and parking lots. We will also be adding a list of plants found along the Foothills Parkway that are not yet known within GRSM itself – the Parkway is administered by the GRSM Superintendant.

Peter S. White, Research Biologist

Another research application of the IBM PC is computerization of the vascular plant check list. It is hoped that when this data base is completed we will have ready access to information on rare and endangered species in GRSM, along with other information pertaining to plant species within the park.

We receive, and print daily, reports over the telephone life from our Look Rock air quality station. Parameters reported include SO_2, O_2, TSP, meteorological data, and data from teleradiometers. We hope to include data from a continuous pH monitor for wetfall. We plan to receive satellite data from the USGS transmitted from a remote weather station on Clingmans Dome.

Our most ambitious application of the IBM PC is to use the remote sensing and cartographic data base being developed for the park by the Geographic Information Systems Unit in Denver. We want a hands-on terminal for this data base which will eventually include vegetation, topography, watersheds, stream systems, disturbance history, soils, geology, roads and trails, buildings, etc! A demographer at the University of Tennessee is helping on this.

Not only has the IBM PC been used for research, but it also has been used for a number of administrative activities. The mailing list for the annual science meeting has been computerized and identified by various categories. Now, 400 to 500 mailing labels can be printed in about 30 minutes. We are currently in the process of creating programs to simplify the budgeting and bookkeeping operations at Uplands. A data base program also is being developed to store inventory information in order to track the location and condition of equipment used by the Lab.

Peine is a sociologist and director of the Great Smoky Mountains Upland Lab.

IBM Personal Computers

By Dominic Dottavio

For the past two years the NPS Southeast Region has been developing microcomputer capabilities throughout the parks of the region. These efforts have resulted in a network of over 50 IBM Personal Computers (PC). Concurrent with this effort, the College of Forest and Recreation Resources at Clemson University has been engaged in a program to upgrade the management of natural areas through a regional information/communication network. The University's program received major impetus through the location of an NPS Cooperative Park Studies Unit (CPSU) in the College. One of its missions is to assist in developing the regional NPS computer system. The College viewed the National Park Service's developing network as a model that should be emulated by other federal and state land management agencies.

As both programs developed, it became clear that the capabilities of the technologies were outstripping the capabilities of the users to make full and creative use of the systems. Both organizations were concerned that the personal computer network would fall short of its promise due to human constraints.

To address this problem, the College of Forest and Recreation Resources and the Clemson CPSU approached International Business Machines, Inc. (IBM) seeking the company's cooperation and partnership in developing a training laboratory featuring the IBM Personal Computer. In September, 1983, IBM responded favorably to the request.

The proposed laboratory will be located on the Clemson University campus adjacent to the CPSU and will provide network links to the NPS system. The laboratory will be wired to accommodate PC to PC communication, PC to main frame (the Clemson IBM 3081) communication, and stand-alone PC capabilities.

IBM is viewing the lab as a showpiece on networking possibilities and is therefore considering installation of the most advanced communication systems available for the Personal Computer.

Equipment for the laboratory will include 19 IBM Personal Computers, with a least one of each model type being represented; printers, instructional projection monitors, modems, and a variety of application software. In total, the grant from IBM is expected to approach one-quarter million dollars.

This facility is being viewed not only as a showpiece for displaying sophisticated equipment, but also as a model of federal, state, and private sector cooperation and partnership. The combination of the resources and talents of the three organizations has resulted in a mutually beneficial, cost-effective means of meeting the needs of each organization.

Dottavio is Research Coordinator at the NPS/CPSU, Clemson University.

Back Country Permits Computerized

By Bob Flewelling

In the summer of 1973 a comupterized system was initiated for processing backcountry use permits from North Cascades NP. The system, developed at the University of Washington, NPS/CPSU, had as its immediate goal the provision of summary information for management on backcountry use. In 1974, three more parks — Mount Rainier, Olympic, and Mount McKinley (now Denali) — were added to the project. In 1977, computer processing responsibilities were turned over to the Washington D.C. office, to be done on a Service-wide basis. This service was discontinued in 1980, and once again backcountry permits from Pacific Northwest parks were processed through the CPSU. Since that time, permit processing services have been extended to include Grand Canyon NP, whereas Mount Rainier NP has developed its own on-line computerized system.

For most parks, at present, backcountry permits data are processeo only at the end of each calendar year. The system generates a set of tables summarizing backcountry use and user characteristics for individual months and for the entire year. The tables produced in a standard run summarize the following:

Travel zone use: number of parties, people, and visitor nights for each travel zone in the park; entry and exit point use; number of parties camping each night of year; number of people camping each night of year; origin of visitors; length of stay in the backcountry; and group sizes.

The computerized system can produce any number of specialized information tables as well, tailored to the specific needs of individual parks.

The permits from all parks involved are sent to the University of Washington, where their information is transferred to magnetic disk files via data entry terminals . . . a task performed by a professional data entry service.

Data processing is done on a large mainframe computer system (CDC Cyber) at the University of Washington. The tables are printed on standard 11" x 14" computer output paper and sent to backcountry managers in the parks. Both the data and copies of

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Back Country Permits (Cont'd)

the final reports are saved on computer files for future access.

Programs for processing permit data are written in Fortran Extended. Version IV. The programs contain rudimentary documentation. Although most medium to large computers do process Fortran programs, some changes in the programs, requiring an experienced programmer, would be needed to accommodate a transfer to other regions on other computers.

Probably most important to managers and/or district rangers is information on the amount of use in various background areas. Although field personnel usually have a fairly accurate idea of how much use is occurring where, the computer outputs quantify this information and portray it objectively. Use information is especially valuable in low use areas where no backcountry personnel may be stationed. Statistics for each travel zone help guide assignment of seasonal personnel to areas where they are most needed. These figures also may help management decide where interpretive programs, trail maintenance, bridge repair, horse facilities, etc., are needed. Use statistics also help identify areas receiving intense visitation and can aid management efforts toward visitor redistribution. Finally, when integrated with physical impact or wildlife data, use statistics can be important in setting and defending use limits where resource protection becomes an acute concern.

Information on the origin of visitors also may help identify where public information efforts can be most worthwhile and where public input should be solicited when required for management decisions. The burden of year-end reporting requirements can be lightened considerably if accurate permit data are available.

North Cascades has constructed special travel zone codes for the 84 climbing peaks within that park. Their codes allow for designation of whether each climbing group reached the summit of each peak attempted. Keying on these codes, a special program generates a climbing summary table for that park. A table of boat use statistics also is produced for North Cascades.

Only slight use of backcountry permit data in applied research efforts has yet been made, although it would seem that much potential exists. A valid concern to research efforts is the accuracy of data. Studies of backcountry permit compliance have yielded estimates of compliance ranging from 72 to 97 percent. Discrepancies between individual permits and actual itineraries are an additional source of error. Thus backcountry permit data must be used with some degree of discretion.

As resource managers become increasingly familiar with computerized information bases and their applications, the various uses of backcountry permit data may become better defined. Permit data offer a number of potential specialized applications specific to needs of individual parks. An important component of the effort with Pacific Northwest Region has been the opportunity for interaction between park managers and data analysis personnel. Park managers must be creative and communicative with their ideas as to how they might make use of permit data. Conversely, those responsible for data analysis must be equally able to work and communicate with park personnel in seeing that permit data are analyzed and presented in meaningful ways.

Recent acquisitions of microcomputers within the parks may change the centralized role now held by a single large computer. Use of microcomputers for storing and processing permit data is especially appealing to parks that have backcountry reservation systems or travel zone limits. A good microcomputer system can be programmed to handle a permit reservation or allocation system, provided proper care and testing go into the design of the system and trained personnel are available to implement it.

An important feature of this type of system is that permit information may be saved as it is entered for future analysis. Considerable effort would be required to develop programs at the CPSU, although it could be done. Mount Rainier NP implemented its own computerized permit system in 1983, and was able to summarize the permit data using programs developed on contract.

Centralized processing of permit data will most likely continue to be an important service for parks which do not require an on-line computerized system of their own. Such parks would include those that do not have a backcountry reservation or use limit policy. For parks which do develop these capabilities, it would still be reasonable to consider eventual transfer of data files to a large computer for more extensive processing or storage for future analysis.

Unfortunately useful, accurate, computerized information management systems are not likely to be implemented easily or cheaply. All too often computer equipment and software are purchased with high expectations, only to result in frustration and disappointment. Developing tailored systems involves time and trained programmers, and without adequate personnel allocation progress is bound to be slow. Prepackaged systems and software often are not capable of meeting individualized needs without at least some degree of tinkering. Thus trained programmer help is nearly always necessary. Contract programming is an option in some cases, although explicit definition of the tasks involved and products desired is essential.

At the other extreme are large, centralized data management efforts with little or no opportunity for interaction between data processing personnel and the users of the information. Such attempts remove the data processing burden from individual parks, but may be so far removed and unresponsive to individualized needs as to be of marginal use. Certain types of very standardized resource management data are appropriate for this level of processing, although even here good communication among involved parties is essential in the initial stages.

An efficient approach to a number of data processing needs in resource management involves strong communication between parks and regions. Organizations with similar types of data and similar needs, may find they can share the costs of development. Ease of transference from one organization to another depends on the similarity of the informational needs and computer equipment of the organizations involved. In most cases, there will be differences. Adaptations will be necessary, and personnel will be needed to accomplish them. Given these limitations, much effort may still be saved through the sharing of ideas and technology.

As computerized information bases come to play a larger role in natural resources management, it will become apparent that careful, sometimes painstaking, efforts are involved to obtain high quality results. Concern for quality begins at the data collection stage and is required throughout the process. Costs of developing useful systems need not be excessive, but they do need to be approached with the proper resources, personnel, and expectations.

Flewelling is Staff Programmer with the University of Washington NPS/CPSU.

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