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Great Smokies Streams Acidified By Anakeesta Formation Exposures

By Darlene J. Kucken, Richard P. Maas, and Steven C. Patch

Exposed Anakeesta Formations, located within the Great Smoky Mountains NP (GSMNP) along Anakeesta Ridge, have long been known to cause negative impacts on aquatic ecosystems. Anakeesta Formations are composed of pyritic and carbonaceous slate and phyllite, which when exposed to air and water oxidize and form leachate containing sulfuric acid, iron, and other heavy metals such as zinc, manganese, and aluminum. In 1964, when a section of U.S. Highway 441 through the GSMNP between Cherokee, NC and Gatlinburg, TN was reconstructed, large Anakeesta Formations were disturbed and used as roadfill material at Newfound Gap. The chemical composition of Beech Flats Creek (BFC), previously a favored pristine trout stream, was severely and perhaps permanently altered by this construction disturbance, rendering it virtually lifeless.

The headwaters of BFC begin just below Clingman's Dome Road, flow under U.S. Hwy 441 at Newfound Gap, and eventually flow into the Oconoluftee River. The extent of stream chemistry alteration was first documented in 1975/76 (Bacon and Maas, 1979), when an attempt was made to determine stream recovery as a function of downstream distance from the source of Anakeesta. A follow-up water chemistry study was conducted from spring 1988 through summer 1990 (Maas et al, 1990) (Kucken, 1991) and the results compared to the 1975/76 study to determine whether significant changes in stream conditions had occurred over the 15-year period.

Author taking mid-winter *water sample from site of entry to Beech Flats Creek.*

Upper reaches *of Beech Flats Creek in spring.*

Research Methods

Grab samples were taken at approximately 3-week intervals from April 1988 to August 1990 at 8 sites on BFC downstream of the Hwy 441 roadfill at Newfound Gap (Fig. 1). The 8 sites were chosen to be consistent with those used in the 1975/76 study. Grab samples also were taken from various small sidestreams and springs feeding into BFC. Sampling began at Site 8 (3960 ft) to avoid disturbing the streambed, and continued upstream past Site 2, just below the roadfill area, to Site 1 (5349 ft) located above the fill area and thus presumed to be a good control site.

The sites were spaced to account for sidestream inputs and mixing zones and covered a 3-mile length of stream. All samples were analyzed for zinc and manganese by atomic absorption spectrophotometry, and for pH. Streamflow was measured at Sites 1,2, and 8 at the time of grab sampling, using a Mini Current Meter. Statistical analysis focused on determining differences between pH, Zn, and Mn in 1975/76 versus 1988-90, and on determining correlations between streamflow, acidity, and metal concentrations.

Results of Stream Samplings

A. Acidity

A statistically significant decrease was found in mean pH at the control site, Site 1 (Fig. 1), between 1975/76 [pH = 6.69(+/−.06)] and 1988-90 [pH = 6.31(+/−.04)], a decrease in ambient pH that is of great interest. Field investigation revealed that BFC splits into two forks; one flows intermittently as a result of rainfall, the other is a continuous flow. It was discovered that the intermittently flowing fork has a lower

(Continued on page 3)

PARK SCIENCE

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WINTER 1992

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

ARTICLES

- Great Smokies Streams Acidified By Anakeesta Formation Exposures 1
- A New Approach to GIS Implementation At Colonial National Historical Park 4
- Great Smoky Mountain Plants Studied For Ozone Sensitivity 6
- Professionalism in Resource Management 8
- Survey of White-tailed Deer Impacts 9
- Native Seed Bank Brooklyn Reclamation Project 10
- Olympic NP Dams Update 11
- GIS Helps Shenandoah Conduct Viewshed Analysis 12
- GIS Program Initiated at the U/AZ CPSU 18
- Visitors Prefer Park Values to Oil and Gas Development 20
- Restoring the Historic Landscape At Wilson's Creek 22

DEPARTMENTS

- Editorial 2
- Regional Highlights 14
- Information Crossfile 16
- Meetings of Interest 17
- Notes From Abroad 23

MISCELLANEOUS

- In the Next Issue 5
- Biodiversity Training Course 7
- Professionalism 8
- Yellowstone Northern Range Study Finds No Negative Impacts 13
- NPs Participate in Statewide Effort Against Alien Pests 13
- Butterfly Habitat Restoration 15
- New Publications 24

editorial

By this time, almost everyone in "the field" has heard the news that the 75th Anniversary Conference at Vail, Colorado, was not your usual run-of-the-mill self-improvement exercise. Despite the earnest iteration of lofty goals and promised results, those of us who have been around for longer than "awhile" were not on tiptoes with expectancy. In fact, the opening day saw a lot of conversation knots where I've-been-here-so-many-times-before was the central theme.

So imagine our surprise – then delight – then, well, almost elation, when the sessions turned into real down-and-dirty discussions about a whole host of things that have been bugging us for lo-these-many – when the leaders of the working groups and the plenary session speakers began to talk in tones seldom heard at such conferences. Instead of the usual self congratulatory droning, we heard the NPS's real needs for change described, deplored, and then turned over to the working groups for suggested reform ACTION. And the groups didn't fudge. They tackled the issues with the energy and thought they so desperately need, and the process is continuing at near boiling point.

There isn't room (nor is it this publication's appropriate task) to enumerate the recommendations and the conference-generated revisions that took place under the four headings: Organizational Renewal, Resource Stewardship, Park Use and Enjoyment, amd Environmental Leadership. It **is** within our purview to suggest that everyone in the Service should be participating strenuously in the process now underway, the outcome of which will be the Report to the Director.

And here's another encouraging straw in the wind: The Director was **there** throughout the entire conference. So were most of the plenary speakers and all the workshop leaders. And almost every one of the 600 participants stayed through the entire three days and took heated part in all the sessions and work groups. They began with our NPS idea and mission and then proceeded to outline just how far short of these ideals our past budgets and leadership have allowed us to fall. Twice during his address to the conference, Secretary Luhan told the delegates that park resources preservation must take precedence over visitor uses.

There was more than aplenty that will affect the field, its research activities and its management mission. Every park unit and office in the Service has received copies of the post-Symposium issues and preliminary recommendations. The period for public comment closed on Dec. 13. The Working Groups' final reports to the Steering committee are scheduled for completion in early January, after which the Steering Committee will prepare the final report to the Director.

I hope this is not a premature paeon of praise. It **is** a heartfelt thank you to the Steering Committee that put the Service on the line, to the outsiders – experts, critics, friends, and advisors – who told us how we looked to them and made strong suggestions as to what we should do about it, and to the Park Service that called this group into being and then bravely stood up and took the flak it had invited.

Hurray for us all!

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Annakeesta Formation Exposures Source of Acid in Streams

(Continued from page 1)

pH, as well as pulses of heavy metals. The decrease in ambient pH could suggest two possibilities: (1) long-term effects of acid deposition on water quality in the GSMNP, or (2) acidification of the headwaters of BFC due to disposal of Anakeesta rockslide debris over the edge of Clingman's Dome Road at the headwaters of the intermittently flowing fork.A8AFurther research will be needed to ascertain whether either, or both, of these possibilities are causing increased acidity at the control site.

The mean pH at Site 2 did not change significantly between 1975/76 and 1988-90. In spring 1988 a sidestream between Sites 5a and 5b was found to be acidic (mean pH = 4.9) with high concentrations of heavy metals. This represents a significant change from the 1975/76 study, in which this sidestream expressed a mean pH = 6.0. Field invetigations revealed the probably source of acidification to be Anakeesta rockslide debris that was disposed of over the edge of the old U.S. Hwy 441 roadbed in the headwaters of this sidestream.

B. Zinc

A significant increase in median Zn concentrations between 1975/76 (<1.0ppb) and 1988-90 (15.0ppb) was observed at the control site, indicating that exposed Anakeesta may be the cause of water chemistry changes observed at Site 1. Median Zn concentrations decreased significantly at Site 2 between 1975/76 (146.0ppb) and 1988-90 (68.8ppb). There was no significant change in concentrations at Site 8, presumably due to the input from the acidic sidestream between Sites 5a and 5b, which often is high in Zn concentrations. Although these levels are significantly higher than background levels for this region, they are not high enough to be of ecological concern.

C. Manganese

Median manganese concentrations increased slightly at Site 1 between 1975/76 (<1.0ppb) and 1988-90 (4.0ppb). However, immediately below the Anakeesta roadfill area at Site 2, the median Mn concentrations increased significantly between the two study periods (210.0ppb versus 572.0ppb). The change in median concentrations observed in the lower reaches of the stream (23.0ppb versus 24.0ppb at Site 8) is not significant and cannot be explained by a simple dilution mechanism, especially since the acidic sidestream is relatively high in Mn. Evidently, chemical precipitation rather than dilution acts as the controlling mechanism for Mn removal (Maas et al, 1990).

The hydrolysis of Mn to an insoluble precipitate is favored under the less acidic conditions of the lower stream reaches. The high concentrations of Mn in the upper reaches of BFC and the acidic sidestream are of ecological concern due to their toxicity to many benthic organisms such as caddisflies, mayflies, and crayfish, and the trout that feed on them.

Summary of Study Results

Beech Flats Creek is experiencing acidification and heavy metal contamination due to the exposure of Anakeesta Formations, which have negatively impacted stream ecology. Anakeesta Formations have had similar impacts on other streams in the GSMNP. There have been no significant improvements in water quality since the 1975/76 study. Overall water quality has degraded somewhat over the 15 years between studies. Mean pH along the stream's length has not increased significantly. Of particular interest is the decrease in pH at the control site above the roadfill area. Possible explanations for this are (1) the long-term effect of acid deposition in the GSMNP; (2) leachate from exposed pyritic rockslide debris that has been dumped over the edge of Clingman's Dome Road, or (3) a combination of (1) and (2).

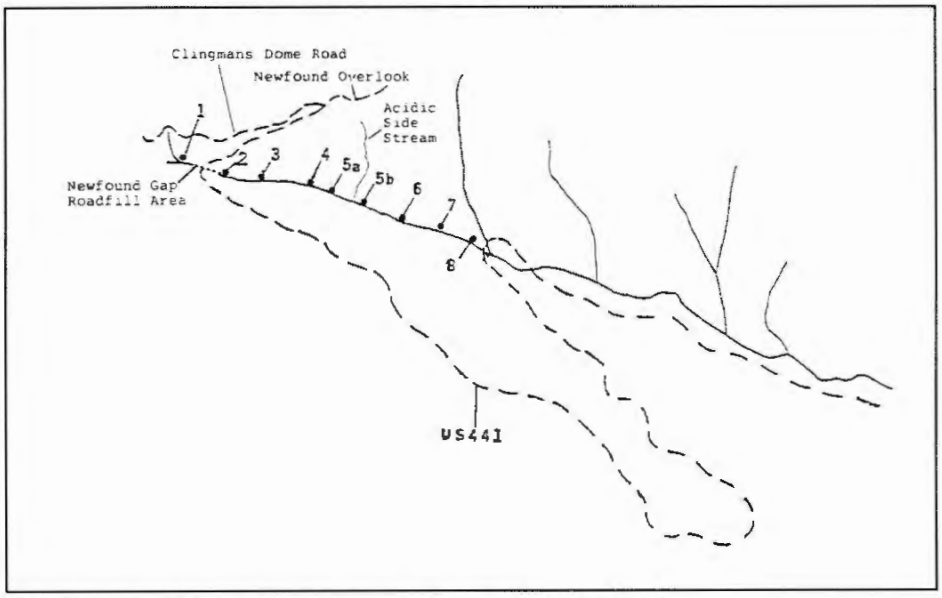


Figure 1. *Beech Flats Creek Sample Sites in the Great Smoky Mountains NP.*

Site of roadcut *and Anakeesta road-fill placement above Beech Flats Creek in GSNP.*

While median concentrations of Zn have increased at the control site (perhaps due to the Anakeesta debris dumped from Clingman's Dome Road), concentrations have decreased significantly at Site 2 since the initial study. The present levels of Zn in BFC are higher than expected ambient levels, but are not of ecological concern.

Median concentrations of Mn have not changed at the control site, but have significantly increased at Site 2, below the roadfill area. One possible explanation is that as the Anakeesta continues to fragment over time, a greater surface area, which may contain higher levels of Mn, is exposed. The reaction of Mn in the stream is pH dependent, so it may be assumed that Mn originating from the Hwy 441 roadfill area, as well as from the acidic sidestream, undergoes rapid hydrolysis to an insoluble precipitate in the lower reaches of BFC.

The absence of significant water quality improvements over this 15-year period suggests that natural processes alone will not restore Anakeesta affected streams such as BFC to life-supporting conditions within the foreseeable future. It is suggested that remedial mitigation be undertaken to increase the recovery rate of not only BFC, but of other GSMNP streams similarly negatively impacted by naturally-occurring exposure of Anakeesta materials.

Compound Anakeesta slide scars within GSMNP have increased greatly in area and volume since 1953 (Ryan 1989), and new slide exposures continue to occur. Due to the fracturably nature of Anakeesta Formations it is expected that disposal of rockslide debris will continue to be a difficult challenge for NPS man-

(Continued on page 4)

A New Approach to GIS Implementation At Colonial National Historical Park

By Hugh Devine, Charles Rafkind, Jean McManus, and John Karish

Colonial National Historical Park is a 9,327 acre park along the James and York Rivers, comprised of Jamestown Island, Yorktown Battlefield, the Colonial Parkway, Green Springs, and Swann's Point. For the past year the Geographic Information System (GIS) Research Group of the College of Forest Resources at North Carolina State University (NCSU) has been working with Colonial NHP to develop a GIS implementation plan.

The plan is unique in three ways. First, it outlines a phased implementation program for a park based system to service the full range of park management activities. Second, Colonial is basically a medium size cultural park (with significant natural resources) and most national park GIS efforts to date have focused on large natural resource based parks. Third, the implementation is designed to allow distributed access to the GIS through the three major park divisions as opposed to a single centralized system as is characteristic of most natural resource GIS applications. The park divisions include resource manaagement and visitor protection, maintenance, and historic interpretation and preservation.

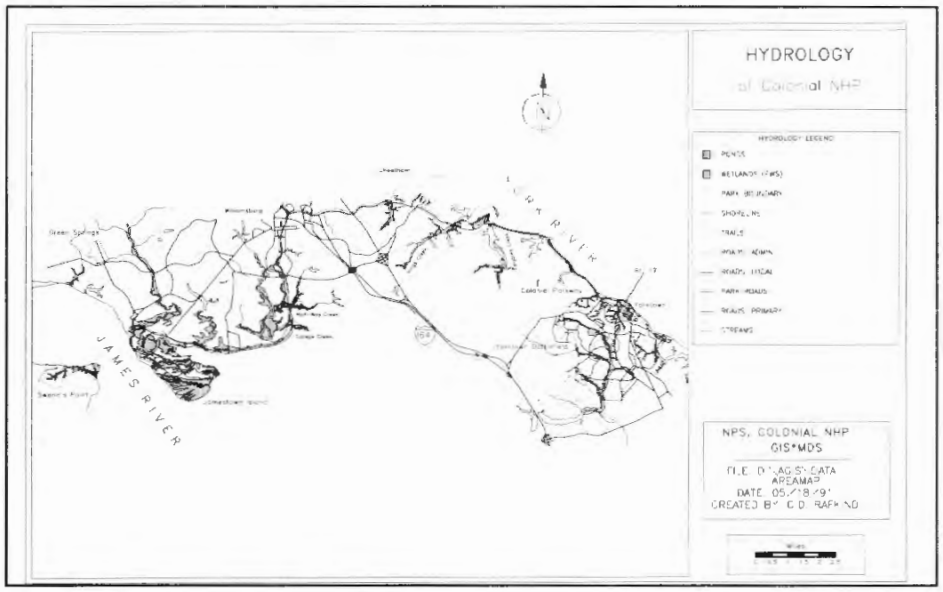
Training and Needs Assessment

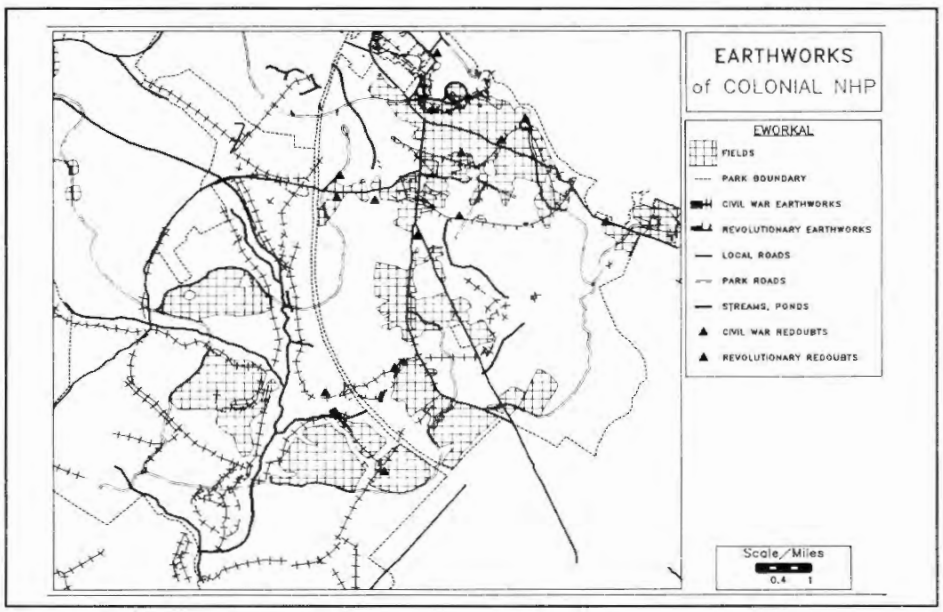
The assessment of needs was performed through a training session, followed by a series of interviews to determine prioritized division needs. Considerable time was spent training managers in both the potentials and costs of GIS for their divisions prior to determining the list of map needs. A brief written description of GIS for park management was prepared and distributed to the Colonial participants in advance of the training.

Training was completed in one full day at Colonial. A morning session focused on introducing a large cross section of the park staff to GIS and its potential for management. This session was completed in about three hours and included a variety of visual aids – video tapes, 35mm slides, and overhead transparencies.

The afternoon session concentrated on developing a more detailed exposure to GIS for Colonial division chiefs and selected staff. This session, again about three hours, was designed to allow participants to work through an actual mapping exercise using Colonial data. Three computer work stations were used, in what was intended to be a step-by-step group experience in construction and plotting of a Jamestown Island vegetation map. However, the participants were quite able to work independently and the anticipated group technique was neither necessary nor efficient. The procedure, therefore, was shifted to three individual instruction efforts (i.e. one per station) with an instructor assigned to each group. The groups then proceeded at their own pace to produce the planned map, plus several variations.

The session also included a demonstration of a Computer Aided Design (CAD) system and a digitizing procedure. In addition, because of its informal structure, this session involved extensive question and





Anakeesta Acid

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agement. While it is assumed that covering the debris materials with soil and vegetation will reduce or eliminate the oxidation processes, it is not known how much soil and what type of vegetation will work best to reduce the formation of acid and metal leachate into GSMNP streams.

Research currently is being planned for on-site plot experiments to determine what depth of topsoil cover is required to reduce the formation of acid and metal leachate to the levels necessary to re-establish viable aquatic ecosystems. This proposed research will provide the necessary information for determining whether, and to what extent, streams such as BFC could be restored to viable trout streams through a strategic, low cost program of soil cover introduction. It is hoped that this method of mitigation will prove a permanent and low cost solution to an on-going and extensive problem within the GSMNP.

Kucken is Research Associate with U/NC-Asheville Environmental Quality Institute; Maas is Director of the Institute; Patch is Assoc. Prof. of Statistics at U/NC-Asheville.

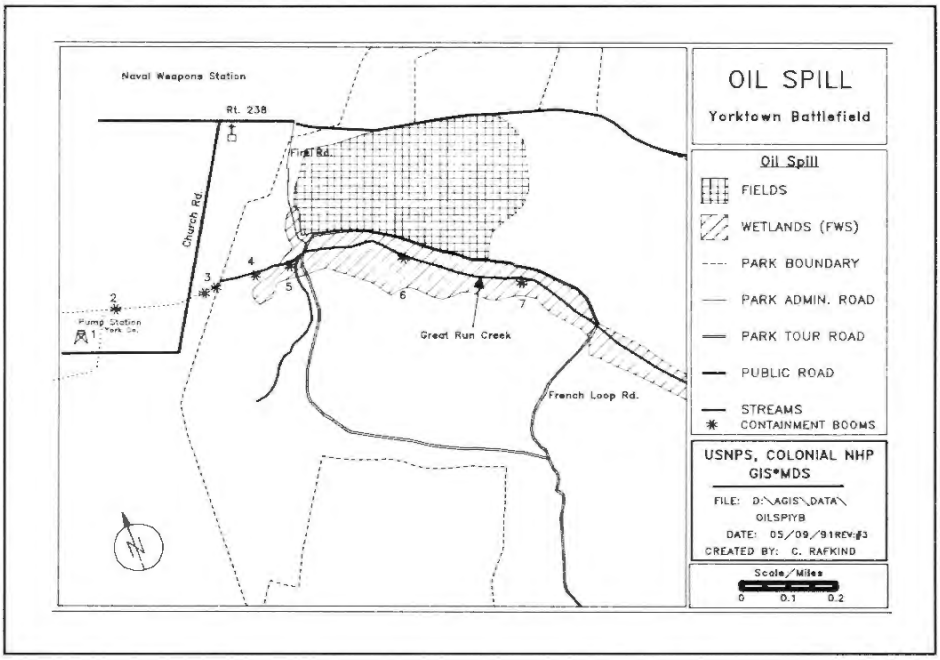
Literature Cited

Bacon, J.R. and R.P. Maas, 1979. Acid and Heavy Metal Contamination of Great Smoky Mountains NP Trout Streams by Anakeesta Formations. Jrnl of Environmental Quality. 8:538-542.

Kucken, Darlene J., 1991. Long term recovery of Beech Flats Creek from exposed Anakeesta Formations in the Great Smoky Mountains NP. Proceedings from 5th National Conf. on Undergraduate Research.

Maas, Richard P., D.J. Kucken, and S.C. Patch, 1990. Long term recovery from exposed Anakeesta Formation runoff. Final Report to Great Smoky Mountains NP.

Ryan, Patrick T., G.M. Clark, 1989. Debris slides and flows on Anakeesta Ridge, Great Smoky Mountains NP, TN. USDI NPS. Abstracts of the 15th Annual Scientific Research Meeting, GSMNP, May, 1989. U.S. Dept. of the Interior, NPS, SE Regional Office, Atlanta, GA.



answer periods concerning GIS, CAD, and related computer and management topics.

Training Session Evaluation

Two recommendations for the training session were developed. The afternoon session should be designed to treat each management function separately; that is, each division should work with its own data and should produce a product relevant to its own needs. Secondly, a standard set of visuals for NPS GIS instruction should be developed.

The development of recommendations for a GIS at Colonial hinged on identification of management's need for mapped information. Such an identification can come only from the managers and users themselves, after they have considered the importance of mapped information in their operations and have evaluated the potential of GIS to produce and manipulate such data.

The training was followed by two days of interviews, which led potential park users through the process first of identifying the role of maps in their tasks, and then enumerating the types and sources of these maps. The information from the survey forms was used to catalog the responses of division personnel and to develop a map theme list.

Recommendations

Evaluation of GIS alternatives for the park was based on three criteria: (1) the appropriateness of raster versus vector data structures, and the need to exchange digital data with other GIS users (local government, state and university systems), (2) the ability to have several park divisions benefit from, and use, the GIS immediately, and (3) realistic staffing, budgeting, and training levels that the park could commit to a GIS.

The recommended GIS software is ATLAS*GIS with appropriate data exchange modules. The choice of ATLAS*GIS was dictated by the low initial cost, user friendly menu system, minimal training requirements, capacity to perform the mapping analyses and production task identified in the interviews, and conversion abilities to and from ARC/INFO. ARC/INFO is used by all government jurisdictions that surround the park, and data exchanges will be performed on a regular basis. USGS, EPA, State of Virginia, Council on the Environment GIS, and VA Institute of Marine Science are the cooperators with whom the park exchanges data regularly.

Current and Future Direction

Currently, the park is developing a series of data themes for the GIS. These themes are being prepared under agreements with the NCSU GIS Research Lab, VA Institute of Marine Science, and the USDA Soil Conservation Service (SCS). During March 1989, winter aerial photography was flown using 70mm true color film at 1:12,000 scale. From this photography, NCSU has interpreted, delineated, and digitized vegetation types, wetlands, streams, ponds, earthworks, roads, and adjoining landownership use (residential, military, commercial), and rare species occurrences and critical habitats. In addition, several communities surrounding the park are developing themes useful for park management (e.g. floodplain, topography, utilities, and tax parcel ownership maps). State agencies have provided USGS digital line graph information on roads, shorelines, hydrology, and political boundaries.

Current efforts also include compilation of the numerous historical and archaeological base maps for Jamestown Island into one data base and map, input of the 100+ right-of-way grants involving road access, security fencing for military bases, and numerous types of public utilities. The soil surveys for the park and a 1000 foot buffer are being recompiled and digitized by SCS. The VA Institute of Marine Science will provide watershed and sub-basin information, near surface geology, water quality and quantity data, floodplains, aquifers, springs, seeps, recharge areas, non-tidal and tidal wetlands. NCSU is developing UTM and Long/Lat grid overlays for wildlife sightings, fire management, and vegetation management projects, road kilometer marking overlay, and a series of applications dealing with historical vegetation pattern changes, adjoining potential developable lands/viewshed impacts, and fire unit maps of values at risk.

The park and NCSU are continuing to develop standard operating procedures to guide the development of new geographic and database files, and cartographic map production. Areas covered include file and attribute naming, database attribute development, quality control, and primary and secondary naming procedures for geographic data. With a leading cartographer from NCSU we are developing a GIS feature taxonomy covering colors, patterns, symbology, and sizing for maps produced on plotters and B/W laser printers. All this will be the focus of a future article.

These themes/databases will be used for fire management, habitat analysis, open fields management, earthwork vegetaion management, wetland identification and preservation, and cultural resource management. Other analyses will include shoreline erosion, land cover and water quality changes, and information calculations (number of acres of Class A, B, or C lawns, acres of the different types of wetlands, miles of earthworks, boundaries, shoreline or trails, number of historic sites).

The park's GIS system already has played an important role in environmental analysis, in response to oil spills, special events, wetlands, vegetation, fire, and air quality management planning, development of new mowing regimes for the park's 1,100 acres of open fields, RTE survey, fire reporting, and historical research into changing vegetation patterns over the past 380+ years.

Dr. Devine is director of the NCSU GIS Research Laboratory and a professor in the College of Forest Resources; Rafkind is Natural Resource Management Specialist at Colonial NHP; McManus is manager of the NCSU GIS Research Lab; Karish is Mid-Atlantic Regional Chief Scientist and GIS Coordinator.

In the Next Issue

The ***Park Science*** Spring issue will contain several articles describing research on marine and terrestrial ecosystems in Virgin Islands NP. Much of the ongoing work builds on previous studies by members of the Virgin Islands Resource Management Cooperative (see Rogers and Zullo, Spring 1985 ***Park Science***, cover and p.3).

A number of studies are addressing the long-term effects of Hurricane Hugo, which swept through the U.S. Virgin Islands in September 1989. The park's research staff has quantified the effects of this powerful storm on long-term transects established on a coral reef in the park. Under a Cooperative Agreement, scientists from the U.S.V.I. Division of USFWS have censused coral reef fish assemblages at several sites inside the park and documented storm effects.

Scientists from U/GA, U/WI, and the Institute of Tropical Forestry have recorded the hurricane's effects on long-term plots established in the dry and moist forests of St. John. Also, in 1991 as part of a network of MAB biodiversity sites, the Smithsonian established a long-term plot in a dry forest area on the island.

In addition, the Soil Conservation Service recently mapped the soils in two watersheds and established automatic data sensors that record soil termperature and moisture at several depths. The USGS and NPS will be collaborating in a paired watershed study to compare sediment loads from a developed and an undeveloped watershed.

Great Smoky Mountain Plants Studied For Ozone Sensitivity

By David Hacker and James Renfro

Plants suffering from the ill effects of a variety of air pollutants are causing widespread concern within the National Park Service. Effects can vary greatly, some plants exhibiting no symptoms, some showing reduced vigor, and some suffering widespread tissue necrosis and death. Injury is not limited to individual plants, but may also be displayed on a community or ecosystem level.

Since 1986, putative ozone injury symptoms have been observed on over 70 native species of plants in Great Smoky Mountains NP (GRSM). GRSM contains more than 1500 native plant species and is one of the largest temperate forest reserves in North America. Ozone (O_3), with its widespread distribution, probably has the greatest negative impact on vegetation of all air pollutants (Reich 1987, Krupa and Manning 1988, de Steiguer et al. 1990). Ground level or tropospheric ozone is a secondary pollutant formed by the reaction of sunlight on the primary pollutants of nitrogen oxides and hydrocarbons. Ozone levels in GRSM rarely exceed the National Ambient Air Quality Standard (NAAQS), but moderate chronic levels do exist.

Ozone is an extremely phytotoxic air pollutant. Ozone enters the plant through the stomata, which are the small pores on the underside of the leaf. Once the ozone is inside the substomatal cavity of the leaf interior, the possibility for foliar injury is present. At low concentrations, typically the first sign of ozone damage is a water-soaked appearance of the leaves. This occurs because of loss of water into the intercellular spaces, due to the loss of membrane integrity. If the ozone stress is removed, the cell membranes may repair themselves and the symptoms disappear. If exposure continues or increases, flecking or stippling may appear followed by chlorosis and then necrosis (Tingley and Taylor 1982).

Ozone, being a very unstable substance, reacts in water and/or with organic compounds to form a number of highly toxic oxides, including O_2 – superoxide; H_0 – hydroxyl; and H_2O_2 – hydrogen peroxide. All these compounds can react with cellular membranes causing damage.

Damage arises primarily from reactions with lipids or fats that are constituents of membranes. For example, superoxide can cause the double bond in the fatty acid half of a lipid to convert to a single bond. The properties of the lipid then are changed, and if enough lipids are altered, the membrane properties are modified.

Ozone itself reacts strongly with saturated fatty acids and other organic compounds, hence disrupting membranes (Heath 1980). Severe ozone exposure may even result in the cleavage of the fatty acid half of a lipid, giving rise to toxic 3C compounds. Ultimately these damaging effects lead to reduced photosynthesis (Reich and Amundson 1985, Reich 1983), modified carbon allocation (McLaughlin and McConathy 1983), or even death of the individual.

Scientists' estimates of percentage annual growth changes due to air pollution for the high elevation spruce-fir forests in the Appalachians varied from -2 to -70 percent, with a median estimate of -10 percent (de Steiguer et al. 1990). These estimates reflect only growth reduction and not air pollution induced death.

A study initiated by the NPS Air Quality Division and GRSM in 1986 was undertaken to characterize the adverse effects of ozone on plants native to GRSM. This study is documenting the physical as well as the dynamic responses individual species exhibit to exposure to ozone. In 1989, the EPA funded a three-year program to study the physiological responses of ozone on selected plant species native to GRSM. This project also is being conducted at the GRSM's Uplands Field Research Lab fumigation site. Together, the NPS and EPA will be able to address the chronic problems of ozone pollution on GRSM plants.

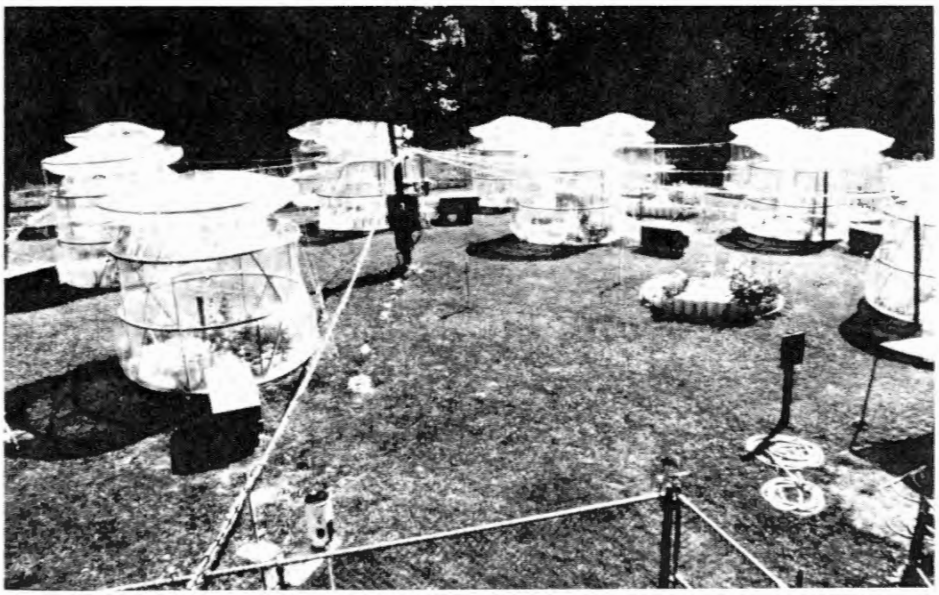


Figure 1. The Ozone fumigation site at Uplands Research Lab.

Methods

Plants native to GRSM are examined in the field to determine if they exhibit any typical or classic symptoms of ozone sensitivity. If a species appears to be ozone sensitive, a specimen is brought back to the lab for verification of ozone damage. Once putative ozone damage has been determined, that species is listed for future ozone fumigation at Uplands Field Research Lab. To date, 74 species of plants in GRSM have exhibited putative ozone injury.

With the conclusion of the 1990 field season, 31 species of plants native to GRSM have been subjected to a gradient of ozone concentrations. In the experiment, plants are cultivated from seed collected in the park. Seedlings are grown in individual pots and are placed in one of 15 open-topped growth chambers or three open plots. This allows for three replications of six treatments.

Treatments include 0.5 x ambient, 1.0 x ambient, 1.5 x ambient, 2.0 x ambient, carbon-filtered, and open-ambient plots. All treatments except the carbon-filtered are proportional to ambient ozone concentrations in order to give a better reflection of what vegetation in GRSM is exposed to. Ambient concentrations are continuously monitored and treatments are updated every two minutes. In addition to monitoring ambient ozone concentrations, all meteorological parameters and CO_2 and NO_2 concentrations are analyzed and recorded on a data logger and computer.

Technicians water the plants manually to ensure that all individuals receive enough water for soil saturation and luxury consumption. This is done because drought has been demonstrated to be a mitigating factor to ozone injury (Reich 1987).

Plants are visually inspected for incidence, extent, and symptoms of ozone damage periodically throughout the growing season. All species are photo-documented for all types of injury in all treatments. Full descriptions of ozone damage are documented and recorded. Growth measurements such as height and diameter are routinely documented at the beginning, the end, and at regular intervals during the growing season. Several phenological measurements are taken on herbacous species including flower count, flower incidence, and seed weight. Most of the species are harvested at summer's end, and leaf count, leaf area, and biomass allocation of roots and shoots are recorded.

Histological sampling also is performed throughout the course of the field season. Sampling of leaf tissue in the fumigation chanbers is compared to leaf samples collected in the field to verify that ozone is causing injury at the cellular level.

Results and Discussion

Twenty-five of the 31 species fumigated in the ozone exposure study displayed some degree of visible sensitivity to ozone. Typical symptoms in hardwoods and herbaceous plants varied, but generally small chlorotic patches would appear with the onset of ozone injury. As damage progressed, necrotic tissue would replace the chlorotic patches, giving a red or brown hue to the leaf. The leaf appeared to look "rusty." Commonly, visible ozone injury occurs on the surface of the leaf, usually in the interveinal areas and on older foliage.

If the disease progresses further, the dead leaf tissue expands, green tissue disappears, and the leaf blackens and dies. Conifers exhibit symptoms that differ from angiosperms. Instead of well defined stipple manifested on the top side of the leaves, conifers display a chlorotic mottled appearance. This is due to the

Table 1. GRSM ozone fumigation program plant testing and sensitivity list, 1987-1990

1987 – Species Tested	Common Name	Visible Sensitivity
1. *Acer saccharum*	sugar maple	R
2. *Angelica triquinata*	angelica	R
3. *Betula lutea*	yellow birch	SS
4. *Cacalia rugelia*	Rugel's ragwort	MS
5. *Euatorium rugosum*	white snakeroot	SS
6. *Glyceria nubigena*	manna grass	MS
7. *Lireodendron tulipifera*	yellow-poplar	ES
8. *Quercus alba*	white oak	R
1988 – Species Tested	**Common Name**	**Visible Sensitivity**
9. *Acer rubrum*	red maple	ES
10. *Cercis canadensis*	eastern redbud	MS
11. *Cornus florida*	flowering dogwood	MS
12. *Pinus pungens*	table-mountain pine	ES
1989 – Species Tested	**Common Name**	**Visible Sensitivity**
13. *Asclepias exaltata*	tall milkweed	ES
14. *Liquidambar styraciflua*	sweetgum	MS
Pinus pungens (12)*	table-mountain pine	ES
15. *Platanus occidentalis*	American sycamore	ES
16. *Prunus serotina*	black cherry	ES
17. *Rhus copallina*	winged sumac	ES
18. *Robinia pseudoacacia*	black locust	SS
19. *Rudbeckia hirta*	black-eyed susan	ES
20. *Rudbeckia laciniata*	cutleaf coneflower	ES
21. *Tsuga canadensis*	eastern hemlock	R
22. *Verbesina occindentalis*	crown-beard	ES
1990 – Species Tested	**Common Name**	**Visible Sensitivity**
Tsuga canadensis (21)	eastern hemlock	R
Pinus pungens (12)	table-mountain pine	ES
Asclepias exaltata (13)	tall milkweed	ES
Liquidambar styraciflua (14)	sweetgum	ES
Liriodendron tulipifera (7)	yellow-poplar	ES
Rudbeckia laciniata (20)	cutleaf coneflower	ES
23. *Aster acuminatus*	whorled-wood aster	MS
24. *Aesculus octandra*	yellow buckeye	MS
25. *Pinus virginiana*	Virginia pine	SS
26. *Krigia montana*	mountain dandelion	SS
27. *Sassafras albidum*	sassafras	ES
28. *Rubus canadensis*	thornless blackberry	MS
29. *Rubus idaeus*	red raspberry	R
30. *Magnolia tripetela*	umbrella magnolia	SS
31. *Pinus rigida*	pitch pine	R

*Plant species in parentheses were fumigated in previous year(s).

Sensitivity Codes:

ES – **E**xtremely **S**ensitive. Foliage exhibited injury (stippling or chlorotic mottle on all treatments equal to or greater than ambient). Ambient treatment injury on >50 percent of the plants. Incidence of injury in the 2.0 times ambient treatment was >90 percent. Symptomatology in chambers was similar to injury documented in the field.

MS – **M**oderately **S**ensitive. Exhibited injury to <50 percent of the plants in the ambient treatment and injury was documented on >50 percent of the plants in the 2.0 times ambient treatment. The symptomatology in chambers was similar to injury documented in the field.

SS – **S**lightly **S**ensitive. No injury was documented in the ambient treatment. Only visible injury documented in the 2.0 times ambient treatment, but <50 percent. Injury documented in the field only on several individuals (<5 percent sampled).

R – **R**esistant. Species did not show visible effects from ozone to the foliage of the plant in any of the treatments. Visible injury not observed in the field.

undifferentiated tissue conifers have in their needles; hence all the cells are equally sensitive to the effects of ozone.

Other symptoms of ozone damage on conifers are tip burn, which tends to be the first sign, overall chlorosis of the foliage, and necrotic lesions on the needles.

Sensitivity of plants to ozone exposure is ranked from very sensitive to resistant. In the GRSM study, it was discovered that many species indigenous to GRSM were sensitive to ozone, with 16 species being very sensitive, 5 species displaying moderate sensitivity, 4 species showing slight sensitivity, and 6 being resistant. Sensitivity based on visible symptoms by species is shown in Table 1.

With heightened public awareness of the problem of declining air chemistry, the need for continued research into the effects of air pollution on forest decline has never been greater. Ongoing research at Uplands Field Research Lab is quantifying the adverse effects of poor air quality and providing baseline data so that resource managers can make educated decisions.

Hacker and Renfro conduct air pollution research at the Uplands Field Research Lab, Great Smoky Mountains NP.

Literature Cited

de Steiguer, J.E., J.M. Pye, and C.S. Love. 1990. Air pollution damage to U.S. forests. J. For. 88:17-22.

Heath, R.L. 1980. Initial events in injury to plants by air pollutants. Annu. Rev. Plant Physiol. 31:395.

Krupa, S.V., and W.J. Manning. 1988. Atmospheric ozone: formation and effects on vegetation. Enviro. Pollu. 50:101-137.

McLaughlin, S.B., and R.K. McConathy. 1983. Effects of SO_2 and O_3 on allocation of 14_C-labeled photosynthate in Phaeseolus vulgaris. *Plant Physiol. 73:620-625.*

Reich, P.B. 1987. Quantifying plant response to ozone: a unifying theory. Tree Physiol. 3:63-91.

Reich, P.B. 1983. Effects of low concentrations of O_3 on net photosynthesis, dark respiration, and chlorophyll content in aging poplar leaves. Plant Physiol. 73:291-296.

Reich, P.B., and R.G. Amundson. 1985. Ambient levels of O_3 reduce net photosynthesis in tree and crop species. Science 230:566-670.

Tingley, D.T., and G.E. Taylor. 1982. Variation in plant response to ozone: a conceptual model of physiological events: in Effects of gaseous pollutants in agriculture and horticulture. M.H. Unsworth and D.P. Ormrod, eds. 113-138.

Biodiversity Training Course

A highly acclaimed interagency training course, "Meeting the Biodiversity Challenge: A Shortcourse for Decision-makers," will be offered again this year by the BLM Phoenix Training Center. Charles Pregler, Wildlife Training Coordinator. Three NPS professionals – David Morris, Assistant Superintendent, Southern Arizona Group; Craig Shafer, Ecologist, WASO, and John Earnst, North Cascades NP superintendent – were enthusiastic in their praise of the benefits after taking the course last summer.

The course was developed by four federal agencies: BLM, USFS, USFWS, and the EPA. Instructors are drawn from around the world – experts active in government, academia, and the private sector. More than 100 top level managers and senior advisors from five major natural resource agencies, GAO, and Canada have attended the four previous sessions.

The workshops tackle such biodiversity preservation problems as human population growth, habitat fragmentation, spread of agriculture into refuges, lack of understanding of what biodiversity means, large federal water diversion projects, exotic species invasions, inadequate information bases, acid rain, defoliation, land ownership patterns, global warming, and more. The lecturers are recognized leaders in both action and theory of biodiversity and are available to help participants after formal class sessions.

But perhaps most important, according to NPS participants in prior sessions, is the interagency give and take – the growing recognition that emerges of how various agencies' problems and perspectives can be coalesced into more effective systems approaches to biodiversity problems. Class exercises emphasized broad-scale regional planning, an area where land management agencies are either playing catch-up or are becoming more aware of the need.

With two more courses being offered this fiscal year (see Calendar on this page), interested persons may contact James Lee, WASO training officer (202) 523-5280 or John Dennis, Chief, Science Branch, Wildlife and Vegetation Division, (202) 343-8128.

Professionalism in Resource Management

Editor's Note: The following is a synthesis of a workshop session at a national meeting of Regional Resource Management Specialists on July 23-25, 1991, and represents the general consensus reached, as it appeared to the author. Since the whole concept of natural resource management, as a profession, is still forming, and given the seemingly active state of evolutionary ferment within the National Park Service, this paper is presented for reflection and comment by our readers. As readers who are (or should be) vitally interested in this subject and all its implications, you are invited to respond, either in article or letter form, to the editor.

By Kathy Jope

To discuss professionalism in resource management, it is necessary first to define resource management, which has evolved as a profession only within the last 10 to 20 years. Given such a short history, it is not surprising that some confusion and disagreement still surround just what it is that a resource manager is supposed to do.

In 1980, Ro Wauer conceptually defined the resource manager as one who "not only works to solve today's problems but identifies and prevents those of tomorrow" (Wauer, 1980). He stated that a resource manager is a *catalyst* who talks to managers, scientists, planners, interpreters, and work crews, relates to the big picture,is responsible for implementation and monitoring, and has the time and staff to do it correctly.

A resource manager is not a researcher. However, resource management *is* closely linked to research. Gary Davis drew an analogy between NPS natural resource programs and the medical profession (Davis 1988). While medicine requires medical research to provide information, research alone doesn't keep the patient well. There must also be a doctor who applies the results of that research. Similarly, the NPS requires research on park ecosystems, but research alone doesn't protect park resources. It is the role of the resource manager to apply the results of research and to serve as the "doctor" for the parks' natural resources.

This could be interpreted to imply that the resource manager is a technician, who unquestioningly follows the instructions of researchers and implements research recommendations. However, a professional resource manager goes beyond the research results. S/he is aware of alternative approaches, critically evaluates them, and selects the one most appropriate to a given situation.

Detecting a problem often requires in-depth knowledge of the resource and how it functions and interacts with others, resulting in sensitivity and ability to recognize situations in which something is not quite right. Defining a problem and developing an approach to resolve it requires skill in problem solving. To do this, a resource manager identifies information needs, determines what information is available from the published literature or other existing sources, and indicates what will require new research.

A foundation in science and critical thinking ability are essential in determining the relevance of particular studies to a given issue. These qualifications probably can best be obtained through a Master's degree in a natural resource discipline. (The needed qualifications exceed what is obtained through a Bachelor's degree. While a Ph.D. gives a better understanding of research design and scientific metnods, its usually narrow focus contributes little to the range of capabilities needed in an effective resource manager.)

When research is needed to provide information not available in the published literature, in most parks the resource manager serves as research coordinator. In this role, s/he: (1) obtains needed funding by preparing funding requests, requests for proposals (RFPs), and other needed documentation; (2) works with the researcher in clearly defining research objectives and developing methods compatible with NPS mandates; (3) monitors progress of the research, and (4) reviews the research report for management implications.

It is not appropriate for the researcher to make management *recommendations*. Since management decisions are based on many other considerations of which the researcher may not be fully aware, the researcher should instead discuss management *implications* of the research findings, such as the likely consequences if the park selects a certain alternative action.

When scientific information is incorporated within a park's resource related programs, the differences between a resource manager and a researcher become clear. The resource manager is responsible for integrating scientific information, as appropriate, with other considerations to achieve the park's objectives for resource protection. Management decisions are not based solely on biological information, but on additional considerations that lie beyond the scope of the research – other information relevant to the issue, park management objectives, NPS management policies and regulations, effects on other park programs, and strategic judgment concerning the long-term benefits of alternative actions.

Achieving a resource protection objective may involve making use of management tools and procedures such as special use permits, concession contracts and commercial use licenses, cooperative agreements, and land use regulations and rights of ownership. The socio-political environment can create new opportunities for alternative approaches or make certain approaches unfeasible. The more knowledgeable a resource manager is in all these areas, the more effective s/he will be.

A resource manager can accomplish only a limited amount alone. Instead, the resource manager must work through others, such as work crews, maintenance, law enforcement, interpretation, public information, and concessions management. The resource manager serves as the focus of natural resource-related activites, helping the various programs work together toward coordinated resource protection rather than at cross purposes. To be effective, the resource manager needs a knowledge of the other park programs, their work requirements and procedures.

In managing a program, resource managers need to be skilled in managing staff and funding. They must be knowledgeable about administrative procedures and regulations and able to develop good working relationships with budget officers, procurement officers, classification specialists, and contracting officers.

They work not only with park employees, but also with personnel from other agencies, adjacent landowners, and interest groups. Thus, they need to be skilled in communication and interpersonal relationships, in negotiation and persuasion. They must be able to communicate effectively the technical information about the resources, threats to their integrity, research findings, potential solutions to problems, and the pros and cons of alternative approaches. This information must be presented in ways that speak to people representing diverse value systems and explain why it is in their interest to care about the well-being of park resources.

Resource managers are primary sources of information about park resources. Increasingly, they need ability in database management. This ensures that resource information is available when needed, that there is continuity over time, and that research results will not be forgotten when the manager transfers.

Resource managers must stay up to date with the most current scientific knowledge. We should think of resource managers as *scientific* resource managers. Unfortunately, because our staffing levels are so spartan, is has been necessary for a single resource manager to be responsible for an extremely broad spectrum of resources.

The GS-401 Biologist classification does not begin to reflect the range of responsibilities. These often include management of air quality, watersheds (including surface and subsurface hydrology, soils, geology, and climatic processes), fish and other aquatic biota, wildlife (including birds, mammals, insects, and other organisms), vegetation, fire, caves, grazing, mining and minerals, hazardous materials and toxic wastes, threatened and endangered species, non-native species, pests, backcountry and frontcountry visitor impacts, and impacts of park facilities.

In developing resource programs and assessing environmental effects of proposed facilities or management actions, it is imperative that resources be dealt with as *systems* of interrelated dynamic components. The challenge for resource managers is to maintain a professional level of expertise as well as knowledge of changing laws and policies over this wide range of subjects. In addition, they should stay abreast of new concepts and emerging fields such as conservation biology, restoration ecology, and behavior of pollutants in the environment. It is clear that we need to develop better ways to meet the need for expertise at the field level.

After we have hired well educated people and given them experience and training to broaden their knowl-

(Continued on page 9)

Professionalism

Other aspects of professionalism that time limitations did not allow the workshop to address adequately included:

Intake routes: Most intake positions are in fields other than resource management and do not necessarily select for qualifications needed in higher level positions. We need an established intake route and a mobility ladder, to insure bringing in qualified people.

Lack of applicants for GS-12s and above: High level resource management positions, particularly in central offices and remote locations, have had difficulty attracting well-qualified applicants. This may be due to the still small number of resource managers Servicewide or because of personal career preferences. There has been little opportunity for RMs in low- to mid-graded NPS RM positions to gain critical experience and training in supervision and program management.

Survey of White-tailed Deer Impacts

By Scott J. Miller, Susan P. Bratton, and John Hadidian

When many of the first NPS areas were designated, problems with ungulate browsing were rare. In the first decades of this century, ungulate populations, from overhunting and habitat loss, often were near their historic lows. In the case of white-tailed deer, hunting regulation, restocking, habitat improvement and protection, and succession on former agricultural lands, all have encouraged population increases. As a result, more and more NPS areas now are reporting concerns with deer impacts on park resources.

As part of a literature review project sponsored by the NPS National Capitol Region, researchers from the NPS/CPSU at U/GA, Athens, investigated the existing literature on white-tailed deer impacts on native vegetation. This project produced little data on such impacts on endangered plant species, so an attempt was made to gather more information. The investigators surveyed by telephone 173 scientists and natural resource managers, asking information such as field observations of deer disturbing endangered or threatened plant populations.

Included were resource managers from 76 NPS areas in the Southeast, Southwest, Midwest, National Capital, Middle Atlantic, North Atlantic and Rocky Mountain Regions, who had responsibilities for parks that might have significant white-tailed deer populations. Areas with limited acreage of forest or of native plant communities were excluded from the survey. The managers were asked if deer were known to disturb endangered flora, if they were influencing forest regeneration, causing a browse line, or depredating crop plants or ornamental species.

Survey Results

In comparison to informants from the Natural Heritage Inventory, NPS staff reported far fewer observations of deer grazing or damaging endangered species. Of the information received concerning rare plants, 60 percent was from the various state Natural Heritage programs, 6 percent from The Nature Conservancy land stewards, 6 percent from NPS resource managers, and 28 percent from experts affiliated with the USFS, USFWS, universities and other institutions.

The informants and literature search produced a list of 98 nationally or state listed or candidate endangered or threatened plant species disturbed by deer. Interestingly, 38.7 percent of these species belonged to either the lily or orchid families (*Liliaceae* or *Orchidaceae*). Sources of impact included not only grazing and browsing, but antler rubbing and trampling. A full report and species list from this part of the survey has been submitted to ***Natural Areas Journal*** and preliminary copies also are available from the authors (listed at the end of this article.)

Of the parks surveyed, 26 (34.2%) reported high deer populations having potentially adverse impacts on park resources (Table 1), whereas 50 parks (65.8%) reported no problems at the current time. Only 3 of the 26 parks (11.5%) had records of deer impacts on endangered or threatened flora, although some parks, such as Catoctin Mountain, expressed concerns for more than one species.

Of the parks with known impacts, 84.6 percent reported browse lines, 19.2 percent reported crop damage, 7.7 percent reported destruction of ornamentals, and 34.6 percent reported suppression of forest regeneration or seedling production (Table 1). Among reported problems were bark stripping from deciduous (*Ulmus* spp) trees at Catoctin Mountain Park, and a concern for grazing of *Platanthera* spp. populations. Apostle Islands National Lakeshore is experiencing a change in forest community structure and function due to intensive browsing. At Lincoln Boyhood National Memorial there are extreme problems of browse on red-stemmed dogwood (*Cornus stolonifera*) as well as newly planted seedlings of deciduous trees.

When Fort Necessity National Battlefield attempted to reestablish trees on part of the site, deer ate many of the newly planted seedlings. Cumberland Island National Seashore is experiencing suppression of live oak (*Quercus virginiana*) regeneration along with reduction of many native forest floor forb populations. Several historic parks, such as Gettysburg National Military Park, George Washington Birth Place, and Hopewell Furnace National Historic Site, are experiencing repeated damage to agricultural crops planted to maintain the historic scene.

The survey produced other patterns of interest in determining an overall NPS strategy for managing white-tailed deer. First, the 26 parks reporting impacts had a smaller average size (34,200 acres) than the 50 parks reporting no impacts (averaging 50,000 acres). Very large parks and, of course, very small parks, are less likely than "middle-sized" parks to have problems.

Second, of the 26 parks reporting deer impacts, 17 were national historic parks, battlefields, or monuments with an average size of 3,600 acres. Third, many of the parks reporting impacts have a high ratio of

(Continued on page 10)

Table 1. U.S. national parks reporting impacts by white-tailed deer.

		Type of Vegetation Affected				
Park	State	E&T Plants	Orna-mentals	Agri-cultural Crops	Seedling Repro-duction	Browse Line
Antietam Natl Battlefield	MD			*		
Apostle Island Natl Lakeshore	WI				*	*
Blue Ridge Parkway	NC					*
Catoctin Mountain Park	MD	*			*	*
Chesapeake and Ohio Canal Natl Hist Park	MD				*	*
Chickamauga & Chattanooga Natl Milt Park	GA					*
Colonial Natl Hist Park	VA					*
Cumberland Island Natl Seashore	GA	?			*	*
Cuyahoga Valley Natl Recreation Area	OH					*
Eleanor Roosevelt Natl Hist Site	NY		*			
Fire Island Natl Seashore	NY					*
Fort Necessity Natl Battlefield	PA				*	*
George Washington Birth Place	VA			*		*
Gettysburg Natl Military Park	PA			*		*
Great Smoky Mountains Natl Park	TN	*			*	
Hopewell Furnace Natl Hist Site	PA			*	*	*
Horseshoe Bend Natl Military Park	AL					*
Lincoln Boyhood Natl Memorial	IN				*	*
Lower St. Croix Natl Scenic Riverway	WI					*
Lyndon B. Johnson Natl Hist Park	TX		*			*
Mammoth Cave Natl Park	KY					*
Morristown Natl Hist Park	NJ				*	*
Pea Ridge Natl Military Park	AR					*
Saratoga Natl Hist Park	NY					*
Valley Forge Natl Hist Park	PA			*		*
Wilson's Creek Natl Battlefield	MO	*				

Professionalism

(Continued from page 8)

edge beyond their education specialty, we need to maintain their professional expertise at the highest level possible. Resource managers should be encouraged to participate in activities such as short courses, scientific conferences, and graduate level continuing education opportunities. The NPS should regularly sponsor workshops specifically targeted toward resource managers, focusing on state of the art themes.

Natural and cultural resources, which form the foundation on which the National Park System is built, are facing threats as never before. Natural resource programs, including research and resource management, made up only 6 percent of the NPS budget in FY 1991. Whether or not the NPS considers its own resource managers to be professionals is projected to others by how the NPS is organized. Resource management must surface as a keystone responsibility, considered a part of "line management," with sufficient personnel and support to deal with the issues faced by the parks in today's world.

Jope is Regional Resource Management Specialist in the Pacific Northwest Region, Seattle, WA.

Literature Cited

Wauer, Roland H. 1980. The role of the National Park Service natural resources manager. NPS Publ. CPSU/UW B-80-2. Coop. Park Studies Unit, U.WA. Seattle. WA 98195. 10pp.

Davis, Gary E. 1988. Inventory and monitoring of natural resources in Channel Islands NP, Ventura, CA.

Native Seed Bank Brooklyn Reclamation Project

By Carol A. Pollio and Walter H. Davidson

The 1977 Surface Mining Reclamation and Recovery Act (SMRCA) requires the reclamation of land disturbed by surface mining. This law also addresses the issue of areas mined prior to 1977, by establishing a fund to begin emergency reclamation of the most hazardous sites. Within New River Gorge National River, there are hundreds of such mine hazards eligible for abandoned mine land (AML) reclamation funding, and many others that, although not hazardous, need reclamation work. The site used for this study, the Brooklyn Mine Refuse Area, (BMRA), was considered a low priority for emergency funding because it was not a serious threat to health and safety or to the environment. The Brooklyn site created an aesthetic problem, however, because of its visibility from the river and the air.

The BMRA consists of a large, almost completely unvegetated mound of unstable refuse. The NPS has developed resource management guidelines that encourage the use of native species for revegation projects within natural zones. This project was developed in order to determine if the native seed bank technique would encourage natural succession to reclaim disturbed sites, allowing for increased stabilization, increased adaptation of plants to local climatic conditions, and at the same time, produce a source of food and shelter for wildlife.

Another consideration was the cost associated with assembling a native seed mixture from commercial sources. The native seed bank method uses local topsoil that already contains seeds of existing native plant communities. These seed banks are excellent sources of both primary and secondary succession species thought necessary to the development of natural ecosystems (Wade 1986).

Native seed banking is not a new technique. It has been used by a number of researchers since the mid 70s, at first in the arid western regions of the country, and more recently in the Appalachian Mountains of the eastern United States. Farmer, et. al. (1982) experimented with spreading Appalachian forest topsoils for reclamation, producing 134 taxa on two mine sites and one nursery site (Farmer et al 1982). This study, conducted in Tennessee, also concluded that a large amount of nitrogen and phosphorous was taken up by the plants growing in the native seed banks. These essential nutrients, they suggested, might be important in the development of later plant communities, possibly enhancing the diversity of species.

***Biological Technician** Judy Weese in 1st replication plot (June 1989). Photo by Carol A. Pollio*

Objectives of this project were twofold. One was to encourage the emergence of native plant species in order to reclaim disturbed sites, such as minespoils. The second was to determine if seasonal variations would change the composition of plant species that emerged. Other considerations, though not specific objectives, were cost effectiveness and personnel time necessary for implementation of native seed banking for future reclamation projects.

Methods

In June of 1989, three 20' x 20'' experimental plots were delineated on the refuse pile at the Brooklyn site. During each phase of implementation, 3 additional plots were installed, creating a total of 12 experimental plots. Phases, or replications (Reps), were installed in June and October, 1989, and April and June, 1990.

Prior to installation of the plots, soil samples were taken from the project site and analyzed by the USDA Laboratory in Berea, KY. Soil analysis data were collected for six plots, two samples from the top and four samples from the slope of the spoil pile. Samples were tested for the following parameters: pH, Aluminum, PO_4, Sulphur, Total Carbon, Calcium, Magnesium, Potassium, Sodium, Barium, Silicon, Zinc, Phosphorous, Iron, Copper, Manganese, Cobalt, Nitrogen, Titanium, Chromium and Lead. This information was then compared to baseline soil composition data to determine the application rates of lime and fertilizer.

Each of the plots had a pH in the range of 3.5 to 4.8, or relatively acidic. Below a pH of 5.0, aluminum, iron and manganese often are soluble in sufficient quantities to be toxic to some plants (Brady 1971). Soil sample results showed high levels of aluminum and iron were present. Treatment with agricultural lime rated at 105 lbs/acre, equivalent to 600 lbs/acre, was performed as a site preparation to reduce the concentration of iron, aluminum and manganese in the experimental plots.

Plots also were pretreated with fertilizer, 100 lbs rated 10-20-20, equivalent to 40 lbs N, 80 lbs P and 80 lbs K per acre. The "native seed bank" material, the top 2 to 3 inches of forest floor and litter, was removed from preselected sites manually and distributed on the plots at approximately the same thickness. The availability of suitable borrow material in the area presented a problem and caused a difference in the soil used for each installation. The highest quality soil was used for the initial plots in June 1989, and suitable material of a lesser quality was used for all subsequent plots. The latter contained a higher percentage of coal refuse material and less organic material (visual observation). In spite of these limitations, all plots exhibited comparable growth of both woody and herbaceous species.

Measurements

Once the plots were installed, the emergence of

White-tailed Deer Impacts Surveyed *(Continued from page 9)*

boundary to interior area, with a majority of these also situated next to suburban, developed, or agricultural areas. And fourth, several of the natural areas reporting problems are either islands or have isolated deer populations without large predators (i.e. Apostle Islands and Cumberland Island).

Discussion

Surprisingly few NPS areas reported white-tailed deer impacts on endangered plant species. This may be due to one of several factors or a combination of them. First, very few moderately sized parks have formal endangered species monitoring programs, hence some deer impacts may not be noticed or documented. Second, the Heritage programs have far more field professionals with training in plant taxonomy and plant ecology than the NPS does. Thus, one might expect the Natural Heritage programs to have more sightings and information.

Third, since many of the parks with white-tailed deer concerns are historic, they may not support many rare plant populations within their boundaries. Although some historic areas, such as Chicamauga-Chattanooga National Military Park, contain regionally important rare plant habitat, NPS historic areas probably have fewer rare plants than the small, but botanically unique, Natural Heritage Conservation areas. The data do suggest, however, that all NPS areas with a potential for "overgrazing" by deer should have completed rare plant inventories and should have field monitoring established, especially for susceptible genera such as *Cypripedium* (lady slippers), *Trillium*, and *Platanthera* (habernarias or fringe-leaf orchids).

The survey results indicate a trend for smaller, historic parks and parks with a high boundary to interior ratio to have greater concerns for deer impacts. This suggests that the NPS tradition of concentrating major wildlife research efforts in the larger natural areas will fail to address properly the issues raised by white-tailed deer.

Further, many of the areas affected have no wildlife biologists or science staff of their own. Environmental conditions and management practices in areas outside the parks may have a major influence on deer impacts inside the parks. This makes NPS deer management extremely "political" because of the large number of sites involved, the influence of other agencies, and the visibility of the issues to the public. Some of the problems are specific to historic parks and districts (e.g. Gettysburg and Cades Cove), and may require management models not normally applied in natural areas.

To deal properly with the issues and problems generated by an increase in white-tailed deer populations in and around parks, it would be most effective to break with the NPS tradition of research and management programs localized in larger parks, and to deal with problems *interregionally*. Communication and cooperation, particularly among the four easternmost Regions, already are moving in this direction. However, the question remains as to how the NPS might best approach such a disperse resource management problem and objectively evaluate deer impacts on both native and cultivated flora.

Hadidian is a wildlife ecologist with the National Capitol Region's Center for Urban Ecology in Washington, DC; Miller and Bratton were with the NPS/CPSU at U/GA, Athens when this research was done; Bratton has since left the NPS to teach environmental ethics at Messiah College in Harrisburg, PA.

Brooklyn Project

(Cont. from p. 10)

***Range pole** in 1st replication plot. Photo by Carol A. Pollio*

herbaceous and woody plants was monitored by park staff. An initial inspection occurred in August, 1989. At that time, there was approximately 80 percent cover in Rep. 1, 50 percent cover in Rep. 2, and 70 percent cover in Rep. 3. Six woody and 13 herbaceous species were noted. Another inspection in November, 1989, indicated that germination was occurring in the October plots, however, the germinants were too small to identify. In August, 1990, the 12 plots were inventoried and the data recorded. The data represent two growing seasons for the June 1989 treatment and one growing season for all subsequent treatments.

Results

One of the objectives of this project was to determine the effectiveness of the native seed bank method to encourage the germination of native plant species. Of the 40 herbaceous species present, 10 were non-native or introduced species (25%). Of the 17 woody plants present, only 1, the Princess-tree or Paulownia, was a non-native. It was interesting to note that the Princess-tree (*Paulownia tomentosa*), considered a take over species, had apparently succumbed to competition. Significant numbers of Paulownia had been identified in several plots during the early part of the study, but very few were present during the inventory process. The herbaceous species present also were primarily shade intolerant species, which will more than likely disappear as woody species develop.

These data also were analyzed based on the time of year the plots were installed. The plot installed in October, 1989, appeared to exhibit more varied species diversity. It is also important to note that several interim species observed prior to the inventory, such as mayapple, are primarily forest floor species and did not survive due to intolerance. Woody species that emerged in the plots might possibly have come from the adjacent natural forest. White ash, yellow poplar, black birch, river birch and red maple are all present in the surrounding forest and, therefore, make it difficult to determine whether or not this seed came from the seed bank.

Although no statistical analysis was attempted because seed bank materials came from different borrow areas, results indicate that a great variety of viable seed was indeed present in the seed bank. Many of the herbaceous species may not persist because of their individual intolerances, however, their presence allows additional organic material to be available for the next generation of germinants.

There were 191 trees, 160 shrubs and vines, and over 1,981 herbaceous plants counted during the August 1990 inventory. Using a multiplier of 100 (the replicates are approximately 0.01 acres) and dividing by 12 (the number of replicates) gives a result of about 1,590 trees per acre, 1,330 shrubs and vines per acre, and 16,508 herbaceous plants per acre. In addition, during the inventory process, several species of wildlife were observed using the plots, namely Eastern box turtle, Northern fence lizard, and black rat snake.

Discussion

This study demonstrates that native materials can be established on abandoned deep mine refuse using the native seed bank technique. Germination of native species did occur, and in some cases, crowded out non-native species that appeared. The scarcity of quality topsoil in this area of the Appalachians did affect our ability to analyze the data statistically, however, it did prove that the native seed bank technique can be successful even with poor quality soil. For the first time in 40 years, there is vegetative cover on a virtually bare coal refuse pile. In addition, it was accomplished at minimal cost and with existing day labor, making this method more cost effective than other revegetation methods.

(For tables showing soil sample results, herbaceous plant species and distributions at 3 different times of year, woody plant species and distributions at 3 different times of year, and the names of all herbaceous and woody plants found at BMRA, contact the authors at New River Gorge National River, P.O. Drawer V, Oak Hill, WVA 25901; (304) 465-1447).)

Pollio is an NPS Resource Management Specialist at New River Gorge; Davidson is a Research Forester with the USDA, stationed at PA State University.

Literature Cited

Wade, Gary L. "Forest Topsoil Seed Banks for Introducing Native Species in Eastern Surface-Mine Reclamation." A Symposium paper for a National Meeting of the American Society for Surface Mining and Reclamation, March 17-20, 1986.

Farmer, R.D. Jr., M. Cunningham, and M.A. Barnhill. 1982. First-year development of plant communities originating from forest topsoils placed on southern Appalachian minesoils. Journal of Applied Ecology 19:283-294.

Brady, N.C., The Nature and Property of Soils, 8th Edition. 1974. MacMillan Publishing, New York, NY.

Olympic NP Dams Update

By Cat Hoffman

The Federal Energy Regulatory Commission (FERC) is considering license applications for two dams on the Elwha River which supply power to a Japanese-owned paper company (Daishowa America, Inc.) in Port Angeles, WA. (***Park Science***, Fall 1989, p. 6) The Elwha is the largest watershed within Olympic NP and is one of few rivers outside Alaska that once supported all 5 species of Pacific salmon. The Glines Canyon Dam is within Olympic NP; the Elwha Dam is downstream from the park.

Both dams were built in the early 1900s without provisions for fish passage. In a river affording 75 miles of habitat to anadromous fish, these dams block upstream migration of salmon 5 miles from the river's mouth. Research has documented the use of anadromous fish on the Olympic Peninsula as a source of food by at least 22 species of birds and mammals, indicating effects of the loss of these fish on many other species in the food chain as well. With the loss of this source of nutrient enrichment, the entire Elwha ecosystem has been disrupted.

Three separate (but not independent) scenarios are in progress regarding this issue:

1. Jurisdiction determination: In April 1991, FERC issued a final order asserting jurisdiction over the Glines Canyon project. Petitions for review of this ruling have been submitted to the 9th Circuit Court by conservation groups and by the Dept. of Justice (representing the Dept. of Commerce and of the Interior). At issue is whether the Federal Power Act gives FERC authority to license (specifically, "relicense") a hydroproject within a national park, or whether Congress must determine who has authority over a project in these circumstances.

Interior's Assistant Solicitor has issued a finding that neither the NPS nor FERC has authority to license the Glines Canyon project, and that only Congress can provide specific authorization needed for continued operation of the dam. The GAO has issued a report supporting Interior's position that FERC has no authority within the park, but maintains that FERC does have jurisdiction to call for removal of the Glines Canyon dam. Lawyers involved in this case estimate 2 years minimum before a court decision regarding jurisdiction is reached.

2. FERC licensing proceedings: In February 1991, FERC released a Draft EIS (DEIS) regarding licensing of Elwha and Glines Canyon dams. The DEIS analyzes four alternatives: (1) retention of both dams, (2) removal of both dams, (3) retention of Elwha dam with removal of Glines Canyon dam, and (4) retention of Glines Canyon dam with removal of Elwha dam. No preferred alternative is indicated.

The DEIS states that the cost of power to Daishowa America will be the same whether the dams remain with the addition of fish passage facilities or whether the dams are removed. The Bonneville Power Administration has indicated it would provide replacement power to Daishowa America if the dams are removed. A final EIS, indicating a preferred alternative, is expected in early 1992.

3. Legislative activity: Staffs of Sens. Brock Adams (WA) and Bill Bradley (NJ; Chair of the Senate Subcommittee on Water and Power) are drafting legislation which, in effect, would resolve this issue through negotiated settlement. The legislation was expected to be in draft form by the first of January 1992.

Summary

Projections of the timing and nature of a final decision regarding these dams confound the best of agency fortune-tellers. Many of the parties involved in this issue regard a negotiated settlement as the most expedient means to an end that is satisfactory to all concerns and, without losing sight of the primary objective, as being the best solution for restoration of the Elwha ecosystem.

GIS Helps Shenandoah Conduct Viewshed Analysis

By Alison Teetor and David Haskell

A primary resource related value of Shenandoah NP is its spectacular views from overlooks along the Skyline Drive from Wilderness mountain peaks. Many of these views are dependent on the continuation of traditional land uses on properties located outside the park. Until recent years, much of the land adjacent to the park has been maintained in forest, agriculture, and pasture.

Development was slow to come to the Shenandoah Valley and the remote hollows of Rappanahock, Green, and Madison counties. With the 1980s came rapidly rising real estate prices in the suburbs of Washington, DC. Completion of Interstate 66 and the shift of populations farther West started a rapid change in land use from rural to an urban style of development. The sudden, unplanned growth of homes, shopping malls, and light industry threatens the integrity of the world famous Shenandoah views.

This alarming new trend prompted initiation of a park management effort, which has become known as the Related Lands Program. Local jurisdictions and private citizens can identify and protect portions of open space that will be mutually beneficial. One objective is to identify adjacent lands that represent or promote park values. Values include, but are not limited to, protecting scenic views, maintaining trail access, providing corridors for wildlife movement, protecting air quality, and assuring the viability of species biodiversity within the region.

One way to describe and evaluate the scenic quality of land outside the park boundary is to create an integral vista/visibility map. The map created for Shenandoah describes the number of times an area can be seen from overlooks along Skyline Drive and highly visited mountain peaks. This paper describes the procedures used in 1990 to create this map.

Methods

In 1978, a visual resource inventory was performed and a visibility map created for the 1980 General Management Plan (GMP) (Stutzman, 1978). In addition, an integral vista report was prepared by the Denver Service Center (DSC) that identified those views integral to visitor enjoyment of the park (Shaver, 1980). These two reports served as the basis for a 1990 update of the viewshed analysis for the park.

The 1980 visibility map was created by VIEW-IT, a computerized mapping program (Stutzman, 1978). Efforts were made to acquire the original data from the DSC, however they no longer were available. Since these data were not available in digital form, a new viewshed analysis was performed, using parameters similar to those used in creation of the first map.

Each of the 76 overlooks along Skyline Drive was visited and compass bearings were established for the maximum angles of the viewing area. The GIS software Geographic Resources Analysis Support System (GRASS) was used for computing which land areas are visible from each overlook based on elevation. The 1:250,000 scale Defence Mapping Agency (DMA) elevation data were used, providing a 50 meter cell resolution.

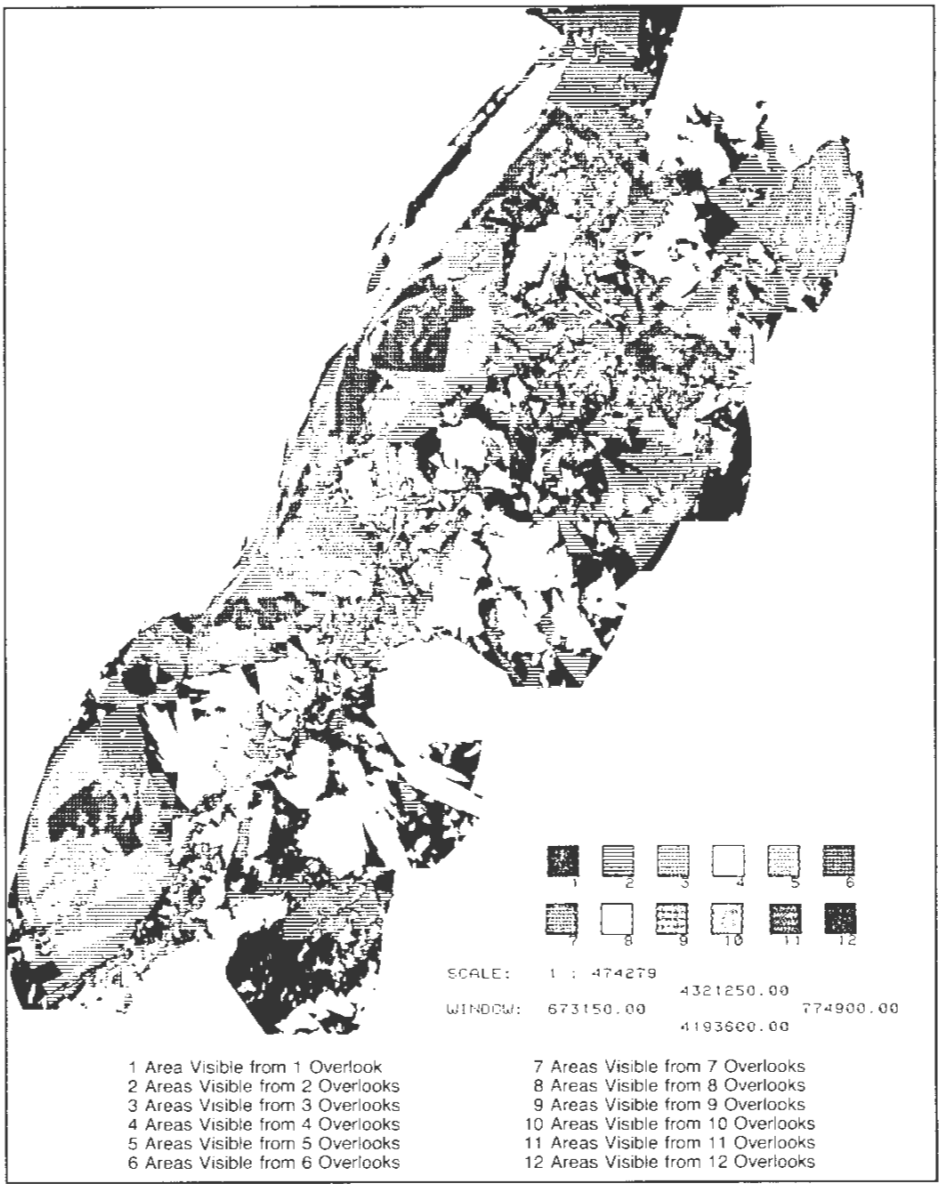
An outline or pattern of each viewing area was plotted on Potomac Appalachian Trail Conference (PATC) maps (1:62,500) and digitized, using d.digit. Each area was given the value of 1. Glos (a GRASS program) was performed on each overlook. This program calculates which areas can be seen from an overlook based on

(Continued on page 13)

Table 1. *Amount of land area visible within 20 kilometers (12 miles) from overlooks and mountain summits in Shenandoah National Park, Virginia, 1990.*

Class	Name	Percent	# Hectares	# Acres
0	Areas Not Visible	75.75	2,431,105	983,855
1	Areas Visible from 1	8.48	272,005	100,079
2	Areas Visible from 2	5.21	167,146	67,643
3	Areas Visible from 3	3.82	122,603	49,617
4	Areas Visible from 4	2.36	75,847	30,695
5	Areas Visible from 5	1.80	57,732	23,364
6	Areas Visible from 6	1.30	41,570	16,823
7	Areas Visible from 7	0.89	28,493	11,531
8	Areas Visible from 8	0.36	11,703	4,736
9	Areas Visible from 9	0.03	877	355
10	Areas Visible from 10	0.01	297	120
11	Areas Visible from 11	0.00	47	19
12	Areas Visible from 12	0.00	5	2
	Totals	100.00	3,209,430	1,298,839

Figure 1. *Viewshed Analysis of Shenandoah National Park – OV*



Park Science Index for Volume 11 (No. 1, 2, 3 & 4)

Beginning in this issue and henceforth in the first issue of each volume of **Park Science**, *the previous volume's contents will be indexed by title, by author, by keyword and by park. Indexes will be bound in the center of the issue for easy removal and filing.*

Park Science Index
Listed by Title

Agricultural Pest Scouting Tried. 1991, 11(3):17.

And Veg Management: A Multi-Agency Look. 1991, 11(3):7

Bald Eagle Studies. 1991, 11(3):17.

Bark Beetle Battle Given Historic Treatment. 1991, 11(1):9.

Biological and Physical Aspects of Dredging On Cumberland Island National Seashore. 1991, 11(3):3-4.

Book Review. 1991, 11(4):20.

Cape Cod's Atlantic White Cedar: Managing a Unique, Natural (?) Community. 1991, 11(3):10.

Caves and the NPS. 1991, 11(2):5-6.

Chiricahua Mountains Annotated Bird Checklist Scheduled for Publication Early This Year. 1991, 11(2):18-19.

Colonial Mowing Pattern Changes Paying Off. 1991, 11(2):17.

Colorado Plateau NPs Hold First Biennial Science Conference. 1991, 11(4):6.

A Commentary on Visitor Statistics. 1991, 11(2):17.

Director's Achievement Awards Go to Van Riper, Taylor, Rambur. 1991, 11(4):15.

Ecological Effects of Stocked Trout on North Cascades Naturally Fishless Lakes. 1991, 11(3):22-23.

Ecological Restoration Research: Applications Manual. 1991, 11(3):6.

Effects of Prairie Fire on Archelogical Artifacts. 1991, 11(1):1,3.

El Malpais Wilderness Suitability Study. 1991, 11(2):1,3-5.

Falcons Carry Heavy Nomenclature. 1991, 11(4):9.

A GIS Assessment of Barrier Island Impacts. 1991, 11(3):5-6.

GIS Used to Develop Fire Management Strategies. 1991, 11(3):16-17.

GIS Users Conference at Denver in November. 1991, 11(4):15.

Global Change Program Update. 1991, 11(2):14.

Great Basin to Test Electronic "Ear Ring" as Cattle Control. 1991, 11(4):6.

Guide to Florida's Natural Resources. 1991, 11(1):18.

GWS 1992 Conference Theme: "Partners in Stewardship". 1991, 11(4):15

Gypsy Moths May Alter Black Bear Population Dynamics in Shenandoah National Park. 1991, 11(4):7-8.

Historic Landscape Restored. 1991, 11(3):7.

Interagency Neotropical Migratory Bird Program. 1991, 11(2):19.

Jordan's View of Restoration. 1991, 11(3):7.

Keystone Dialogue on Biological Diversity on Federal Lands Goes to Field. 1991, 11(4):20.

Little Islands Floating in Seas of Indifference? 1991, 11(3):19

Loon Survey Conducted. 1991, 11(3):17.

Mapping Jewel Cave - From the Surface. 1991, 11(2):6-7.

Mexican Spotted Owls in Zion NP: Inventory and Monitoring Methods. 1991, 11(4):18-19.

Mexican Spotted Owls Shyer Than Their Northern Cousins. 1991, 11(1):18.

Mountain Goats in Yellowstone: The Horns of a Dilemma?. 1991, 11(3):8-9.

Mountain lion-Human Interaction Studied. 1991, 11(4):8.

Native Plants Delight Visitors at Columbia Gorge Plot. 1991, 11(4):4-5.

The Natural Resources Publication Program: What is it?. 1991, 11(3):2,24.

Neotropical Migratory Bird Conservation Pact Signed. 1991, 11(3):19.

New Perspectives in Science. 1991, 11(2):11.

New Plant Discovered in Guadalupe NP. 1991, 11(1):7.

NPS and SCS Cooperate on Native Plant Materials Program. 1991, 11(4):5.

Olympic NP Mountain Goat Removal Project Subject of Risk Assessment Report. 1991, 11(1):14-15.

Parks, Pollution, and People: An International Conference on Management of Protected Areas Under Atmospheric Emission Impact. 1991, 11(1):5.

Peregrine Falcon Releases End. 1991, 11(3):8.

Publications. 1991, 11(4):20.

Reclamation of Abandoned Mines at New River Gorge, Gauley River, and Bluestone. 1991, 11(2):8-10.

Red Wolves Thrive at Gulf Islands. 1991, 11(1):6-7.

Redwood NP Geologist Reports on Gravel Bed Rivers Workshop in Italy. 1991, 11(1):12-13.

Restoration of Farm Woodlots at Gettsburg NMP. 1991, 11(3):18.

Revegetation Efforts Using Native Species. 1991, 11(2):15.

Revegetation notes: Brooklyn Native Seed Bank Project Near Completion. 1991, 11(2):16.

Sea-Kayakers at Apostle Islands National Lakeshore Summary of a 1989 Exploratory Study. 1991, 11(2):20.

Seagrass Die-Off Threatens Ecology of Florida Bay. 1991, 11(4):21-23.

Search for Cave Swallow's Winter Range Underway. 1991, 11(2):16.

SEAs Successful as Alien Species Controls. 1991, 11(4):1,3-4

Seeing the Forest for the Trees: An Analysis of Cumulative Impact in Environmental Documents. 1991, 11(3):21.

Shenandoah NP Pilots Air Quality Advisory. 1991, 11(3):1.

Should Recreational Boating on Upper Delaware Be Limited? What We Have Learned . 1991, 11(1):23-24

A Slice of Parks' Future?. 1991, 11(4):6.

Sociological Contributions to Everglades Backcountry Use Management Plan. 1991, 11(1):4-5.

Special Initiative Funding for Servicewide Projects Now Into Second Year. 1991, 11(1):22.

Tallgrass Prairie Site Studies. 1991, 11(3):7.

Technical Writing As a Tool - An Art. 1991, 11(1):13.

Tree Line Research in Gates of the Artic NP: A Follow-up to Robert Marshall's Research. 1991, 11(2):22-24.

Ungulate Populations Models and Carrying Capacity: Predicting Effects of Fires, New Winter Range, and Proposed Wolf Reintro... 1991, 11(1):8-9.

Western Rattlesnake Ecology at Natural Bridges NM, Utah. 1991, 11(4):10-11.

Where the Mind Runs Free: Observations of an Interpreter. 1991, 11(4):23-24

Woodland Caribou Studied. 1991, 11(3):8.

Park Science Index
Listed by Author

Ahler, Stanley A.
Effects of Prairie Fire on Archelogical Artifacts. 1991, 11(1):1,3.

Alderson, Judy
Tree Line Research in Gates of the Artic NP: A Follow-up to Robert Marshall's Research. 1991, 11(2):22-24.

Beavers, William R.
NPS and SCS Cooperate on Native Plant Materials Program. 1991, 11(4):5.

Bradshaw, Dwight
Red Wolves Thrive at Gulf Islands. 1991, 11(1):6-7.

Brock, William
Great Basin to Test Electronic "Ear Ring" as Cattle Control. 1991, 11(4):6.

Brown, William E.
New Perspectives in Science. 1991, 11(2):11.

Buker, David
Seagrass Die-Off Threatens Ecology of Florida Bay. 1991, 11(4):21-23.

Cavanaugh, Cecile M.
Restoration of Farm Woodlots at Gettsburg NMP. 1991, 11(3):18.

Cofer-Shabica, Stephen V.
Biological and Physical Aspects of Dredging On Cumberland Island National Seashore. 1991, 11(3):3-4.

Cole, Kenneth L.
GIS Used to Develop Fire Management Strategies. 1991, 11(3):16-17.

Dawson, Richard
A GIS Assessment of Barrier Island Impacts. 1991, 11(3):5-6.

Dennis, John
Keystone Dialogue on Biological Diversity on Federal Lands Goes to Field. 1991, 11(4):20.

Dennis, John G.
Neotropical Migratory Bird Conservation Pact Signed. 1991, 11(3):19.

Douhan, Carl
GIS Used to Develop Fire Management Strategies. 1991, 11(3):16-17.

Draugh, Frank
Seagrass Die-Off Threatens Ecology of Florida Bay. 1991, 11(4):21-23

Droesser, Terry
Tree Line Research in Gates of the Artic NP: A Follow-up to Robert Marshall's Research. 1991, 11(2):22-24.

Esher, Robert
Red Wolves Thrive at Gulf Islands. 1991, 11(1):6-7.

Farnweather, Stephen E.
Restoration of Farm Woodlots at Gettsburg NMP. 1991, 11(3):18.

Figlio, David
Global Change Program Update. 1991, 11(2):14.

Graham, Tim B.
Western Rattlesnake Ecology at Natural Bridges NM, Utah. 1991, 11(4):10-11.

Gruber, Rolf M.
Shenandoah NP Pilots Air Quality Advisory. 1991, 11(3):1.

Hassell, Wendell. G.
NPS and SCS Cooperate on Native Plant Materials Program. 1991, 11(4):5.

Hearn, Katherine A.
Notes From Abroad. 1991, 11(4):9.

Hiett, Kathy L.
Chiricahua Mountains Annotated Bird Checklist Scheduled for Publication Early This Year. 1991, 11(2):18-19.

Ivy, Mark I.
Sociological Contributions to Everglades Backcountry Use Management Plan. 1991, 11(1):4-5.

Jackson, James R.
Notes From Abroad. 1991, 11(4):9.

Janca, Chuck
Olympic NP Mountain Goat Removal Project Subject of Risk Assessment Report. 1991, 11(1):14-15.

Jarvis, Destry
Ecological Restoration Research: Applications Manual. 1991, 11(3):6.

Johnson, Larry W.
Search for Cave Swallow's Winter Range Underway. 1991, 11(2):16.

Johnson, R. Roy
Chiricahua Mountains Annotated Bird Checklist Scheduled for Publication Early This Year. 1991, 11(2):18-19.

Jope, Katherine L.
Mountain lion-Human Interaction Studied. 1991, 11(4):8.

Karish, John
Gypsy Moths May Alter Black Bear Population Dynamics in Shenandoah National Park. 1991, 11(4):7-8.

Karish, John F.
Should Recreational Boating on Upper Delaware Be Limited? What We Have Learned.. 1991, 11(1):23-24.

Kaye, Glen
Where the Mind Runs Free: Observations of an Interpreter. 1991, 11(4):23-24.

Kerbo, Ronald
Caves and the NPS. 1991, 11(2):5-6.

Knutson, Randy
GIS Used to Develop Fire Management Strategies. 1991, 11(3):16-17.

Kunzmann, Michael R.
Chiricahua Mountains Annotated Bird Checklist Scheduled for Publication Early This Year. 1991, 11(2):18-19.

Lange, Arthur L.
Mapping Jewel Cave - From the Surface. 1991, 11(2):6-7.

Larson, Gary L.
Ecological Effects of Stocked Trout on North Cascades Naturally Fishless Lakes. 1991, 11(3):22-23.

Laundre, John W.
Mountain Goats in Yellowstone: The Horns of a Dilemma?. 1991, 11(3):8-9.

Lime, David W.
Should Recreational Boating on Upper Delaware Be Limited? What We Have Learned.. 1991, 11(1):23-24.
Sea-Kayakers at Apostle Islands National Lakeshore Summary of a 1989 Exploratory Study. 1991, 11(2):20.

Liss, William J.
Ecological Effects of Stocked Trout on North Cascades Naturally Fishless Lakes. 1991, 11(3):22-23.

Lovaas, Al
A Commentary on Visitor Statistics. 1991, 11(2):17.

Mabery, Ken and Kenney, Dave
El Malpais Wilderness Suitability Study. 1991. 11(2):1,3-5.

Madej, Mary Ann
Redwood NP Geologist Reports on Gravel Bed Rivers Workshop in Italy. 1991, 11(1):12-13.

Matthews, Jean
Arid Veg Management: A Multi-Agency Look. 1991, 11(3):7.
Colorado Plateau NPs Hold First Biennial Science Conference. 1991, 11(4):6.
Book Review. 1991, 11(4):20.

Motzkin, Glenn
Cape Cod's Atlantic White Cedar: Managing a Unique, Natural (?) Community. 1991, 11(3):10.

O'Leary, Donna
The Natural Resources Publication Program: What is it?. 1991, 11(3):2,24.

Parsons, David
Notes from Abroad. 1991, 11(3):15.

Patterson, Samuel
A GIS Assessment of Barrier Island Impacts. 1991, 11(3):5-6.

Patterson, William A. III
Cape Cod's Atlantic White Cedar: Managing a Unique, Natural (?) Community. 1991, 11(3):10.

Peine, John D.
Parks, Pollution, and People: An International Conference on Management of Protected Areas Under Atmospheric Emission Impact. 1991, 11(1):5.

Peterson, David L.
Notes From Abroad. 1991, 11(2):21-22.

Phelps, Carolyn C.
Sea-Kayakers at Apostle Islands National Lakeshore Summary of a 1989 Exploratory Study. 1991, 11(2):20.

Pollio, Carol A.
Reclamation of Abandoned Mines at New River Gorge, Gauley River, and Bluestone. 1991, 11(2):8-10.

Quigley, Thomas
Great Basin to Test Electronic "Ear Ring" as Cattle Control. 1991, 11(4):6.

Quinn, James
National Park Biotic Inventories Assessed. 1991, 11(4):16-17.

Rinkevich, Sarah E.
Mexican Spotted Owls in Zion NP: Inventory and Monitoring Methods. 1991, 11(4):18-19.

Rose, Michael
Seagrass Die-Off Threatens Ecology of Florida Bay. 1991. 11(4):21-23.

Ruggiero, Michael
National Park Biotic Inventories Assessed. 1991, 11(4):16-17.

Sayler, Rodney D.
Effects of Prairie Fire on Archelogical Artifacts. 1991, 11(1):1,3.

Schonewald-Cox, Christine
A Slice of Parks' Future?. 1991, 11(4):6.

Seabloom, Robert W.
Effects of Prairie Fire on Archelogical Artifacts. 1991, 11(1):1,3.

Shelton, Napier
MAB Notes. 1991, 11(1):22.
MAB Notes. 1991, 11(2):15.
MAB Notes. 1991, 11(4):19.

Simons, Ted
Red Wolves Thrive at Gulf Islands. 1991, 11(1):6-7.

Singer, Francis
Ungulate Populations Models and Carrying Capacity: Predicting Effects of Fires, New Winter Range, and Proposed Wolf Reintro... 1991, 11(1):8-9.

Snow, Ray W.
Sociological Contributions to Everglades Backcountry Use Management Plan. 1991, 11(1):4-5.

Stewart, William P.
Sociological Contributions to Everglades Backcountry Use Management Plan. 1991, 11(1):4-5.

Stohlgren, Thomas
National Park Biotic Inventories Assessed. 1991, 11(4):16-17.

Tiedemann, Arthur
Great Basin to Test Electronic "Ear Ring" as Cattle Control. 1991, 11(4):6.

Tuler, Seth
Olympic NP Mountain Goat Removal Project Subject of Risk Assessment Report. 1991, 11(1):14-15.

Tunison, Tim
SEAs Successful as Alien Species Controls. 1991, 11(4):1,3-4.

Van Pelt, Nicholas and Tuhy, Joel S.
Relict Vegetation Sties: Urgent Inventory Need for Desert Parks. 1991, 11(3):20.

Vaughan, Michael R.
Gypsy Moths May Alter Black Bear Population Dynamics in Shenandoah National Park. 1991, 11(4):7-8.

Waggoner, G.
National Park Biotic Inventories Assessed. 1991, 11(4):16-17.

Weller, John
Red Wolves Thrive at Gulf Islands. 1991, 11(1):6-7.

West, Ron
Seeing the Forest for the Trees: An Analysis of Cumulative Impact in Environmental Documents. 1991, 11(3):21.

Wiles, Mike
Mapping Jewel Cave - From the Surface. 1991, 11(2):6-7.

Wood, Jim
Technical Writing As a Tool - An Art. 1991, 11(1):13.

Zimmer, Chris
SEAs Successful as Alien Species Controls. 1991, 11(4):1,3-4.

Park Science Index Listed by Keyword

Acid deposition
Information Crossfile. 1991, 11(4):14.

Acid mine drainage
Regional Highlights: Southeast Region. 1991, 11(4):12.

Acid rain
Information crossfile. 1991, 11(1):11.
Information crossfile. 1991, 11(3):14.

Air pollution
Parks, Pollution, and People: An International Conference on Management of Protected Areas Under Atmospheric Emission Impact. 1991, 11(1):5.
Information crossfile. 1991, 11(1):10.
Shenandoah NP Pilots Air Quality Advisory. 1991, 11(3):1.
Regional Highlights: Southeast Region. 1991, 11(4):12.

Air quality
Shenandoah NP Pilots Air Quality Advisory. 1991, 11(3):1.

Algae
Information Crossfile. 1991, 11(4):14.

Alien species
SEAs Successful as Alien Species Controls. 1991, 11(4):1,3-4.

Amphibians
Information Crossfile. 1991, 11(4):14.

Archeology
Effects of Prairie Fire on Archelogical Artifacts. 1991, 11(1):1,3.
Regional highlights: Rocky Mountain region. 1991, 11(2):12.

Arid vegetation
Arid Veg Management: A Multi-Agency Look. 1991, 11(3):7.

Artic
Tree Line Research in Gates of the Artic NP: A Follow-up to Robert Marshall's Research. 1991, 11(2):22-24.

Atlantic White Cedar
Cape Cod's Atlantic White Cedar: Managing a Unique, Natural (?) Community. 1991, 11(3):10.

Backcountry management
Sociological Contributions to Everglades Backcountry Use Management Plan. 1991, 11(1):4-5.

Bald eagle
Regional highlights: Western region.. 1991, 11(3):12.
Bald Eagle Studies. 1991, 11(3):17.

Barrier Islands
A GIS Assessment of Barrier Island Impacts. 1991, 11(3):5-6.

Bats
Information crossfile. 1991, 11(1):11.

Beetles
Bark Beetle Battle Given Historic Treatment. 1991, 11(1):9.

Biological diversity
Keystone Dialogue on Biological Diversity on Federal Lands Goes to Field. 1991, 11(4):20.

Biosphere reserves
MAB Notes. 1991, 11(1):22.
MAB Notes. 1991, 11(2):15.
MAB Notes. 1991, 11(4):19.

Birds
Search for Cave Swallow's Winter Range Underway. 1991, 11(2):16.
Chiricahua Mountains Annotated Bird Checklist Scheduled for Publication Early This Year. 1991, 11(2):18-19.
Interagency Neotropical Migratory Bird Program. 1991, 11(2):19.

Bison
Ungulate Populations Models and Carrying Capacity: Predicting Effects of Fires, New Winter Range, and Proposed Wolf Reintro... 1991, 11(1):8-9.
Regional highlights: Rocky Mountain.. 1991, 11(1):18.
Regional highlights: Rocky Mountain region.. 1991, 11(3):13.

Black bears
Gypsy Moths May Alter Black Bear Population Dynamics in Shenandoah National Park. 1991, 11(4):7-8.

Black Bears
Book Review. 1991, 11(4):20.

Boating
Should Recreational Boating on Upper Delaware Be Limited? What We Have Learned.. 1991, 11(1):23-24.
Sea-Kayakers at Apostle Islands National Lakeshore Summary of a 1989 Exploratory Study. 1991, 11(2):20.

Butterflies
Regional highlights: Pacific Northwest. 1991, 11(2):12.

Caribou
Woodland Caribou Studied. 1991, 11(3):8.
Regional Highlights: Alaska Region. 1991, 11(4):12.

Caves
Caves and the NPS. 1991, 11(2):5-6.
Mapping Jewel Cave - From the Surface. 1991, 11(2):6-7.
Search for Cave Swallow's Winter Range Underway. 1991, 11(2):16.

Climatic Changes
Information Crossfile. 1991, 11(4):14.

Clouds
Information crossfile.. 1991, 11(3):14.

Coastal research
Biological and Physical Aspects of Dredging On Cumberland Island National Seashore. 1991, 11(3):3-4.

Conferences
Colorado Plateau NPs Hold First Biennial Science Conference. 1991, 11(4):6.
GWS 1992 Conference Theme: "Partners in Stewardship". 1991, 11(4):15.

Conservation
Neotropical Migratory Bird Conservation Pact Signed. 1991, 11(3):19.
Information Crossfile. 1991, 11(4):14.

Conservation education
A Slice of Parks' Future?. 1991, 11(4):6.

Convection
Information crossfile.. 1991, 11(3):14.

Coral reefs
Information crossfile. 1991, 11(1):10.
Information crossfile. 1991, 11(3):14.
Information Crossfile. 1991, 11(4):14.

Cumulative impact
Seeing the Forest for the Trees: An Analysis of Cumulative Impact in Environmental Documents. 1991, 11(3):21.

Deer
Regional highlights. 1991, 11(1):18.

Desert ecology
Regional highlights: Rocky Mountain region. 1991, 11(3):12.
Relict Vegetation Sties: Urgent Inventory Need for Desert Parks. 1991, 11(3):20.

Ecological restoration
Ecological Restoration Research: Applications Manual. 1991. 11(3):6.

Ecosystem
Guide to Florida's Natural Resources. 1991, 11(1):18.

Ecosystem research
Regional highlights. 1991, 11(1):16.

Ecosystem restoration
Regional highlights: Pacific Northwest.. 1991, 11(1):17.

Elk
Ungulate Populations Models and Carrying Capacity: Predicting Effects of Fires, New Winter Range, and Proposed Wolf Reintro... 1991, 11(1):8-9.
Regional highlights: Rocky Mountain region. 1991, 11(2):13.

Endangered plants
Regional highlights: Rocky Mountain.. 1991, 11(1):17.

Endangered species
Regional Highlights: Midwest Region. 1991, 11(4):12.
Information Crossfile. 1991, 11(4):14.
MAB Notes. 1991, 11(4):19.

Estuaries
Biological and Physical Aspects of Dredging On Cumberland Island National Seashore. 1991, 11(3):3-4.

Exotic plants
Publications. 1991, 11(4):20.

Fire
Regional highlights: Midwest region.. 1991, 11(3):13.

Fire ecology
Regional Highlights: Pacific Northwest Region. 1991, 11(4):13.

Fire Management
Effects of Prairie Fire on Archelogical Artifacts. 1991, 11(1):1,3.

Fire management
Regional highlights: Rocky Mountain.. 1991, 11(1):18.
GIS Used to Develop Fire Management Strategies. 1991, 11(3):16-17.

Fire research
Regional Highlights: Rocky Mountain Region. 1991, 11(4):13.
Information Crossfile. 1991, 11(4):14.

Fish
Regional Highlights: Alaska Region. 1991, 11(4):12.
Regional Highlights: Rocky Mountain Region. 1991, 11(4):13.

Fish stocking
Regional Highlights: Alaska region.. 1991, 11(1):16.
Information crossfile. 1991, 11(3):14.
Ecological Effects of Stocked Trout on North Cascades Naturally Fishless Lakes. 1991, 11(3):22-23.

Forest management
Notes From Abroad. 1991, 11(2):21-22.

Forests
Regional Highlights: Rocky Mountain Region. 1991, 11(4):13.

Fossils
Information crossfile. 1991, 11(1):10.
Information crossfile. 1991, 11(3):14.
Regional Highlights: Pacific Northwest Region. 1991, 11(4):12.

Funding
Special Initiative Funding for Servicewide Projects Now Into Second Year. 1991, 11(1):22.
Regional highlights: Rocky Mountain region. 1991, 11(3):12.

Geographical Information System
Regional highlights: Rocky Mountain region. 1991, 11(2):13.

Geothermal development
Regional highlights: Rocky Mountain region. 1991, 11(2):12.

Giant sequoia
Regional Highlights: Western Region. 1991, 11(4):12.

GIS
Regional Highlights: Southwest region.. 1991, 11(1):16.
Regional highlights: Rocky Mountain region. 1991, 11(2):13.
A GIS Assessment of Barner Island Impacts. 1991, 11(3):5-6.
Regional highlights: Midwest region.. 1991, 11(3):13.
GIS Users Conference at Denver in November. 1991, 11(4):15.
Seagrass Die-Off Threatens Ecology of Florida Bay. 1991, 11(4):21-23.

Glaciers
Regional Highlights. Alaska Region. 1991, 11(4):12.

Global change
Information crossfile. 1991, 11(1):10.
Regional highlights: Rocky Mountain region. 1991, 11(2):13.
Global Change Program Update. 1991, 11(2):14.
Notes from Abroad. 1991, 11(3):15.

Grasses
Colonial Mowing Pattern Changes Paying Off. 1991, 11(2):17.
Tallgrass Prairie Site Studies. 1991, 11(3):7.

Grassland management
Notes From Abroad. 1991, 11(4):9.

Grizzly bear
Regional highlights: Pacific Northwest. 1991, 11(2):12.

Gypsy moths
Gypsy Moths May Alter Black Bear Population Dynamics in Shenandoah National Park. 1991, 11(4):7-8.
Regional Highlights: Southeast Region. 1991, 11(4):12.

Haskell, Dave
Regional Highlights: Mid-Atlantic Region. 1991, 11(4):13.

Hazardous waste
Regional highlights: Rocky Mountain region. 1991, 11(2):12.

Insecticides
Regional Highlights: Pacific Northwest Region. 1991, 11(4):13.

Integrated pest management
Agricultural Pest Scouting Tried. 1991, 11(3):17.

Interpretation
Where the Mind Runs Free: Observations of an Interpreter. 1991, 11(4):23-24.

Introduced species
Regional Highlights: Rocky Mountain Region. 1991, 11(4):13.
Information Crossfile. 1991, 11(4):15.

Inventory
Regional highlights: Wildlife & Vegetation Division. 1991, 11(2):12.
Regional highlights: Mid-Atlantic region. 1991, 11(3):13.
Relict Vegetation Sties: Urgent Inventory Need for Desert Parks. 1991, 11(3):20.
Regional Highlights: Mid-Atlantic Region. 1991, 11(4):13.
National Park Biotic Inventories Assessed. 1991, 11(4):16-17.
Mexican Spotted Owls in Zion NP: Inventory and Monitoring Methods. 1991, 11(4):18-19.

Jarvis, Jon
Regional Highlights: Pacific Northwest Region. 1991, 11(4):12.

Jordan, William R. III
Jordan's View of Restoration. 1991, 11(3):7.

Lake ecosystems
Regional highlights: Pacific Northwest. 1991, 11(1):17.

Lake Superior
Sea-Kayakers at Apostle Islands National Lakeshore Summary of a 1989 Exploratory Study. 1991, 11(2):20.

Leialoha, Julie (photo)
SEAs Successful as Alien Species Controls. 1991, 11(4):1,3-4.

Livestock grazing
Great Basin to Test Electronic "Ear Ring" as Cattle Control. 1991, 11(4):6.

Loons
Loon Survey Conducted. 1991, 11(3):17.

Migratory birds
Neotropical Migratory Bird Conservation Pact Signed. 1991, 11(3):19.

Mines
Revegetation notes: Brooklyn Native Seed Bank Project Near Completion. 1991, 11(2):16.

Mining
Reclamation of Abandoned Mines at New River Gorge, Gauley River, and Bluestone. 1991, 11(2):8-10.

Mining research
Regional highlights: Rocky Mountain region. 1991, 11(2):13.

Monitoring
Regional highlights: Mid-Atlantic region. 1991, 11(3):13.
National Park Biotic Inventories Assessed. 1991, 11(4):16-17.
Mexican Spotted Owls in Zion NP: Inventory and Monitoring Methods. 1991, 11(4):18-19.

Mountain goats
Olympic NP Mountain Goat Removal Project Subject of Risk Assessment Report. 1991, 11(1):14-15.
Mountain Goats in Yellowstone: The Horns of a Dilemma?. 1991, 11(3):8-9.

Mountain lions
Mountain lion-Human Interaction Studied. 1991, 11(4):8.

Native Americans
Regional highlights: Rocky Mountain region. 1991, 11(2):13.

Native plants
Regional highlights: Rocky Mountain.. 1991, 11(1):18.
Revegetation Efforts Using Native Species. 1991, 11(2):15.
Native Plants Delight Visitors at Columbia Gorge Plot. 1991, 11(4):4-5.
NPS and SCS Cooperate on Native Plant Materials Program. 1991, 11(4):5.

Natural resources bibliography
The Natural Resources Publication Program: What is it?. 1991, 11(3):2,24.

Nature reserves
Little Islands Floating in Seas of Indifference?. 1991, 11(3):19.

Noise
Regional highlights: Rocky Mountain region. 1991, 11(2):12.

NPS
A Commentary on Visitor Statistics. 1991, 11(2):17.

NPS history
New Perspectives in Science. 1991, 11(2):11.

NPS publications
The Natural Resources Publication Program: What is it?. 1991, 11(3):2,24.

Oil spills
Information crossfile. 1991, 11(1):11.

Old-growth forests
Regional highlights: Pacific Northwest region.. 1991, 11(3):12.

Owls
Regional highlights: Southeast region.. 1991, 11(3):13.

Ozone
Information crossfile. 1991, 11(1):10.

Peregrine falcon
Information crossfile. 1991, 11(1):11.
Peregrine Falcon Releases End. 1991, 11(3):8.

Peregrine falcons
Regional highlights: Rocky Mountain.. 1991, 11(1):18.
Regional highlights: Western region. 1991, 11(3):12.
Falcons Carry Heavy Nomenclature. 1991, 11(4):9.

Plants
New Plant Discovered in Guadalupe NP. 1991, 11(1):7.

Pollution
Information crossfile. 1991, 11(1):10.

Population dynamics
Ungulate Populations Models and Carrying Capacity: Predicting Effects of Fires, New Winter Range, and Proposed Wolf Reintro... 1991, 11(1):8-9.

Prairie restoration
Arid Veg Management: A Multi-Agency Look. 1991, 11(3):7.

Pronghorns
Regional highlights: Western region. 1991, 11(3):12.

Rainbow trout
Regional highlights: Western region.. 1991, 11(3):12.

Rambur, Richard
Director's Achievement Awards Go to Van Riper, Taylor, Rambur. 1991, 11(4):15.

Rare plants
Regional highlights: Southeast region.. 1991, 11(1):17.
Regional highlights: Rocky Mountain region.. 1991, 11(3):12.
Regional Highlights: Rocky Mountain Region. 1991, 11(4):13.

Reclamation
Revegetation notes: Brooklyn Native Seed Bank Project Near Completion. 1991, 11(2):16.

Red wolves
Red Wolves Thrive at Gulf Islands. 1991, 11(1):6-7.

Reptiles
Western Rattlesnake Ecology at Natural Bridges NM, Utah. 1991, 11(4):10-11.

Resource management
Information crossfile. 1991, 11(1):10.
Regional Highlights: Rocky Mountain.. 1991, 11(1):18.

Restoration
Information crossfile. 1991, 11(1):11.
Regional highlights: Rocky Mountain.. 1991, 11(1):18.
Ecological Restoration Research: Applications Manual. 1991, 11(3):6.
Historic Landscape Restored. 1991, 11(3):7.
Regional highlights: Rocky Mountain region. 1991, 11(3):12.
Restoration of Farm Woodlots at Gettsburg NMP. 1991, 11(3):18.

Restoration ecology
Reclamation of Abandoned Mines at New River Gorge, Gauley River, and Bluestone. 1991, 11(2):8-10.
Native Plants Delight Visitors at Columbia Gorge Plot. 1991, 11(4):4-5.

Revegetation
Regional highlights: Rocky Mountain.. 1991, 11(1):18.
Revegetation Efforts Using Native Species. 1991, 11(2):15.

River research
Redwood NP Geologist Reports on Gravel Bed Rivers Workshop in Italy. 1991, 11(1):12-13.

Sewage disposal
Regional Highlights: Southeast region.. 1991, 11(1):17.

Software
Regional highlights: Mid-Atlantic region. 1991, 11(3):13.

Species diversity
Information crossfile. 1991, 11(3):14.

Species preservation
Cape Cod's Atlantic White Cedar: Managing a Unique, Natural (?) Community. 1991, 11(3):10.
Information crossfile. 1991, 11(3):14.

Spotted owl
Mexican Spotted Owls Shyer Than Their Northern Cousins. 1991, 11(1):18.
Regional highlights: Pacific Northwest.. 1991, 11(2):12.

Spotted Owls
Mexican Spotted Owls in Zion NP: Inventory and Monitoring Methods. 1991. 11(4):18-19.

Taylor, Dan
Director's Achievement Awards Go to Van Riper, Taylor, Rambur. 1991. 11(4):15.

Technical writing
Technical Writing As a Tool - An Art. 1991. 11(1):13.

Trails
Regional Highlights: Mid-Atlantic Region. 1991, 11(4):13.

Trees
Notes From Abroad. 1991. 11(2):21-22.
Tree Line Research in Gates of the Artic NP: A Follow-up to Robert Marshall's Research. 1991. 11(2):22-24.

Trout
Ecological Effects of Stocked Trout on North Cascades Naturally Fishless Lakes. 1991, 11(3):22-23.

Tundra
MAB Notes. 1991. 11(4):19.

Van Riper, Charles III
Director's Achievement Awards Go to Van Riper, Taylor, Rambur. 1991. 11(4):15.

Vegetation
Regional Highlights: Mid-Atlantic Region. 1991, 11(4):13.

Visitor study
Sea-Kayakers at Apostle Islands National Lakeshore Summary of a 1989 Exploratory Study. 1991. 11(2):20.

Wade, Bill
Regional Highlights: Mid-Atlantic Region. 1991. 11(4):13.

Water quality
Regional Highlights: Southeast Region. 1991. 11(4):12.

Weed Control
Regional highlights: Rocky Mountain region. 1991, 11(2):13.

Weed control
Publications. 1991. 11(4):20.

Wilderness areas
El Malpais Wilderness Suitability Study. 1991, 11(2):1,3-5.

Wolves
Ungulate Populations Models and Carrying Capacity: Predicting Effects of Fires, New Winter Range, and Proposed Wolf Reintro... 1991. 11(1):8-9.
Regional highlights: Rocky Mountain region. 1991, 11(2):13.
Regional highlights: Southeast region. 1991, 11(2):13.

Youtie, Berta
Native Plants Delight Visitors at Columbia Gorge Plot. 1991, 11(4):4-5.

Park Science Index Listed by Park Code

APIS
Sea-Kayakers at Apostle Islands National Lakeshore Summary of a 1989 Exploratory Study. 1991. 11(2):20.
Bald Eagle Studies. 1991, 11(3):17.

BADL
Regional Highlights: Rocky Mountain Region. 1991. 11(4):13.

BIHO
Regional highlights: Rocky Mountain region. 1991, 11(2):13.

BISO
Regional Highlights: Southeast Region. 1991, 11(4):12.

BRCA
Regional highlights: Rocky Mountain. 1991. 11(1):18.
Regional Highlights: Rocky Mountain Region. 1991. 11(4):13.

CACA
Search for Cave Swallow's Winter Range Underway. 1991, 11(2):16.

CACO
Cape Cod's Atlantic White Cedar. Managing a Unique, Natural (?) Community. 1991, 11(3):10.

CAHA
Regional Highlights: Southeast region. 1991. 11(1):17.

CINS
Biological and Physical Aspects of Dredging On Cumberland Island National Seashore. 1991. 11(3):3-4.

COLM
Regional highlights: Rocky Mountain region. 1991, 11(2):13.

COLO
Colonial Mowing Pattern Changes Paying Off. 1991, 11(2):17.

COSW
Regional highlights: Southeast region. 1991. 11(3):13.

CRLA
Regional Highlights: Pacific Northwest Region. 1991. 11(4):12.

CUVA
Agricultural Pest Scouting Tried. 1991, 11(3):17.

DETO
Regional highlights. 1991. 11(1):18.

DEWA
Regional Highlights: Mid-Atlantic Region. 1991. 11(4):13.

DINO
Regional highlights: Rocky Mountain region. 1991, 11(3):12.

EVER
Sociological Contributions to Everglades Backcountry Use Management Plan. 1991, 11(1):4-5
Information crossfile. 1991, 11(1):11.
Guide to Florida's Natural Resources. 1991, 11(1):18.
Publications. 1991. 11(4):20.
Seagrass Die-Off Threatens Ecology of Florida Bay. 1991. 11(4):21-23

GAAR
Tree Line Research in Gates of the Artic NP: A Follow-up to Robert Marshall's Research. 1991, 11(2):22-24.

GETT
Restoration of Farm Woodlots at Gettsburg NMP. 1991, 11(3):18.

GLAC
Regional highlights: Rocky Mountain region. 1991. 11(2):13.
Information Crossfile. 1991. 11(4):14
Information Crossfile. 1991. 11(4):15.

GLCA
Regional Highlights: Rocky Mountain Region. 1991. 11(4):13.

GRBA
Great Basin to Test Electronic "Ear Ring" as Cattle Control. 1991. 11(4):6.

GRSA
Regional highlights: Rocky Mountain region. 1991. 11(3):12.

GRSM
Regional Highlights: Southeast Region. 1991. 11(4):12.
Regional Highlights: Southeast Region. 1991. 11(4):12.

GRTE
Regional highlights: Rocky Mountain. 1991. 11(1):18.

GUIS
Red Wolves Thrive at Gulf Islands. 1991. 11(1):6-7

GUMO
New Plant Discovered in Guadalupe NP. 1991. 11(1):7.

HAVO
SEAs Successful as Alien Species Controls. 1991. 11(4):1,3-4.

INDU
Regional highlights: Midwest region. 1991. 11(3):13.
GIS Used to Develop Fire Management Strategies. 1991. 11(3):16-17.

JRO
Woodland Caribou Studied. 1991, 11(3):8.
Peregrine Falcon Releases End. 1991, 11(3):8.
Loon Survey Conducted. 1991, 11(3):17.
Falcons Carry Heavy Nomenclature. 1991. 11(4):9.

JCNM
Mapping Jewel Cave - From the Surface. 1991. 11(2):6-7.

JODA
And Veg Management: A Multi-Agency Look. 1991. 11(3):7.
Native Plants Delight Visitors at Columbia Gorge Plot. 1991. 11(4):4-5.
Regional Highlights: Pacific Northwest Region. 1991. 11(4):12.

KATM
Regional Highlights: Alaska Region. 1991, 11(4):12.

KICA
Regional Highlights: Western Region. 1991. 11(4):12.

KNRI
Effects of Prairie Fire on Archelogical Artifacts. 1991. 11(1):1,3.

LACL
Regional Highlights: Alaska Region. 1991, 11(4):12.

MACA
Regional Highlights: Southeast Region. 1991, 11(4):12.

NABR
Western Rattlesnake Ecology at Natural Bridges NM, Utah. 1991. 11(4):10-11

NERI
Reclamation of Abandoned Mines at New River Gorge, Gauley River, and Bluestone. 1991, 11(2):8-10.
Revegetation notes: Brooklyn Native Seed Bank Project Near Completion. 1991, 11(2):16.

NOCA
Ecological Effects of Stocked Trout on North Cascades Naturally Fishless Lakes. 1991, 11(3):22-23.

OLYM
Olympic NP Mountain Goat Removal Project Subject of Risk Assessment Report. 1991, 11(1):14-15.
Regional highlights: Pacific Northwest. 1991, 11(1):17.

ORPI
Regional Highlights: Western Region. 1991. 11(4):12.

PEFO
Regional highlights: Western region. 1991. 11(3):12.

PRWI
Regional Highlights: Mid-Atlantic Region. 1991, 11(4):13.

REDW
Redwood NP Geologist Reports on Gravel Bed Rivers Workshop in Italy. 1991. 11(1):12-13.

RICH
Regional Highlights: Mid-Atlantic Region. 1991. 11(4):13.

SACN
Regional Highlights: Midwest Region. 1991. 11(4):12.

SAGU
Regional Highlights: Western Region. 1991. 11(4):12.

SEQU
Regional Highlights: Western Region. 1991. 11(4):12.

SHEN
Shenandoah NP Pilots Air Quality Advisory. 1991. 11(3):1.
Gypsy Moths May Alter Black Bear Population Dynamics in Shenandoah National Park. 1991. 11(4):7-8.
Regional Highlights: Mid-Atlantic Region. 1991. 11(4):13.

TONT
Regional Highlights: Western Region. 1991. 11(4):12.

UPDE
Should Recreational Boating on Upper Delaware Be Limited? What We Have Learned. 1991. 11(1):23-24

WACA
Regional highlights: Western region. 1991. 11(3):12.

WICA
Regional highlights: Rocky Mountain. 1991. 11(1):18.
Regional highlights: Rocky Mountain region. 1991. 11(2):12.

WICR
Historic Landscape Restored. 1991. 11(3):7.

WRST
Regional Highlights: Alaska Region. 1991. 11(4):12.

WUPA
Regional highlights: Western region. 1991. 11(3):12.

YELL
Ungulate Populations Models and Carrying Capacity: Predicting Effects of Fires, New Winter Range, and Proposed Wolf Reintro. 1991. 11(1):8-9.
Regional highlights: Rocky Mountain. 1991. 11(1):18.
Regional highlights: Rocky Mountain region. 1991. 11(2):13.
Mountain Goats in Yellowstone. The Horns of a Dilemma?. 1991. 11(3):8-9.
Regional highlights: Rocky Mountain region. 1991. 11(3):13.
Book Review. 1991. 11(4):20.

ZION
Regional highlights. Rocky Mountain. 1991. 11(1):17.
Regional Highlights: Rocky Mountain. 1991. 11(1):18.
Mexican Spotted Owls Shyer Than Their Northern Cousins. 1991. 11(1):18.
Mexican Spotted Owls in Zion NP: Inventory and Monitoring Methods. 1991. 11(4):18-19.

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Shenandoah Viewshed Analysis *(Continued from page 12)*

Table 2. *Percent of land visible from overlooks and mountain summits at various distances from the Park boundary. Shenandoah National Park, Virginia. 1990.*

Class	Name	Percent			
		1.6 km	3.2 km	4.8 km	6.4 km
0	Areas Not Visible	50.10	38.29	31.76	30.15
1	Areas Visible from 1	24.48	21.85	19.96	14.81
2	Areas Visible from 2	11.39	13.10	13.61	14.96
3	Areas Visible from 3	6.01	10.86	11.96	12.35
4	Areas Visible from 4	3.32	5.67	6.79	9.06
5	Areas Visible from 5	1.88	5.06	7.28	6.60
6	Areas Visible from 6	1.55	2.22	5.06	5.27
7	Areas Visible from 7	0.66	1.23	2.73	4.61
8	Areas Visible from 8	0.62	1.69	0.77	2.07
9	Areas Visible from 9	0.00	0.01	0.05	0.04
10	Areas Visible from 10	0.00	0.01	0.04	0.06
11	Areas Visible from 11	0.00	0.00	0.00	0.03
12	Areas Visible from 12	0.00	0.00	0.00	0.00
	Totals	100.00	100.00	100.00	100.00

elevation. Each pattern developed in step one and the UTM coordinates of the center of the overlook were utilized in the equation. A maximum distance of 20 kilometers (12 miles, was used as the furthest point visible. Observer height was defined as 1.5 meters (5 feet).

The information is displayed in cell format. Each cell has a numeric value that describes the angle of view at which the area is visible. The angle of view is defined as the angle from the oberver's eye to an area on the ground. For example, the horizon would be at an angle of about 90, a point at the bottom of a steep slope might be 120 degrees. This concept is further described in Stutzman's report. The angle of view can be used to define the relative importance of the view. For this analysis, the angle of view was ignored and all angles were treated as equally important.

Next, each view was reclassified into two classes: a classification of "1" indicating areas visible, and a "0" indicating areas not visible. Appendix A of Stutzman describes the view angles, center point, and GRASS files used to delineate each view. Seventy-six overlooks and four mountain summits or trail destinations were described in this manner.

Thirteen overlooks and four trail destination vistas were defined as integral or encompassing the overall viewing experience of the park. In 1980, photographs showing the panorama of these views were taken to document the scene at that time. These were included in the integral vista report. In an effort to describe changes over time, photos were taken again in 1990, using the parameters outlined in the original report. In addition, these integral views were used in the compilation of the visibility map (Fig. 1).

In order to create a visibility map detailing areas of land seen from multiple views, individual views were combined, using Gmapcalc. Each of the resulting integral vistas was then added, and together they created a composite map showing areas visible from multiple overlooks.

Results and Discussion

Land areas were visible from 1 to 12 overlooks (Table 1). The amount of land within 1.6 (1 mile), 3.2 (2 miles), 4.8 (3 miles), 6.4 (4 miles), and 20 kilometers (12 miles) of the park visible in each class is outlined in Table 2. Ninety-seven percent of the areas were visible from 0 to 7 overlooks. Most of the areas seen from great than 7 overlooks occur further than 6.4 kilometers (4 miles) from the park boundary. Distance from the park can be an important consideration when evaluating the relative importance of land outside the park.

Another factor to be considered is whether or not an individual view is more "valuable" (scenic, unique) than another. The integral vista assessment was used as a guide to the relative importance of specific views.

Conclusion

The viewshed analysis and production of a visibility map were created to help park managers identify which land areas outside the park are significant in terms of scenic values. The map is intended to be used as a screening tool. Areas of particular interest will be visited to verify the map projections. Information concerning which views overlook a particular parcel can be determined from the pattern files. Photographs of each integral vista will be maintained every 10 years to document changes in scenery and the areas visible over time.

The viewshed map already is being used extensively in the park's Related Lands Program. For example, it was used to determine which of several alternative new land fill sites in an adjoining county would be the least visible from key park viewpoints. The park recommendation was used by the county planner to make the final determination for the site.

Haskell is Chief, Division of Natural Resources and Science at Shenandoah NP; Teetor is a GIS Specialist, formerly with the park.

Literature Cited

Shaver, David. 1980. Identification of Integral Vistas. Unpubl. NPS Report. 80 pp.

Stutzman, Susan. 1978. Using Field Surveys and Computer Techniques: A Visual Resource Inventory for Shenandoah NP. Denver Service Center. Unpubl. NPS Report. 16 pp.

Yellowstone Northern Range Study Finds No Negative Impacts

A 5-year study by 33 scientists representing 3 federal agencies and 12 universities was released by Yellowstone NP in November 1991; the findings showed no negative impacts of native ungulates in grasslands and in the majority of shrublands in the park's northern range. Reaction, as mirrored in the public press, found the report to be highly controversial.

An article by Francis J. Singer, Yellowstone research scientist and one of the report's authors, will be carried in the Spring issue of ***Park Science.***

NPs Participate in Statewide Effort Against Alien Pests

Haleakala NP, having recently successfully fended off an invasion of rabbits, has come to the realization that the park cannot afford to wait until aggressive alien invaders arrive within park boundaries before taking action. The park is actively involved in an embryonic outreach campaign against a number of incipient plant invaders on Maui, including *Miconiacalvescens*, *Cyatheacooperi*, *Cortaderiajubata*, *Pennisetumsetaceum*, and *Verbascumthapsus*. We are particularly delighted, therefore, to have participated from an early stage in a project that may well prove to be a landmark among efforts to protect Hawaii's natural areas from the onslaught of alien invaders.

Along with Hawaii Volcanoes NP, Haleakala is an active participant in a statewide effort, coordinated by The Nature Conservancy of Hawaii and the Natural Resources Defense Council, to reduce the flow of alien pest species becoming established in Hawaii. Other participants include the Hawaii Department of Agriculture (HDOA) Plant Quarantine Branch; HDOA Plant Pest Control Branch; HDOA Animal Industry Division, Inspection and Quarantine Branch; the Hawaii Department of Land and Natural Resources (HDLNR) Division of Forestry and Wildlife; HDLNR Division of Aquatic Resources; the Hawaii Department of Health, Environmental Services Division, Vector Control Branch; the U.S. Customs Service; the U.S. Army, Pacific Command; the U.S. Postal Service; the U.S. Forest Service; the U.S. Fish and Wildlife Service, Enforcement Division; the USDA Animal and Plant Health Inspection Service, and the Hawaii Sugar Planters Association.

The need for coordination and cooperation among such a diverse array of players is obvious, in view of what is at stake!

A well-attended workshop, held in Honolulu on Oct. 1, 1991, was successful in identifying the major areas where "the system" can be tightened. For national Parks, one of the highest priorities is for increased effectiveness of "the system" in rapidly eradicating newly reported alien species before they become established.

This can best be done through improved communication and coordination among agencies, through at least modestly increased funding for the lead agencies, and through tightening pertinent legislation and rules. Other very high priorities include fostering of public understanding and cooperation through education, and changing the law to allow for inspection of first class mail for illegal entry of prohibited alien pests.

We hope to establish a small working subgroup on Maui to deal with local alien pest eradication efforts at a grassroots level.

Lloyd Loope, Research Scientist,
Haleakala NP
Donald Reeser, Superintendent,
Haleakala NP

regional highlights

Southeast Region

Dr. Caroline Rogers, Research Biologist at Virgin Islands NP, was an invited participant in the National Forum on Ocean Conservation, sponsored by the Smithsonian and NOAA and held in Washington, DC, Nov. 19-21, 1991. Rogers presented a paper on the effects of sedimentation on coral reefs. She went from there to Martinique for a meeting on "Ecology and Management of Coastal Areas in the Wider Caribbean," sponsored by UNEP and co-organized by the Conseil Regional de la Martinique and the Universite des Antilles et de la Guyane. There, she spoke on "Protected areas and coastal management: the case of Virgin Islands NP and Biosphere Reserve."

* * *

Assateague Island National Seashore recently hosted its second science conference; 21 researchers presented findings to an audience of 150, many of whom were part of the first such conference in 1987. Presenters represented 9 universities and colleges and 5 state and federal agencies. Two thirds of the funds for Assateague's resource management program in 1991 came from sources other than the national seashore's operating budget.

Pacific Northwest

A year-long process to develop a management plan and EIS for mountain goats on the Olympic Peninsula was announced on Oct. 31, 1991 by Olympic NP, Olympic NF, and the Washington Department of Wildlife. An interagency team has been appointed to develop a plan balancing the mandates and objectives of each agency, the preservation of fragile alpine ecosystems, and the concerns of the public.

Olympic NP has been working actively on the mountain goat problem within the park for more than 10 years. Recognizing potential effects from mountain goats on rare plants within forest wilderness areas, Olympic NF has joined the planning effort. The Wash. Dept. of Wildlife, as manager of wildlife within the national forest, is a cooperating agency. Scoping meetings for preparation of the plan and EIS will begin in January 1992. The management plan and final EIS are slated for completion in spring 1993.

* * *

Steve Gibbons, Natural Resource Specialist for the PN Region, attended a 2-day workshop on "Biology and Management of Wild, Edible Mushrooms in Pacific Northwest Ecosystems" on Oct. 29-30, 1991 in Eugene, OR. Co-sponsors were the Willamette NF, the Pacific Northwest Research Station, Oregon State University, and the Washington Dept. of Natural Resources. Participants (270 of them) represented the commercial mushroom industry, mycological societies, state and federal agencies, the scientific community and the NPS.

Objectives of the workshop were to educate resource managers on the basic ecology of fungi in forest ecosystems, characterize the major edible species with commercial implications, discuss current regulations and concerns regarding commercial harvest, and provide a forum to develop regional consensus for managing and monitoring this resource.

For more information on this workshop and its applicability to resource management and protection of wild edible fungi in the PNR, contact Gibbons in Seattle, WA at (206) 553-5670 or FTS 399-5670.

***Ted Fremd, paleontologist** at John Day Fossil Beds National Monument in Eastern Oregon, scrutinizes a hillside near the burial site of "Ellen the rhino," (described in the Fall 1991 issue's Regional Highlights). The rhino* (Rhinocerotidae Diceratherium armatum), *who died nearly 25 million years ago, had the largest skull known – almost 2 feet from nose to neck. Photo by Ellen Morris Bishop, courtesy of The Oregonian, Portland.*

* * *

A gray wolf, listed by the USFWS as an endangered species, was sighted last summer in the Hozomeen area of Ross Lake National Recreation Area, first by a park archaeologist and later by a park biologist and several park rangers. The visual sighting, photographs and tracks provided undisputed evidence that the animal is a gray wolf. In 1990 a wolf was sighted in late May and vocal responses from 2 adults and several pups indicated an active den in the same approximate area. The den location was never found.

Hozomeen is at the north end of Ross Lake on the US/Canada border, approximately 40 miles south of the town of Hope, BC. The lucky "sighters" included Park Geologist Jon Riedel (into whose camp the gray wolf entered and passed within 15 feet of him), Chief Ranger Dave Spirtes, Park Biologist Bob Kuntz, and WA/Dept. of Wildlife biologists Jon Almack and Scott Fitkin.

Western Region

Fifty-eight authors presented 65 papers and posters to more than 120 participants at the Fourth Biennial Conference on Research in California's National Parks Sept. 10-12, 1991. Sequoia-Kings Canyon was the subject of 15 presentations, Channel Islands and Redwood followed with 10 each. Award for the best presentation went to Dr. Jim Gramann of Texas A&M. In his plenary session, "Contributions of Sociology to the NPS," Gramann used the visitor survey work in progress at Yosemite to demonstrate the types and complexities of sociological studies available to park managers.

Papers are being reviewed and a conference Proceedings is slated for early 1992. Meanwhile, CPSU Leader Stephen D. Veirs, Jr., at U/CA/Davis, has produced a 50-page program with 63 abstracts, available from the NPS/CPSU, Institute of Ecology, U/CA/Davis, (916) 752-3026.

* * *

The CPSU at U/AZ, Tucson, has published, as a supplement to a 1988 publication, the following:

Nagel, Carlos. *Report on Treaties, Agreements, and Accords Affecting Natural Resource Management at Oregan Pipe Cactus National Monument*, 1991. Special Report No. 8 (Supplement).

In June 1991, ***Wilson Bulletin***, 103(2), 1991, pp 309-310, published the following:

Kunzmann, Michael R. and R. Roy Johnson (with the U/AZ NPS/CPSU). *Unusual Behavior in a Solitary Vireo*.

Copies of these papers may be had from the NPS/CPSU, 125 Biological Sciences (East) Bldg. 43, U/AZ, Tucson 85721.

* * *

Gary Fellers, Research Biologist at Point Reyes National Seashore, and Charles Drost have published a monograph, "Ecology of the Island Night Lizard, *Xantusia riversiana*, on Santa Barbara Island, CA" in *Herpetological Monographs*. In spite of their federal

***Endangered gray wolf** is caught by the camera in the Hozomeen area of Ross Lake National Recreation Area. The gray wolf resembles a large domestic dog but has longer legs, larger feet, and a narrower chest.*

status as a threatened species, island night lizards were quite abundant in some Santa Barbara Island habitats and clearly not in need of federal protection. In spite of their common name, night lizards were found to be strictly diurnal.

Drost and Fellers also published a paper on "Density cycles in an island population of deer mice, *Peromyscus maniculatus*, in *Oikos*. Though mainland deer mice have rather stable population levels, deer mice on Santa Barbara Island (Channel Islands NP) have distinct population fluctuations that have ranged from 2 to 462 mice/ha. Deer mice play a large part in the ecological workings of Santa Barbara Island. Due to their abundance, their position as both first and second level consumers, and their importance as a prey species, deer mice are one of the most important components of the simplified terrestrial ecosystem. Changes in deer mouse populations affect a variety of plant species, terrestrial invertebrates, the hawks and owls, and even some of the seabirds.

Fellers presented an invited paper for the American Society of Ichthyologists and Herpetologists at the American Museum of Natural History in New York last June. His paper, "Conservation Biology of an Abundant Lizard, *Xantusia riversiana*," was part of the symposium, "Strategies and Programs for the Conservation of Biodiversity."

Alaska Region

Two new Resource Management Specialists welcomed to the Region are Rick Potts (Katmai NP) and Patty Rost (Gates of the Arctic NP). Two Resource Management position vacancies exist at Yukon-Charley Rivers NP and Lake Clark NP.

* * *

Dale Taylor, Jeanne Schaaf, Paul Haertel, Rich Giamberdine, Sean Bursel, and Leslie Star-Hart were in Providenyia, Chukotka attending a conference in on the Beringian International Park when the Soviet coup attempt occurred. Concern over the event was lightened by the Soviets in attendance, who requested the US to make Chukotka the 51st United State.

* * *

The Alaska Region's Global Change program, USGS, US Army Corps of Engineers Cold Regions Research and Engineering Lab, and the U/AK Geophysical Institute co-sponsored a glacier research workshop in 1991, report copies of which are now available from Dale Taylor, Regional Headquarters in Anchorage (907)257-2568. Goal of the workshop was to promote cooperation among scientists involved in glacier research and land managers. Participants included 16 parks, 8 from Alaska and 8 from the lower 48. The report contains recommendations.

* * *

Carol McIntyre, a wildlife biologist temporary with ARO, presented a paper and chaired a session of the Raptor Research Foundation Annual Meeting in Tulsa, OK in November 1991. The paper, "Using satellite radio-telemetry to track local and long distance movements of an Alaskan golden eagle," reported on a pilot effort to use the technology to determine migration and wintering areas of golden eagles from Denali NP and Preserve.

In August 1990, McIntyre fitted a nestling golden eagle with a prototype satellite transmitter and was able to track the eagle from Denali to its wintering ground in northern Idaho. McIntyre has been researching golden eagles in Denali, as well as other raptors in Alaska, for the last 5 years. She is completing an MS at U/AK-Fairbanks; her thesis is on "Breeding biology of golden eagles in Denali NP."

* * *

Layne Adams, ARO Wildlife Research Biologist, presented a paper at the First Arctic Ungulate Conference in Nuuk, Greenland Sept. 3-8, 1991. The conference combined the International Muskox Symposium and International Reindeer/Caribou Symposium and was attended by 120 from North America, Scandanavia, and the Soviet Union. Adams' paper, "Relationships between calf sex ratio and birth date in the Denali caribou herd," described variation in calf sex ratio *within* the calving period (calves born during the peak of calving are predominantly female), the population effects of that variation, and a possible behavioral mechanism that could lead to the observed sex ratios.

Adams has been conducting research on population dynamics of the Denali caribou herd, which is the only naturally regulated barrenground caribou herd in North America.

Butterfly Habitat Restoration

Laura Nelson and Terri Thomas, Natural Resource Specialists at Golden Gate NRA, report a pilot stody to assess the effectiveness of revegetating coastal grassland and scrub habitat of 2 federally listed endangered species – the Mission Blue and the Blue Elfin butterflies. Their habitat has been reduced by urbanization of the San Francisco Bay area and disturbed by introduction of invasive exotic plants. Revegetation efforts in the GGNRA include removal of approximately 100 acres each of frech broom and pampas grass, using manual pulling and cutting, herbicide, or heavy equipment.

At Milatra Ridge, San Mateo County, 6 experimental seeding and planting treatment plots were established in 1988 following removal of pampas grass by heavy equipment. The plots were monitored in the summers of 1989 and 1991. Treatments included different combinations of hand-broadcast seeding with locally collected natives, hydroseeding with commercial native grasses, and transplanting native seedlings grown in a nursery. To sample the vegetation cover, both point and quadrat methods were used.

The point method gave a more accurate representation of the plant species present. A mix containing seeds collected from native plants in the immediate vicinity, hand broadcast and raked in, resulted in the greatest overall coverage by natives after 2 years, and the least amount of invasion by nonnative forbs. Results of this pilot study will provide park resource managers with preliminary information needed to conduct a 3-year restoration effort leading to long-term management of the community and recovery of the endangered butterflies.

Recent publications by AK Region personnel include:

Wesser, S.D. and W.S. Armbruster. 1991. "Species distribution controls across a forest-steppe transition: a causal model and experimental test." *Ecological Monographs* 61:323-342.

Rocky Mountain Region

The only wild population of black-footed ferrets in the world was established in the Shirley Basin of Wyoming last summer when about 50 ferrets were released from a captive population. This was the first of several planned releases in the recovery program for the species. The next release is scheduled for the summer of 1992 in northern Montana followed by a proposed release in 1993 in Badlands NP. The last known wild ferrets were discovered and captured a few years ago in western Wyoming, sometime after it was thought the species was extinct.

* * *

The FWS has published a proposed rule to list the Mexican spotted owl as a threatened species (Fed. Reg. Vol. 56 No. 213, 11/4/91). RMR parks participated in the status review for the subspecies and have been conducting spotted owl surveys for several years. Zion NP completed a third year of Mexican spotted owl surveys in 1991 (funded by the RMR). Twenty-one birds representing at least 8 pairs of spotted owls were observed. Owl pairs reared at least 7 young in Zion NP this season. Limited surveys revealed at least 5 spotted owls in Capitol Reef NP, 2 owls in Canyonlands NP, and 2 owls in Glen Canyon NRA.

Work by the USFS and park staff revealed a nesting pair of spotted owls that successfully reared young in Mesa Verde NP. A home range and habitat use study of Mexican spotted owls on the Colorado Plateau was begun this season. This is an interagency project involving the FWS, BLM, the State of Utah and NPS. The project is being conducted by Charles van Riper and David Willey out of the CPSU at Northern Arizona Univ. Park and RMR staff are participating in interagency efforts to coordinate management, surveys and research on the subspecies. Mike Britten of the RMRO is coordinating spotted owl work in the Region.

* * *

The RMR has completed 3 years of intensive fieldwork towards the recovery of peregrine falcon populations. Survey efforts in 1991 documented breeding peregrine falcons in 15 park areas, including 60 + territories in Glen Canyon NRA, 11 each in Dinosaur NM and Zion NP, 7 in Yellowstone NP, 6 each in Capitol Reef NP and Canyonlands NP, and 4 in Bryce Canyon NP. The NPS supported a final release effort (5 birds successfully released) of captive reared young peregrines in Bighorn Canyon NRA. At least one adult peregrine was sighted in Bighorn Canyon this past summer.

Glacier NP, where peregrines once nested, had several encouraging but unconfirmed observations made by visitors this season. The Recovery Team is currently working on an Addendum to the Rocky Mountain/Southwest Peregrine Falcon Recovery Plan to reclassify the species to reflect this peregrine population explosion.

The peregrine falcon program at Black Canyon of the Gunnison NM is typical of smaller park units in the RMR. In 1991 surveys in the NM revealed 2 nesting pair

(Continued on page 16)

information crossfile

"The Yellowstone Vision: An Experiment That Failed or a Vote for Posterity?" is the title of a paper by Yellowstone Supt. Bob Barbee, Biologist John Varley, and author Paul Schullery, from the Proceedings of a conference on "Partnership in Parks and Preservation," held in Albany, NY Sept. 9-12, 1991. In it, the authors describe a document created by the Greater Yellowstone Coordinating Committee – an overarching statement of principles that would guide future coordination among the many natural resource management agencies operating in the Greater Yellowstone Area. The document was called *Vision for the Future, A Framework for Coordination in the Greater Yellowstone Area*.

The paper describes how the document took shape, why it was attempted, and its stormy greeting from emotional and misinformed commodity groups (who termed it "a giant land-grab, another Federal lockup") and from the conservation community (who felt it didn't go far enough and who failed to come together in its defense).

They observe that "the American public, the owners of the parks and forests of the greater Yellowstone area, played virtually no role at all ... So we were faced with a powerful regional campaign, superbly engineered by special interest groups and featuring stunning inflammatory rhetoric against the *Vision*. We failed to convincingly invite the pro-*Vision* interests to mobilize adequately."

They conclude that "bureaucracies are put in place to police the status quo" and add: "Perhaps the foremost lesson we learned, at least so far, is this: before you undertake a project of this magnitude, be absolutely certain that your own leadership is prepared to give you full support, as far up the chain of command as imaginable."

***

A $4.6 million study underway in southern Oregon has scientists from BLM and Oregon State University inquiring into the possiblity of logging in northern spotted owl habitat without destroying the habitat. Researchers will take detailed measurements of existing stands to identify what makes them attractive to owls, develop logging methods to reproduce those characteristics, and devise computer models to estimate timber yields. The study will be conducted over the next 10 years in the BLM's Medford District, neighboring private lands, and much of the Rogue River and Siskiyou national forests – an area covering about 3 million acres that is home to about 450 pairs of spotted owls. The study area has been logged over for decades, leaving a patchwork of clearcuts, partial cuts, old growth, and second growth that also has been shaped by fires, windstorms, and insect infestations.

***

How Earth's biota will respond to the next major (possibly anthropogenically induced) environmental change can be predicted best on the basis of the fossil record, according to Scott Elias, a research associate at the Institute of Arctic and Alpine Research, U/CO, Boulder. Elias's article in ***BioScience*** (Sept. 1991, pp 552-559) examines the insect fossil record of the Rocky Mountains and finds that changes in insect distribution have taken place in a relatively short time, indicating that insect species are extremely mobile and able to move great distances to satisfy their ecological requirements in the face of changing climates.

"These distribution changes also suggest that the current insect communities of the Rocky Mountain region are simply the latest reshuffling of species," Elias notes, "and that insect species composition is probably in a more-or-less continuous state of flux." Elias suggests that the fossil record "forces us to ask ourselves how much we really know about rates of speciation" and related questions such as how long a population must be geographically isolated before it diverges from the species' gene pool.

***

The Sept. 6, 1991 issue of ***Science*** (pp.1099-1104) contains an article by Geerat J. Vermeij (U/CA-Davis Geol. Dept) entitled "When Biotas Meet: Understanding Biotic Interchange." The author looks at the history of biotic interchange over the past 25 million years – what happens when a barrier separating two biotas with long independent histories breaks down and species from the "donor biota" invade the "recipient biota." He then looks at the "unprecedented scale" with which barriers are being breached in the human-dominated biosphere – both deliberately and accidentally, and reaches three tentative conclusions: (1) that many episodes of interchange are strongly asymmetrical; (2) biotas providing the bulk of invading species in asymmetrical interchanges contain species that have evolved high competitive, defensive, and reproductive performance in comparison with native species in the recipient biotas, and (3) biotas in which the magnitude of extinction before the onset of interchange was high are especially vulnerable to invasion.

***

Laboratory exposure of bivalve molluscs (*Mercenaria mercenaria L.*) for 48 hours to 9 parent polynuclear aromatic hydrocarbons (PAHs) found in waste crankcase oil and analyzed over a 45-day depuration (cleansing) period found that the activated carbon filtration aquaria system did not depurate PAHs, but rather maintained them at detectable levels. The research, reported by NPS Ecologist John T. Tanacredi (Gateway NRA) and Raul R. Cardenas (Brooklyn's Polytechnic University) appears in ***Environ. Scie. Technol.*** 1991, 25, 1453-1461. The authors conclude that consumers of bivalve molluscs chronically exposed to persistent levels of PAHs in urban estuaries may be at higher than normal health risk. They recommend reevaluation of clam relay programs in urbanized estuarine systems and further research in this area.

***

"Interdisciplinary Research in Historic Landscape Management" is the title of a supplement to Vol. 14: No. 6 of the ***CRM Bulletin***, cultural resource management information bulletin published by NPS. Gerald Kelso, a supervisory archeologist in the NPS North Atlantic Regional Office, describes the principles and techniques (still evolving) for identifying, evaluating, and preserving the vegetation of historic landscapes, and uses the knowledge thus gained to reconstruct the

regional highlights

(Continued from page 15)

occupying historic territories on the "Painted Wall" and near "Red Rock Canyon"; 6 peregrine chicks fledged from the 2 eyries.

* * *

The RMR is conducting a Bighorn Sheep Initiative with the primary goal of re-establishing the bighorn to 18 National Parks, Monuments and Recreation Areas. Seven scientific committees made up of conservation biologists, population ecologists, veterinarians, and bighorn sheep experts are conducting a problem analysis for the involved park areas. Look for a ***Park Science*** article on the Initiative. Frank Singer, currently at Colorado State University, is coordinating the project.

* * *

In late August 1991, Yellowstone NP hosted three visiting scientists from Russia as part of their 3-week tour of the Greater Yellowstone and Northern Continental Divide Ecosystems. The scientists were invited by the Interagency Grizzly Bear Committee to view occupied grizzly bear habitat and discuss with NPS, state, and USFS biologists techniques for managing bear-human conflicts. Despite the fact that their day in Yellowstone coincided with the beginning of the aborted coup attempt in the USSR, the scientists had a successful visit and were lucky enough to observe a grizzly bear sow with cubs in the park.

Grizzly bear reproduction exceeded target goals again in 1991 for the greater Yellowstone area. In 1990 a record number of cubs was observed in the GYA; 23 sows produced 57 cubs, including one litter of 4. The recovery goal is to average 15 sows with "cubs of the year." In 1991, 24 sows were observed with 43 cubs of the year. These higher figures could represent increased reproduction in the population, or they could mirror an increased effort to observe sows with cubs.

Mid-Atlantic Region

Three new resource management personnel have joined the Region's staff. Dave Reynolds has assumed duties as Regional Resource Management Specialist in Philadelphia, Hank Snyder is the new Supervisory Natural Resource Specialist at Shenandoah NP, and Julie Thomas is Shenandoah's new Air Quality Program Manager. Reynolds comes from the International Affairs office in Washington, where he was detailed to the Peace Corps and before that he served as Resource Management Specialist at New River Gorge; Snyder was previously at George Washington Parkway; Thomas was Regional Air Quality coordinator for the Southeast Regional Office.

* * *

Delaware Water Gap NRA, the USFS, EPA, and Delaware River Basin Commission co-sponsored a conference on Sustainable Wastewater Management, addressing different wastewater treatment methods and how they affect the hydrology and water quality of a watershed. The conference also examined the new water quality regulations for the Delaware River and how they will impact regional wastewater treatment.

* * *

Researchers at New River Gorge NR have identified a new state-listed rare species in an abandoned mine that was about to be sealed by the state. A population of the cave salamander (*Eurycea lucifuga*) will necessitate a revision of the state's plans.

information crossfile

behaviors and guess at the attitudes behind the behaviors of the people who made up the early industrial inhabitants of what is now Lowell National Historical Park and environs.

⁂

Climatically sensitive huon pine tree-ring chronology from western Tasmania is used by 8 authors to draw inferences about Austral summer temperature change since A.D. 900 and reported on pages 1266-8 in ***Science***, Vol. 253. Since 1965, huon pine growth was found to have been unusually rapid for trees that are in many cases over 700 years old. This growth increase correlates well with recent anomalous warming in Tasmania on the basis of instrumental records and supports claims that a climatic change, perhaps influenced by greenhouse gases, is in progress.

⁂

An informal survey to determine what information is now available on the extent, character, and management of old-growth forests on NPS lands has resulted in a 54-page report (Great Lakes CPSU Report 91-1) published in October 1991 by the Great Lakes CPSU at U/WI-Madison. Responses to a 1988 questionnaire from all 58 NPS units containing this community type found more than 4,867,800 acres, located in 32 states and the District of Columbia and in all 10 NPS regions.

Species listed for old-growth stands are available for vascular plants in 53 percent of the units and for birds in 35 percent. Many units (35%) had no information on which species are strongly associated with old-growth. Most frequently reported disturbances were logging, wildfire, windthrow events, and fire suppression. More than half (54%) of the units reported no management plan specific to old-growth forests. Research efforts in these forests included current research projects (60% of the NPS units), long-term data sets (63%), and permanent plots (35%).

⁂

Two related articles, attesting to the continuing worldwide interest in declining amphibian populations, appeared in the Aug. 23, 1991 ***Science***. One, by David Wake of U/CA's Museum of Vertebrate Zoology, maintains that scientific study of amphibians holds promise for a deeper understanding of the resilience as well as the limits of environments. Noting that modern amphibians have been on this planet for well over 100 million years, and thus could fairly be classed as "survivors," Wake suggests that "amphibians may serve usefully as bioindicators, organisms that convey information on the state of health of environments. How we read the message, and what to do about it, are timely challenges to scientists and to the public.

The companion article by Joseph H.K. Pechmann et al, deals with the problem of separating human impacts from natural fluctuations and concludes that distinguishing between natural population fluctuations and declines with anthropogenic causes may require long-term studies.

⁂

According to the Florida DNR's quarterly, ***Resource Management Notes***, wetland losses for states in the South Atlantic area are: West Virginia (-24%), Virginia (-42%), North Carolina (-49%), South Carolina (-27%), Georgia (-23%), and Florida (-46%). Approximately 28.7 million acres of wetlands are in these six states, which represent 27% of the total wetlands in the conterminous U.S. Overall, we have lost around 40% of the wetlands in the south Atlantic area. The source is the Society of Wetlands Scientists, South Atlantic Chapter Newsletter, June 1991.

⁂

A Department of the Interior pamphlet entitled *Wetland Activities* describes wetlands, why they are important, the President's goal for wetlands, and Interior agencies' wetlands programs (Fish and Wildlife Service, Bureau of Land Management, Bureau of Reclamation, Geological Survey, Bureau of Mines, Office of Surface Mining, Minerals Management Service, National Park Service, and Bureau of Indian Affairs).

For copies of the pamphlet and additional information, write WETLANDS, Mail Stop 6217 Main Interior Bldg., U.S. Dept. of the Interior, 1849 C St., NW, Washington, DC 20240.

⁂

A thorough (and thoroughly accessible) look at the links between land and water is provided in "An Ecosystem Perspective of Riparian Zones" in ***BioScience***, Sept. 1991, pp 540-551. Two stream ecologists (Stan Gregory of Oregon State U and Ken Cummins of U/Pittsburgh), a geologist (Fred Swanson with the USFS Research lab in Corvallis, OR) and a plant ecologist (Art McKee of OSU) propose a conceptual model of riparian zones that integrates the physical processes that shape valley-floor landscapes, the succession of terrestrial plant communities on these geomorphic surfaces, the formation of habitat, and the production of nutritional resources for aquatic ecosystems. Charts, graphs, and tables extend this concept through time and space and provide understanding of the wide array of ecological processes and communities associated with the land-water interface.

⁂

Helping Nature Heal: An Introduction to Environmental Restoration is the title of A Whole Earth Catalog/Ten Speed Press publication (Box 7123, Berkeley, CA 94707, $14.95) edited by Richard Nilsen and featuring theory of environmental restoration, how it is practiced the USA and around the world, and what is needed to jump start it anywhere. Barry Lopez's Foreword is a call to arms, bringing to mind an Information Crossfile piece that got "bumped" several issues ago. It quoted Frank Press, president of the U.S. National Academy of Sciences, who told an international meeting of the Group of Seven industrial nations in Paris in mid-1987: "What we are doing to the Earth's atmosphere, to the blue planet on which we live, is not merely ominous. It may already be beyond correction."

meetings of interest

1992

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

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

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

Feb. 24-28, NINTH INTERNATIONAL CONFERENCE ON BEAR RESEARCH AND MANAGEMENT, Holiday Inn Parkside, Missoula, MT. Contact: James Claar, USFS Northern Region, PO Box 7669, Missoula, MT 59807 (406) 329-3288.

Mar. 4-6, HIGH ALTITUDE REVEGETATION WORKSHOP, University Park Holiday Inn, Fort Collins, CO: a biennial forum for discussion of the technology and unique environmental issues pertaining to reveg and rehab of disturbed lands at high elevations. Contact: Gary L. Thor, Dept. of Agronomy, CO/State/U, Fort Collins, CO 80523 (303) 491-7296.

Mar. 9-12, BIODIVERSITY TRAINING COURSE, in Tucson, AZ: (see article elsewhere on this page). Contact: Charles Pregler, BLM Training Center, 5050 N. 19th Ave., Suite 300, Phoenix, AZ 85015 (602) 640-2651, FAX 602-640-2870.

Apr. 23-24, MAPPING TOMORROW'S RESOURCES, A Symposium on the Uses of Remote Sensing Geographic Information Systems and Global Positioning Systems for Natural Resource Management. Utah State Univ., Logan, Utah. Contact: Dean's Office, Coll. of Nat. Res., Utah St. Univ., Logan, UT 84322-5200 (801) 750-2445.

May 15-17, CRATER LAKE NP 90TH ANNIVERSARY SYMPOSIUM, Southern Oregon State Coll., Ashland, OR. Contact: Dr. Frank Lang, Dept. of Biology, Southern OR/State/Coll, Ashland, OR 97520 (503) 552-6342.

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

June 22-25, BIODIVERSITY TRAINING COURSE, location to be announced. See Mar. 9-12 notice above.

Nov. 16-20, PARTNERS IN STEWARDSHIP, the George Wright Society Conference on Research and Resource Management in Natural and Cultural Parks and Reserves, Jacksonville, FL. Contacts: John Donahue, NPS, 18th & C Sts NW, Washington, DC 20240 (202) 208-4274 and Harry Butowsky, NPS, PO Box 37127, DC 20013-7127 (202) 343-8155.

GIS Program Initiated at the U/AZ CPSU

By Tom Potter, Michael R. Kunzmann, and D. Phillip Guertin

Geographic Information Systems (GIS) have arrived at the National Park System in Arizona. In a joint effort at the University of Arizona at Tucson, the Cooperative Park Service Unit (CPSU/UA), Advanced Resource Technology Lab (ART) in the School of Renewable Natural Resources, and the Arizona State Museum have been working together to create GIS compatible databases for several Arizona NPS Units. So far, several themes of spatial data have been digitized for Tonto National Monument, Chiricahua National Monument, Organ Pipe National Monument, Montezuma's Castle National Monument, Wupatki National Monument, and Petrified Forest National Park. Work covering other Arizona Units is in the planning stage. Analysis and modeling of the data already captured also is in its beginning stages, but useful results have already emerged.

Initial data for each Arizona unit were digitized using a Calcomp 9500 digitizing tablet and AutoCAD (Autodesk, 1989) on a DOS-based 386 computer. The data were then loaded into IDRISI, a largely raster-, or grid-, based geographical analysis system that was originally developed as a GIS research and teaching tool for microcomputers. Since its introduction in 1987, IDRISI (Eastman, 1990) has grown to become one of the most popular raster-based GIS and image processing systems on the market. It is used in over 70 countries by a wide range of governmental and research institutions. It was chosen as the primary software for this project for numerous reasons (Table 1).

One of the objectives of the CPSU/ART program was to provide Park Units with limited staff or technical expertise with the GIS software and data that could be used directly by the existing staff. IDRISI provides a low cost, user friendly program that fulfills this objective.

Examples of Current GIS Applications

Tonto National Monument

Tonto National Monument is located on the shores of Theodore Roosevelt Lake about 60 miles east of Phoenix, AZ. The monument is known primarily for its spectacular examples of Sinagua cliff dwellings. Due to its proximity to Phoenix and Roosevelt Lake, a major concern at the unit is how increased development around the lake will affect the resources and prehistoric setting of the monument. The principal objective at Tonto is to evaluate the visual impacts of potential recreational camp sites and other development on the prehistoric viewshed.

Two basic themes, elevation data and features of interest, have been digitized for Tonto National Monument. The features of interest include entities such as the monument boundary, roads, trails, buildings and cliff dwellings. Several other themes, including a digital elevation model, slope and aspect, and a viewshed analysis were generated using appropriate IDRISI modules. Viewshed analysis consists of choosing one

Table 1. *Advantages of IDRISI as a PC-based GIS*

1. It is a low-cost (<$300) vehicle for teaching and scholarly research.
2. It is easy to learn and use and runs on a DOS-based PC, which would facilitate teaching GIS principles in a familiar PC environment.
3. The program is small (<2.5 Megabytes) and runs on PPC DOS-based platforms that are ubiquitous throughout the National Park Service.
4. IDRISI offers the analytical capabilities common to most raster-based GIS systems.
5. The data format is compatible with GRASS, the recommended raster-based GIS.
6. Has excellent data-interfacing capabilities with commonly used software such as Lotus 123, Oracle, dBASE, Arc/Info, and AutoCAD.
7. The software is produced and actively supported by the Graduate School at Clark University as a non-profit project.

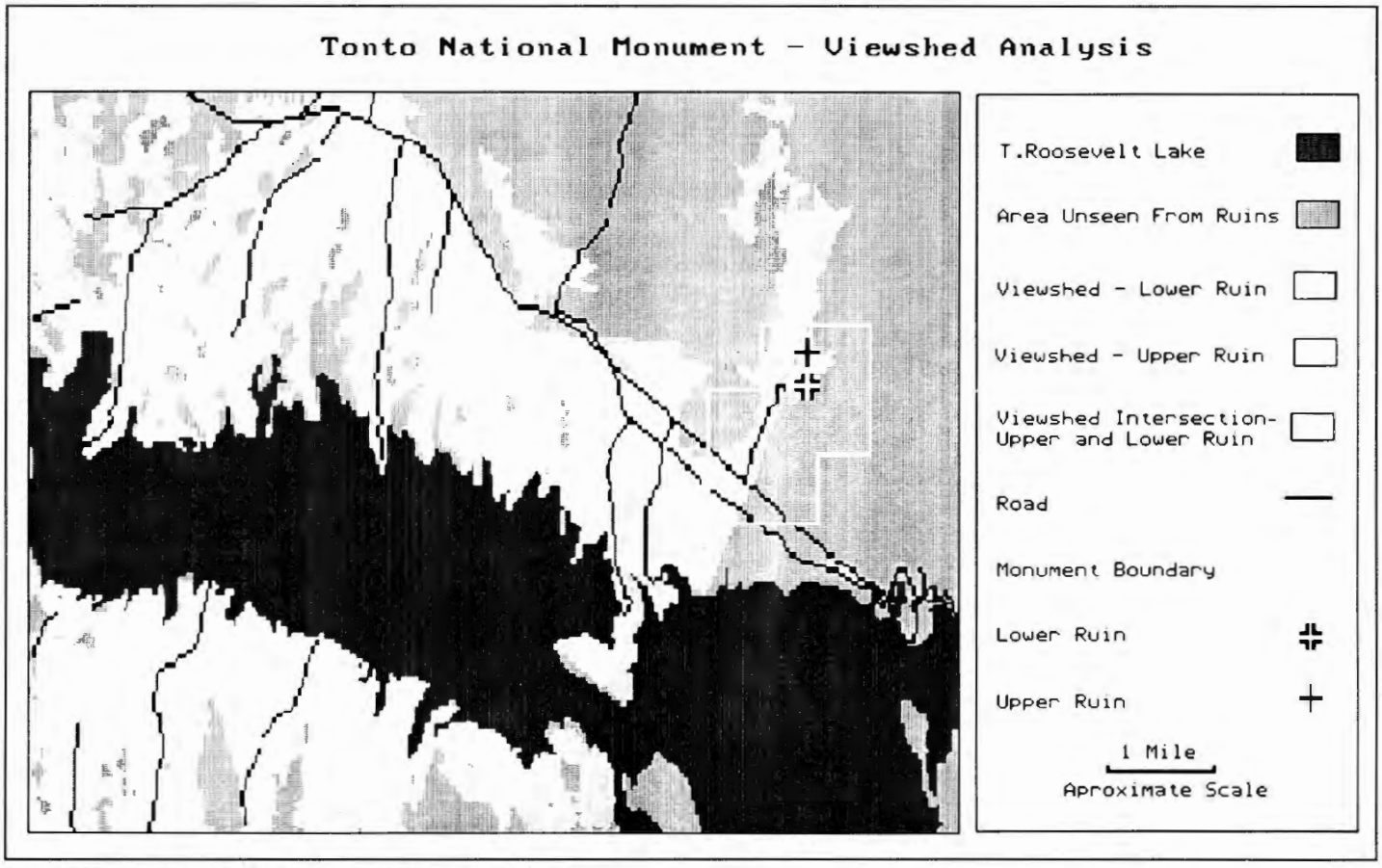

Figure 1. *Viewshed analysis for Tonto National Monument and vicinity*

or more viewpoints on a map and then generating another map that indicates areas that can be seen from the viewpoint(s). For the Tonto National Monument database, two viewsheds where generated, one from each of the two Sinagua cliff dwellings within the monument (Fig. 1). The monument staff now has an effective way of analyzing the impacts of proposed multi-use recreational sites on the prehistoric scene.

Chiricahua National Monument

Chiricahua National Monument is located in the Chiricahua Mountains in southeastern Arizona, about 125 miles east of Tucson. Four themes, including topography, vegetation, fire history, and physical/cultural features (Fig. 2), were digitized and loaded into IDRISI. Topography was used to create a digital elevation model along with slope and aspect. Fire data were coded by ignition cause, size, and date. With these data, and the addition of some lightning strike data, maps of fire probability and potential fire hazard can be generated. Work has also been initiated with the Laboratory of Tree Ring Research at the University of Arizona to digitize spatially-referenced tree ring data in order to map and analyze the paleo-fire history of the Chiricahua mountains.

Future GIS activities at Chiricahua will include the testing of GIS-compatible fire simulation software using data from the Chiricahua database (Ball and Guertin, 1991), and possibly the development of a model for the prediction of LD50 species mortality from fire intensity (Kunzmann et al., 1991).

Organ Pipe Cactus National Monument - Quitobaquito Springs

Organ Pipe Cactus National Monument is comprised of 300,000 acres in Southwestern Arizona and includes several distinct ecosystems. One of the unique environments in Organ Pipe National Monument is that surrounding Quitobaquito Springs, home of the endangered species, the desert pupfish (*Cyprinodon macularius* var. *eremus*). There are numerous management concerns related to the Quitobaquito Springs area, but of particular interest is how international border management will affect the springs. Of these concerns, the effect of topographic alterations on water levels in the main pond at Quitobaquito is of utmost importance.

For Quitobaquito Springs topography, vegetation, surface hydrology, and physical and cultural features were digitized and a digital elevation model and slope and aspect generated. These data are intended to help model the effects of alterations in topography on the local hydrology.

Montezuma's Castle National Monument

The data base for Montezuma's Castle is still under development. Topography and physical cultural features have been digitized and transferred to IDRISI, where a digital elevation model has been generated. As with Tonto National Monument, Montezuma's Castle is also facing increased development along its borders. Our intent is to use GIS-assisted analysis and modeling to help clarify some of the planning issues related to the monument.

Two other issues at the unit are maintaining riparian corridors along Beaver Creek and monitoring and maintaining the sensitive aquatic habitats and rich archaeological resources at Montezuma's Well, a spring-fed pool bounded by the sheer walls of a limestone sinkhole.

Wupatki National Monument

Wupatki National Monument is located in north-central Arizona north of Flagstaff. The unit preserves a series of beautiful Sinagua pueblo dwellings. The entire unit is rich in archeological resources. Dr. Ken Kvamme at the Arizona State Museum has loaded the locations of known archeological sites, topographic data, and soils data into IDRISI. With these data, he has created archeological site-probability maps that can provide information for planning purposes and help direct future archeological field surveys.

Petrified Forest National Park

Petrified Forest NP is located in northeastern Arizona, about 120 miles east of Flagstaff. The park is known primarily for the rich fossil remnants of Mesozoic forest preserved within its boundaries. But the park also preserves other unique, though lesser known, archeological, ecological, and scenic resources.

GIS work at Petrified Forest NP begam recently when a team from the Arizona State Museum started to compile and digitize data on the archeological, geo-

(Continued on page 20)

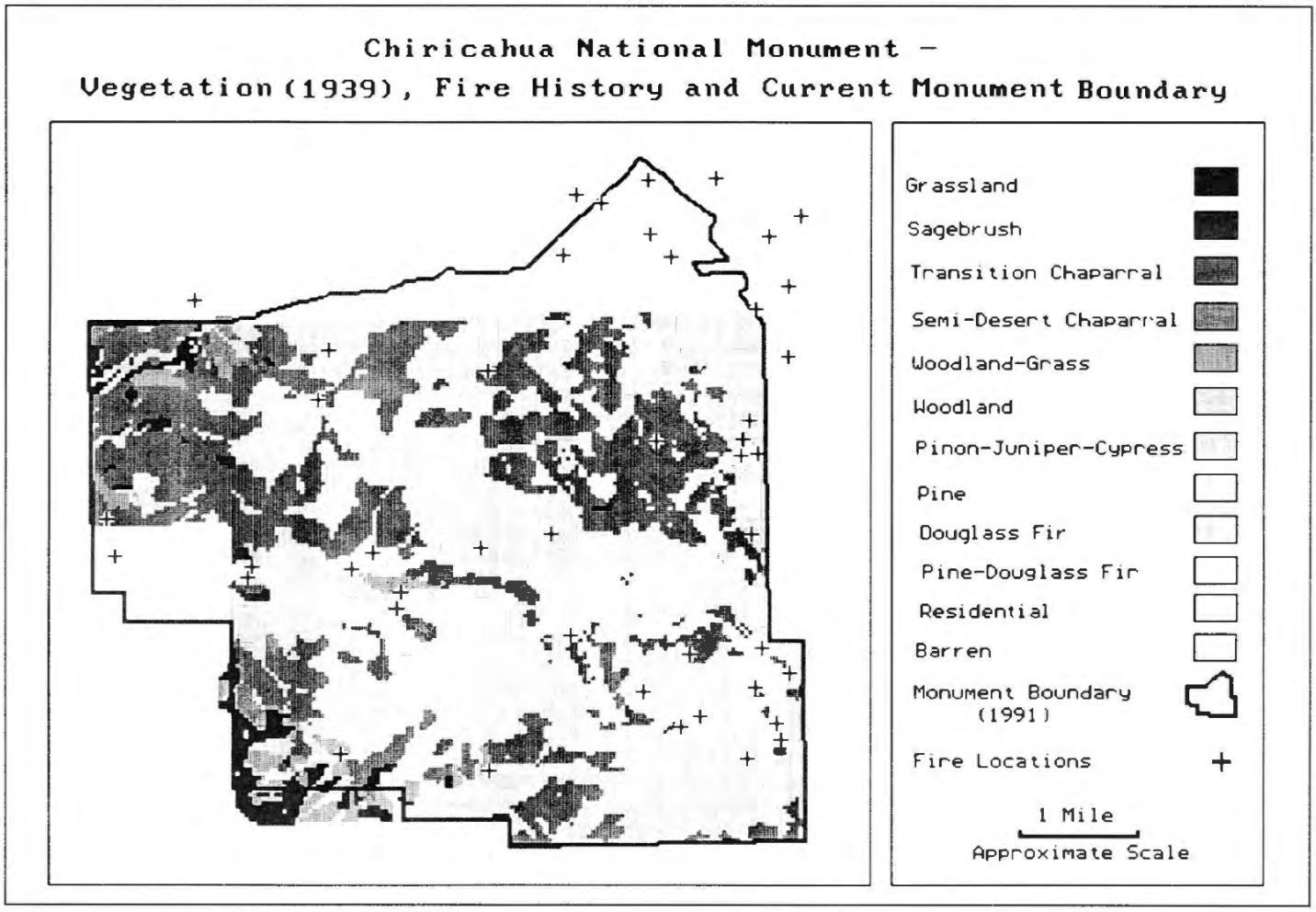

Figure 2. *Vegetation (1939), fire history and current monument boundary for Chiricahua National Monument*

Visitors Prefer Park Values to Oil and Gas Development

By George Wallace

Visitors stopping at viewing points in all three units of Theodore Roosevelt NP (TRNP) see a dramatic landscape that combines badlands, prairie, and riverbottom vistas. Such views often extend over several miles of parkland and beyond park boundaries. Park staff have felt for some time that the park's unique values may be threatened by increasing numbers of nearby oil wells, tanks, roads, powerlines, and communication towers visible from many points inside the park.

More than 1000 oil and gas wells lie within 10 miles of the park, some within a quarter mile of park and wilderness boundaries. Additional impacts associated with these sites include flare pits, electrical lines, an extensive network of roads, truck traffic noise, and accompanying dust and odors. Industrial human and wildlife fatalities have occurred near the park as a result of accumulations of hydrogen sulfide gas, which can collect near the wells. Were such human-caused landscape features affecting the visitors' experience, park visitation – hence the park's contribution to the local economy?

Despite a variety of laws and directives clearly entrusting parks with management of scenery, visual resources, viewsheds, integral vistas, and air quality related values (NPS Act 1916, Clean Air Act 1963, Wilderness Act 1964, NEPA 1969, Surface Mining Act 1977, etc.) TNRP managers frequently found themselves in hearings and negotiations attempting to stop or mitigate adjacent development but armed with little data on which to make their case.

In 1988, at the request of TRNP staff, the University of Wyoming NPS Research Center sponsored a study designed to look at the effect of external development on the economic and aesthetic values of TRNP. Researchers from Colorado State University worked with park staff to design and conduct a study that inquired into visitor perceptions, expenditures, and other related information over a 2-year period.

"The thousands of visitors to Theodore Roosevelt NP expect and deserve more than to have their vistas marred by adjacent oil and gas development," said Park Supt. Pete Hart after the Little Missouri National Grassland Oil and Gas Final Environmental Impact Statement (FEIS) and Record of Decision (ROD) was released on Oct. 24, 1991. "The FEIS vastly understates the seen areas visitors are viewing," he said, "especially from the wilderness area.

"The projection of over 500 new wells on USFS lands in the vicinity of park and designated wilderness area will severely impact the quality of the visitor experience and cause the degradation of park resources for decades to come."

Hart referred to the study described in this article as having "direct management implications for dealing with external development impacts. Our major concerns are for the cultural integrity of the Elkhorn Ranch, air quality, wilderness values, and visual resources," Hart said. Formal comments on the FEIS are being prepared by the park, the Region, and WASO in a joint memorandum for signature by the NPS A/D for Planning to the Regional Forester (Northern Region.)

Study Design

On site interviews were conducted at 6 of the park's main vistas, where visitors interviewed could see large landscape areas while responding to survey items about (1) the value of a mixed grass prairie ecosystem national park like TRNP, and (2) external impacts and human-generated landscape features. This second part of the study included items best evaluated while visitors were viewing the resource and/or items less appropriate for a mail survey. Those interviewed were then given a mailback questionnaire to be filled out upon completion of their visit to the park.

The questionnaire was to gather information about (1) visitor and trip characteristics such as length of stay, group size and composition, locations visited, and activities pursued and most enjoyed; (2) visitor satisfaction; (3) expenditures associated with the visit; (4) socio-demographic information, and (5) comments.

The study was piloted in the summer of 1988, with a stratified random sample of 250 visitors, refined and continued in 1989 with a sample of 686. The number of interview days allocated each of the 6 sites was in proportion to the visitation typically received (annual visitor hours) at that site. Interviews were distributed over the summer to reflect vegetative changes in the landscape and changes in types of visitors.

Interview Procedure Features

Prior to the field interviews, photographs were taken at each of the 6 integral vistas, duplicated and enlarged to 11" x 17". On one of the paired photos for each vista, simulations either *added* or *removed* human-generated landscape features. All simulations were put to scale: added features like oil wells or powerlines were put in locations where they were slated to be built. In photos where human-caused features were removed, natural vegetative conditions were simulated in their places.

These photos were used as "cues" to help visitors make "mind's eye" judgments about a particular portion of the landscape seen during the interview as it might look under other conditions. Using the cues and the real landscape, visitors were asked to rate the attractiveness of the two landscapes and then to answer questions regarding how the simulated landscape (with external impacts either added or removed) might affect their behavior at that place (time spent viewing, picture taking, hiking, camping, and using the wilderness area in or near that landscape.)

GIS Program at U/AZ CPSU *(continued from page 19)*

logical, soils and vegetation resources in the unit. Future data acquisition efforts at Petrified Forest will likely include the collection and analysis of data from either satellite platforms or airborne video. In addition to basic research, these data will be used to predict the locations of archaeological and paleontological resources on land surrounding the unit.

Future Work

Many GIS projects are in the planning stages. Archeologist Trinkle Jones at the Western Archeological and Conservation Center (WACC) has extensive spatially-referenced archeological records in a dBASE format. Plans are in the works to develop a dBASE interface to permit directional transfer of these records into IDRISI. The Dbase/Idrisi map interface would allow park staff to easily transfer their own spatially-referenced dBASE records into IDRISI. In addition, IDRISI map files are easily transferred into GRASS, the primary GIS supported by the Service's Geographic Information Systems Division in Denver.

Efforts are under way to develop cooperative relationships with the state of Arizona and other federal agencies to collect and share spatially-referenced digital data. One example is the GAP project developed by the Fish and Wildlife Service. The GAP project will use various sources of digital data (Landsat, aerial video and other GIS-compatible data) to comprehensively map critical wildlife habitat in the state of Arizona. In a cooperative effort, the data have the potential to provide much valuable information to the parks in Arizona.

Provision of GIS training for Arizona NPS personnel also is underway. A workshop covering a wide range of GIS-related issues took place at the University of Arizona's ART lab in June of 1991. The aim of the workshop was to familiarize Park Service personnel with GIS technology and provide them with some hands-on experience. Future workshops will be held according to interest.

Conclusion

The CPSU/ART GIS program is still in the initial stages of collecting and digitizing spatial data and developing techniques of modeling and analysis. The potential for useful GIS analysis is limitless, now that the effort has been started. Park managers in Arizona have responded positively to these initial efforts and see GIS as a promising tool that can enhance their abilities to accomplish many resource management tasks. For additional information about the CPSU/ART program call Mike Kunzmann (FTS) 762-5534 or Phil Guertin (602) 621-1723.

Potter is a graduate student in the School of Renewable Natural Resources at U/AZ; Kunzmann is a research ecologist at the NPS/CPSU at U/AZ; Guertin is an assistant professor of Watershed Management at the School of Renewable Natural Resources at U/AZ.

Literature Cited

Autodesk, Inc. 1989. AutoCAD Release 10.0. Produced by Autodesk Inc., Sausalito, CA.

Ball, George L. and D. Philip Guertin. 1991. Fire simulation in natural ecosystems. In Proceedings: Resource Technology 90. Second Symposium on Advanced Technology in Natural Resource Management. Amer. Soc. for Photogrammetry and Remote Sensing, Bethesda, MD. pp 108-118.

Eastman, J. Ronald. 1990 IDRISI release 3.2. A grid based geographic analysis system. Produced by Clark Univ. Grad. School of Geography, Worcester, MA 01610.

Kunzmann, Michael R., Peter S. Bennett, and George Ball. 1991. The use of GIS for ecological modeling: the prediction of LD50 tree mortality from fire intensity. in Proceedings: Resource Technology 90 (see above) pp 118-137.

Tomlin, C. Dana 1986. The IBM personal computer version of the Map Analysis Package. GSC IBM ACIS Project Report No. LCGSA-85-A8A16 Laboratory for Computer Graphics and Spatial Analysis. Graduate School of Design, Harvard.

Minnesota State Planning Agency, 1990 EPPL7 - Eppl Version 2.0. State of Minnesota, Minn. State Planning Agency.

The Spring issue of *Park Science* will carry an article by Kunzmann, George Ball, and Petger S. Bennett, describing Dynamic Fire Modeling Using GRASS 4.0, developed at the U/AZ NPS/CPSU.

Table 1. Mean Landscape Attractiveness Ratings at Six Integral Park Vistas Cued by Photo Simulation (on a 10 point scale with 10 being most attractive), Summer 1989.

Integral Vista	Photo-Simulation				
	As Is	Man-Made Features Added	Man-Made Features Removed	(N)	% Change
Bentonite Clay	9.2	3.4	—	81	−63.0
Boicourt Ridge	5.6	—	8.5	179	−51.8
Riverbend Overlook	9.1	5.4	—	70	−40.7
Man and Grass	5.2	—	8.0	34	−53.8
Painted Canyon	6.6	—	8.8	133	−33.3
Schramm Hill	6.5	—	8.7	182	−33.8

— = no photo simulation made

Table 2a. Expected Vista-Viewing and Picture Taking Behavior, by Park Site (Summer, 1989).

	Park Site					
	Bentonitic Clay†	Boicourt Ridge*	RiverBend Overlook†	Man and Grass*	Painted Canyon*	Schramm Hill*
(N)	82	179	73	35	133	182
	Percent					
Stop coming	1.2	0.0	1.4	0.0	0.0	0.0
Spend less time	61.0	38.4	2.9	2.3	2.2	
Spend same amount of time	35.4	60.9	60.3	62.9	73.7	66.5
Spend more time	2.4	37.4	0.0	34.3	24.1	31.3

† = external development added
* = external development removed

Table 2b. Expected picknicking, hiking and camping behavior, by Park site (Summer, 1989).

	Park Site					
	Bentonitic Clay	*Boicourt Ridge*	*RiverBend Overlook*	*Man and Grass*	*Painted Canyon*	*Schramm Hill*
(N)	82	179	73	35	133	182
	Percent					
Stop coming	7.3	0.0	5.5	0.0	0.0	0.0
Spend less time	59.8	1.1	34.3	2.9	3.8	1.1
Spend same amount of time	30.5	61.8	60.3	54.3	69.2	69.2
Spend more time	2.4	37.1	0.0	42.9	27.1	29.7

Table 3. Man-made or man-caused features reported in Boicourt Ridge landscape, by order of mention (Summer, 1989).

	Order of Mention					
	First	Second	Third	Fourth	Fifth	Percent Noticing
(N)	178	175	102	43	14	
1. Oil and gas well site	97.8	0.6	0.0	0.0	0.0	98.4
2. Oil and gas well site	0.0	98.9	1.0	0.0	0.0	99.9
7. Oil and gas well site	0.6	0.0	49.0	25.6	7.1	82.3
5. Road (with scoria surface)	1.1	0.0	12.8	11.6	0.0	25.5
3. School and church	0.0	0.0	18.6	0.0	0.0	18.6
8. Access road	0.0	0.0	6.9	25.6	35.7	68.2
9. Reservoir/pond	0.0	0.0	7.8	18.6	7.1	33.5
10. Other	0.0	0.0	1.0	14.0	35.7	50.7
6. Agricultural fields	0.0	0.0	2.0	0.0	0.0	2.0
11. Other	0.0	0.0	0.0	0.0	7.1	7.1
4. Combine	0.0	0.0	0.0	0.0	0.0	0.0

Economic Analysis Features

The mailback survey enabled researchers to estimate visitor expenditures by category (transportation, lodging, food, etc.) both within 50 miles of the park and within the rest of North Dakota. These expenditures were combined with those that the operation of TRNP itself contributes to the economy (payroll, local purchases, sub-contracts, etc.) and converted to fit the categories and coefficients used by the North Dakota Input-Output Model. The IMS Regional Economic Input-Output Model developed by John McKean at Colorado State University was run using the data. Such models include the multiplier effect of expenditures for each sector of the economy and provide the estimated value of a park like TRNP to the local and state economy. Following are a few of the salient results from the study.

Economic and Non-Economic Values Revealed

The economic portion of the study revealed some figures that should enable park managers to provide information of high interest to local decision makers. In 1989, TRNP produced the equivalent of **1164** jobs in North Dakota's private sector, and an **economic contribution to the state** (changes in total sales) of **$62,740,000.** Visitors were asked during the interviews how they valued a prairie park like TRNP compared to other national parks. Although TRNP is off the beaten path and not typically a destination park, the study showed that 76.7 percent of all visitors valued the park equally as much, and 20.5 percent valued TRNP more than other parks; 94.4 percent of all visitors said that environmental laws protecting the park's resource quality should be adhered to, even if it adds to the costs of oil and gas production.

Although the information is not politically viable at the moment, the study asked – as an indicator of public sentiment – for visitor opinion about creating a 1-mile buffer zone around the park. More than 72 percent responding favored such a buffer, regardless of whether oil and gas companies were compensated; 16.5 percent favored a buffer with compensation, and 11 percent opposed any buffer. The park has a sizeable group of return users, many of whom are locals and who value the park highly. Local visitors, many of whom depend on the energy sector, were among those assigning the highest value to the park, but showed the highest opposition to the buffer zone concept (34.3%).

External Development and Visitor Experience

The study showed TRNP to be a very visually oriented park, where the most frequent and enjoyed activities are vehicle touring, stopping at scenic vistas, viewing wildlife, and day hiking. At all 6 vistas where sampling was done, the simulated removal of visual impacts (human-caused features) increased ratings of attractiveness while the simulated inclusion of visual impacts in photo cues lwered landscape attractiveness ratings (Table 1). Even subtle simulated changes in landscape features caused noticeable differences in attractiveness ratings. Increases in external development which actually occurred near interview sites between 1988 and 1989 also are distinctly reflected in the data.

In the on-site interviews, visitors were asked "if the landscape was like that shown in the simulated photo," how would it affect the amount of time they would spend (a) vista viewing or picture taking, (b) picnicking, hiking or camping, (c) or using the wilderness area nearby. Results clearly indicate that for landscapes where human-caused landscape features related to external development were added, many people reported they would spend less time or not come at all. Where development was removed, they would spend more time (again, photos were used as cues for judgments about the actual landscape) Table 2.

Although visitors still rate their experience at TRNP as good, the external development (particularly of oil and gas and its associated structures, noise, odors, and dust), is negatively affecting their experience. The context within which human-caused landscape features are seen is very important. Obviously not all

(Continued on page 22)

Restoring the Historic Landscape At Wilson's Creek

By Lisa Thomas

"The hills bore some scattering oaks and an occasional bush, but we could see clearly, because fires had kept the undergrowth eaten out and the soil was flinty and poor."

Thus was the scene described by private Eugene Ware on Aug. 10, 1881, when over 15,000 Confederate and Union solders met along the slopes above Wilson's Creek in southwestern Missouri.

Since that time, intense agricultural use and the exclusion of natural forces such as fire have changed the savanna landscape dramatically. Fescue and successional fields have replaced prairie meadows. Steep slopes that never were plowed have succeeded to forest in the absence of fire. And exotic species dominate, even in areas such as the limestone glades, where agricultural disruptions were less severe.

Since the establishment of Wilson's Creek National Battlefield (WICR) in 1960, the 1750 acres of rolling terrain has been recognized as the park's principal resource. Efforts to restore a savanna landscape began in the late 1960s with the planting of 220 acres of prairie grass. Studies completed in the 1970s and 1980s have formed a clearer picture of the historic landscape and of WICR's restoration needs. Over the last decade an additional hundred acres have been planted with native warm season grasses.

In the spring of 1991, the park completed an action plan to provide long-term guidance and priorities to landscape restoration. The plan outlines specific management objectives and prescriptions for WICR's various community types and provides a multi-year restoration timetable. The plan also identifies certain areas where more research is needed to develop restoration methods. Monitoring to assess treatment success is emphasized as a key component of the restoration process.

Restoration goals at WICR include reconstructing savanna communities in current fescue and successional fields, increasing species diversity in old prairie plantings, and reducing woody and exotic dominance on limestone glades. Over the next 3 years, restoration efforts will focus on a 330-acre area known as Bloody Hill, which contains the park's most significant historic and natural features. Eventually, 1000 acres, comprising the historic core of the park, will be restored.

The current restoration phase began in late summer, 1990, with a prescribed fire in a 35-acre fescue field. The fire promoted vigorous fescue regrowth, insuring a more complete kill when the field was sprayed with Roundup in November. In April 1991, the field was planted with prairie grasses and wildflowers that are native to southwestern Missouri.

Last summer (1991) the park's restoration crew brushhogged overgrown successional fields, sprayed exotic weeds, and cut down exotic Osage orange trees in preparation for planting. Prescribed fires were carried out in the fall.

While the restoration crew already is applying well-

Visitors Prefer *(Cont'd from p. 21)*

human-caused landscape features detract. Some are expected and add to the visitor experience. Smoke from natural sources like burning coal seams, from controlled burns, and from oil and gas wells were all evaluated differently, although most visitors were unable to distinguish among these different types of smoke.

Mitigating Impacts

At each vista, those interviewed were asked simply to tell researchers what human-caused landscape features they saw on the landscape in question. Responses were recorded on a vista grid in the order of mention and the results compared with a master grid having all visible human caused features on it. These data, displayed for the Boicourt Ridge site in Table 3, allow managers to better understand the relative visibility of external features and to see whether managers and visitors notice the same things. Mitigation priorities (painting with earth tones, changing the color of a road surface material, moving and site planning, etc.), can become more evident with such data, and like other of the study's results, can be useful during negotiations with energy companies, county commissioners, or during the permitting and site planning process.

Study results show that TRNP is a highly valued park that makes a significant contribution to the local and state economies, a park where the principal activities pursued by visitors are being impacted by external development. Indications are that eventually this may affect the amount of time visitors spend on these activities. There is some evidence too that impacts from external development may be reducing the economic contribution the park makes to the local economy. Several factors, like displacement (some visitors may already have stopped coming), make it difficult for this study to assign an exact dollar value to the impacts of external development, but many of the results seem to stand on their own.

Results from this and similar studies will make it easier for park managers to explain the economic, aesthetic, and other values the park embodies. The data generated quantify external impacts and suggest necessary mitigation for both present and proposed external development.

Wallace is an Associate Professor in the Recreation Resources and Landscape Architecture Department at Colorado State University.

notes from abroad

Editor's Note: Schoenberg, an archaeologist with the NPS Regional Office in Alaska,has worked in Alaska for 20 years. His area of research is the prehistory of arctic and boreal regions, with emphasis on adaptation and cultural ecology. In July and August of 1990, upon invitation from the USSR Academy of Sciences and with support from the Horace Albright fund, he traveled to Novosibirsk, Siberia (with a stopover in Moscow), to present a professional paper on a Beringian archaeological site in Gates of the Arctic NP. The paper was presented at an international symposium on Chronostratigraphy of the Paleoloithic of Northern Asia, organized by the Institute of History, Philosophy, and Philology of the USSR Academy of Sciences. References to the USSR were all made before recent events made that designation a dubiously descriptive title.

By Ken Schoenberg

Scholars from the USA, Canada, France, Korea, China, Japan, India, Germany, and all parts of the Soviet Union attended the Chronostratigraphy Symposium. Papers on recent discoveries in Siberia, Korea, China, the United States and Japan showed a common interest in investigating the paleoenvironment of the north and understanding cultural adptation to those environments.

Some of the most exciting recent finds, in relation to human migration to the New World, have been made in northern China, Mongolia, and the Amur region of Siberia (for instance the Ust-Ulma site that was excavated by Derev'anko). The evidence is good that the ancestral population pool of the human migrants across Beringia was centered in this area in the late Pleistocene.

Much of the discussion centered on methods of interpreting the stratigraphy of deep loess sites through the use of geological and pedological interpretation. It was agreed that dating sites through stratigraphy (chronostratigraphy) provides only relative dates. The need is to apply more multidisciplinary techniques, such as radiocarbon and thermoluminescence, in order to obtain more precise absolute dates for these sites.

Global Change Clues

The technological and financial resources to apply these and other scientific techniques to archaeological and geological research are lacking at present in Mongolia, China, and Siberia. These deep loess sites, however, appear to hold great potential for providing paleoenvironmental baseline data for global change research. Scholars in these countries are looking to Europe, Japan, and the U.S. for expertise, facilities, and equipment to pursue more in-depth research on these sites.

The paper I presented, "The Archaeology of Kurupa Lake: A Northern Beringian Site," describes a site just north of the Brooks Range in Gates of the Arctic NP. This site has been occupied intermittently over the last 8000 years, and shows similarities to sites in Siberia and northern China that warrent further investigation.

One key point made in this session was that Beringian research, both archaeological and biological, would benefit greatly from investigation of sites geographically close to one another, such as on either side of the Bering Strait and Chukchi Sea. Too often, especially in northern archaeology, sites that are several thousand kilometers apart are compared, and the intervening gap is ignored. There is need for a "chain of sites" that are geographically close, to provide comparative data links across the existing gaps.

Beringian Park Proposal

The Beringian Heritage Park proposal between the NPS and the Soviet Union is one attempt to facilitate such research. The idea of the park (unknown to most of the researchers at the symposium until I presented it) was enthusiastically received. Another mechanism to sponsor Beringian research was presented by Hans Muller-Beck of Germany, who chairs a committee on human entry to the New World for the International Quaternary Union (INQUA). This committee is organizing an interdisciplinary and international research effort on both sides of the Bering Strait.

The conference revealed a basic problem in the lack of a common scientific terminology among scholars in different countries. Lack of such a descriptive and analytical framework makes communication and comparison of data and interpretation difficult. NPS is attempting, as part of the Beringian Heritage project, to address this problem through the development of a Russian-English archaeological dictionary. If this project is successful, then as the need arises, dictionaries for other disciplines could be undertaken.

I traveled with a group of colleagues from Novosibirsk to the Lake Baikal region of Siberia, visiting archaeological sites and exploring the national park areas around the lake. We met with local residents and managers and discussed resource management problems there (consumptive use of resources and anthropogenic change) as well as the impact of the park on their lives.

Field Camps Visited

After traveling to Irkutsk, our first field camp was at the southern end of the Bratsk Sea, formed by the damming of the Angara River, which is the only outlet of Lake Baikal. This area has been the scene of intensive archaeological work in the last 20 years because the formation and industrialization of the Bratsk reservoir has led to major environmental degradation of the area. About 100 meters of shoreline has been eroding every decade, exposing numerous archaeological sites.

Our hosts informed us that the environmental movement in the USSR gained its first real strength in response to environmental problems in this area and threats to the unique ecosystems of Lake Baikal. One response was the founding in 1971 of a National Park around parts of Lake Baikal.

The second field camp we visited was at the headwaters of the Lena River, near the town of Verkolensk, founded in 1641 by Russians and Cossacks as part of their conquest of Siberia. It also was the place to which the Czar exiled Leon Trotsky prior to the 1917 Revolution. The archaeological sites in this area date back at least 20,000 years, and are characterized by deep loess deposits even though the area has been heavily forested at various times.

Our last field camp was at Ulan-Hada Bay on Lake Baikal. The Geophysical Institute of Irkutsk maintains a permanent research camp (of tent frames) there. Because this part of Lake Baikal is shallow and the water warms up enough for bathing and boating, there is a long history of human occupation here. There also is a productive fishery at the boundary of the shallow, warm bay and the cold, deep waters of the main lake. The area is the main recreation area around the lake for visitors from all over the Soviet Union. Local authorities would like to see greatly increased international tourism here. Management of this complex park, which lacks an institutional park service with traditions and expertise, is evolving on a day-to-day basis.

Wilson's Creek *(Cont'd)*

established restoration treatments, new methods are being developed to meet unique restoration problems. One of the goals is to increase species diversity in both old and new prairie grass plantings. Research to compare establishment success of 20 prairie wildflowers was begun in the spring of 1991. Another research project is exploring methods to reduce woody and exotic cover on the park's limestone glades. These areas require careful handling because they are home to several rare species, including the federally endangered Missouri Bladderpod (*Lesquerella filiformis* Rollins).

Park biologists currently are collecting vegetative baseline data that will be used to measure restoration success. Monitoring protocols have been developed for each restoration objective. We anticipate that such specific monitoring data are needed to judge the success of particular treatments and to identify new problems while they still are manageable.

WICR's historic restoration plan integrates research, monitoring, and management into the restoration process. Including research and monitoring components requires a greater initial commitment of resources. We expect this investment to pay off with management that is more responsive to changing restoration demands.

Our long-term goal is to restore communities that are sustainable with little management beyond periodic prescribed fire. Early management aimed at increasing native diversity and reducing exotic dominance is the key to restoring a landscape that will stand the test of time.

Thomas is a Biological Technician at WICR and is heading up the restoration project.

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New Publications

Eight new publications have been announced by and are available from Donna O'Leary, NPS Natural Resources Publication Coordinator (P.O. Box 25287, Denver, CO 80225-0287; FTS 327-2156, (303) 969-2156).

1. *NPS Annual Science Report: 1990 Inventory of Research Activities in the National Parks*. Anne Frondorf, ed. Data sorted by region and park: NRSR-91/04; Data sorted by field of study: NRSR-91/05.
2. *Proceedings of the Symposium on Exotic Pest Plants*. Ted D. Center, Robert F. Doren, Ronald H. Hofstetter, Ronald L. Myers, and Louis D. Whiteaker, eds. NRTR-91/06.
3. *Annual Report of the National Park Marine Debris Monitoring Program: 1990 Marine Debris Surveys*. David A. Manski, William P. Gregg, C. Andrew Cole, and Daniel V. Richards. NRTR-91/07
4. *1990 Highlights of Natural Resources Management*. Lissa Fox, ed. NRR-91/03.
5. *Designing and Implementing Comprehensive Long-term Inventory and Monitoring Programs for National Park System Lands*. David G. Silsbee and David L. Peterson. NRR-91/04.
6. *White-tailed Deer in Eastern Ecosystems: Implications for Management and Research in National Parks*. William F. Porter. NRR-91/05
7. *Developing a Natural Resource Inventory and Monitoring Program for Visitor Impacts on Recreation Sites: A Procedural Manual*. Jeffrey L. Marion. NRR-91/06
8. *Air Quality Management Plan: A Prototype, Colonial National Historical Park*. Sandra Manter, Charles Rafkind, Erik Hauge, and John Karish. AQD/NRR-91/01.

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