PARK SCIENCE

A Resource Management Bulletin

Volume 13 - Number 4 National Park Service U.S. Department of the Interior **Fall 1993**

Restoration of Estuarine Tidelands In South Slough National Research Reserve

Editors Note: Simply adding water "doth not a wetlands make." The importance of wetlands – their preservation and restoration – is increasingly making itself felt on the national consciousness. In the following article, the problem of restoring an estuarine ecosystem is painstakingly addressed by a formidable group of scientists, willing to acknowledge the long-term nature of any such re-creation. The South Slough project is blazing a remarkably thorough and honest trail in the wetlands restoration wilderness – one that will be of intense interest to NPS site managers with similar problems.

By Steven S. Rumrill and Craig E. Cornu

Once a salt marsh, this area is now largely a neglected pasture with a narrow region of estuarine influence. Steve Rumrill considers mechanisms to accelerate the rate of estuarine recovery.

Estuarine habitats in the Pacific northwest have been functioning at less than full ecological capacity for nearly a century. In most cases, estuarine channels, mudflats, and saltmarshes have been dredged, diked, and drained for timber and agricultural purposes. Research and management staff members at the South Slough National Estuarine Research Reserve (NERR) are working together to reverse the enduring effects of estuarine habitat degradation with a restoration strategy that will accelerate re-establishment of full estuarine wetland functions to a series of neglected agricultural lands.

The Winchester Tidelands are an integral component of the 5,000 acre South Slough National Estuarine Research Reserve located on the southern Oregon coast near Coos Bay. Situated at the Estuarine Turbidity Maximum (ETM) along the western arm of the estuary, the Winchester Tidelands historically consisted of highly productive estuarine channels, mudflats, and salt marshes. The majority of these tidal lands were diked and removed from tidal circulation to promote draining, crop production, and other agricultural uses around the turn of the century. These alterations of the landscape resulted in loss of critical habitat for anadromous fish, migrating waterfowl, shorebirds, invertebrates, and mammals. As a consequence of diking and draining activities, the Winchester Tidelands currently exist as a series of degraded agricultural lands and freshwater drainage channels.

The Winchester Tidelands Restoration Project (WTRP) will remove old earthen dikes and tide gates to restore tidal circulation, eelgrass beds, and native salt marsh vegetation to ca 75 acres of degraded agricultural lands. In addition, the WTRP provides outstanding opportunities to accelerate restoration of estuarine processes to degraded coastal wetlands, and to address important research and educational issues during the course of habitat restoration.

Marsh Subsidence and Invasive Species

Successful restoration of estuarine functions to the WTRP area will require solutions to several significant problems. First, removal of historic marsh lands from tidal inundation has resulted in subsidence of the marsh base to an elevation approximately 1 to 2 feet below normal levels. Marsh elevation is critical to habitat function in tidal marshes because elevation determines the ratio between exposure to air and submergence beneath brackish water. Desirable target marsh plants (e.g. *Juncus balticus*, *Jaumea carnosa*, *Deschampsia caespitosa*) have relatively narrow tolerances for tidal inundation. Since the rate of ambient sediment accretion is slow at 3-4 mm per year, recovery of the WTRP marshes to their original elevations is likely to take 70-100 years or longer. Moreover, the restoration activities will take place within an estuarine landscape that is replete with invasive species.

The initial stages of estuarine wetland recovery are characterized by a transitional period of disturbance that opens the way for invasive exotic plant and animal species to colonize recovering marshes. In addition, tidal waters within the South Slough NERR are inhabited by more than 40 species of non-

Continued on page 4

PARK SCIENCE

NATIONAL PARK SERVICE

FALL 1993

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

ARTICLES

DEPARTMENTS

Editorial

The National Biological Survey: Opening Day

By Dr. F. Eugene Hester

In the last issue [see Summer 1993] I explained the concept behind the creation of the National Biological Survey (NBS), a non-advocacy biological research and inventory agency in the U.S. Department of the Interior. Oct. 1, 1993 is the date scheduled for NBS's opening day. The NBS Implementation Task Force continues to work energetically to ensure the transition is smooth.

Earlier this month, Assistant Interior Secretary for Fish and Wildlife and Parks George Frampton asked me to continue on with NBS after October 1 as Deputy Director. It is an honor I gladly accept.

NBS becoming a bureau on October 1, however, depends on several steps involving the Congress and the Secretary of the Interior.

To date, three NBS authorizing bills have been introduced–two in the Senate and one in the House. None of the bills was voted on by Congress before its summer recess; however, Congressional leaders have been supportive of the NBS, as reflected in the House vote action and Senate Committee mark up of the FY94 NBS budget.

Since budget authority is expected–even if a Continuing Resolution should be operative on October 1–Secretary Babbitt will be able to establish the NBS through a Secretarial Order. While the Secretary is cooperating fully with Congress, authorizing legislation is not required for the new bureau to open its doors.

So what will be the picture on October 1, when NBS formally begins operation? For scientists in universities, research centers, and in the field, the picture will look very familiar. In fact, for most of FY94, the picture may be nearly indistinguishable from the current one. While more than 1,700 employees will be transferred administratively from other Interior bureaus to the NBS, not one person has been identified who will have to undergo a geographical move that would involve a change of residence. Nearly all available positions within the new bureau are expected to be filled through the lateral transfer of employees within programs being moved. We are expecting that it will be a number of months before the Eco-regional Offices are established as well.

It is a rare occurrence in the career of a federal employee to have the opportunity to participate in the creation of a new agency. This is an exciting time for everyone involved in this process, and a promising time for improving our understanding of ecosystems through research, inventory and monitoring, and information transfer.

For some further thoughts on **NBS**, see page 31.

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Fort Clatsop Schedules Wetlands Restoration

By David A. Ek

Fort Clatsop National Memorial is located at the convergence of the Oregon Coast Range and the lower Columbia River estuarine wetland system. Approximately half of the 125.1 acre park is fresh water or estuarine wetland. The other half consists of young to mature coastal spruce/hemlock forest. Historically, the park and surrounding area had been impacted and altered by the creation of dikes and other water diversions, land use conversions to agriculture and industrial developments, and intensive forestry practices.

Management of these forests and wetlands is becoming more difficult, due to increasing development and encroachment--impacting the natural and cultural resources of the park. Park plans include restoring the Memorial's wetlands that were altered by diking projects prior to creation of the park. This complex project will consist of removal of all or part of the dikes, construction of new dikes to prevent flooding of adjacent private lands, removal of part of the existing vegetation, possible lowering of portions of the surface topography, and continuous monitoring throughout.

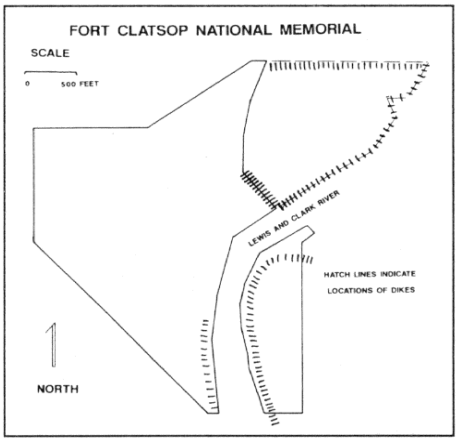
Even if the project is successful and the end result is not an anaerobic quagmire, any such habitat change of this scale will create dramatic changes in the hydrology, soil, flora, fauna (including microbial), and topography (including visual characteristics as well as social perceptions). All of these aspects will need to be carefully addressed in the wetland restoration plan.

An important concern is that large portions of Fort Clatsop NM's wetlands lie beyond the current park boundary. To begin dealing with these and other issues and concerns, the General Management Plan and Resource Management Plan currently are being rewritten. These draft plans identify the need for boundary expansion and Congressional lifting of the Memorial's current 130-acre boundary ceiling.

These plans, along with several inventory and monitoring projects either recently started or proposed for funding, are the first of a long series of steps in the restoration of the important wetlands of Fort Clatsop National Memorial.

Ek is Resource Management Specialist at Fort Clatsop NM.

Park Ranger, Ricardo Perez (right), and Biological Aid, Doug Johnston, along the Lewis and Clark River Estuary of Ft. Clatsop National Memorial.



The solid line represents the boundary to Fort Clatsop National Memorial; the dashed line represents property planned to be donated to the park by the Fort Clatsop Historical Association.

Dollar Value of Wetlands

"...But as far back as 1974, Eugene Odum, director of the University of Georgia's Institute of Ecology, extrapolated the dollar value of seafood resources that wetlands nurtured. He also calculated the worth of the waste assimilation, water purification, and flood control functions marshes performed, and determined that in sum, an average acre of wetlands provided $50,000 a year in goods and services to society."

Edward Flattau,
Columnist

Newspapers of Aug. 11, 1993

"...At issue is funding for the Wetlands Reserve Program [under which] farmers with eligible land can offer to restore it to permanent wetlands status in exchange for a government payment. The program would bring about a host of environmental benefits while dramatically reducing the amount of money in federal disaster aid that the government would have to spend in aid to people whose properties have been destroyed by flooding."

Michael Zimmerman, *Dean*
College of Letters and Science
University of Wisconsin, Oshkosh

native invertebrates. Post-implementation monitoring will track colonization of the recovering marshes by target plant and animal species, and will identify problems posed by the invasive exotics.

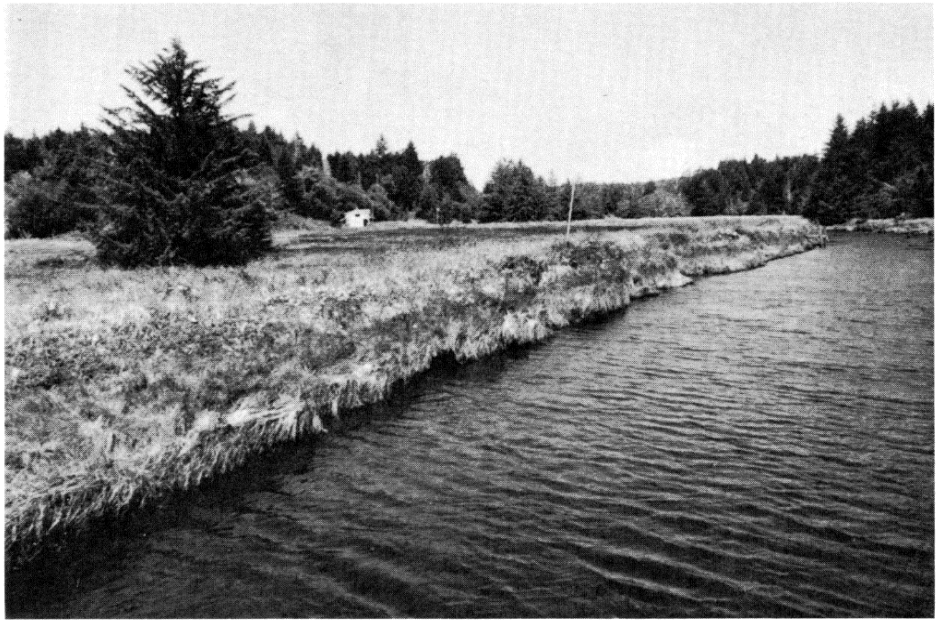
WTRP Advisory Group: Partnerships for Planning

Veterans in the field of estuarine recovery have noted that few, if any, dedicated estuarine habitat restoration projects along the Pacific coast have gone through a comprehensive process including scientific design, implementation, and monitoring. These shortcomings place severe constraints upon the status of the rapidly emerging ecotechnology of restoration science (Zedler, 1986; Simenstad and Thom, 1993).

The WTRP will fill an important gap by making use of an experimental approach to accelerate restoration of estuarine processes. In order to proceed with critical decisions regarding restoration and research within the Winchester Tidelands project marshes, South Slough NERR staff members assembled an advisory group to seek technical expertise on restoration options and development of project protocol. Personnel selected for the group were chosen from nationally recognized experts in the fields of estuarine ecology, botany, hydrology, and habitat restoration, and included members from state and federal agencies, academic institutions,and private industry.

During a workshop held at South Slough NERR and the U/OR Institute of Marine Biology (June 28-30, 1993), the multi-disciplinary team (1) helped articulate project goals and objectives, and (2) contributed to the design of a phased restoration plan for the WTRP.

The primary goal of the WTRP is to carry out restoration activities designed to re-establish estuarine processes within diked modifed habitats encompassed by the Winchester Tidelands Project area. The Advisory Group also established several objectives: **(a) Habitat Function:** restore lost habitat functions to a diversity of regions including salt marshes, mudflats, and tidal channels within the Winchester Tidelands project area, **(b) Research:** conduct empirical research to gain a more complete understanding of the response of natural estuarine processes to the initiation of restoration events, **(c) Education:** provide resource decision makers with guidance and technical information regarding restoration of estuarine habitats, and **(d) Management:** manage the WTRP to emulate a natural system that will require minimal external maintenance.



Aging tide gates (right) allow some tidal flow through the earthen dikes (above) that dominate the Winchester Tidelands landscape. (*Photos by Steve Rumrill*)

Acceleration of Estuarine Recovery

The WTRP Advisory Group considered a series of restoration options, hydrologic constraints, and functional criteria to design a multi-phased implementation plan:

Phase 1. Collection of Baseline Information

Baseline information will be collected from the Winchester Tidelands Project marsh sites, a series of off-site diked and naturally breached marsh sites, and natural (or control) marsh sites located within or adjacent to the South Slough NERR. The baseline survey will include topographic and bathymetric mapping, installation of permanent stream gauges and water quality meters, assessment of historic marsh elevations from peat cores, analysis of aerial photographs, and quantitative field surveys (sediment accretion rates, sediment types, soil salinities and redox potential, plant community composition, utilization by fish and benthic invertebrates).

Phase 2: Active Breach/Passive Restoration

Old dike materials at the Kunz site will be redistributed within the pasture to construct a temporary earth-berm that will separate an existing *Typha* (cattail) marsh from remaining portions of the diked pasture lands. Portions of the old dike will be removed at the location of the historic tidal channel mouth to re-establish tidal connections with the South Slough estuary. These activities will require redistribution of ca 1,200-1,5000 yd^3 of old dike material. Natural processes (tidal inundation, sediment accretion, and successional

Topographic mapping is currently underway (below) at the Kunz site. (*Photo by Steve Rumrill*)

vegetative colonization) will be allowed to continue passively to restore estuarine functions to a 7-acre region. It is expected that full recovery of estuarine processes in this region will require 70 to 100 years.

Phase 3: Active Breach/Experimental Restoration

In an experimental attempt to accelerate marsh recovery, the base elevation of portions of the Kunz site will be raised to re-establish appropriate tidal elevations. Existing dike materials will be redistributed to separate the remaining portions of the site into 3 experimental restoration marshes and a control marsh (approx. 1.7 acres each). The failing Kunz pasture tide gate will be removed and topsoil recovered during removal of the existing Kunz dike will be used to regrade the experimental restoration marshes in a series of 3 basic elevations:

- Control marsh – existing elevations (subsidence to -1.2 ft)
- Experimental marsh #1 – low/mid marsh elevations
- Experimental marsh #2 – mid/high marsh elevations
- Experimental marsh #3 – high transitional marsh elevations

The existing Kunz dike will be breached at four points to allow tidal waters to inundate the control and experimental marshes. These activities will require redistribution of ca 9,000-12,000 yd^3 of old dike material. It is expected that full recovery of estuarine processes will be accelerated within the graded series of experimental marshes and that lost habitat values will be restored after 20-40 years. Complete development of restored marsh structure and function will be monitored over a long-term (>50 yr) monitoring/research program.

Phase 4: Improved Implementation of Restoration Activities

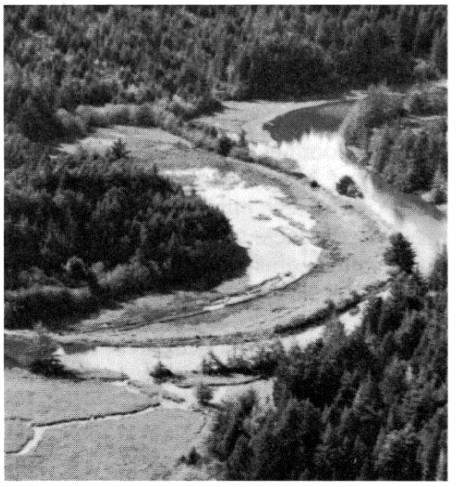
Information derived from the Kunz experimental restoration marshes will be used to help plan and implement restoration of the remaining marshes in the Winchester Tidelands Project Area. Activities carried out during the final phases of implementation will include salvage and stockpiling of existing marsh plants and native eelgrass, eradication of non-native plants (especially Himalayan blackberry and reed-canary grass), construction of multiple training channels to control tidal scour and erosion, and reconstruction of Dalton Creek and Cox Canyon streambeds with gravel bottoms, woody debris, and multiple overhangs to provide habitat for native cutthroat trout and coho salmon. Once these tasks are complete, existing tide gates will be removed from all westside project marshes and portions of existing dikes will be removed or lowered to reintroduce full tidal inundation and flushing.

Phase 5: Monitoring

Recovery of estuarine habitat elements (tidal channels, mudflats, salt marshes) will be monitored following the implementation of restoration procedures. Intensive monitoring will continue for at least 8 years and will focus on the critical evaluation of structural and functional attributes. Evaluation of structural attributes will include assessments

Continued on page 6

Aerial photo of the Kunz site at high tide. Note tidal water within diked area due to failing tide gate. (*Photo by Mike Graybill*)



Bird's eye perspective drawings showing existing (above) and restored (below) conditions at the WTRP sites. (*Drawings by Craig Cornu*)

New Natural Resources Directory Available on Discs

A new Natural Resources directory, in disc form, is now available, providing the latest (and easily updatable) information on all National Park System sites identified by the Regions as having significant natural resource activity (the approximately 250 "I&M" parks). A software manual that comes with the disc describes the system, its rationale, its components, its maintenance, its various uses, and how to submit changes in the system's information as such changes are needed.

The manual is in WP5.1 and contains information on all natural resource-connected personnel by Regions. Abby Miller, Program Coordinator for the NPS Associate Director of Natural Resources, notes that "there are a few missing persons due to nonresponsiveness to requests for information." She further notes that "researchers seem to be disproportionately among the missing."

Field personnel who wish to be listed and have not yet responded may remedy this situation by contacting their Regional Resource Management Chiefs and providing the information needed. Washington Office (WASO) personnel and organizations who are not presently listed may contact Jon Paynter in Miller's office [(202) 208-4640] for inclusion.

The NPS Natural Resource Personnel Directory Software is a dBase III+ data base system (Clipper-compiled) that allows a user to produce the NPS Directory on his or her local PC. The user can run a series of reports, either to the screen or as a hardbopy paper output. Many of the paper reports can be quite lengthy. It is hoped that in most cases the screen reports will provide the needed information, thereby saving paper and space on a shelf.

In addition to running the "canned" reports that come with the software, users are able to create their own formatted reports using the STAFF.DBF file and a copy of dBase III Plus.

Bajada Takes Prize

Bajada, the newsletter produced by CPSU/UA won first runner-up in the category "internal color newsletter" in a nationwide contest sponsored by the weekly publication *Government Computer News* (GCN). Seventy entries, all from government agencies, had been submitted for 12 categories. This is the first time GCN has run this contest, and the results have been reported successful enough to repeat the contest next year. An article reporting the results will appear in the desktop publishing government supplement of GCN September 13.

Interpretive Handout

Napier Shelton of the Washington Office (WASO) Wildlife and Vegetation Division sends word of a "nice little interpretive handout" titled "Forests and Interesting Trees in the National Park System," now available from the WASO Public Inquiries Office in main Interior, (202) 208-4747, (Room 1013), 18th and C Sts. N.W., Washington, DC 20240. The 10-page piece was produced by the Wildlife and Vegetation Division in response to requests from Public Inquiries and was sent also to selected National Parks.

Restoration of Estuarine Tidelands continued from page 5

of tidal circulation, evaluation of marsh vegetation and productivity, composition of infaunal and epibenthic invertebrate communities, and establishment of rates of sediment accretion.

Evaluation of functional attributes will include assessments of hydrologic function and water quality, estimation of food chains support, and development of breeding habitat and forage areas for fish and wildlife. The temporal trajectories of habitat recovery will be identified during the monitoring process, and recommendations for remediation and enhancement will be developed.

Benefits for Coastal Wetland Elements

Construction of dikes and levees has been the most widespread and destructive activity leading to loss of estuarine channels and intertidal marshes in the Pacific northwest (Boule and Bierly, 1987; Frenkel and Morlan, 1991; Simenstad and Thom, 1993). Estuarine wetlands have been identified as temporary residence areas for juvenile salmon, and estuarine channels within South Slough NERR currently support limited populations of Coho, Chinook, Chum, and sea run Cutthroat trout. These anadromous fish are considered sensitive species throughout the southern Oregon coast by the OR Dept. of Fish and Wildlife (UDFW, 1992). The WTRP will provide valuable temporary residence and feeding habitat for juvenile salmon, and will emphasize practical implications for salmon resource management and habitat protection.

In addition to benefits for anadromous fish, restoration of tidal circulation within the Winchester Tidelands also will increase habitats for local populations of threatened plants and migratory shorebirds. The South Slough NERR also provides critical year-round habitat for several sensitive species including Bald Eagles, river otters, black bears, and cougars; habitats within South Slough NERR are used on a temporary basis by Peregrine Falcons, Long-beaked Curlew, and several other migratory shorebirds.

Benefits from the Winchester Tidelands Restoration Project will include documentation of resource benefits and changes in habitat quality that result from tidal restoration. Information developed will be used to guide future estuarine restoration efforts throughout the Pacific nrthwest.

Common Issues and Outreach

Restoration of tidal wetlands during the WTRP will provide an informative example of cooperative wetland conservation, restoration, and management in the Pacific northwest. The South Slough NERR is managed as an estuarine nature preserve and special-use area that is set aside for research and education. South Slough NERR is operated as a partnership between the Oregon Division of State Lands (ODSL) and the National Oceanic and Atmospheric Administration/Sanctuaries and Reserves Division (NOAA/SRD). Successful implementation of the WTRP and identification of effective techniques to accelerate recovery of estuarine habitats and functions will aid in the campaign to restore degraded estuarine tidelands throughout the Pacific northwest.

Rumrill is a Research Scientist and South Slough NERR Research Program Coordinator; Cornu is a Wetland Planner with the Oregon Division of State Lands/South Slough NERR.

References

Boule, M.E. and K.F. Bierly, 1987. History of estuarine wetland development and alteration: what have we wrought? Northwest Environ. Jrnl 3:43-61.

Frenkel, R.E. and J.C. Morlan, 1991. Can we restore our salt marshes? Lessons from the Salmon River, Oregon. Northwest Environ. Jrnl 3:43-61

Oregon Dept. of Fish and Wildlife, 1992. Sensitive Species Listings.

Simenstad, C.A. and R.M. Thom, 1993. Restoring wetland habitats in urbanized Pacific northwest estuaries, pp. 423-472, in Restoring the Nation's Marine Environment (G.W. Thayer, ed.). Maryland Sea Grant, College Park.

Zeller, J.B., 1986. Wetland restoration: trials and errors in ecotechnology, pp. 11-16, in Wetland Functions, Rehabilitation, and Creation in the Pacific Northwest: The State of Our Understanding (R. Strickland, ed.) WA Dept.Ecol.Publ.#86-14, Olympia. 184 pp.

Al Lovaas: 1953-1993 – A Professional Obituary

By Ross Kavanagh

In April of this year the NPS Alaska Region lost, through retirement, a highly valued employee, a hardy stump of a Regional Chief Scientist/Chief, Natural Resources Division with deep roots in the fields of wildlife management and ecological research. Though professionally dead, Al Lovaas, with his less cranky half, Nancy, is physically alive, well, and well watered in his new home in Hot Springs, SD, and is even said to be growing a few inches.

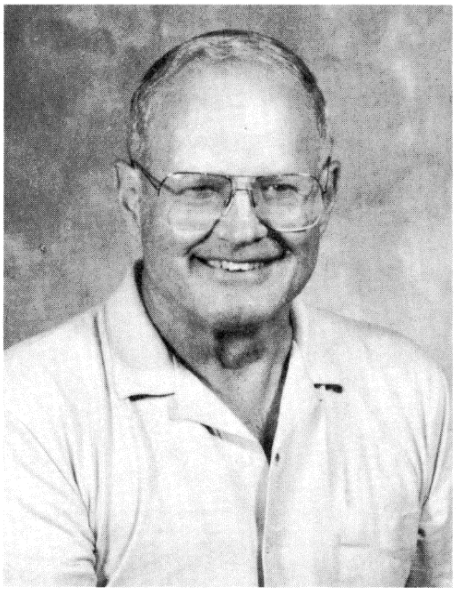
His long and distinguished 40-year career is worth at least a brief review: 1953–Graduated SD State U, BS in wildlife management; 1953-55–U.S. Army, tour in Germany; 1957–Graduated MT State U, MS in wildlife management; 1957-59, Wildlife Biologist, MT Dept. of Fish and Game; 1960-61–Mammalogist, Canadian Wildlife Serv., Edmonton, Alberta; 1962-63–Research Biologist, MT Dept. of Fish and Game, Gallatin Canyon, working on joint elk project funded by USFS, NPS, and MT Dpt of F&G; 1964-65–District Game Manager, MT Dpt of F&G, Great Falls, MT; 1966-70–Regional Biologist, NPS Midwest Reg., Omaha, NE; 1970-75–Research Biologist, Wind Cave NP, SD; 1975-80–Regional Chief Scientist, NPS Midwest Region, Omaha; 1981-93–Regional Chief Scientist/Chief, Natural Resources Div., NPS Alaska Region, Anchorage.

Al was a popular employee in the Alaska Region and won a certain renown as an occasional writer for Park Science. Whenever he had an article printed in Park Science, the editor could always look forward to frantic letters to the editor immediately afterwards.

Al never aspired to every new-fangled computer contraption for his personal office. He was often found, pencil poised over yellow legal pad, solemnly regarding his electric pencil sharpener as the epitome of high technology. (He was often heard to say "Computers are but a passing fad.")

What He Stood For

Al was particularly interested in improving human resource management within the NPS. He was a strong advocate of professionalism, including the creation, upgrading, and/or redescription of professional resource management/research positions, and revision of selection criteria and prerequisite training for new superintendents and other new top NPS managers. In effect, Al championed change within the NPS.



Letter from Lovaas

August 4, 1993

...Would you believe I haven't garnered even one eagle yet? Only a couple of birds...but sure lots of bogies and double (and higher) bogies, plus a few pars. My excuse is I hardly golfed at all during my 12 Alaskan years. Have bought a sailboat and ordered a new outboard for my Boston Whaler fishing boat. I'm finding that playing is almost as much work as working!

I've fallen in with some evil 70-year-old companions and we golf every weekday morning. Yesterday I lost 70 cents but today I made 40 cents. Got to start keeping track for IRS purposes. Course, today I paid for the coffee (30 cents).

(Excerpt from a letter to the editor.)

A man with high, positive standards always has similarly strong dislikes and Al was no exception.

His Gripes

Employee attitudes were important to him. His pet peeve, at least in the early days of post-ANILCA (Alaska National Interest Lands Conservation Act) Alaska, was NPS employees who ignored mandates of Congress because they didn't agree with them. These employees felt that sport hunting in Alaskan preserves and subsistence hunting in new Alaskan parks, preserves, and monuments was inappropriate and that hunters were less than highly valued visitors to NPS-managed lands. He felt that those NPS employees should try to change the law and transfer to areas where hunting is prohibited, but should willingly carry out congressional mandates. To him, that was the mark of a true professional.

His Pleasures and Irritations

While in Alaska, a point of satisfaction for Al was his role in solidifying relationships with the Alaska Department of Fish and Game. In addition, he was most proud of the world-class wolf and caribou research done by Layne Adams and crew (begun by Frank Singer), an ambitious effort to elucidate the workings of a truly natural ecosystem.

Al felt that better understanding of these workings can have immense implications for NPS resource management everywhere, with wolves present or in their absence, often for many years. To have some NPS employees scoff at the value of such research and oppose its long-term funding was personally irritating–even demoralizing to him. Al argued that as predators at the top of the food chain, wolves directly or indirectly affect entire ecosystems, including vegetation, soil, water, fish, and birds as well as their mammalian prey species.

His Integrity

Al will be sorely missed in the Alaska Region (for at least a year or two). He once commented to me that a past Regional Director told him he could always be counted upon for totally honest advice and recommendations uncolored by what he thought the Regional Director wanted to hear. To me, that statement best describes Al and his professional career, and has since become one of the key standards I strive to apply to my own career.

Although he received letters of appreciation during his career, interestingly enough Al, with his direct, sometimes blunt approach, never received any special awards or financial bonuses from management during his 28 year sojourn with the NPS. Those who know him well do not wonder why.

Have a great retirement Al, and we all wish you the best!

Kavanagh is Regional Fishery Biologist at the Alaska Regional Office.

Andrew Blaustein and Deanna Olson (of the U.S. Forest Service) conducting their yearly census of toads in the central Cascade Range of Oregon.

Declining Amphibian Populations in Perspective

By Andrew R. Blaustein

The National Science Board (1989) recently concluded that an ongoing and unprecedented loss of the variety and numbers of species around the world exists. Indeed, members of all taxa are affected. As part of this overall "biodiversity crisis" there have been numerous recent reports suggesting that the populations of amphibian species in a wide array of geographic regions and habitats apparently have declined or have experienced range reductions (e.g. reviewed by Barinaga 1990; Blaustein and Wake 1990; Phillips 1990).

Disappearance of frogs, toads, and salamanders have been reported on all continents where amphibians are found. Some species have become extremely rare and others recently may have gone extinct. For example, the golden toad (*Bufo periglenes*) from Costa Rica was abundant as recently as 1987 and has become extremely rare since then (Crump et al. 1992). The gastric brooding frog (*Rheobatrachus silus*) from Australia has not been seen since 1979 (Tyler 1991).

However, not all amphibian species are in decline and there are species whose populations seem to be persistent in the same areas where populations are declining. Moreover, most of the reports on declining amphibian populations are based primarily on anecdotal information. The lack of long-term data regarding amphibian populations makes it difficult to assess the overall significance of these reports. Below, I briefly summarize some of the major issues concerning the amphibian decline problem.

Ecological Importance of Amphibians

Amphibians are integral components of many ecosystems and they may constitute the highest fraction of vertebrate biomass in certain ecosystems (e.g. Burton and Likens 1975). Because of the important contribution of amphibians to trophic dynamics in a variety of communities, a decline in their numbers could have important impacts on other organisms. Adult amphibians play major carnivore roles in many systems and serve as prey in others (Duellman and Trueb 1986); larval amphibians can be important

predators and herbivores as well as prey (Duellman and Trueb 1986) in aquatic habitats.

Moreover, amphibians may serve as good bioindicators of environmental stress (1) due to their permeable skin that readily absorbs toxic substances, (2) because they are not protected by hair or feathers, (3) because their eggs are not encased in hard shells, and (4) because many species may come in contact with both terrestrial and aquatic stresses due to their complex life cycles.

Long-term Studies

There have been few studies where amphibian populations were sampled at least once per year on a long-term basis. Of those long-term studies that have been conducted, some show populations that are in decline, whizle others do not. Two long-term studies from Europe have documented declines. Semb-Johansson's (1989) study of common toads (*Bufo bufo*) on islands off the Norwegian coast is one of the best examples of a long-term population study of an amphibian. Toads were monitored for 24 years (1966 to 1989). Their numbers declined dramatically from 1966-1975 and have remained low. Beebee et al. (1990) have documented the decline of the natterjack toad (*Bufo calimata*) in Great Britain over a 20 year period.

Studies in the U.S. show different population dynamics in different regions. Corn and Fogleman's (1984) study documented the local extinction of leopard frogs (*Rana pipiens*) in Colorado across a number of sites. In this study, six populations of *R. pipiens* were examined for 10 years (1973-1982). Reproductive failure was seen in 1973 at one site and by 1981 no *R. pipiens* were seen at any site. *Rana pipiens* was absent from the area at the end of the study.

Kagarise Sherman and Morton (1993) documented the population changes over 20 years in *Bufo canorus* at Tioga Pass, California. Comprehensive surveys of breeding aggregations were made from 1971-1982 and less systematic observations were taken from 1983 to 1991 at Tioga Pass. Six additional populations in northern Calfornia also were monitored from 1973-1990. At the largest breeding pools at Tioga Pass, the populations declined about 9-fold from 1974-1982. The mean number of toads found in daily searches also declined during the 20 year period. Similar declines at the other sites were reported.

A 14 year study by Jaeger (1980) in Virginia suggests that the Shenandoah salamander (*Plethodon shenandoah*) has been declining probably due to competition with *P. cinereus* whose populations are relatively rare.

Pechmann et al. (1991) monitored the breeding population sizes of four amphibian species at one site in South Carolina for 12 years. They showed that the populations of three species fluctuated and one species increased over that time span.

In addition to the subjects of the the long-term studies cited above, populations of other amphibian species have disappeared from portions of their historical ranges (without concomitant shifts in their ranges) and have failed to reestablish at such sites for periods longer than their estimated maximum life span. For example, this has occurred in several species in western North America, including the Cascades (*Rana cascadae*), Red-legged (*R. aurora*), and western-spotted (*R. pretiosa*) frogs and the western toad (*Bufo boreas*). In addition, the eggs of several of these species have experienced unusually high mortality in recent years (Blaustein et al. 1993). In the same region as these species, populations of the Pacific treefrog (*Hyla regilla*) seem to be persistent.

Causes

Habitat destruction and habitat alteration probably are the major causes for decline in amphibian populations. However, due to lack of long-term data it is difficult to distinguish between human-induced causes and natural population fluctuations. For example, very little is known about the population dynamics of golden toads and gastric brooding frogs, so it is possible they may be in dormancy and may again be common when conditions are better.

The author (Andrew Blaustein) holding a device that filters out ultraviolet light. The filters are placed over developing eggs in experiments investigating the role of ultraviolet radiation on amphiban declines.

Besides overt habitat destruction and natural population fluctuations, other proposed causes include introduction of exotic species such as fish and bullfrogs, disease, ultraviolet radiation, and acidification. Most of these hypothetical explanations have not been examined experimentally.

In the Pacific Northwest, where there have been range reductions in a number of species, unusual egg mortality, and disappearances of large numbers of tadpoles, we are continuing to accumulate long-term population data at a variety of sites for a number of species. We also are investigating the role of pathogens and ultraviolet radiation in the declines of several species of amphibians from Oregon.

Blaustein is a professor in the Department of Zoology, Oregon State University, Corvallis, and co-chair of the Pacific Northwest section of the IUCN's Declining Amphibian Populations Task Force.

Literature Cited

Barinaga, M. 1990. Where have all the froggies gone? Science 247:1033-1034.

Beebee, T.J.C., R.J. Flower, A.C. Stevenson, S.T. Patrick, P.G. Appleby, C.Fletcher, C. Marsh, J. Natkansi, B. Rippey, and R.W. Battarbee. 1990. Decline of the Natterjack toad *Bufo calamita* in Britain: Paleoecological, documentary and experimental evidence for breeding site acidification. Biological Conservation 53:1-20.

Blaustein, A.R., D.G. Hokit, R.K. O'Hara, and R.A. Holt. 1993. Pathogenic fungus contributes to amphibian losses in the Pacific Northwest. Biological Conservation. In Press.

Blaustein, A.R. and D.B. Wake. 1990. Declining amphibian populations: A global phenomenon? Trends in Ecology and Evolution 5:203-204.

Burton, T.M. and G.E. Likens. 1975. Salamander populations and biomass in the Hubbard Brook experimental forest, New Hampshire. Copeia 1975:541-546.

Corn, P.S. and J.C. Fogelman. 1984. Extinction of montane populations of the northern leopard frog (*Rana pipiens*) in Colorado. Journal of Herpetology 18:147-152.

Crump, M.L., F.R. Hensley, and K.L. Clark. 1992. Apparent decline of the golden toad: Underground or extinct? Copeia 1992:413-420.

Duellman, W.E. and L. Trueb. 1986. Biology of Amphibians. McGraw-Hill, New York.

Jaeger, R.G. 1980. Density-dependent and density-independent causes of extinction of a salamander population. Evolution 34:617-621.

Kagarise Sherman, C. and M.L. Morton. 1993. Population declines of Yosemite toads in the eastern Sierra Nevada of California. Journal of Herpetology 27:186-198.

National Science Board. 1989. Loss of Biological Diversity: A Global Crisis Requiring International Solutions. Report NSB-89-171. National Science Foundation, Washington, DC.

Pechmann, J.H.K., D.E. Scott, R.D.Semlitsch, J.P. Caldwell, L.J. Vitt, and W. Gibbons. 1991. Declining amphibian populations: The Problem of separating human impacts from natural populations. Science 253:892-895.

Phillips, K. 1990. Where have all the frogs and toads gone? BioScience 40:422-424.

Semb-Johansson, A. 1989. Padden (*Bufo bufo*)-Et stebarn inorsk zoologi. Fauna 42:174-179.

Tyler, M.J. 1991. Declining amphibian populations - a global phemomenon? An Australian perspective. Alytes 9:43-50.

Status of Amphibians in Arizona

By Cecil R. Schwalbe

As in many other parts of the world, Arizona has seen declines in populations of some of its amphibians. And as Andy Blaustein indicates, lack of long-term data makes it difficult to differentiate human-induced causes from natural population cycles. Native ranid frogs [specifically the Tarahumara frog (*Rana tarahumarae*), northern leopard (*R. pipiens*), and Chiricahua leopard (*R. chiricahuensis*) frogs] seem to have suffered greater declines than other frog and toad species (Hale and Jarchow 1988, Clarkson and Rorabaugh 1989).

The last Tarhumara frogs seen in the United States were found dead in the Santa Rita Mountains in 1983. Populations of Chiricahua and lowland (*R. vavapaiensis*) leopard frogs cohabiting with Tarahumara frogs also declined but were not extirpated; canyon tree frogs (*Hyla arenicolor*) and red-spotted toads (*Bufo punctatus*) living there seemed unaffected by whatever caused the ranid reductions (Hale and Jarchow 1988).

While there is concern that the numbers of individuals in some breeding aggregations of desert anurans such as Sonoran green (*Bufo retiformis*), Sonoran Desert (*B. alvarius*), and Great Plains (*B. cognatus*) toads, burrowing tree frogs (*Pternohyla fodiens*), and desert spadefoots (*Scaphiopus couchi*) have declined, large numbers of local extirpations have not been documented. Long-term monitoring programs are needed, for both anurans and tiger salamanders, Arizona's only tailed amphibian.

Wetland habitat loss and degradation probably are responsible for most declines and extirpations of historical anuran populations in Arizona; however, conclusive data are lacking. Declines in some frog populations have been correlated with the introduction of exotic predators such as game fish, bullfrogs, and crayfish (Hayes and Jennings 1986, Schwalbe and Rosen 1988, Schwalbe and Rosen unpublished data). We also are testing the interaction of pathogens and ultraviolet light on some anurans, (suspected causes in the extirpation of the Tarahumara frog from the U.S.). Our preliminary data indicate that the true frogs (family Ranidae) may prove to be the most sensitive vertebrate indicators of air quality.

Because of the scarcity and fragility of wetlands in the desert Southwest, resource managers here are concerned about the health of these wetland ecosystems. The AZ Game and Fish Dept., AZ Nature Conservancy, NPS, USFWS, and USFS are conducting surveys of and working to establish monitoring programs for wetland biota, including amphibians, in Arizona. Cooperative research and management programs also are being pursued between agencies and institutions in the U.S. and in Mexico for sensitive wetlands and their components. Long-term studies of populations, coupled with directed experimental research, are necessary if we are to separate out human-induced causes of declines from normal population fluctuations.

Schwalbe is a Research Ecologist with the NPS Cooperative Park Studies Unit (CPSU) at U/AZ.

Literature Cited

Clarkson, R.W. and J.C. Rorabaugh. 1989. Status of leopard frogs (*Rana pipiens* complex: Ranidae) in Arizona and southeastern California. Southwestern Naturalist 34:531-538.

Hale, S.F., and J.L. Jarchow. 1988. The status of the Tarahumara frog (*Rana terahumarae*) in the U.S. and Mexico: Part II). Unpub. report to AZ Game and Fish Dept., Phoenix, and Off. of Endangered Species, USFWS, Albuquerque, NM, 83 p.

Hayes, M.P. and M.R. Jennings. 1986. Decline of ranid frog species in western North America: Are bullfrogs (*Rana catesbeiana*) responsible? J. Herpetol. 20:490-5009.

Schwalbe, C.R., and P.C. Rosen. 1988. Preliminary report on effect of bullfrogs on wetland harpetofaunas in southeastern Arizona. p. 166-173. IN Proc. of symposium on management of amphibians, reptiles, and small mammals in North America. July 19-21, 1988, Flagstaff, AZ. USFS General Tech. Rpt RM-166. 458 p.

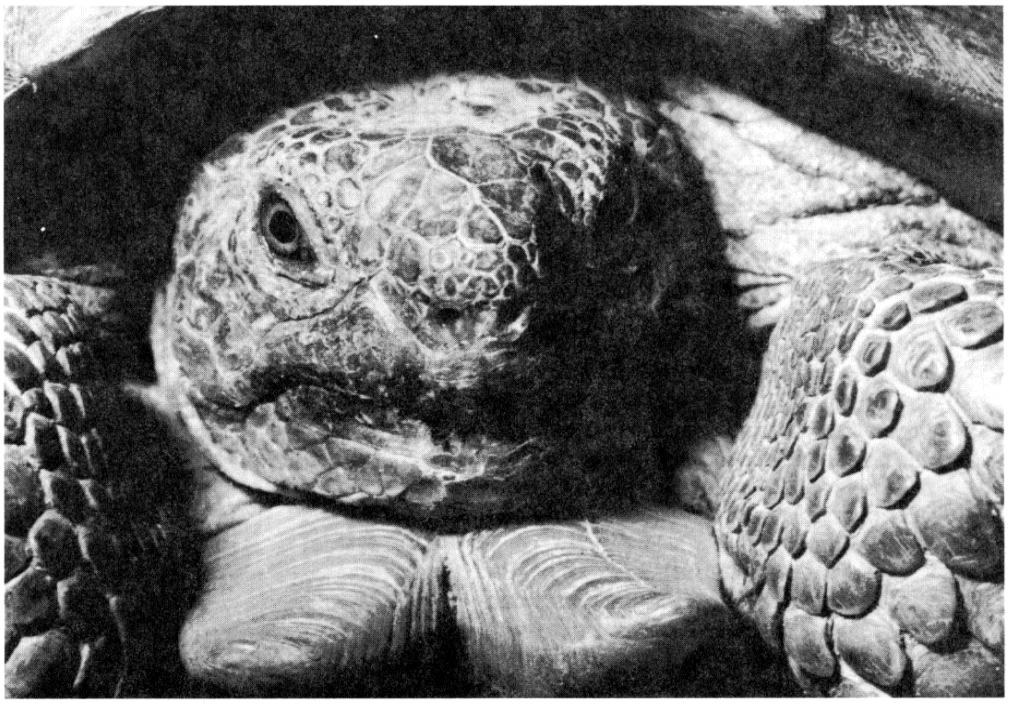
Amphibian Decline on the Colorado Plateau

The Cooperative Park Studies Unit at Northern Arizona University (CPSU/NAU) is collecting information to help address the question of amphibian decline on the Colorado Plateau. CPSU biologists are conducting inventory and assessment of reptile and amphibian communities at Montezuma Castle National Monument (MOCA) and a survey of leopard frogs in Glen Canyon NRA (GLCA). They are compiling these data in conjunction with information previously obtained by the CPSU on historical occurrence of these species in other Colorado Plateau national parks and monuments.

The CPSU survey of the herpetofaunal community at MOCA began in December 1992, and is part of the NPS Natural Resources Protection and Preservation Program. Sso far, three amphibian species have been found; two appear to have stable breeding populations: Woodhouse's toad (*Bufo woodhousei*) and Canyon treefrog (*Hyla arenicolor*). The third species is the non-native bullfrog (*Rana catesbeiana*). The impact of these introduced predators on the local amphibian community is not yet known.

Continued on page 11

Sonoran Desert Tortoise. (*Photo by Cecil Schwalbe*)



Amphibian continued from page 10

Nine additional amphibian species have occurred in the Verde Valley historically or have ranges that include MOCA but have not yet been found. Of these, (the tiger salamander, Southwestern toad, Great Plains toad, red-spotted toad, Sonoran Desert toad, Southern Spadefoot, possibly Northern leopard frog, Lowland leopard frog, and the Chiricahua leopard frog), the Chiricahua frog and the tiger salamander are listed by Arizona as threatened species and the Northern leopard frog is a candidate species for listing.

The CPSU also is conducting a leopard frog survey in GLCA along the Colorado River corridor below Glen Canyon dam. Leopard frogs first were found in this area in 1992 by GLCA Resource Management Division and CPSU/NAU staff. In a follow-up survey in early June 1993, biologists from these units found an isolated but stable breeding population of Northern leopard frogs, located in a natural spring and run-off area not contiguous with the Colorado River under existing water flow regimens from the dam. The water in the breeding pools is warmer than that of the adjacent river, and no predatory fish were found. These factors undoubtedly have allowed this leopard frog population to remain healthy despite dramatic changes in temperature and flow of the Colorado River. No satellite populations of dispersed leopard frogs have been found to date, but an additional survey will be conducted later this year.

The CPSU will continue efforts to gather information on amphibian populations on the Colorado Plateau, including analysis of existing information in park inventory and monitoring databases, and coordination with other agencies, including the two regional working groups of the IUCN/SSC's Declining Amphibian Populations Task Force.

CPSU biologists will continue the Montezuma Castle inventory and monitoring program until 1995; will conduct additional surveys for leopard frogs in the Grand Canyon area; and will be compiling information on the historical distribution of regional amphibian species. The CPSU welcomes any information about amphibian populations on the Colorado Plateau and in return will provide information and assistance for implementation of I&M programs to interested managers.

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Can We Afford Biodiversity?

In view of the National Park Service's preservation mandate, the question of whether or not we can afford biodiversity may appear to be rhetorical. But as scientists learn more and more about the habitat requirements of the myriad species still extant in North America, the cost of maintaining species richness–beginning today and extending into the unforeseeable future–mounts to confounding proportions. Mounting political resistance and shrinking preservation budgets may have a lot to do with how the emerging controversy plays itself out.

The June 25, 1993 issue of *Science* devotes its News & Comment section to a piece entitled "The High Cost of Biodiversity." Its authors, Charles C. Mann and Mark L. Plummer, describe the plan to protect North American biodiversity that emerged from the seventh annual meeting of the Society for Conservation Biology, held June 11 at Arizona State University in Tempe. This dramatic proposal, labeled the Wildlands Project, calls for nothing less than the resettling of the entire continent–"the most ambitious proposal for land management since the Louisiana Purchase of 1803."

Even the dedicated faithful ("a mix of Oxford cloth and Birkenstocks, with a preponderance of male facial hair") greeted the design with gasps. It calls for a network of wilderness reserves, human buffer zones, and wildlife corridors stretching across hundreds of millions of acres--as much as half of the continent. The long-term goal of the Wildlands Project is the transformation of the United States "from a place where 4.7% of the land is wilderness to an archipelago of human-inhabited islands surrounded by natural areas."

Ecologist Reed F. Noss, editor of *Conservation Biology* and one of the plan's architects, called it "a vision of what this continent might look like in 200 years if we can reduce the scale of human acitivities."

Wild as the notion may seem, Mann and Plummer report that the principles behind it have been endorsed by scientists of stature including Edward O. Wilson of Harvard, Paul Ehrlich of Stanford, and Michael Soule of the University of California, Santa Cruz, who view the approach as the logical follow-up to the reserve design underlying the proposed Northwest spotted owl reserves. One prominent ecologist who asked not to be named acknowledged that the plan "seems nuts," but added that when you think about it, it is more or less where the science is pointing.

The color maps that accompany the *Science* article show how the plan would affect coastal Oregon and Florida. Color coding shows core areas, corridors, and buffer zones that would protect not just spotted owls (in Oregon) and panthers (in Florida) but a host of other species–from charismatic to microscopic.

The article explores the controversy surrounding the concept of corridors, questioning their efficacy on the one hand (data is scanty as to their actual use) and proposing on the other hand that relatively little use "may be enough" if one or two individuals a decade manage to migrate and add new genes to a stagnant pool.

NPS ecologist Craig Shafer, author of **Nature Reserves: Island Theory and Conservation Practice**, is quoted as having some doubts about the numbers on which the Wildlands plan is based, but as contending that the whole package–core reserves, buffer zones, and corridors–is needed for complete protection. "For every line of analysis," Shaffer said, "the weather vane is pointing in the same direction ... toward needing a network in the landscape."

Deborah Jensen, the Nature Consevancy's director of conservation science, commented "drily" that "this whole business about wildness being fierce is a male thing" and disagreed with the plan's decision to begin with present wilderness areas ("often species-poor") instead of focussing on areas of maximum biodiversity and preserving those first.

Mann and Plummer spent one paragraph alluding to the hue and cry that would inevitably go up if the plan were to be sprung as a whole on the political scene. Dave Redmond, press secretary to Rep. Bob Smith (R-Or), who has introduced legislation to scale back the Endangered Species Act, warned that "the people who would be impacted by such reserves are absolutely terrified by them." Politically, Redmond said, the plan "is just undoable." If such a plan is the only way to preserve biodiversity, then said Redmond, some biodiversity will have to go. "That is what we are facing."

Jean Matthews, *Editor*

Paleoecology of Late Triassic Metoposaurid Amphibians: Evidence from Petrified Forest National Park

By Adrian P. Hunt, Vincent L. Santucci and William P. Wall

The Late Triassic (235 to 208 million years ago) was a time of major change in the terrestrial ecosystem. Archaic animals, that had dominated the land during the Late Paleozoic and earlier Triassic (e.g. therapsids, temnospondyls), dwindled or became extinct and the major groups preeminent in the later Mesozoic and Tertiary (e.g. dinosaurs, mammals, pterosaurs) evolved and diversified. In North America, the last of the temnospondyl amphibians are members of the family Metoposauridae (Figure 1). The paleoecology of this family has received little study.

One of the best places to study the paleoecology of metoposaurids is at Petrified Forest NP (PEFO). Abundant specimens collected in the park can be studied to determine the paleoecological context of these ancient amphibians. Metoposaurids at PEFO are found in the Blue Mesa (lower) and the Painted Desert (upper) members of the Petrified Forest Formation.

Buettneria perfecta is a large species (2 meters long) with deep otic notches, a lacrimal that borders the orbit and short intercentra. *Apachesaurus gregorii* is a small species (less than 1 meter long) with shallow otic notches and elongate intercentra. *Buettneria* is common in the lower stratigraphic sections of the park and becomes rarer in the upper member, whereas *Apachesaurus* is rare in the lower member and is relatively more common in the upper member.

Paleoecologic information regarding the Late Triassic metoposaurs is derived from three primary sources: sedimentology of the deposits in which metoposaurs are preserved; morphological characteristics; and taphonomic associations with other fossil remains. Evaluation of the data available from these three sources suggest that *Apachesaurus* probably was more terrestrial than *Buettneria*.

The sedimentary deposits containing *Apachesaurus* vary considerably from those sediments in which *Buettneria* remains are preserved. *Buettneria* occurs predominately in near stream facies. Those depositional environments include fluvial overbank and lacustrine deposits. *Apachesaurus* occurs frequently in more terrestrial sediments formed as distal floodplain deposits. Paleosol (fossil soil) analysis provides supporting data associating wetter near-stream facies and drier terrestrial facies.

Comparing the morphology of these two metoposaurs reveals a number of differences that indicate *Apachesaurus* was more terrestrial than *Buettneria*. First, the deeper acetabulum (pelvis) of *Apachesaurus* provided a more effective transmission of hindlimb force, which is important for terrestrial locomotion. Second, the vertebrae of *Apachesaurus* are elongate compared to other metoposaurs. This elongation, coupled with a possible reduction in number of vertebrae, would have given this animal a rigid backbone. This pattern is characteristic of terrestrial vertebrates where weight support is necessary. Third, the lateral line system (pressure receptors sensitive to vibrations in water) is reduced in *Apachesaurus* compared to *Beuttneria*. Cranial and dental characteristics, however, indicate that *Apachesaurus* probably was an aquatic feeder. The low cranial profile is suited to rapid jaw closure, but the jaw muscles could not have generated much force after closure. This feeding pattern is characteristic of fish-eaters. Homodont dentition, as seen in *Apachesaurus* and other metoposaurs, also is commonly associated with fish-eating.

The taphonomic associations which co-occur with *Buettneria* are predominantly composed of semiaquatic and aquatic fauna (phytosaurs, lungfish). *Apachesaurus* often is found in association with more terrestrial assemblages of vertebrates (dinosaurs, rauisuchians, sphenosuchians). These associated fossil forms provide additional information on the paleoecology of these ancient amphibians.

The Petrified Forest metoposaurs provide useful information for interpreting the Late Triassic environment in this region. The oldest strata in the park were laid down during wet periods resulting in larger lacustrine and fluvial systems. This environment provided *Buettneria* with suitable open water habitat to accommodate a highly aquatic, large-size amphibian. The younger strata in the park indicate a drier environment with more restricted shallow pools of water. The morphological characteristics of *Apachesaurus* were better adapted for movement over land in this drier and more patchy environment.

Hunt is a professor of geology at U/CO, Denver; Santucci is a paleontologist and curator at Petrified Forest NP; Wall is a professor of biology at Georgia College, Milledgeville, GA.

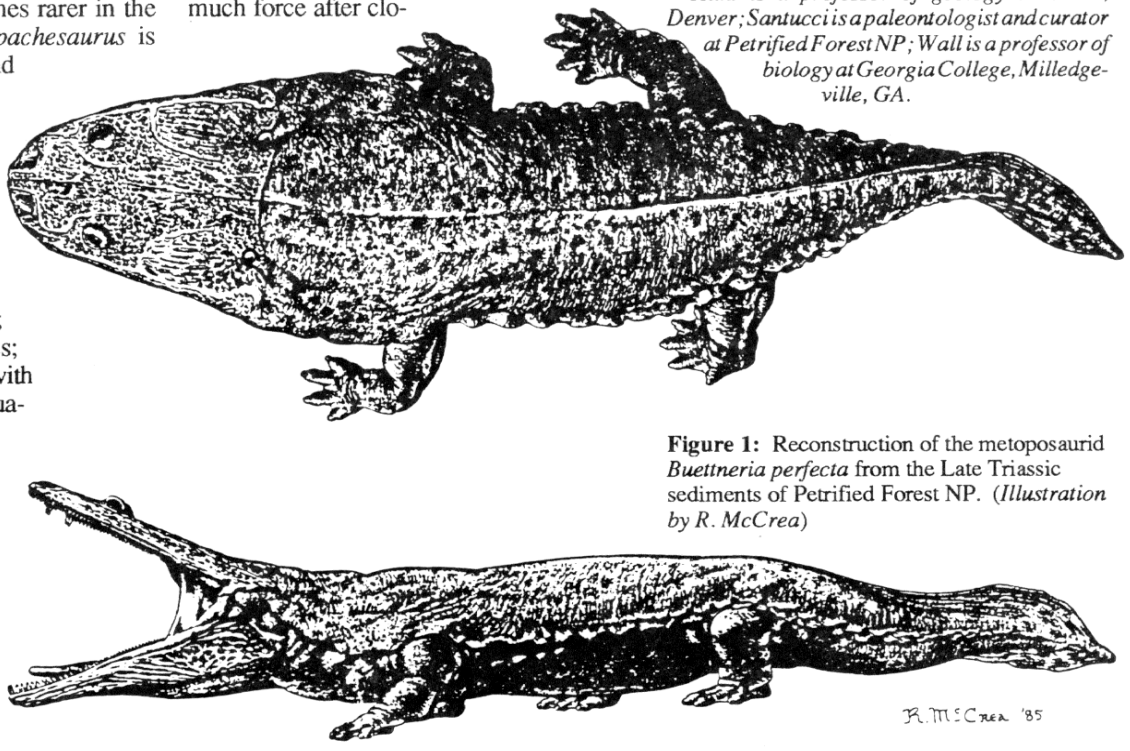

Figure 1: Reconstruction of the metoposaurid *Buettneria perfecta* from the Late Triassic sediments of Petrified Forest NP. (*Illustration by R. McCrea*)

New Fossil Mammals Found at Florissant Fossil Beds NM

By Emmett Evanoff and Peter M. de Toledo

New discoveries of fossil mammals in Florissant Fossil Beds National Monument (NM) indicate that the Florissant Formation is late Eocene in age, and correlates with the Chadrom Formation in Badlands NP.

Fossil mammals are rare in the Florissant Formation and have been somewhat ambiguous age indicators. Previous to the recent discoveries, mammals from the Florissant Formation have included oreodons (*Merycoidodon*), a horse (*Mesohippus*), a mouse opossum (*Peratherium*), and an unidentified rhinoceros. Of these specimens, only the mouse opossum (*Peratherium* near *P. huntii* (Cope)) has been described in detail (Gasin, 1935). These mammals indicate a Chadronian or Orellan North American Land Mammal Age for the formation. The Chadronian and Orellan are now considered to be latest Eocene and earliest Oligocene age, respectively.

In June and July of 1992, a field crew from the University of Colorado Museum found fossil mammal bones, including a piece of a neck vertebra from a large brontothere, a lower jaw of a *Mesohippus* (Fig. 1), bone fragments from an oreodon-sized animal, and bone fragments and isolated teeth from a small artiodactyl. These fossils occurred in sandstones lateral to the main lake shales and fluvial mudstones below the level of the fossil stumps.

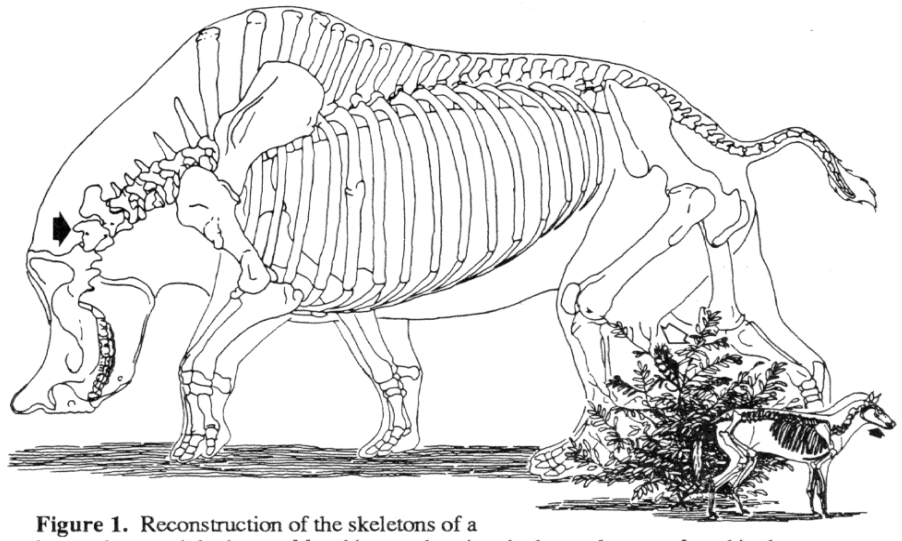

Figure 1. Reconstruction of the skeletons of a brontothere and the horse, *Mesohippus*, showing the bone elements found in the summer of 1992 (arrows) at Florissant Fossil Beds National Monument. Also shown is a mouse opossum in the bush (open arrow). The skeletons are drawn to the same scale, with the bush representing a height of 1 meter.

The co-occurrence of a brontothere, *Mesohippus*, and *Merycoidodon* indicates that the Florissant Formation was deposited at the same time as the Chadron Formation of Badlands NP. The Florissant vertebrate fauna also include fossils of fish and birds, and together they may supplement paleoenvironmental data provided by the plant and insect fossils.

Evanoff and de Toledo are with the University of Colorado Museum, Boulder, CO, 80309-0315.

Literature Cited

Gazin, C.L., 1935. A marsupial from the Florissant beds (Tertiary) of Colorado: Journal of Paleontology, v.9, p 57-62.

5th Wilderness Conference Addresses Changing Picture

The 5th Annual Interagency Wilderness Conference was held May 17-21 in Tucson, AZ, with 268 persons from NPS, FWS, BLM, USFS, and numerous universities, attending. The program addressed three major themes: (1) Wilderness Restoration: Use of minimum tools in revegetation, (2) Managing Wilderness, Cultural Resources, and Cultural Diversity, and (3) Emerging Challenges: Adjacent land uses, day use, outfitters, and access for the disabled.

A pair of plenary speakers addressed each theme. Thought and dialogue about wilderness restoration focused on the minimum tools necessary to accomplish reintroduction of extirpated plants and removal of alien species. The need for and lack of comprehensive inventory and monitoring efforts in daily wilderness management programs surfaced repeatedly. One of the most widely-attended sessions depicted the strong role trail maintenance staff can have in revegation activities, as well as reducing original losses of vegetative cover and soil.

Gary Machlis, (CPSU/U/ID) asserted that viability of the wilderness concept may wane as demographic, social, and political change sweeps the country. This was underscored by Hal Salwasser (U/MT-Missoula), who predicted that wilderness managers who view their role as merely stewards of dynamic ecosystems may be overlooking important actions necessary to manage or restore spiritual, religious, economic, subsistence, social, or cultural values.

A conference handbook with the 70+ papers presented is available upon request from Resource Management Specialist/Wilderness Forester Alan Schmierer via FAX 415-744-3932 or cc:mail.

Alan Schmierer,
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1993 Interagency Wilderness
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ISSN-0735-9462

This five-toed track produced by a small lizard-like animal was among the first of the vertebrate tracks to be discovered in the park.

Late Triassic Vertebrate Tracks Discovered at Petrified Forest NP

By Vincent L. Santucci and Adrian Hunt

Fossilized tracks of Late Triassic reptiles were discovered in April 1993 at Petrified Forest NP. Although paleontological field work has been conducted in the Chinle Group of Arizona since the turn of the century, these are the first fossil vertebrate tracks discovered. The presence of fossil tracks in association with fossilized bone brings us closer to identifying tracks with track-makers.

Two different track types have been identified in 220-million year old channel sandstone blocks. The sandstone unit represents a shallow stream with episodic flow that meandered across a broad plain. Tiny five-toed tracks called *Rhynchosauroides*, produced by a small, lizard-like animal, were the first vertebrate tracks to be discovered in the park. This fossil vertebrate track type is known from rocks in New Mexico, Utah, and Colorado. A swimming trace of a larger reptile, possibly a phytosaur, was located during a secondary survey. This trace preserves scrape marks where the reptile claws scratched the substrate.

Fossil invertebrate tracks, trails, burrows, and other traces are abundant within the park. A type specimen of horseshoe crab track, (*Kouphichnium arizonae*), was described in 1944 by Kenneth Caster. Steve Hasiotis, a graduate student at the University of Colorado at Boulder, is involved with a comprehensive survey of the park's ichnofossils (trace fossils). Steve recently collected and described the earlist known fossil termite nest from the Petrified Forest Formation in the park.

The importance of trace fossils and their identification has increased dramatically over the last two decades. Trace fossils have been reported from many National Park Service units. In addition to these found at Petrified Forest NP, vertebrate tracks occur at Arches NP, Badlands NP, Canyonlands NP, Colorado NM, Death Valley NM, Dinosaur NM, Glen Canyon NRA, Grand Canyon NP, Montezuma's Castle NM, Pipe Spring NM, and Zion NP. There is even a stone bridge at Gettysburg NBP that has a dinosaur track in one of the quarried blocks.

Recently it has been recognized that vertebrate tracks are not randomly distributed throughout Late Triassic rocks of the western United States. Most tracks are in the uppermost (youngest) strata of this age (e.g., Dinosaur NM, Canyonlands NP, Colorado NM). The tracks at Petrified Forest NP are several million years older than the other known Late Triassic tracksites in the western U.S. The high density of associated skeletal remains in the park produces a rare opportunity to correlate the track with the track-maker.

Santucci is Paleontologist/Curator at Petrified Forest NP; Hunt is a Vertebrate Paleontologist (and caffeine junkie) with the Dept. of Geology, U/CO at Denver.

Book Review

By Ed Starkey

Every now and then I stumble onto a book about which I become so enthusiastic that my friends suspect that I own stock in the publishing company. **Extinction: Bad Genes or Bad Luck?** by David M. Raup (W.W. Norton, 1991) is such a book.

Although, for many of us, a book on paleontology may not seem to be a likely choice for recreational reading, this book is fun to read. Raup makes a potentially dull subject exciting, partially at least with irreverence. Stephen Jay Gould writes in the Introduction that if Raup "has any motto, it can only be; Think the unthinkable (and then make a mathematical model to show how it might work); take an outrageous idea with a limited sphere of validity and see if it might not be extendable to explain everything".

Raup's emphasis throughout the book is on extinction. His main question is "whether the billions of species that died in the geologic past died because they were less fit (bad genes) or merely because they were in the wrong place at the wrong time (bad luck)." He concludes that extinction is a combination of bad genes and bad luck. Some species die out because they cannot compete or cope in their normal habitat, but "most species die-out because they are unlucky. They die because they are subjected to biological or physical stresses not anticipated in their prior evolution and because time is not available for Darwinian natural selection to help them adapt."

Raup explores the likelihood that meteorite impact has been the primary cause of species extinctions detected in fossil records, ie. the source of "bad luck" and unanticipated biological or physical stress. Both sides of the issue are discussed, but after reading the book it is hard for me to dismiss meteor impact as a likely cause of extinctions. He really got my attention with the suggestion that the risk of a "civilization destroying" impact during a human lifetime might be 1:4,000.

Raup further suggests that extinction through bad luck does not challenge Darwin's natural selection. He believes that natural selection remains the best explanation for sophisticated adaptations such as eyes and wings, and that we would not be here without natural selection. His view is that extinction by bad luck only adds another element to the evolutionary process, operat-

Continued on page 15

Book Review

Ecology and Our Endangered Life-Support Systems, by Eugene P. Odum, from The Institute of Ecology, The University of Georgia. Published by Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts. Second Edition. 301 pp. ($18.95 at the Northern Arizona University bookstore).

In this refreshing and very readable paperback book, aptly titled *Ecology and Our Endangered Life-support Systems*, Eugene P. Odum unfolds and lays out his concepts of Ecology. The principal theme of the book, (and which is now one of the 'hot' topics of ecology), is that of integrating the relationships between individual organisms, the physical environment, and human society.

The basic precepts are biological, but someone only vaguely familiar with biological terms and definitions could easily pick up this book and read, enjoy, and profit from it. Using the concepts of life support systems, first introduced in the Prologue by a detailed description of the flight and life support systems of Apollo 13 (the spacecraft crippled by an explosion in 1970), the reader is carried on a journey to understand how the earth is composed of interlocking and interacting systems that holistically add up to mankind's 'life-support.' The developed, cultivated, and natural aspects of the landscape must interact to support life as we know it now and in the future. Odum shows how these systems exist at a variety of levels, from individuals through populations and communities to the biosphere on a global scale, and how they interact synergistically.

Interestingly, one of the major components Odum inserts into the ecological picture is economics, a theme carried throughout this book. He feels that the interface between ecology and economics is so strong that the human population problem is probably economic, or perhaps political (but he does not emphasize any biological role). His often repeated reason for the degradation of species and their environments are economic pressures. Likewise, his solution for protecting species and their environs is economics. This concept will be an ever increasingly important one for land managers trying to deal with the impact of land development contiguous to (and within) their managed lands.

Energy is addressed as a common denominator of life on earth linking ecosystems to economics. When a problem occurs—and many problems are pointed out—Odum insists that there is no quick fix. All three components (ecology, economics, energy) must be considered if any degree of long term success is to be expected. An example of one idea is to use energy as a basis for evaluating so called 'worthless land' in terms of energy produced for the biosphere upon which we all are dependent. For example, under this system one acre of tidal estuary becomes worth $20,000 to $50,000. Our real cost of living is not always accounted for in terms of money. This gap in our decision making process needs to be closed before the proper values can be placed on our survival in the ecological world.

However, all the basics of Ecology are also contained within this book —i.e., the food webs, energy systems, ecosystems. But what separates this work from other ecology texts is its slant to human influence. Many examples come from the impact of farming and industry, yielding a refreshing blend of scientific concepts and a dose of the real world.

These examples and others throughout the book are presented clearly in diagrams and then the same symbols are consistently used throughout the book. Therefore, all diagrams are simplistic and easily understood with consistently labeled inputs and feed-back loops. Reference is made to widely read magazines such as *Time*, and at the end of the chapters are excellent references with some notes inserted by the author.

A recurrent theme in the book is the contention that narrow economic theories and policies dominating world politics are major obstacles to achieving balance of non-market and market goods and services. Odum contends that the 1992 Earth Summit, while producing few meaningful agreements, may have opened pathways for future cooperation among nations and therefore some hope for the future. In the epilogue he states three certainties as predictions for the future: 1. human beings will continue to increase in numbers; 2. We need to do something about the fouling of our life support systems; and 3. Humanity will make a major and painful transition in energy use as fossil fuels decrease. If we could summarize the essence of this book in one statement it would be that: only when ecology and economics can be merged, and ethics extended to include environmental as well as human values, can we be optimistic for the future of mankind.

For someone wanting a purely biological, "hardcore" scientific approach to ecology, this book will be disappointing. But, for an introduction to ecology and a balanced look at ecology as it is being influenced by mankind—this book is a great starting point. The book's major value lies in Odum's approach that man is not only part of the ecosystem and biosphere, but that he is a major factor and driving force and must take some responsibility for his influences. The material contained within, and the approaches used by this author, would be enlightening for anyone from park superintendent, to resource manager, to naturalist interacting with the public.

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Book Review continued from pate 14

ing at the level of species, families, and classes instead of at the level of breeding populations of individual species.

Because I have recently spent considerable time thinking about threatened and endangered species, Raup's perspectives on recent and ongoing extinctions were especially interesting. He suggests that "human activities provide the first strike necessary to reduce species' ranges so that extinction from other causes is likely. Thus, current concerns about endangered species are justified because the human species is producing first strikes regularly – first strikes that nature supplies only at intervals of millions of years."

As Malcolm W. Brown of the **New York Times Book Review** wrote, this book is "An eminently entertaining and informative read." I especially recommend the book to those interested in conservation biology and biodiversity issues. Raup challenges us to consider time-frames greater than those measured in human lifetimes, and to keep an open mind about causes of extinction.

Raup is the Sewell Avery Distinguished Service Professor and a statistical paleontologist at the University of Chicago. Other books by him include The Nemesis Affair, *also published by Norton.*

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Succession and Biological Invasion at Mesa Verde NP

By Lisa Floyd-Hanna, William Romme, Deborah Kendall, Allan Loy and Marilyn Colyer

In a study of plant succession following the 1989 Long Mesa burn in Mesa Verde National Park (MVNP), Colorado, we documented a rapid invasion and increase in exotic (non-native) weeds into areas subjected to hot fires. Although the 1,200 ha burn covered both mountain shrub (*Quercus gambelii* and *Amelanchier utahensis*) communities and well-developed pinon-juniper (*Pinus edulis* and *Juniperus osteosperma*) woodland, only the latter show prolific non-native plant invasion. These sites were characterized by high mortality and exposure of mineral soils, and now support dense stands of Musk thistle, *Carduus macrocephalus* (nutans).

We presently see no evidence that native species will replace Musk thistle in the 1989 Long Mesa Fire area. Rather, it appears that Musk thistle has preempted extensive areas in the burn, particularly those of high fire intensity, and that this very competitive species will dominate these sites for a very long time--perhaps indefinitely. This fear is nurtured by the persistence of stands of exotic thistles–both Musk and Canada (*Cirsium arvense* L. throughout La Plata and Montezuma counties since their invasion during the 1970s. Where the weeds are abundant, new pathways of succession may be in progress, pathways that never before have been documented and are largely unpredictable with our present knowledge.

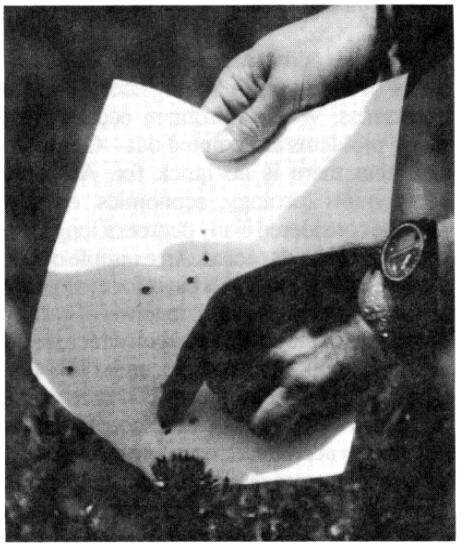
Nature reserves are not immune to degradation by aggressive invader species. Indeed, nearly all reserves in the world today are troubled by invasive vascular plants (Mooney and Drake 1989). For instance, Kruger National Park in Africa had 6 non-native plant species in 1937, 43 in the 1950s, and >160 today (Soule 1990).

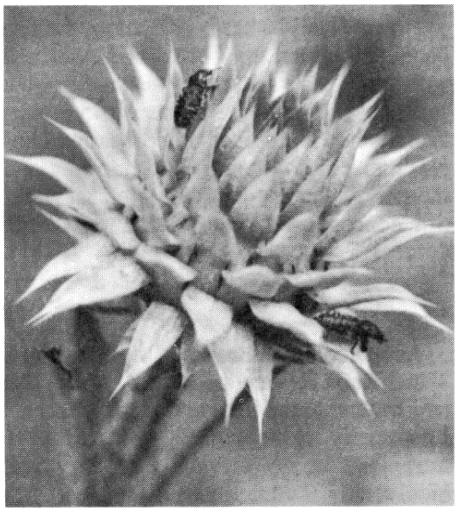
Why be concerned about invasion of exotic plant species in a national park like Mesa Verde? A major reason is that invasive species have the potential to displace native species and alter natural ecological processes. For example, cheatgrass (*Bromus tectorum*), an annual originally from Eurasia, now is well established throughout the intermountain region in North America, especially in areas disturbed by plowing or heavy grazing, but also in relatively undisturbed areas (Mack 1986). Once cheatgrass forms a dense stand, it alters the fire regime by creating a continuous, highly flammable fuel bed that can readily carry fire across large areas. The species composition and ecological functioning of steppe communities over much of the intermountain west have been altered by the invasion of this single exotic plant species.

An Ecological Irony

At MVNP, natural disturbances such as fires and gaps created by forest pathogens are common. Man has added to the native regime with roads, visitor facilities, and sewage plants, all necessary to maintain a highly visited park. There is deep irony here, and also a serious dilemma for managers of nature reserves. Recent research in ecology has shown clearly that disturbance is essential to maintain the natural components and processes of the communities and ecosystems we are trying to perpetuate in our national parks and other nature reserves (e.g. Pickett and White 1986). However, disturbance also promotes invasion and degradation of habitats if seed sources for potential invaders are close by (Hobbs and Huenneke 1992).

Look out below! Thistle head weevils are given a helping finger during their application to a field of musk thistles.





How are we to deal with this double-edged process of disturbance? One approach is to recognize that the native species are adapted to the disturbance regime that prevailed in pre-settlement times, i.e. to a particular frequency, intensity, and type(s) of disturbance. The strategy for maintaining native species, then, is to maintain this pre-settlement disturbance regime. In most of our parks and reserves, disturbance regimes and pools of species available have changed dramatically since pre-European settlement times (Hobbes and Huenneke 1992). Reserve managers need to identify and subsequently eliminate or ameliorate changes in disturbance regimes that are "beyond the evolutionary experience of the native biota" (Macdonald et al. 1989).

Natural Disturbances

What was the pre-settlement disturbance regime in MVNP? Research currently is underway to answer this question. We are attempting to determine, for example, the frequency and spatial extent of severe, stand-replacing fires in the pinon-juniper and mountain shrub communities, and the mechanisms by which the dominant species became re-established after fire. Such fires apparently were an important part of the pre-settlement environment of Mesa Verde and therefore should be allowed to continue in some form. Small fires occurred an average of 7.6 times per year between 1927 and 1976, and 13.7 times per year between 1976 and 1989. Large tracts burned in 1934, 1959, and 1972 and they were not invaded by exotic species (unless intentionally seeded with *Bromus inermis*).

The successional pattern changed dramatically with the 1989 Long Mesa fire. The southern sector of the burn supports prolific weedy invasion (the true extent of Musk thistle invasion requires immediate documentation), while the northern sector is dominated primarily by native perennial shrubs. The substantial gradient in post-fire successional patterns across the 1989 fire is alarming. It is clear that pre-fire community structure plays a role in directing subsequent succession. On the southern half of the burn, pinon-juniper woodlands had been destroyed, exposing mineral soils. In contrast, the northern, shrub dominated section was repopulated with sprouts from native perennials within the first year after the burn.

Throughout MVNP, fungal and insect pathogens have killed thousands of pinon pines, leaving patches in the forest that have been invaded by non-native plant species.

The most devastating infestation has come from the Black-root rot, *Verticicladiella wageneri*, which infests patches of pinon pines, killing trees of all ages. The largest invasion of Musk thistle coincided with Black-root invasion patches, although supporting thistle stands, are isolated from one another. However, should the patches become more extensive or common, they eventually may provide "corridors" for movement of weedy seeds.

Disturbances Related to Human Activities

In general, areas disturbed earlier this century and abandoned are free of weedy species. Disturbances that occurred since the mid 1970s or those that are continually disturbed support non-native plant species. Abandoned roadways are found throughout the park and date from the 1930s to the 1960s. Construction upgrades on the existing paved road that took place in 1983 may have directly introduced weedy species through the use of sewage sludge, as well as indirectly by creating open habitats. A pipeline originally built in 1946 to carry water from the "Chicken Creek" National Forest area into the water treatment facility at the park entrance is being replaced. It crosses the steep north-facing escarpment, and then runs south to the heavily used Chapin Mesa facilities. Both roadways and waterline construction serve as effective "corridors" that facilitate weedy dispersal in the park. (The first Musk thistle stands in Mesa Verde were on Chapin Mesa around 1980 following road construction activities that imported gravel from thistle-infested sites.)

Sewage facilities, constructed in 1963, 1965, and 1975, are located on Wetherill Mesa, Chapin Mesa, Far View, and Morefield Canyon. These are moist areas with continual disturbance and support large weedy populations. Such disturbances probably have no evolutionary precedent, and also create absolutely ideal conditions for invasions by exotics. Sewage treatment ponds provide bare substrate and nutrient enrichment, and–not coincidentally–support some of the most vigorous thistle stands in the park.

Grazing of trespass cattle and horses is a problem in Mesa Verde, punctuated by numerous fence breaks on the park's southern boundary. Grazing compacts the soil and reduces native grasses, and the animals may disperse exotic seeds. One example illustrates the extent to which grazing affects native flora. In Navajo Canyon, the average cheatgrass cover was 40 percent between 1980 and 1989. Fences were erected in 1987, and native grasses were returning to the area by 1990. In 1991, western wheatgrass, slender wheatgrass, and salina wild rye covered >60 percent, and cheatgrass was reduced to <20 percent. It has taken only 4 to 5 years to return the area to a nearly natural native flora.

> Of all the many functions our national parks perform, one of the most important is maintaining examples of natural ecosystems populated by native biota. Today these systems are continually shrinking in size and ecological integrity. In many areas the public has become so accustomed to seeing landscapes dominated by exotic species that they think these are the normal condition (Heywood 1989). Aldo Leopold, in his classic essay on the land ethic, wrote that the ecological damage that already has occurred in the southwest "is quite invisible to the tourist who finds this wrecked landscape colorful and charming (as indeed it is, but it bears scant resemblance to what it was in 1848)."
>
> To the credit of past and present managers, the vegetation of MVNP is still largely intact. To keep it that way, in the face of impending global-scale changes in climate and human impact, will require insightful research, enlightened and assertive management, and informed public support.

Biological Invasions

More than a dozen exotic species are considered troublesome at MVNP, but to illustrate the extent of such invasions and possible management scenarios, we will discuss the two thistle species further. Two of the most conspicuous invaders, Musk thistle and Canada thistle, have life history characteristics that make them potentially serious threats to the integrity of the park's natural vegetation. They display rapid rates of population growth, relatively short life cycles, early reproductive maturity, high reproductive allocation, pollination by wind or by generalist pollinators, and rapid response to resource availability. All these are general characteristics of colonizing plant species that can successfully enter new habitats following disturbance (Bazzaz 1986).

In 1976, economically threatening populations of Musk thistle species were located in eastern Colorado (Dunn 1976). Since then, Musk thistle has spread at an alarming rate. Musk thistle is a biennial, reproducing from seed exclusively. Canada thistle is more difficult to control because of horizontal adventitious roots that may extend 2 m deep (Hodgson 1968; Rees 1990).

Control of Biological Invasions

Control of Musk and Canada thistles should be geared specifically to the extent of the invasion and the degree of expected recurrence of disturbances. In MVNP, only the most extensive disturbances–large, hot fires, waste treatment, waterline construction–facilitate invasion of large acreages of thistles. Thus, treatment of weedy patches of various size and severity must be weighed carefully. Methods used to curtail thistle invasion include:

A. Biological control strategies for Musk thistle: *Rhinocyllus conicus* (Frowl) and *Trichosirocalus horridus* (Panzer) are thistle weevils, which have been used extensively in the U.S. for control of Musk thistle (McCarty and Lamp 1982; Rees 1982). *R. conicus* has spread into MVNP from surrounding agricultural land. In the spring, *R. conicus* females oviposit on the developing flower bud bracts, moving from primary to lateral buds as they become oversaturated with eggs. Eggs hatch in 6 to 8 days, and larvae burrow into the receptacle, reducing seed viability. *T. horrendus* attacks the stems and crown and produces feeding scars that allow entry of pathogens, further weakening the plant. Together they are effective in controlling Musk thistle.

Another insect species, *Vanessa cardiu* L. is presently established on thistles in many areas. *V. cardui*, the painted lady butterfly, is a migratory herbivore than cannot tolerate winter temperature, migrating to the southwestern U.S. and Mexico in fall. The larvae are locally effective herbivores of Canada and Musk thistle (Larry Hays, Natural Resource Specialist, Wind Cave NP, pers. comm.).

In the summer of 1992, systematic releases of *T. horridus* were made in Morefield Canyon, a densely thistle-infested area of MVNP. One hundred individuals were released on specifically tagged experimental plants in May, 1,000 in June, and control plants were paired with experimental plants. Native thistle species were monitored along with Musk thistles for possible infestations. First year result summaries show 1,748 seedhead weevils emerged from 106 Musk thistle seedheads and only one seedhead weevil emerged from 30 native thistle seedheads. We are confident that the success of the biological control agents by intentional and accidental introductions from surrounding lands will be effective in reducing the spread of Musk thistle in MVNP.

B. Use of mechanical control: Removal of Musk thistle biomass prior to "bolting" (establishment of seed head) seems a reasonable approach to eradication. In MVNP, to the extent possible with YCC, the hazardous fuel crew, the road crews, trail crews, ruins stabilization crew, and concessions personnel, inflorescences have been removed from bolt-

Continued on page 18

ing plants prior to seed shed (in 1985-1992). Musk thistles are cut just below ground level in early summer. Generally a well developed rosette has enough root mass to produce a second and often a third head. Elimination of the current year's growth depletes the root carbohydrate reserves and plants experience increased mortality and reduced fecundity.

C. Use of Chemical control: Herbicides are effective means of eradicating most species of thistle. Applications of picloram, Round-up, Glean, Curtail, and other commercial preparations are used locally. Mesa Verde's policy has been to avoid introduction of herbicide into the ecosystem whenever possible. However, because of the extent of the problem, a combination of limited chemical treatment, in conjunction with mechanical and biological controls, is under consideration (B. Heyder, pers. comm.).

Looking to the Future

Biological invasion on disturbed habitats within MVNP illustrates the complexity of problems created by species migration and the role of human interference in plant establishment. Although weedy species are adapted to exactly the habitats that humans maintain, their positive influences -- soil stability and erosion prevention for example – may be overridden if they tend to re-direct the native successional process. The extent of ecosystem disturbance and the proximity to seed sources of aggressive weeds have created at MVNP a critical biological invasion.

Although we cannot yet predict with confidence the long-term effects of exotic plant invaders in MVNP, from other studies we know that changes in community or ecosystem function following establishment of exotic species has not always been significant; the potential effects of the new species range from modest usurpation of resources from many native species (hence no extinctions) to intense competition with one or a few natives species, with significant competitive displacement of the native(s) (Westman 1990).

Invaders may have positive ecosystem effects, especially with regard to repair of damaged ecosystems. For example, weedy herbaceous invaders may sequester nutrients more efficiently than the native species in severely disturbed sites (Mooney and Drake 1989). Despite substantial research to date, we still can make only very general predictions about which species are likely to be successful invaders or which communities are most susceptible to invasion. Each species and situation must be examined individually. (Bazzaz 1986; Westman 1990).

Sites disturbed before 1970 and abandoned to natural successional sequences support native flora in Mesa Verde today. But given the rapid expansion of exotic thistles in the park and surrounding region in the last few decades it appears likely they will spread to an even greater area in the near future, especially if disturbances continue to occur.

Disturbance of native vegetation, either natural or anthropogenic, is nearly always inducive to establishment of exotic species in new habitats (Westman 1990). Invasion was particularly severe in the record high precipitation of May 1992. In some areas of MVNP where spring moisture remains high and disturbance is continual (e.g. sewer ponds and surroundings), thistles predominate despite dense grass cover. What actually happens on any particular site depends on variables such as intensity of disturbance, weather conditions in the first years after a fire, and the local seed bank of aggressive exotic weeds.

Chenopodium fremontii, lambs quarter or goosefoot, growing in the 1989 Long Mesa burn one year after the fire. Photograph taken October 1990 in Mesa Verde NP.

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Literature Cited

Bazzaz. F.A. 1986.Life history of colonizing plants: some demographic, genetic, and physiological features; pp. 96-110 IN Mooney, H.A., and J.A. Drake (editors), Ecology of biological invasions of North America and Hawaii. Springer-Verlag, New York.

Dunn, P.H. 1976. Distribution of *Carduus nutans*, *C.acanthoides*, *C. pycnocephalus* and *C. crispus* in the United States. Weed Science 24:518-524.

Heywood, V.H. 1989. Patterns, extents, aand modes of invasions by terrestrial plants; pp. 31-55 IN Drake, J.A., H.A. Mooney, F. diCastri, R.H.Groves, F.J.Kruger, M.Rejmanek, and M. Williamson (editors), Biological invasions: a global perspective. SCOPE, Wiley & Sons.

Hobbs, R.J. and L.F. Huenneke. 1992. Disturbance, diversity, and invasion: implications for conservation. Conservation Biology 6:324-337.

Hodgson, J.M. 1968. The nature, ecology, and control of Canada thistle. USDA Tech. Bull. 1386.

Leopold, A. 1966. A Sand County almanac, with essays on conservation from Round River. Sierra Club/Ballantine Books, New York.

Macdonald, I.A.W., L.L. Loope, M.B. Usher, and O. Hamann. 1989. Wildlife conservation and the invasion of nature reserves by introduced species: a global perspective; pp. 215-255 IN Drake, J.A., H.A. Mooney, F. diCastri, R.H. Groves, F.J. Kruger, M. Rejmanek, and M. Williamson (editors), Biological invasions: a global perspective. SCOPE, Wiley & Sons.

Mack, R.N. 1986. Exotic plant invasion into the intermountain west: a case history; pp. 191-213 IN Mooney, H.A., and J.A. Drake (editors), Ecology of biological invasions of North America and Hawaii. Springer-Verlag, New York.

McCarty, M.K. and W.O. Lamp. 1981. Effect of a weevil, *Rhinocyllus conicus* on Musk thistle seed production. Weed Science 30:136-140.

Mooney, H.A., and J.A. Drake. 1989. Biological invasions: a SCOPE program overview; pp. 491-510 IN Drake, J.A., H.A. Mooney, F. deCastri, R.H. Groves, F.J. Kruger, M.Rejmanek, and M. Williamson (editors), Biological invasions: a global perspective. SCOPE, Wiley & Sons.

Pickett, S.T.A., and P.S. White (editors). 1985. The ecology of natural disturbance and patch dynamics. Academic Press.

Rees, N.E. 1982. Collecting, handling and releasing *Rhinocyllus conicus*, a biological control agent of Musk thistle. USDA Agric. Handbook No. 579.

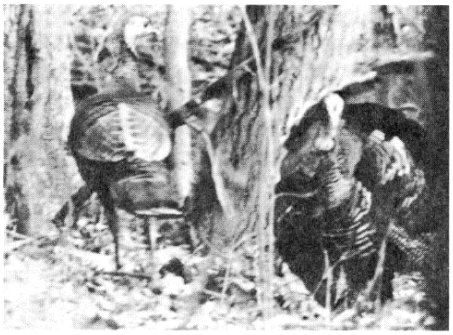
Rees, N.E. 1990. Establishment, dispersal, and influences of *Ceuthorhynchus litura* on Canada thistle in the Gallatin Valley of Montana. Weed Science 38:198-200.

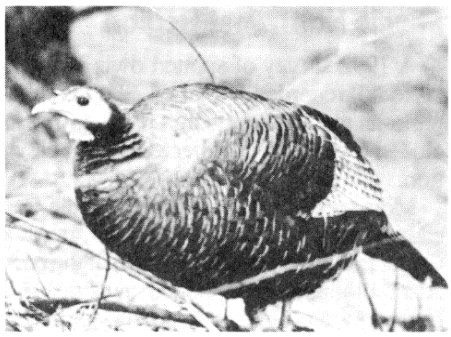
Soule, M.E. 1990. The onslaught of exotic species, and other challenges in the coming decades. Conservation Biology 4:233-239.

Westman, W.E. 1990. Park management and exotic plant species: problems and issues. Conservation Biology 4:251-260.

Wild Turkey Restoration at Indiana Dunes

By Eddie Childers





Young male ("jakes") wild turkeys (left) strutting and preparing for the spring breeding season. (*Photo by Randy Childers*)

Wild Turkey Hen (right) is intrigued by the camera. (*Photo by Eddie Childers*)

The eastern wild turkey originally inhabited much of the presettlement land east of the Mississippi River and was a valued resource for settlers and native Americans. Northwestern Indiana supported wild turkey populations throughout the 1800s; however, wild turkeys were extirpated thereafter, following loss of habitat due to intensive logging operations and exploitation by settlers, native Americans, trappers and hunters.

By the early 1940s wild turkeys did not exist in Indiana (USFWS 1987); however, since then, Indiana has restored the wild turkey to much of its original range where suitable habitat exists.

Wild turkey restoration is a successful management technique that involves live trapping the birds and transporting them to suitable habitat areas where no turkeys are. Midwestern states that have reported success with such programs include Missouri, Wisconsin, Michigan, Ohio and Illinois. In fact, wild turkeys now are known to occupy oak-savanna type habitats in Illinois, similar to the oak-savanna habitat found at Indiana Dunes National Lakeshore (Sullivan and Robinson, 1993). Suitable habitat appears to be one of the key limiting factors to successful wild turkey restoration.

Indiana's restoration efforts began in the mid 1950s and have accelerated rapidly during the 1980s, with an estimated 1,923 released birds at 127 sites throughout Indiana (Backs and Eisfelder, 1990). Wild turkeys now are present in more than 60 counties in Indiana and their numbers and range continue to grow (Ind. Div. of Fish and Wildlife, 1993). Successful statewide reintroduction of the wild turkey by the Indiana Department of Natural Resources (IDNR) suggested that restoration could begin at Indiana Dunes NL. GIS analysis was used to evaluate the habitat suitability for wild turkey restoration in the East Unit of Indiana Dunes NL based on IDNR's guidelines.

Wild turkey population growth and dispersal in newly restored areas is influenced by land use, human population levels, and physiography, among other factors. Selection of suitable release areas became an important topic of investigation for IDNR wildlife biologists as public pressure to consider marginal quality turkey habitats increased throughout Indiana (Backs and Eisfelder, 1990). Consequently, criteria and guidelines for wild turkey release priorities in Indiana were developed by IDNR to help agency personnel and the public better understand how restoration priorities are determined in Indiana. IDNR's guidelines for wild turkey restoration criteria are given for three levels: Level 1 (optimum), Level 2 (less than optimum), and Level 3 (poorest), based on the estimated potential for wild turkey establishment and growth at a proposed release site (Backs and Eisfelder, 1990).

The GIS analysis used the 68 previously classified plant communities for the East Unit of the National Lakeshore and reclassified them into the IDNR Level 1 habitat category types, that included forested (hard/soft mast-producing species; scrub/brush seral stages; openland (meadows, pastures, fields); human development (paved areas); and other habitat types (e.g. open water). The total area for each of the habitat types was generated for the East Unit of Indiana Dunes NL and compared with the IDNR guidelines to evaluate habitat suitability, using *r.reclass* and *r.report* (GRASS 4.0, 1991).

The wild turkey habitat in the East Unit meets most of the area requirements mandated by the IDNR. Forest cover, including hard and soft mast-producing species, shrub and brush seral stages, openland, and human development are all within 5 percent of the recommended ranges of Level 1 (optimum) habitat recommended for wild turkey restoration.

The East Unit does not meet the human development criteria, defined as <12 people and <0.8 km rural roads/km2. Human populations also are much higher than IDNR guidelines specify, due to the Dune Acres and Beverly Shores communities located within the boundaries of the National Lakeshore; however, barriers to wild turkey population expansion within the East Unit are minimal or nonexistent if these criteria are not considered.

The East Unit does meet other primary Level 1 criteria established by the IDNR, including requirements that the proposed release areas are between 25 and 50 km2 in size and are currently unoccupied by wild turkeys. Total area of the East Unit is approximately 43 km2 and no wild turkeys exist there today.

Reintroducing wild turkeys to the East Unit of the National Lakeshore would provide the added benefit of protection of a small, newly established population from hunting and poaching. Hunting is not permitted at Indiana Dunes. Furthermore, the population could increase in size within the National Lakeshore from an initial stocking, expanding and migrating to areas outside park boundaries, thereby providing hunting opportunities to residents on private lands in northwestern Indiana were none exist today.

The influence of wild turkeys on plant and animal communities within the National Lakeshore will be assessed before an active wild turkey restoration project is implemented. While impacts on plant and animal communities may be minimal, the effects wild turkeys have on endangered plant species and other communities are presently unknown.

Childers is with the National Park Service, Indiana Dunes NL.

References

Backs, S.E., and C.H. Eisfelder. 1990. Criteria and Guidelines for Wild Turkey Release Priorities in Indiana. IN Proceedings of the 6th National Wild Turkey Symposium. National Wild Turkey Federation. Edgefield, SC.

GRASS 4.0, Geographic Resources Analysis and Support System. July 1991. U.S. Army Corps of Engineers Construction Research Lab. Champaign, IL.

Indiana Division of Fish and Wildlife. March-April 1993. FOCUS. Bimonthly publication of the Indiana Dept. of Natural Resources, Indianapolis, IN.

Sullivan, J. and S. Robinson. 1993. Illinois Savanna Birds. IN Ecosystem Recovery Plan (DRAFT), Oak Savanna and Woodland of the Midwest.

U.S. Dept. of the Interior, Fish and Wildlife Service. 1987. Restoring America's Wildlife. U.S. Govt. Printing Off., Washington, D.C. 394 p.

Regional Highlights

Pacific Northwest Region

A 1992 survey of spotted owls in Crater Lake NP recorded a total of 29 owls in the park–an unexpectedly high number that included owls at an unexpectedly high elevation.

Most spotted owls occur west of the Cascade divide, but four of the pairs found at Crater Lake were on the east side of the park. Also, although most spotted owls occur in fairly low elevation old-growth coniferous forests, sightings at Crater Lake included one at 6,550 feet–the highest at which a spotted owl nest ever has been found.

The survey involved a cooperative team effort among the Oregon Department of Fish and Wildlife, the U.S. Forest Service, and NPS.

Western Region

A recent publication by Dr. Lisa Graumlich (Professor at the Laboratory of Tree-Ring Research and Director of the Institute for the Study of Planet Earth at U/AZ), "A 1000-Year Record of Temperature and Precipitation in the Sierra Nevada"–Quaternary Research, 1993;39:249-255), has attracted considerable attention with its documentation of extensive drought periods during previous centuries. Summaries of her findings and their possible implications for both park ecosystems and State water supplies were covered by local newspapers as well as by the *New York Times*. Dr. Graumlich is a principal investigator on the Sierra Nevada global change research program.

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Research Scientist David Parsons has been asked to serve on an ad hoc committee on ecosystem management by the Ecological Society of America (ESA). NPS representation in such activities is critical in building the credibility of NPS science activities, Parsons notes, as well as in assuring the committee's findings are applicable to park issues. Parsons also has been asked to serve on an independent science team appointed to assess the current status and management alternatives for old growth and associated ecosystems of the Sierra Nevada...a study mandated by Congress.

Parsons continues to serve on the board of editors for the ESA journal, *Ecological Applications*. The journal is interested in publishing more articles related to national park resource issues, and Dr. Parsons encourages potential contributors to contact him at Kings Canyon NP/Sequoia NP, Three Rivers, CA 93271-9700.

North Atlantic Region

John T. Tanacredi and Robert P. Cook of Gateway NRA at Floyd Bennett Field in Brooklyn, N.Y., are co-authors of two recent papers: "Interagency Cooperation in Restoring Freshwater Wetlands in an Urban National Recreation Area," published by the National Institute for Urban Wildlife (*Wildlife Conservation in Metropolitan Environments*, 1991, *NIUW Symp. Ser. 2*), and "Management Strategies for Increasing Habitat and Species Diversity in an Urban National Park," (*Ecosystem Management: Rare Species and Significant Habitats*, NY State Museum Bulletin 471. 1990. pp 248-250.)

Tanacredi is either the sole or a participating author in the following six publications: "The effects of low doses of waste crankcase oil on *Melita nitida* Smith (Crustacea: Amphipoda)," in *J. Exp. Mar. Biol. Ecol.* 166 (1993) 39-46; "Naphthalenes associated with treated wastewater effluents in an urban national wildlife refuge," *Bull. Environ. Contam. Toxicol.* (1990)44:246-253; "Is Commercial shellfish harvesting compatible within an urban national wildlife refuge?" *Fresenius Envir. Bull.* (1993) 2:174-178; "Secondary production of the amphipod *Ampelisca abdita* Mills and its importance in the diet of juvenile winter flounder in Jamaica Bay, NY, *Estuaries*, (June 1992)15:2, pp 193-203; "Coastal zone management practices at an urban national park," *Envir. Mgmt.* Vol. 7, No. 2, pp 143-150; and "Natural resource management policy constraints and trade-offs in an urban national recreation area," from *Proceedings Natl. Symp. on Urban Wildl. Conf.* on Integrating Man and Nature in the Metropolitan Environment, 1986.

National Capitol Region

The ecological rejuvenation of Kenilworth Marsh continues to progress at a pace that has far exceeded expectations. The growth of planted and volunteer marsh species has reached the point where one would believe this fresh water tidal marsh had long been in existence and had not just this year been established upon dredge material. A monitoring committee comprised of many agencies including NPS, USFWS, EPA, Corps of Engineers, District of Columbia, Interstate Commission on the Potomac River Basin, and Metropolitan Washington Council of Governments has been documenting the restoration process.

* * *

Results of the Dutch elm disease symposium, co-sponsored by the NPS and Michigan State University, have been published in M.B. Sticklen and J.L. Sherald (eds), *Dutch Elm Disease Research: Cellular and Molecular Approaches*. Springer-Verlag, New York. 1993.

* * *

James Patterson, Research Agronomist at the NPS Center for Urban Ecology, has developed a micromorphologic technique coupled with image analysis to study human impact on soil systems.

* * *

Jonathan Hoeldtke participated in the service-wide gathering of the White-tailed Deer Committee to discuss progress with the draft management alternatives. John Hadidian participated in the Social Progress Workshop at Easton, MC as part of the Human Dominated System's Directorate Core Project; Phase II of the Project has been funded. Hadidian, Bill Hebb, and John Howard attended the R-MAP Workshop in Boston, and Hadidian is chairing the section for research for the 3rd International Wildlife Symposium to be held in Seattle, WA in the fall of 1994.

Southeast Region

Dr. Suzette Kimball, former Research Ecologist at the NPS/CPSU, University of Virginia, is the new Deputy Assoc. Regional Director for Natural Resources and Science in the Southeast Region. Dr. Kimball earned her BA and BS degrees from the College of William and May, her MS from Ball State in geology and geophysics, and her PhD from U/VA in environmental sciences and coastal processes.

While at the CPSU, Dr. Kimball served as the Barrier Island Global Climate Change Coordinator for the SE, SW, North Atlantic, and Mid-Atlantic Regions. Prior to joining NPS in 1991, Dr. Kimball was Co-director of the Center for Coastal Management and Policy and an Assoc. Prof. at the Virginia Institute of Marine Science, as Chief of Coastal Morphology Unit of the U.S. Army Corps of Engineers, and as a Research Physical Scientist at the Corps' Waterways Experiment Station in Vicksburg, MS. She is a certified Professional Geologist, who has served on a variety of boards and committees, including chairperson for the VA State Board of Geology, vice-president of the Mid-Atlantic Shore and Beach Preservation Society, and chairperson of the Nearshore Research

Group of the American Geophysical Union. She began her new duties at the Southeast Regional Office on July 19.

* * *

The NPS Coastal Parks CPSU, previously located at U/VA, has been relocated to NC State University. Dr. Ted Simons can be reached there at: NPS/CPSU, Campus Box 7106, Raleigh, NC 27695-7106. FAX (919)515-3439. The NPS has a long history of collaboration with NC State faculty and staff and will continue with coastal parks projects such as the groundwater studies at Cape Hatteras, GIS support, development of I&M protocols, and migratory bird research.

* * *

Recently published reports include:

- Nodvin, S.C., J. Rigel, and S.M. Twigg. 1993. *An Indexed Reference Database of the Great Smoky Mountains, NC and TN*. NPS/SERGRSM/NRTR 93-08.
- Nix, L.E. and J. Barry. 1992. *Investigation of the Impacts of Clearcutting, Feral Hogs, and White-tailed Deer on the Native Vegetative Resources of the Congaree Swamp National Monument*. NPS/SERCOSW/NRTR 93-09.
- White, P.S. and R. Busing. *LTERM: Long-term Monitoring and Research in Great Smoky Mountains NP: Vegetation Monitoring and an Assessment of Past Studies*. NPS/SERGRSM/NRTR 93-10
- Rogers, C., M. Ratnaswamy, and R.J. Warren. *Vegetation Communities of Chickamauga Battlefield NMP, GA*. NPS/SERCHCH/NRTR 93-11.
- Schmidt, T.W. *Community Characteristics of Dominant Forage Fishes and Decapods in the Whitewater Bay Estuary, Everglades NP*. NPS/SEREVER/NRTR 93-12.
- Van Cleave, R. and A.Van Cleave. *Trail Use in Cataloochee, Balsam Mountain, Elkmont, Smokemont and Tremont Areas of Great Smoky Mountains NP*. NPS/SERGRSM/NRTR 93-13.

Meetings of Interest

1993

Oct. 13-16 **SOCIETY OF VERTEBRATE PALEONTOLOGY,** 53rd Annual Meeting at Ramada Inn Classic Hotel, Albuquerque, NM, hosted by the NM Museum of Natural History and Science.

Oct. 17-21 **HUMAN ECOLOGY AND CLIMATE CHANGE: THE ROLE OF PARKS AND PROTECTED AREAS**, an invitational workshop at U/WA's Pack Forest, hosted by Daryll R. Johnson and David L. Peterson of the U/WA's NPS/CPSU. To address human interaction with climate change, for which NPS and other agencies have research responsibility. Key papers will be published in a special issue of *Society and Natural Resources*.

Oct. 25-28 **SECOND BIENNIAL CONFERENCE ON RESEARCH INCOLORADO PLATEAU NPs**, at Northern AZ University, Flagstaff; highlighting biological, cultural, social, and physical science research in NPs and related areas on the Plateau. Contact: Mark Sogge, CPSU/NAU, Box 5614, Northern Arizona U, Flagstaff, AZ 86001; (602) 523-9090.

Nov. 5-6 **PROTECTING INTEGRITY AND ETHICS**, at Holiday Inn, Bethesda, MD; sponsored by Public Employees for Environmental Responsibility (PEER); speakers will include James Baca, Director of BLM; Dan Beard, BLM Commissioner; Jim Lyons, Asst. Secty. for Natural Resources and Environment at Agriculture, and Congresswoman Patricia Schroeder, among others. Contact PEER, 810 First St., N.E., Suite 680, Washington DC; (202) 408-0041.

Nov. 11-13 **NATIONAL WATCHABLE WILDLIFE CONFERENCE**, Corpus Christi, TX. To explore ways to become more effective at conservation, education, and economic development through watchable wildlife efforts. Contact Gary Graham, conf. co-chair (512)448-4311, or Mary Garrett, conf. coordinator (512) 888-5400.

Feb. 23-25 **2nd SYMPOSIUM ON SOCIAL ASPECTS AND RECREATION RESEARCH**, at San Diego, CA; hosted by USFS Pacific SW Research Station, BLM, and the Social Aspects of Resource Management Institute at CA State Polytech U, Pomona. Contact Lisa Maggiore, (909) 869-4591.

Mar. 23-25 **5 YEARS AFTER THE EXXON VALDEZ OIL SPILL**, An International Conference on Prevention, Response, and Oversight; sponsored by the Alaska Sea Grant College Program, U/AK, Fairbanks. Contact Brenda Baxter, U/AK, Fairbanks, 99775-5040; (907) 474-7086.

May 4-6 **1994 GEOLOGIC SOCIETY OF AMERICA, ROCKY MOUNTAIN SECTION MEETING,** Durango, CO; Papers from a platform session on NPS Paleontological Research, chaired by Vincent L. Santucci, will be published in a symposium volume. Contact Santucci at Petrified Forest NP, PO Box 2266, Petrified Forest, AZ 86028; (602) 524-6228 x227.

1994

June 7-10 **FIFTH INTERNATIONAL SYMPOSIUM ON SOCIETY AND RESOURCE MANAGEMENT**, CO/State/U, Fort Collins, CO. Michael J. Manfredo, program chair, has called for papers by Nov. 1, 1993, to Manfredo, Human Dimensions in Natural Resources Unit, CO/State/U, Fort Collins, CO 80523.

Aug. 28-Sept. 2 **6th ANNUAL INTERAGENCY WILDERNESS CONFERENCE,** tentatively scheduled for Santa Fe or Albuquerque,NM.

20th Annual Natural Areas Conference

"Conservation in Working Landscapes" was the theme of the 20th Annual Natural Areas Conference, convened by the Natural Areas Assn. in cooperation with the Maine State Planning office and held June 22-26 at U/ME in Orono. More than 500 attendees (the most thus far) came from as far away as Poland and Brazil. Topics ranging from natural areas aesthetics to sampling design were covered in about 143 papers. The 66 conference sponsors included Georgia Pacific and L.L.Bean, and underwriters were BLM, NPS, NOAA, EPA, USFWS, USFS, and the Canadian Wildlife Service.

More than 40 posters and 21 symposia covered inventory and monitoring, biological diversity, marine ecosystems, wildlife conservation, communications and landowner contact, fire management, botanical conservation, rare and endangered species, land aesthetics, old-growth, and global perspectives. Fifteen field workshops, pre- and post-conference field trips, and round-table lunch discussions allowed extended access to speakers. An address by Dr. George Woodwell, Director of Woods Hole Research Center, was followed by a question and answer session on the status of the National Biological Survey. Eight NPS people gave papers, talks, or acted as moderators, and Acadia NP staff hosted 2 of the field workshops.

The 21st Annual Conference is scheduled for southern Florida.

Craig Shafer
NPS Ecologist, WASO

Seasonal and Diurnal Discharge Fluctuations In Medano Creek, Great Sand Dunes National Monument

By James P. McCalpin

Medano Creek at the Great Sand Dunes National Monument has long been noted for its unique surge-flow behavior (Bean, 1977); Schumm and others, 1982). However, little was known of the discharge characteristics of the creek because it never had been gauged. The impetus for this collection of multi-year baseline discharge data was the projected decline of the regional water table (as much as 150 ft) underneath Medano Creek, due to groundwater pumping on adjacent property north of the Monument. The projected decline was thought to pose potential adverse effects to the surge flow in Medano Creek, and possibly to the NPS water right.

The 2-year study began in June 1991. Two standard dimension 3 ft-wide Parshall flumes were constructed of plywood and sheet metal and installed in Medano Creek at two locations. Because the area is in Wilderness, flume components were hand-carried to the sites and assembled on site, without the aid of machinery. The Boundary flume is located 5 km downstream. These flumes record creek stage via a float gauge and Omnidata (TM) DP-115 data logger in an adjacent stilling well. The Boundary flume was installed on June 28, 1991 and has a continuous record of discharge measured hourly. Corresponding measurements of depth to shallow groundwater in the floodplain are given in McCalpin (1992).

Discharge of Medano Creek at the Boundary flume is shown in Figure 1a for the 16-month period July 1991 to November 1992. The record begins after the 1991 peak snowmelt had occurred, and discharge had decline to less than 10 cfs (cubic feet per second). The mid- and late-summer seasons in both 1991 and 1992 are marked by a slow decline in discharge (due to decreasing baseflow from snowmelt), interrupted by two types of increases in discharge.

The largest discharge increases come from summer rainstorms. Large storm systems, such as the one in August 1991 (Fig. 1) can increase discharge up to 15 cfs, with the receding part of the hydrograph lasting up to one month. Smaller storms (such as mid-August 1992) create smaller flow increases (7 cfs) lasting a shorter time (one week). On more detailed hourly graphs of discharge (McCalpin, 1992) even smaller rainstorm effects can be observed–increases of 2-3 cfs over several hours.

The second summer increase occurs on July 16 of each year, when about 5 cfs of water is returned to Medano Creek from an irrigation diversion at Medano Pass. This increase merely shifts the declining part of the hydrograph up by about 5 cfs, and does not alter the overall trend.

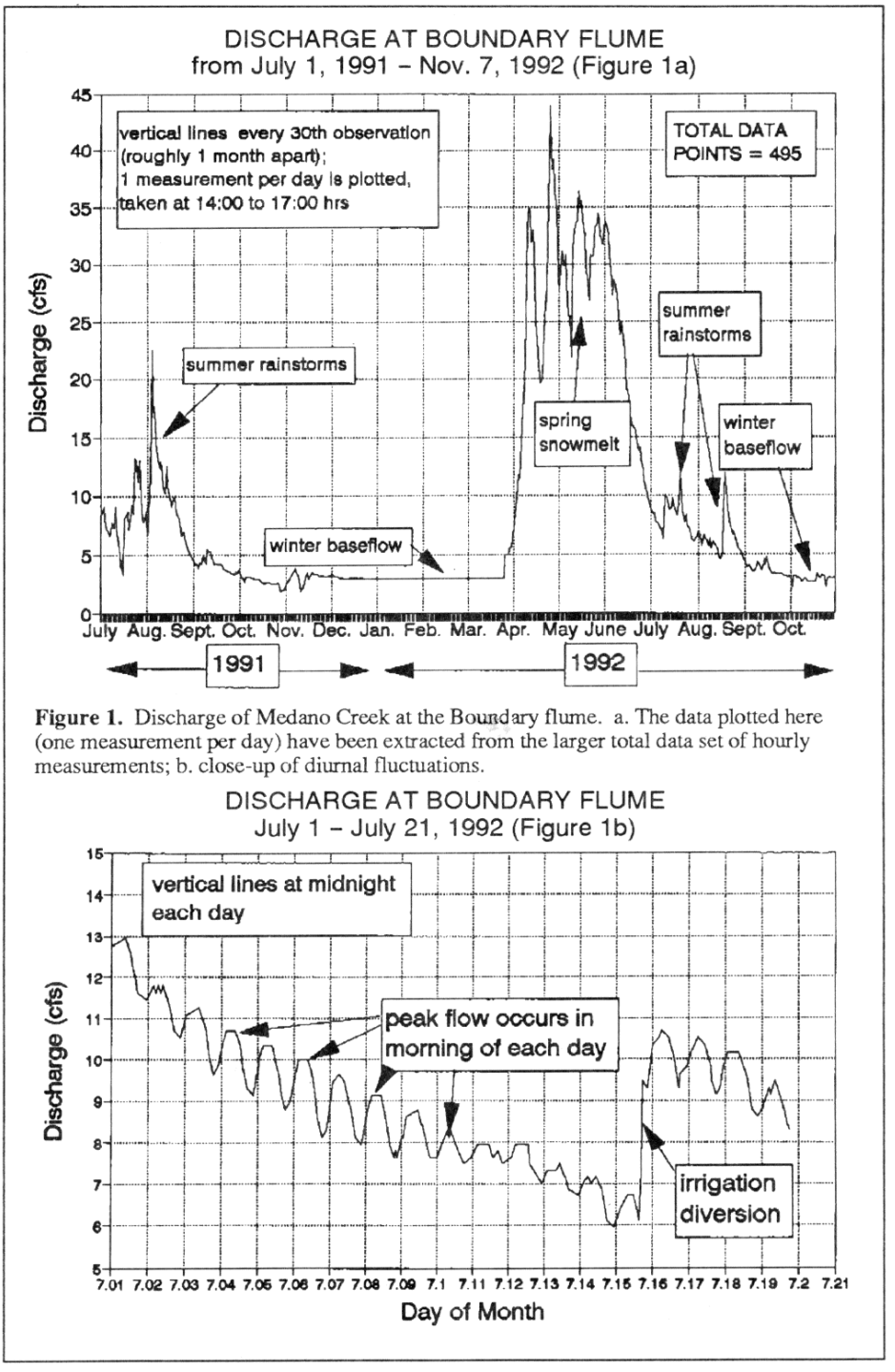

Figure 1. Discharge of Medano Creek at the Boundary flume. a. The data plotted here (one measurement per day) have been extracted from the larger total data set of hourly measurements; b. close-up of diurnal fluctuations.

In both 1991 and 1992, surface flow declined to a winter baseflow of ca. 3 cfs by October 1. Flume measurements from mid-October through late March were made only by visual observations every 2-6 weeks because stilling wells were frozen.

Spring snowmelt began rapidly in early April 1992, and reached discharges of over 30 cfs (peak=44 cfs) that lasted for two months. The pronounced peaks and troughs in the snowmelt discharge record reflect variations in weather, mainly in temperature, as recorded by the weather station at Monument Headquarters. The highest discharge peaks occur during warm, sunny

Supt. William E. Wellman examines the Boundary flume at Medano Creek.

weather when snowpack is melting rapidly. Troughs in discharge are created by cool, cloudy weather systems accompanied by light snow. For example, cooling of 10 dgrees F. during mid-April and early May led to decreases of 15 and 20 cfs in discharge, respectively, merely by suppression of solar-induced snowpack melt. Once the surface snowpack was melted from all but the highest parts of the drainage basin, discharge declined rapidly, dropping from ca. 35 cfs in early June to <10 cfs in early July. In a typical year this decline would continue in an exponential curve unless interrupted by summer rainstorms or irrigation diversions.

Unexpectedly, we observed significant diurnal fluctuations in discharge throughout the year in Medano Crek (Fig. 1b). During the initial 1992 spring snowmelt (April 1-9), the peaks and troughs of discharge appeared 2-3 hours later at the downstream (Castle Creek) flume than at the Boundary flume. Peak flow at the Boundary flume occurred at about 8-9 p.m., after the hottest part of the day, but did not appear at the Castle Creek flume until midnight. The timing of peak discharge in the early evening, and the lag time between the flumes, suggests that each day a "slug" of snowmelt water enters the channel from high in the basin during the late morning and afternoon, and this slug travels downstream at about the velocity of water in the stream. To travel the ca. 5 km between the flume sites in 3-4 hours, velocities of 2-3 ft/sec are indicated. Current meter measurements confirm this as the average water velocity in the channel.

In contrast, the fluctuations during June-September are exactly in phase between the two flumes (Fig. 1b). This similarity is unusual, and suggests that a simultaneous mechanism is controlling flow at both sites. This mechanism may be phreatophyte transpiration by streambank cottonwoods, which would withdraw water from Medano Creek. As discharge decreases throughout the summer and fall, so does the amplitude of diurnal fluctuations. For example, during the spring snowmelt (April 9-14, 1992) discharge fluctuates as much as 5 cfs at discharges of 15-30 cfs. By July, fluctuations are down to 1-2 cfs at discharges of 8-15 cfs. In early September fluctuations are less than 1 cfs at 4-7 cfs, and decrease to about 0.25 cfs in October at 3 cfs.

The seasonal fluctuations in discharge observed in Medano Creek are typical of mountain streams that receive most of their precipitation as snowmelt. In contrast, the diurnal fluctuations in discharge are unusual and have not previously been described in the literature in much detail. The diurnal fluctuations in Medano Creek thus have two unique aspects. First, the creek is one of the few well-documented cases of diurnal stream fluctuations supported by nearly 2 years of high-quality, hourly discharge measurements. Second, the diurnal fluctuations induce diurnal changes in the position of the surface flow terminus at Medano Creek. The terminus advances each day during the hours of peak discharge, and retreats upstream during times of low discharge. Observant visitors, who must wade across the creek to access the main dune mass, can now appreciate two rare fluvial phenomena at the same time--surge flow, and abnormally large diurnal discharge fluctuations.

Dr. McCalpin is president of Geo-Haz Consulting, Inc., of Estes Park, CO.

Literature Cited

Bean, D.W. 1977. Pulsating flow in alluvial channels: MS thesis, CO/State U, Fort Collins, CO 124 p.

McCalpin, J.P. 1992. Surface flow on Medano, Mosca, and Sand Creeks in relation to fault zones and water tables: unpublished Annual Report to the National Park Service, NPS Project No. GRSA-R91-0152m Nat 14m 1992m 39 p. plus Appendices.

Schumm, S.A., Bean, D.W. and Harvey, M.D. 1982. Bedform-dependent pulsating flow in Medano Creek, southern Colorado: Earth Surface Processes and Landforms, v. 7, p. 17-28.

Letters

To the Editor:

Now that I am about to be Shanghaied to NBS (*Morituri te salutamus!*) I have one last act to do vis-a-vis *Park Science*, aside from wishing you well.

It is this. I note that with increasing frequency you are mentioning particular species of birds in *Park Science*. That is terrific, and clearly demonstrates a maturing publication.

However, there is one thing that you (and others: you are not alone) are doing, and which is incorrect. It is this: English-language vernacular names of birds around the world are carefully chosen, formal and precise names. They are also for that reason proper nouns. Thus, **English names of bird species are always capitalized**. There are no exceptions to this: it is uniform ornithological format. Pick up any ornithological journal or book in English and you will see what I mean. The format is for initial caps only; thus, Red-winged Blackbird, Greater Golden-Plover, Western Bluebird, but convention also leads to Common and Roseate terns–omitting the initial caps for the collective in strings of common names.

Aside from indicating exactly which particular species you are talking about, this practice cleanly obviates such ambiguities as "eastern bluebird": is this a bluebird in the decadent east, or *Sialia sialis*? Etc.

Off the soapbox. Best wishes for the continued health of *Park Science*.

Sincerely,

P. A. Buckley
NPS Senior Scientist

Forest Ecosystem Management in the Pacific Northwest: A New Approach

By Edward E. Starkey
Research Biologist,
Cooperative Park Studies Unit, Oregon State University

On April 2, 1993, President Clinton held a Forest Conference in Portland, OR to address the existing forest management gridlock in the Pacific Northwest. For at least the last 20 years, management of federal forests in the region has been at the center of intense controversy. With the listing of the northern spotted owl as threatened under the Endangered Species Act, the debate moved to the courts. Currently, timber cutting on Forest Service and Bureau of Land Management lands within the range of the northern spotted owl has been essentially brought to a halt by federal court orders.

Following the Forest Conference, President Clinton created The Forest Ecosystem Management Assessment Team and two other working groups dealing with agency coordination and labor and community assistance. In his opening remarks, President Clinton stated the fundamental question for these working groups: "How can we achieve a balanced and comprehensive policy that recognizes the importance of the forests and timber to the economy and jobs in this region, and how can we preserve our precious old-growth forests, which are part of our national heritage and that, once destroyed, can never be replaced?".

The Forest Ecosystem Management Assessment Team was asked to identify management alternatives that attain the greatest economic and social contributions from the forests and also meet the requirements of the applicable laws and regulations, including the Endangered Species Act, the National Forest Management Act, the Federal Land Policy Management Act, and the National Environmental Policy Act.

From the beginning of this effort, agencies were explicitly instructed that they would be expected to work together in developing and implementing a regional forest plan. The Forest Ecosystem Management Assessment Team was further instructed to develop alternatives without regard to agency boundaries. Thus, all options were based on ecological conditions and objectives rather than agency jurisdiction.

Ten options were developed and analyzed, and subsequently included in a Draft Supplemental Environmental Impact Statement. These options included various combinations of Late-Successional Forest Reserves, Riparian Reserves, and prescriptions for management inside and outside of reserves.

Most timber cutting would occur outside the reserves. Size of the reserve systems varied from 4.2 to 11.5 million acres.

For all options, the team evaluated the likelihood of maintaining well-distributed habitat for populations of threatened marbled murrelets and northern spotted owls. Additionally, for seven of the options, similar assessments were completed for more than 1,000 plant and animal species that are closely associated with late-successional forests. The likelihood of maintaining connected, viable late-successional ecosystems was also evaluated. Likelihoods varied by option, but were generally related to the amount of late-successional forest included within reserve systems. Similar assessments were conducted for at-risk fish species and stocks, and these ratings were sensitive to degree of stream-side/watershed protection provided. Collectively these assessments probably represent the most extensive evaluation of biological risk ever undertaken to assist decision-makers in determining the degree to which an array of options might meet legal requirements.

Timber harvests under any of the options would be significantly less than levels of 1980-1989 (4.6 billion board feet per year), and ranged from 0.2 billion board feet per year to 1.8 billion board feet per year. A number of local communities would be seriously impacted by any of the options.

On July 1, President Clinton announced his selection of "Option 9" as the preferred alternative. This option includes approximately 7 million acres of congressionally reserved areas (eg., national parks and wilderness areas), 7 million acres of Late-Successional Reserves, 2.2 million acres of Riparian Reserves, 1.7 million acres of lands administratively withdrawn from timber harvest, and 4.9 million acres which would continue to be available for timber production and cutting. Approximately 1.2 billion board feet of timber could be cut each year under this option.

National parks represent approximately two million acres of the congressionally reserved areas included within Option 9. Although most national parks of the Pacific Northwest contain significant areas that are above tree line, these parks also contain invaluable stands of late-successional forests. For example, Olympic NP contains nearly all of the remaining uncut forest on the Olympic Peninsula, and is the cornerstone of any conservation strategy for the peninsula. Mt. Rainier, North Cascades, and Crater Lake NPs, along with adjacent U. S. Forest Service lands, also are integral components of Option 9. Redwoods NP contains the only significant federal forests on the north coast of California.

Implementation of Option 9 would significantly affect national parks and their management. Most importantly, the area of protected ecosystems in the vicinity of most parks would be greatly increased. Increased protection for Olympic NP is especially significant. The park and several small Wilderness Areas managed by the USFS contain approximately 960,000 acres. Under Option 9, an additional 500,000 acres of adjacent federal lands would be managed as a Late-Successional Reserve. Thus the effective size of the protected ecosystem would increase by more than 50 percent. However, because of past timber cutting, less than one-half of this additional area presently contains forests with late-successional characteristics. Therefore, it will be many decades before the Late-Successional Reserve becomes fully functional.

Significant additional protection is also provided for North Cascades and Mt. Rainier NPs, where nearly all adjacent federal lands would be managed as Late-Successional Reserves. Late-Successional Reserves would be established along portions of the eastern

Continued on page 25

Forest continued from page 24

and southwestern boundaries of Crater Lake, providing somewhat less protection than for the Washington parks.

Option 9 also provides increased opportunities for park managers to participate in regional land management planning. Regional coordinating groups may be established which would include park managers. Permanent technical support groups, with staff from all appropriate agencies, would carry out day-to-day activities, including coordination of monitoring, data information management, and sharing of information.

The team recommended that "federal agencies through the interagency coordination effort, should develop a multi-organizational resource monitoring system. Standards and guidelines that address design and quality control should be included." and "federal agencies in collaboration with public and private interests ..., should develop a research plan for the Pacific Northwest." As inventory and monitoring (I&M) programs are developed for national parks of the Pacific Northwest, park managers have an opportunity to contribute information which may be required to measure the effectiveness of the regional conservation strategy. Hopefully, this will be reflected in increased interagency cooperation and integration of I & M and research plans.

The scientific input to the process was essentially completed when President Clinton selected Option 9 as the preferred alternative. Now, policy-makers, the courts, and the public must decide whether the plan will be implemented. During the summer and fall, the plan will undergo judicial review to determine whether the current injunction on timber cutting can be removed or modified. Also, public and agency comments will be sought, as required by the National Environmental Policy Act.

Copies of both the ***Draft Supplemental EIS on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted-Owl*** and ***Forest Ecosystem Management: An Ecological, Economic and Social Assessment***, the Report of the Forest Ecosystem Management Assessment Team, are available from the Interagency SEIS Team, P.O. Box 3623, Portland, Oregon, 97208-3623 (503-326-7883).

The comment period on the SEIS ends Oct. 28, 1993, but allows plenty of review time. Each document is several hundred pages in length.

Dr. Starkey served as a member of the Forest Ecosystem Management Assessment Team, as well as the Recovery Team for the Northern Spotted Owl.

MAB Notes

Important issues addressed at the July 19-20 meeting of the U.S. MAB National Committee included the upcoming managers' workshop and funding of several research projects. The **U.S. Biosphere Reserve Action Plan Workshop** will be held Dec. 6-10, 1993 at Estes Park, CO. Of the 47 U.S. biosphere reserves (BRs), 44 expressed interest in participating in Plan development and planned to send representatives to the workshop. Beginning with a skeletal draft action plan, participants will produce a final draft action plan to guide biosphere reserve activities over the next decade or so. This will be the first national biosphere beserve managers' meeting since 1984, and will have broader representation, since the earlier meeting consisted largely of NPS biosphere reserve managers.

* * *

Research projects funded for FY 1993 included three that involved NPS biosphere reserves. The Human-Dominated Systems Directorate Core Project, Ecological Sustainability and Human Institutions, will characterize ecological sustainability, using case studies of the south Florida region, the Virginia Coastal Reserve, and the New Jersey Pinelands.

The Circumpolar Biosphere Reserve project will initiate several cooperative surveys and data exchanges and an exchange of managers between Archipelago Sea National Park in Finland and Glacier Bay NP and Preserve in Alaska. Both of these BRs face important challenges to commercial and Native subsistence fisheries management issues.

Biological, Socio-Economic and Managerial Concerns of Harvesting Edible Mushrooms on the Olympic Peninsula and in the Southern Appalachians will complement the core research of the Temperate Ecosystems Directorate, which will provide information to "...manage temperate landscapes for diversity, resilience, productivity, and sustainability for the long-term.

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The **Mammoth Cave Area Biosphere Reserve**'s power to take regional action has been greatly strengthened by a cooperative agreement between Mammoth Cave NP and the Barren River Area Development District (BRADD). The Economic Development Administration has granted BRADD $50,000 for sustainable economic development studies in the BR area, and the Soil Conservation Service is administering a $5 million program in the area focusing on protection of groundwater integral to cave resources. The BRADD board of directors--the city and county officials directly affected--has voted to more than double the BR's present size of 80,000 acres.

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Great potential for MAB regional and international cooperation has arisen with the establishment on June 10 of a biosphere reserve in northwest Sonora, Mexico. Three core areas totaling more than 1 million acres are included: the volcanic Pinacate region; Gran Desierto de Altar, a vast, mountain-studded area of sand dunes; and the Colorado River delta with some adjacent waters of the Gulf of California.

Secretary of the Interior Bruce Babbitt attended the dedication ceremony at Puerto Penasco, joining Mexico's President Salinas and Mr. Colosio, head of the Secretariat of Social Development, which will administer the reserve. Several Mexican government bodies are jointly developing a management plan. On the Arizona side of the border, Organ Pipe Cactus National Monument and the Cabeza Prieta National Wildlife Refuge provide large protected areas that could be part of an international regional MAB program. On-going community-based "town meetings," facilitated by the Sonoran Institute, are exploring ways to promote cooperation and implement biosphere reserve concepts in the region.

* * *

EuroMAB is making good progress with its **Biosphere Reserves Integrated Monitoring Program** (BRIM)). The purpose of BRIM is to "harmonize" the collection, reporting, and accessibility of scientific data from the 32-country, 175-unit EuroMAB biosphere network, which includes Canada and the U.S. Biological inventory data are the primary initial focus for developing the broad-based network.

Twenty-five inventory databases for birds have been completed and many more are expected. Biological records in some BRs span several centuries. A few BRs in the Czech Republic have floristic collections dating from the 16th to the 18th centuries. A computer program called MABBird has been designed to allow users to efficiently access, edit, and retrieve information contained in BR bird survey databases. Peace Corps volunteers may assist with computerization of inventory data in Eastern European biosphere reserves.

Napier Shelton
NPS Washington Office

Karst Groundwater Basins: An Abstract of Analysis

By Joe Meiman

The protection and conservation of aquatic resources poses special problems to resource managers; typically, drainage basins extend far beyond park boundaries. As any land use within the watershed is manifested in the water quality down-basin, the most effective resource management decisions are born from a watershed approach. A watershed strategy takes into account all land use activities occurring within a drainage basin and determines the effects of each activity on the water quality downstream. At Mammoth Cave NP, hydrologists have used a watershed strategy in analyzing karst* groundwater basins.

The analogy between a surface drainage system, with dendritic flow patterns converging on a master stream, and the transfer of groundwater through a cave system, is often used when describing flow through the karst aquifer of south-central Kentucky. Since in many fundamental ways a karst aquifer behaves as a surface stream network, similar sampling strategies, with important modifications, are used to document the water quality of a karst basin.

As the boundaries of a karst groundwater basin are being defined by qualitative dye tracing, non-conditional synoptic water quality sampling is conducted. Non-conditional synoptic sampling (extracting a sample on a fixed date regardless of flow condition) will provide the researcher with an inventory of contaminants in a cave stream or spring under the continuum of discharge conditions.

Furthermore, the investigator must measure, or at least best approximate, site discharge upon sampling. Discharge, when combined with parameter concentrations, yields mass flux (mass per time), which may provide valuable information regarding contaminant transfer from the surface to the subsurface. For example, mass flux data at Mammoth Cave NP reveal that flood pulse-producing sudden recharge events (rainfall) are the primary agents of groundwater quality degradation. When we have the highest water quantity we have the lowest water quality.

After flood pulses are identified as instruments of karst groundwater contamination, they must be parametrically quantified. Without frequent sampling, it is difficult to accurately measure the large fluctuations in many water quality parameters that occur in karst waters during and following storm events. As products of conduit flow aquifers, these fluctuations are commonly of high amplitude and short wavelength. However, even brief increases in certain contaminants may yield serious consequences at water supply springs, and have lasting detrimental effects on aquatic cave life. Therefore, storm event spring sampling must be included in any karst groundwater characterization effort.

It is vital that flood pulse sampling include a series of sequential samples beginning prior to the recharge event and continuing until flow and water quality approach antecedent conditions. Repeated, rigorous circum-storm water sampling at a particular spring or cave stream may reveal a unique combination of parametric response traits. A spring's storm response is actually composed of numerous overlapping subset responses, each originating from individual inputs or groups of inputs. The chemical and physical waveforms of a flood pulse are modified by various attributes unique to individual karst basins. Antecedent phreatic water within the conduit system may cause a significant delay between a spring's discharge response and the eventual arrival of storm-derived water. A flood wave may be compressionally propagated through a phreatic conduit possibly creating peak discharges well before the arrival of storm waters.

An analogy may lie as close as your backyard. A garden hose filled with water on a warm day immediately discharges warm water when the tap is turned on, and the arrival of the cool water, which actually caused the expulsion of warm water, may take some time. In the same way, it is possible that if the investigator only samples up to the peak discharge, a significant portion of the contaminant pulse will be missed.

Tracer dyes injected with the storm water runoff may help to identify the contribution of a particular subset of inputs to the whole storm response. In order to tag a flood pulse, the investigator must equip the spring with an automatic sampler. The sampling interval will be determined by factors such as the spring's relative response to recharge and groundwater flow velocities defined by previous quantitative tracing. At the onset of recharge, the fluorescent dye is injected into a sinkpoint with the runoff. Samples then will be analyzed for targeted parameters as well as the dye. An in-phase relation between the dye recovery curve and a contaminant pulse may not only identify the pollution source, but also suggest the amount of contaminant exported from that particular input.

A detailed account of flood pulse tagging and circum-storm sampling at Big Spring Groundwater Basin, Mammoth Cave NP has been written and is available to interested parties. An NPS Scientific Monograph also is being written by the author, describing holistic karst groundwater basin analysis. Write to: Joe Meiman, Mammoth Cave NP, Mammoth Cave, KY 42259

Meiman is Park Hydrologist at Mammoth Cave NP.

* Karst: A limestone region marked by sinks and interspersed with abrupt ridges, irregular protruberant rocks, caverns, and underground streams.

Hot Springs NP Considers Flood Control Alternatives

Hot Springs National Park and the adjacent city of Hot Springs, Arkansas, have been subjected to periodic devastating floods many times over the last century. In an effort to reduce the intensity and damage from floods, the City, the NPS, and the U.S. Army Corps of Engineers have been involved in a series of studies to determine alternative solutions.

The Corps has identified a preferred alternative: a 26 foot diameter tunnel through West Mountain (inside the park) to route flood waters away from the most vulnerable area of the park (the historic Bathhouse Row) and the city. Regional and WASO Water Resources Division staff have worked closely with the Corps on this project for many months and have succeeded in getting the Corps to name a distinguished panel of independent hydrogeologists to develop the strategy for feasibility investigations.

While the NPS is satisfied that maximum precautions will be taken to protect the springs and other resources of the park, the Service is reluctant to pursue this course. The Corps has applied for a Special Use Permit to drill a series of test wells to study the tunnel route. Rather than deny the permit request outright, NPS Director Kennedy has promised the Corps some positive alternatives that would be acceptable to the Park Service.

The NPS has named its own panel of experts to develop those alternatives to the tunnel proposal and a report was expected by the end of September.

Four New Videos Made in NPs Take Honors at Film Festival

Four national parks are featured in award winning videos, honored at the 30th National Outdoor-Travel Film Festival, sponsored this year by the Michigan Outdoor Writers Association. Brief reviews of the four were submitted to *Park Science* by K.R. Cranson, recently retired after a 31-year teaching career, most recently at Lansing Community College in Michigan.

***Yellowstone: Imprints of Geologic Time*, Blair Robbins, 1992, 27 min., Terra Productions, 2019 Fairview Ave. East, Suite K, Seattle, WA 98102, (206) 238-3080, $29.95**...Gives the gologic history of the world's first national park. Aimed at a popular audience, it affords a comprehensive review of Yellowstone's geologic record. All components are included, from the 2+ billion year old Precambrian rocks to the workings of geysers. A nice set of simple graphics illustrates the numerous geologic concepts presented. The presentation of wildlife early in the film is designed to capture attention of students in a classroom, but teachers interested in the geology message would do well to prepare students prior to viewing, preferably with some kind of handout or a worksheet focused on the geologic history of Yellowstone. As an introduction or review of the Yellowstone geology story it's the best I've seen in recent years.

***Isle Royal Reflections*, Frida Waara and Mike Settles, 1992, 22 min., On-Cue Production, 200 Timberlane, Marquette, MI 48955, (906) 249-1903, $24.95**... Impressions of this remote region by four artists, each using a different medium: photography, painting, writing, and sculpture. Abundance of water and variety of wildlife and vegetation are paramount in this look at the most isolated island national park in the United States. The film provides insight into how direct contact with natural areas can inspire creativity–a nice link between arts and the natural world.

***Grand Canyon: River of Dreams*, John Wilcox, 1992, American Adventure Productions, 3190 Baltic Ave., Aspen CO 81611, (303) 920-3777, $24.00**... received the Best Environmental Documentary award for exploring one of the earth's great river systems. The emphasis in definitely on adventure–the excitement of white water rides in the same boat with world champion river runners. Nice photography of the canyon walls and river illustrate the dramatic geology, but little dialogue contributes to this topic. Same is true for wildlife and vegetation along the canyon bottom. With proper introduction and study aids, this video provides a significant environmental story, told excitingly in an extremely scenic setting.

***Stephen Lyman: Warmed By the View*, Jonathan S. Felt, 1992, 12 min., Greenwich Workshop Gallery, 2600 Post Road, Southport, CT 06490, (800) 243-4260, contact producer for cost**... A nice, short introduction to interdisciplinary discussion in art, humanities, or social science topics, filmed at Yosemite National Park. There is far too little science content to be useful for science purposes, but the video certainly qualifies for the award it received–Most Unusual Treatment of an Outdoor Subject.

K.R. (Rod) Cranson
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Lansing, MI 48917

T & E Workshop in Southwest Draws on Several Agencies

The Southwest Region's Division of Natural Resource Management and Science staff presented a threatened and endangered (T&E) workshop in Albuquerque, NM Aug. 18-20, 1993. The course featured substantial involvement from the New Mexico Natural Heritage Program, U.S. Forest Service, New Mexico Department of Game and Fish, New Mexico Energy, Minerals and Natural Resources Department, the Bureau of Land Management, a number of parks, and the Southwest Regional Office.

Highlights included a talk on the future of T&E species management by USFWS Regional Director Dr. John Rogers, as well as a field trip to the Rio Grande Zoo to learn about the captive breeding program for endangered species, including the Mexican wolf.

The program was co-funded by the Washington Office and organized by John Miller, Chief of the Resource Management Division at Padre Island National Seashore.

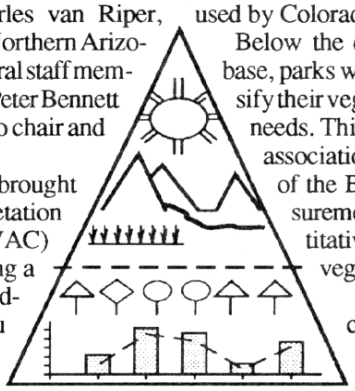
Colorado Plateau Vegetation Advisory Committee: A Working Model for Standardization

By Elena T. Deshler

The need to standardize a Colorado Plateau-wide vegetation classification scheme in relation to Geographic Information System (GIS) requirements was recognized two years ago, at the 1991 Colorado Plateau (COPL) Workshop. Charles van Riper, leader of the NPS CPSU at Northern Arizona State University, and several staff members identified the need, and Peter Bennett (CPSU/U/AZ) was named to chair and coordinate the effort.

Bennett has effectively brought the Colorado Plateau Vegetation Advisory Committee (CPVAC) vision into reality by creating a handbook that provides guidance to all Colorado Plateau parks. The handbook is based on the Brown, Lowe, and Pase vegetation classification system (BLP) and was presented on October 27-28, 1992, to 21 participants at a meeting to explain the methodologies and techniques suggested in the draft handbook.

At that meeting, Van Riper conceptualized the BLP hierarchical system in a triangle diagram (above). The top of the triangle represents the biogeographical realm; the base of the triangle represents the detailed quantitative measurements designed for intensive vegetation studies. The dotted line across the triangle stands for the mappable, standard vegetation classification level, based on climax plant dominants, that would be used by Colorado Plateau parks.



Below the dotted line level, along the base, parks will have the freedom to classify their vegetation to meet specific park needs. This level would incorporate the association and sub-association levels of the BLP, utilizing detailed measurements and assessments of quantitative, as opposed to qualitative, vegetation characteristics.

Dr. Charles Lowe, one of the co-authors of BLP, gave an historical perspective of the system, emphasizing the need to incorporate both field methodology and the BLP system in order to gain a COPL vegetation map. The COPS resource managers will be responsible for the continued use and additions to the handbook, thus providing a continually evolving process that will be molded to fit the needs of the users on the Colorado Plateau.

Deshler is a Biological Technician with the CPSU at Northern AZ Univ.

Shared Beringian Heritage Program Underway

By Dale Taylor

Editor's Note: This is the first of several articles planned to cover results stemming from the Shared Beringian Heritage Research Program.

Mysticism surrounds the narrow strait separating the continents of Asia and North America. This region, which today is ice covered much of the year giving rise to extremely cold water during the short summer, is near the heart of "Beringia." Beringia, the name used by botanist Hulten as early as 1937 (Matthews 1982), describes an area of Alaska and Siberia that was, in part, intermittently covered by seas (Fig. 1). Evidence points to the Bering Land Bridge between North America and Asia at numerous times beginning in the early Tertiary and as recently as 13,0000 and possibly 11,000 years ago (Hopkins 1967). This alternate formation and later covering of the land bridge by water as the continental ice sheets waxed and waned, provided opportunities for genetic and cultural exchanges and isolation.

The cultural and biological heritage of Beringia has been recognized for many years (Hopkins, et al, 1982 and Hopkins 1967). Prevailing political climate prevented proposals by Roberts (1981, 1984, and 1985) for an international research park in Beringia from reaching fruition. However, in 1986 the Beringian Heritage International Park project was established under the authority of the 1972 US-USSR Agreement on Cooperation in the Field of Environmental Protection, working group 02.04.20. Specific activities were developed by the working group in protocols of June and October 1987. The Agreement was reauthorized in May 1992 and included working group 02.04.40-44 dealing with establishment, management, policy, and research in the Beringian Heritage International Park.

In September 1989, American and Soviet planning teams recommended an international park in a report entitled the *Beringian Heritage Reconnaissance Study* (1989). Presidents Bush and Gorbachev issued a summit agreement in June 1990 calling for cooperation in studying ecology, archaeology, and cultural heritage in the Bering Strait. Though President Gorbachev stepped down from power following the September 1991 coup in the USSR, the process for establishing the park continued. Presidents Bush and Yeltsen issued a joint statement in June 1992 to reaffirm their vision of the Beringia International Park as formal recognition of the shared natural and cultural heritage of the Bering region. Legislation to establish the park is in various stages in both countries.

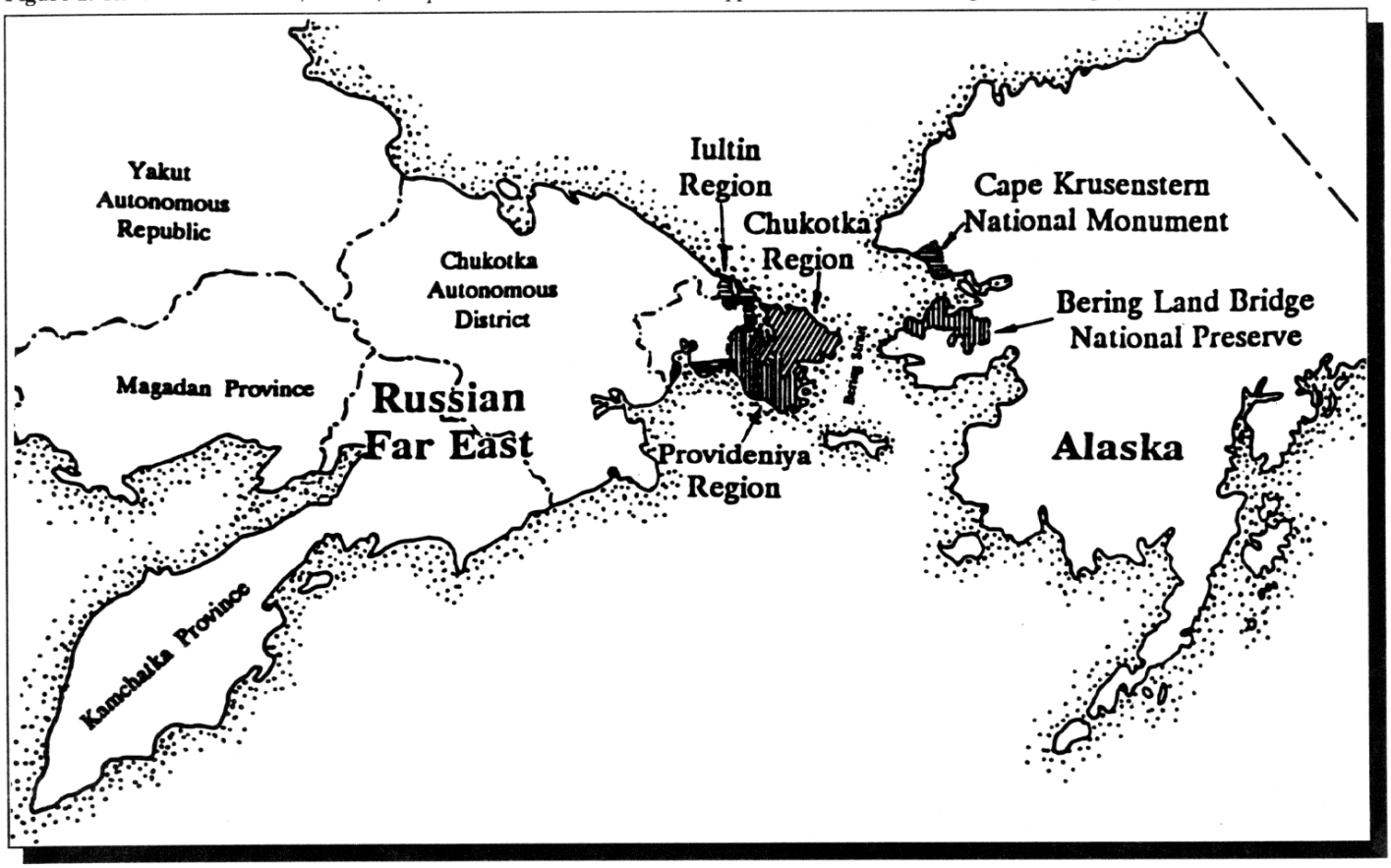
In response to these agreements, yet ever mindful of the political arena, where changes could influence final establishment of the park, the NPS embarked on a Shared Beringian Heritage research program. The international, multidisciplinary research program brings Russian and American scientists, resource managers, and Native people together in a long-term, integrated study of traditional lifeways, biogeography, and landscape history on the Seward and Chukotka Peninsulas (Schaaf 1992). Papers describing the research will be presented in future issues of *Park Science*. The purpose of this paper is to present preliminary results from botanical studies being conducted in Alaska and Chukotka as part of the Shared Beringian Heritage Program.

THE FLORA PROJECT

The Need

The intermittent emergence of the Bering Land Bridge favored an exchange between the two continents, predominantly the dispersal of plants from Asia to America. Knowledge of the flora, which will lead to understanding interchanges between two continents, although greater in Chukotka than in

Figure 1. The Russian Far East, Alaska, and portions of Canada outline the approximate area of "Beringia." *Drawing by Kate Solovjova.*



Alaska, is incomplete in both areas. Botanists from the Komarov Botanical Institute, St. Petersburg, Russia, have been collecting information in Chukotka for years.

On the other hand, Kelso (1993) describes the first plant collectors on the Seward Peninsula as naturalists on the early voyages of arctic exploration. They focused almost entirely on areas around the few harbors offering protection from the Bering Sea storms. Major inventories in the interior are few, but include the survey prior to establishment of the Bering Land Bridge National Preserve (Melchior) and work by Kelso (In prep.). The Bering Land Bridge National Preserve herbarium contains about 1,000 specimens and represents ongoing work. Little work had been done on non-vascular plants on the Seward Peninsula.

Project objectives are to: create databases for Bering Land Bridge National Preserve in a standard format that can be used by other parks; complete a checklist for different taxa; complete monographic descriptions of flora for comparison on a continental scale; complete geographic ranges; develop systems of biodiversity monitoring; create a standard geographical basis for the analysis of arctic biota; identify areas where intensive inventory and monitoring will be conducted on selected taxa; and develop general principles for database organization for analysis of floristic data.

Project Staff

An International Panarctic Biota Project is being organized by scientists from Russia and North America. The project is divided into categories of flora, mammals, birds, fish, invertebrates, etc. Project objectives fit with the overall objectives of the Beringian project and provide the added benefit of making the work a part of a circumpolar effort. An agreement was reached with leaders of the Panarctic Flora project in 1992 to begin in this "crossroads of the continents" with priority for work being done in Bering Land Bridge National Preserve.

Dr. Boris Yurtsev, Head, Laboratory of Vegetation of the Far North, Komarov Botanical Institute, St. Petersburg, (vascular plants), and Dr. David Murray, Curator of the Herbarium, U/AK Fairbanks (vascular plants), are leaders of the Circumpolar Flora project. Dr. Yurtsev has worked on the Chukotka Peninsula part of the Beringian International Park; Dr. Murray has worked in Alaska and headed the Herbarium for over 20 years. Co-Investigator Dr. Barbara Murray is Research Professor of Cryptogamic Botany and Honorary Curator of the Cryptogamic Collection at the U/AK Herbarium, and specializes in bryophytes and lichens. Dr. Sylvia Kelso, Colorado College (vascular plants), Dr. Mikhail Andreev (lichens), Dr. Olga Afonina (mosses), and Dr. Alexey Potemkin (hepatics), all of the Cryptogamic Botany Lab, St. Petersburg, and I completed the field crew. Dr. Alan Batten (database manager) and Carolyn Parker (herbarium assistant), Rich Harris, Anne Coupland, and Tauny Rogers (Bering Land Bridge National Preserve Resources Management staff) completed the working crews over the 2-year period.

After a 2-month field and laboratory season in 1992, the following preliminary results have been provided by specialists:

Vascular Plants (*David Murray*)

Collected were 669 plants, which translated into 2 or 3 times as many sheets of specimens. These were re-examined in the lab and now await data entry and labels, which the computer will print automatically, before breaking them into sets for distribution to Bering Land Bridge Preserve, Komarov Institute, and the Herbarium in Fairbanks.

Among the 480 taxa noted, one appears to be a new species and several are new to science at infraspecific ranks (subspecies or variety); 25 Asian taxa have been reported for the first time from North America; 30 taxa are new records for the Seward Peninsula as per the checklist of Kelso (manuscript), and more than 100 extensions of range on the Seward Peninsula are recorded. The final precise tally awaits further work and, most of all, a resolution of differing traditions in taxonomy and species concept manifest in the view of the Russians of the Komarovian school vs. the Americans.

Hepatics (*A. D. Potemkin*)

Generally it is true that the liverwort flora of arctic Alaska is poorly known, and prior to this study only about 20 species had been reported from the Seward Peninsula. Almost all the taxa collected represent additions to the flora of the Seward Peninsula. We found taxa new to arctic Alaska, new to Alaska, new to North America, and one taxon new to science.

During the expedition about 400 specimens were collected. These included about 150 taxa (126 species, 4 subspecies, 13 varieties, and 4 forms). Approximately 1/3 of all taxa (35 species, 2 subspecies, 8 varieties, and 3 forms) are new for arctic Alaska.

Some discoveries represent considerable range extensions. Three species were found in the Arctic, in the strict sense, for the first time; two species were known previously in North America only in the Northwest Territories, and one species only in Washington and British Columbia. Several taxa are new to North America. Before confirming the identification for some taxa among those apparently new to North America, it will be necessary to examine material at other herbaria.

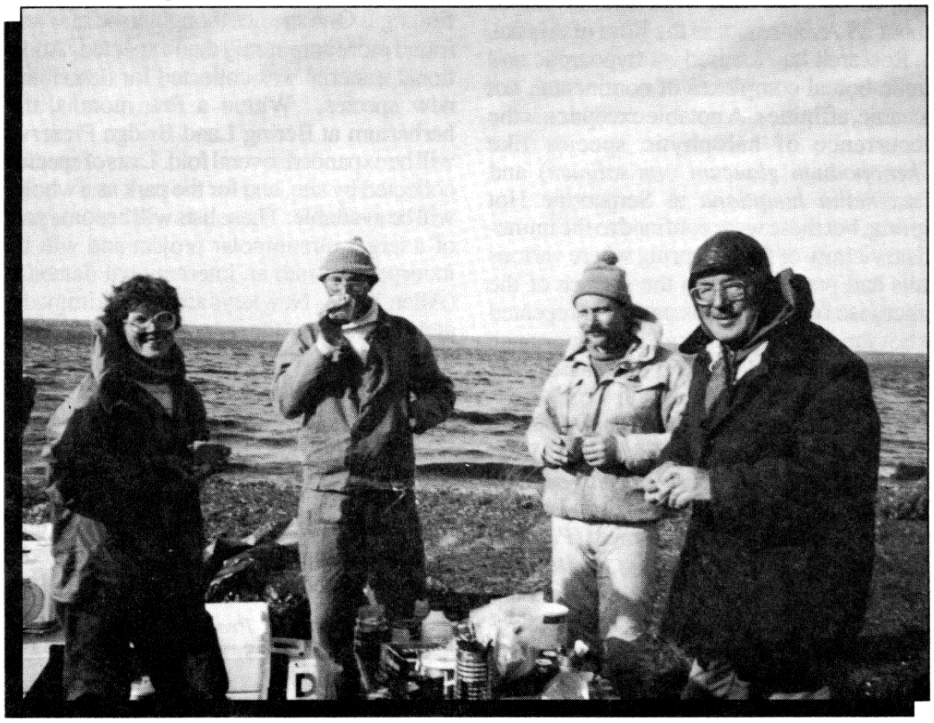
A taxonomic description is being prepared for *Gymnocolea fascinifera*, a species new to science.

Mosses (*O.M. Afonina*)

Little has been recorded about the Seward Peninsula mosses, so many of the species found in 1992 represent new records for the

Continued on page 30

Russian scientists Dr. Olga Afonina, Dr. Alexey Potemkin, Dr. Mikhail Andreev, and Dr. Boris Yurtsev in Bering Land Bridge National Preserve. *Photo by David Murray.*



Peninsula. Approximately 1,000 collections were made. To date, about 70 percent have been identified. The preliminary checklist includes about 230 species; three are new for North America and five are new for Alaska. Several rare and otherwise interesting species for the Seward Peninsula were found and new data on their distribution and ecology were obtained.

Lichens (*M.P. Andreev*)

Time constraints have prevented identification of approximately 1/2 the collection made during 1992. Those identified include the most common species, mostly macrolichens (fruiticose and foliose forms). Much of the unidentified material is of difficult crustose lichens.

At this time the species list totals 218, most of which have been reported previously from Alaska. Because the Seward Peninsula is poorly known lichenologically, 30 species otherwise common in Alaska are reported here as new to the Seward Peninsula. Identified material includes two species new to North America, one species new to Alaska, and nine rare Beringian species.

Comparison of Alaskan And Chukotka Vascular Flora (*B.A. Yurtsev*)

The vascular plant floras of Chukotka and western Alaska are very similar. Of the 480 taxa at the rank of species and subspecies in our preliminary list, fewer than 40 are not found in Chukotka as well. The similarity is especially strong on calcareous habitats such as the Eldorado Creek uplands. The Asiatic component of the Alaskan flora was better defined by 1992 field work that has added about 25 Asiatic taxa to the flora of Alaska.

Research has focused on hypoarctic and arctic-boreal complexes of continental, not oceanic, affinities. A notable exception is the occurrence of halophytic species like *Chenopodium glaucum* (var.*salinum*) and *Puccinellia hauptiana* at Serpentine Hot Spring, but these were confined to the immediate vicinity of the hot spring where various salts had precipitated on the surface of the otherwise bare soil. This pattern is repeated at hot springs on Chukotka. The importance of the continental species decreased with elevation, which was evident in the distribution and local importance of *Rhododendron camtschaticum* subsp. *glandulosum*, *Saxifrage nudicaulis*, and *Luzula beringensis* on the slopes of Mt. Boyan at Kuzitrin Lake.

There is a larger boreal element (*Populus balsamifera*, *P. tremuloides*, *Betula* cf *kenaica*, *Picea glauca*) on the Seward Peninsula than on Chukotka, which is a reflection of the major zonation represented at each locality. The Seward Peninsula is mainly in the southern hypoarctic subzone, whereas Chukotka is primarily in the middle hypoarctic subzone of the tundra. There also was an underrepresentation of arctic and arctic-alpine species (e.g. of the genus *Draba*) even on calcareous substrates.

Traveling by air from south to north on the Peninsula revealed a shift from shrublands and thickets in the south to rolling hills and high terraces covered, for the most part, by tussock tundra, *Eriophorum vaginatum*. In the shrub zones the willow thickets on carbonate landscapes have a parallel in the Chegitun River drainage on the Chukotka Peninsula, and the mixed thickets of willow, shrub birch, and alder on non calcareous areas are similar to those on the coast of the Anadyr estuary and in the Amguema internmontaine depression.

Generally, the shrub birch thickets, which are so prominent in Alaska, play insignificant roles in adjacent, easternmost Chukotka. The tussock tundra associations have a less diverse herbaceous element in Alaska than in Chukotka; that is, the vascular plant species richness is higher in Chukotka. Extensive surveys near the village of Yanrakynnot have yielded 450 taxa. While the very short surveys in Alaska are not strictly comparable to Yanrakynnot results, nevertheless it is instructive to note the following talleys: Eldorado Uplands (1 day) 140 taxa, Trail Creek (1 day) 170 taxa, Lost Jim Lava Flow (2,000 years old) (1/2 day) 50 taxa, Quartz Creek (3 days) 220 taxa, Serpentine Hot Spring (4 days) 200 taxa.

1993 Fieldwork has just concluded with results similar to 1992, but with fewer "new" findings. One species thought to be rare was found more commonly than expected. Additional material was collected for describing new species. Within a few months, the herbarium at Bering Land Bridge Preserve will be expanded several fold. Lists of species collected by site, and for the park as a whole, will be available. These lists will become part of a larger circumpolar project and will be incorporated into an international database (Allen 1993). New keys are needed immediately to replace the one rendered obsolete with the new data.

There are still areas needing botanical work within Bering Land Bridge National Preserve, and as this work occurs, more species will be found and more range extensions will be noted. For now, we have "finished" a plant inventory in one park unit in Alaska, leaving **only** 53 million acres more to contemplate!

Taylor is Special Projects Leaders, Alaska Regional Office, NPS, 2525 Gambell St., Anchorage, AK 99503.

Literature Cited

Allen, W.H. 1993. The rise of the botanical database. Bioscience 43 (5): 274-279.

International Park Program. 1989. Beringian Heritage: A Reconnaissance Study of Sites and Recommendations. Denver Service Center, NPS, Denver, CO. NPS D-1. 56 pp.

Hopkins, D.M. ed. The Bering Land Bridge. 1967. Stanford: Stanford Univ. Press.

Hopkins, D.M., J.V. Matthews, C.E. Schweger and S.G. Young. 1982. Paleoecology of Beringia. New York: Academic Press.

Kelso, Sylvia. 1993. Field report. 1992 Panarctic Flora project expedition to Bering Land Bridge National Preserve, Seward Peninsula, Alaska. NPS AK Regional Office, Anchorage.

Kelso, Sylvia. In prep. Vascular plants of the Seward Peninsula.

Matthews, J.V. 1982. East Beringia during late Wisconsin Time: A review of the biotic evidence. pp. 127-150. IN Hopkins, D.M., J.V. Matthews, C.E. Schweger and S.G. Young. Paleoecology of Beringia. New York: Academic Press.

Melchior, Herbert R., Ed; 1974 Final Report Chukchi-Imuruk Biol. Surv., CPSU U/AK, Fairbanks, 517 pp.

Roberts, Walter Orr. 1991. Letter to Robert O. Anderson. University Corporation for Atmospheric Research, Boulder, CO 80307.

Roberts, Walter Orr. 1984. Why not U.S.-Soviet Bering team effort? *Los Angeles Times*. Nov. 6.

Roberts, Walter Orr. 1985. Out of an impasse through a Strait: A proposal for a research park. J. World Resources Institute. 1985:68-70.

Schaaf, J. 1992. The shared Beringian Heritage program. Gederal Archeology Report 5(2):1-4.

In the next issue . . .

Editor's Note: Due to the timeliness and length of this month's articles, "Information Crossfile" will not appear in this issue. It will return in the next issue with the stories which were to appear this time plus those for the winter issue – promise!

- "Extended Gap Analysis and NPS Planning" by Gary Machlis and Deborah Forester
- "Ancient Geology of the Columbia River" by Dan Brown
- "BLM's Global Positioning System at Hagerman Fossil Beds" by Chris Force
- "Laughing Gulls at Kennedy Airport" by John Tanacredi
- "Natural Restoration of Black Bears at Big Bend NP" by RickLoBello
- "Evaluating the Effects of Commercial Fishing at Glacier Bay NP" by Philip Hooge
- "Notes from Abroad (China)" by David Ek
- "Integration vs. Separation in Natural and Historic Stewardship" by Ethan Carr
- "Vegetative Aspects of the Olympic NP Goat Report" by Paul Crawford

Commentary on the emerging National Biological Survey has been appearing here and there in print as the concept evolves. Some of the more interesting thoughts, from qualified "thinkers" on the subject are herewith excerpted and presented, together with the source from which they were taken:

From ***Colorado Plateau***, *Quarterly Newsletter for Resource Management of Colorado Plateau NPs*, Vol. 3, No. 3, Summer 1993:

"Kilgore [Dr. Bruce Kilgore, Chief of Western Region's Division of Natural Resources and Research] is pleased with the Secretary's commitment to better science and to better service to resource managers by providing a national focus for inventorying and monitoring biological resources, by ensuring that NPS decision makers receive high quality biological information, and by conducting the proactive research needed to avoid conflicts between economic and environmental goals.

"Kilgore encourages Park Service personnel 'to work closely with Denny Fenn, Gene Hester, and the NBS Implementation Team to see that they are successful in achieving these very ambitious goals.'

"Since the NBS proposal is to be implemented through the transfer of NPS and Fish and Wildlife Service research scientists, Kilgore states that 'the Park Service is faced with the challenge to find a way to ensure that the NBS can provide for both the broad strategic research needs of our country's ecosystems, while continuing to serve the immediate, short-range, tactical research needs of Park Service superintendents and other managers.'

"Kilgore also wants to ensure that 'our current NPS scientists and our CPSUs are supported in their new assignment in a way that not only allows them, but encourages them, to finish on-going high priority research projects and to begin a new series of both long-term and short-term I&M research and information transfer to managers.'

"Kilgore continues, 'It's my feeling that our superintendents need to have easy access to the new NBS Coop Units, not unlike the relationship they have developed with our existing CPSUs.'"

* * *

From the statement by Gary E. Davis, Research Marine Biologist, presented at the NBS Eco-Center Meeting, May 3-5, 1993, in Portland, OR:

"To suggest an initial agenda for the NBS, I will identify four broad national trends affecting biotic resources, describe a research agenda to understand and mitigate the negative effects of those trends, and suggest a national focus for these programs to enhance NBS credibility.

Some Additional Thoughts On the NBS

"National attitudes toward natural resources drive all of the trends I will identify. Oddly, the Nation's approach to natural resource-based economic development did not change when the American frontier closed in the 19th Century. We continue to consume resources as if they were inexhaustible, as if we could still go over the next mountain range when we run out of land, but we can't. We live in a **finite** world with **finite** resources, yet we continue to act as if technology would always bail us out, no matter how much we degrade our environment. The rapidly increasing human population in the U.S. that continues to demand more resources per capita from a finite resource base drives trends in biotic resources that require immediate attention to avert economic, social, and environmental catastrophe.

Trends

"1. UNSUSTAINABLE CONSUMPTION OF 'RENEWABLE' RESOURCES drives populations and communities to failure, e.g. serial depletion of coastal fishery stocks and harvest of ancient forests. California's largest coastal fishery is a prime example. In southern California, the diving fishery exhausted stocks of abalone species, one after another, from 1950 to 1980, shifted to red sea urchins in the mid 1970s, expanded into northern California in the late 1980s when stocks declined, and began developing new markets for purple urchins in the early 1990s. This pattern of biotic resource exploitation is common worldwide.

"2. LAND-USE PRACTICES THAT FRAGMENT HABITATS erode society's productive resource base when populations and communities collapse for lack of appropriate space, i.e. critical habitat. Coastal development threatens migratory birds and coastal fisheries with the loss of marshes and estuaries. Loss of large, wide-ranging predators alters community structure and function, thereby accelerating loss of biodiversity.

"3. HUMAN ALTERATIONS OF AIR, WATER, AND SOIL drive ecosystems toward unstable and less productive states, e.g. pollution simplified systems, reduced productivity of contaminated wildlife, ground water extraction, and surface water diversion.

"4. SPREAD OF ALIEN SPECIES causes loss of biodiversity and disrupts ecosystem structure and function. The virtual extinction of native birds on Guam caused by introduced brown tree snakes provides a sobering example of the serious ecological impacts of alien species. Alien species are wreaking havoc on Hawaiian flora and fauna."

Davis's statement asked that the NBS agenda address these trends "with directed programs, not simply collections of related projects." He named five areas of focus needed (1) to lead the exploration of ecological restoration, (2) to develop ecosystem monitoring protocols, (3) to improve understanding of viable populations, (4) to invent ways to predict ecosystem behavior, and (5) to explore adaptive ecosystem management.

"As Machiavelli warned his prince," Davis said, "a new organization that seeks to change established ways of conducting business has few allies. To overcome this handicap, I suggest that the NBS use the National Park System, to focus attention on the nationwide plight of biotic resources...not just to help resolve park issues, but to help realize the potential of national parks to resolve society's broader environmental issues and to produce truly sustainable economic development."

Campfires and Firewood: A Global Perspective

Dick Cunningham is at it again!

The creative, energetic (does this man *ever* sleep?) Chief of Interpretation for the NPS Western Region has produced another small interpretive gem–this time a 6-page piece of resource material for interpreters who want to use the traditional campfire as the centerpiece for a program about firewood.

"I need to strongly emphasize," Cunningham says, "that I am **NOT** advocating the abolishment or the reduction of campfire talks. They are an important part of our interpretive history and will continue to be so. What I do want to discuss for your consideration is the use of firewood on a global basis, its environmental impacts, and the relationship to our campfire programs."

The piece begins with a nod to the "something magical" about staring into a blazing campfire, "listening to the pop of the burning wood," smelling the smoke and perhaps groping our way back via these sensations to an earlier stage of human development when fire represented the center of human life.

Then he describes the results of deforestation and fuel-wood cutting in Africa (6 specific countries), Asia (5 countries), and Latin America (5 countries). Twelve selected references are given for the student who wants more. The result could be a sober reflection of how blessed the United States has been, with the "luxury" to burn wood in our home fireplaces and at park campfires. "There is a strong environmental message here," Cunningham says, "that we interpreters should be personally aware of. I further believe it is a message that should be integrated into our campfire talks."

So perhaps the next time someone says "Ranger, throw another log on the fire," Cunningham suggests the response might be: "That reminds me... I have a story to tell you about firewood."

Dave Mech Receives National Award

Dr. L. David Mech, principal investigator on the Denali Wolf Project, has received the Aldo Leopold Award, given for distinguished service in wildlife conservation – considered by many to be the ultimate recognition of a wildlife professional.

In presenting the award at the North American Wildlife and Natural Resources Conference in Washington, DC in March, Dr. Alan Wentz, president of The Wildlife Society, stated that Mech "stands as testimony that one individual can indeed make a difference in the complex world of conservation and do so without benefit of a large staff. His trademarks are a boundless productive capacity, unswerving dedication, ability to win others to his cause, and above all his willingness to freely work with and exchange views with anyone. He has been called 'the most prominent wolf biologist in the world,' 'dean of wolf researchers,' and 'the alpha wolf.' He has touched practically every wolf project in the world."

The object of this high praise has been overseeing wolf research in Denali since 1986. This research has become one of the most important field studies of wolves and their prey in the world and is providing major insights on the natural functioning of northern wolf/prey systems. Mech's knowledge and enthusiasm has been a driving force behind the efforts of all of us involved in this multi-faceted predator/prey study.

Layne Adams,
Wildlife Research Biologist
Alaska Region

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