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In this Issue

Diversity and Conservation of Bats In North America

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After years of neglect, fostered by misunderstanding and outright persecution, bats are finally being acknowledged as important components of biological diversity. In turn, there is increasing concern about their conservation status. This awakening of public interest and concern is coming none too soon, as many species of bats are widely believed to be imperiled by human actions.

Among mammals, bats are the second most diverse order (after rodents) and occur on all continents except for Antarctica (Kunz and Pierson 1994). Of the estimated 44 species living in the United States and Canada (North America as defined here; Jones et al. 1992), four species plus two subspecies of a fifth species are federally endangered, and at least 19 species, in whole or part, have been listed as federal Species of Concern (former Category 2 Candidate Species; Fish and Wildlife Service 1994a). Bats face multiple threats of ignorance, suspicion, pesticide poisoning, roost destruction and closure, habitat loss, over-exploitation, and outright extermination. Cole et al. (1994) estimate that for bats worldwide, 1% (10 species) became extinct in the last 500 years, 3% are now endangered, 2% are vulnerable, 50% have stable population levels, and no assessment is possible for the remainder. This lack of information on status and trends of bat populations severely hampers our ability to develop meaningful management and conservation plans for bats.

In the last 40 years or so, our understanding of bat biology has grown enormously. Much of this growth has been furthered, if not actually precipitated, by new techniques for the study of bats (e.g., Kunz 1988). Even the now-standard use of bird "mist" nets for capture and examination of free-flying bats is relatively recent. More recently, a variety of methods have emerged that allow us to "hear" bats by use of ultrasonic detectors, to "see" them with the aid of night-vision equipment, to study foraging and flight paths by applying small capsules of luminescent chemicals, and to track them by using miniaturized radio transmitters. These new methods are providing greatly enhanced details of the life history of bats, including information on roosting habits, which are critical to bat survival.

Bat Diversity in North America

Most species of North American bats are insectivorous, have only one young per year in early summer, and hibernate during the winter (Barbour and Davis 1969). A few species are dependent on nectar and pollen for food, and several species undertake moderately long autumnal migrations to the south where their food resources are available in winter. Many bats roost in natural situations such as trees, rock crevices, and caves, but many also use buildings, bridges, and mines. Bats forage for food after darkness falls, in cities and towns and over fields and lakes. We often see them swooping around lights where they exploit dense clouds of insects that are attracted to the lights. Average life span for most North American bats is in the range of 5-10 years, and some have lived as long as 30 years (Hill and Smith

Long-legged myotis (*Myotis volans*) drinking over a pool of water. Photograph by J. S. Altenbach.

1984). They truly are not like rodents, with which they are frequently compared, and which are short-lived and reproduce prolifically. Bats seem to have evolved as moderately long-lived, intelligent creatures with a low reproductive potential and specialized senses, such as echolocation, that allow them to exploit the resources of the night.

Bats in North America belong to four different families: Mormoopidae, Phyllostomidae, Vespertilionidae, and Molossidae. The Mormoopidae are represented by a single species, the ghost-faced bat (*Mormoops megalophylla*), which is found in extreme southern Arizona and southern Texas (Hall 1981).

The Phyllostomidae, often called New World leaf-nosed bats, has five species that are known north of Mexico, at least seasonally. Three of these species are dependent on nectar and pollen. Two of these species, the Southern long-nosed bat (*Leptonycteris curasoae*) and Mexican long-nosed bat (*L. nivalis*), are categorized as Endangered by the Fish and Wildlife Service (1996). Both species enter the extreme southern United States in Arizona and New Mexico; the Mexican long-nosed bat also is found in the Big Bend region of Texas. There is little information on status and trends of the third nectarivore, the Mexican long-tongued bat (*Choeronycteris mexicana*), which is known (in the U.S.) from southern California, Nevada, Arizona, New Mexico, and the southern tip of Texas. It is a Species of Concern. The California leaf-nosed bat (*Macrotus californicus*), also a Species of Concern, occurs in southern Arizona, California, and extreme southern Nevada (Hall 1981). In the United States the California leaf-nosed bat occupies arid regions and depends on large night-flying insects (e.g., grasshoppers, katydids, dragonflies, moths, and beetles) for food (Ross 1967). Finally, there is a single enigmatic record of one of the three true vampires, the hairy-legged vampire (*Diphylla ecaudata*), from the Big Bend area of Texas. A solitary individual was found in an abandoned railroad tunnel in Val Verde County in 1967 (Schmidly 1991).

The most diverse family of North American bats, in terms of species, is the Vespertilionidae. At least 32 species of this family (with about 300 species worldwide) occur in North America. Vespertilionidae includes most of the bats with which humans come in contact. The typical vespertilionid is small- to medium-sized, dark brown in color, insectivorous, and hibernates in the winter. The common big and little brown bats (*Eptesicus fuscus* and *Myotis lucifugus*) are typical representatives of this family. However, the family includes several larger species, including some that migrate to Central America, and several of the species are strikingly colored. *Myotis* is the most diverse genus and comprises at least 15 species in the United States. Many bats among the *Myotis* are aerial insectivores and capture insects in open spaces, others appear to be adapted to forage in more closed spaces, in and around vegetation, and some seem to prefer foraging over bodies of water, often exploiting hatches of insects emerging from water.

Other North American vespertilionids include Eastern and Western pipistrelles (*Pipistrellus subflavus* and *P. hesperus*) the smallest bats on the continent; seven species of large, tree-dwelling, migratory hoary and red bats and their relatives (*Lasiurus* spp.); four species of long-eared bats of the genus *Plecotus* (or *Corynorhinus*), *Idionycteris*, and *Euderma*; the pallid bat (*Antrozous pallidus*), which often feeds on terrestrial arthropods such as scorpions and centipedes; and the evening bat (*Nycticeius humeralis*) of the south-central U. S. With its large pinkish ears and striking white spots on a black background, the spotted bat (*Euderma maculatum*) is arguably the most attractive species of bat in North America.

Endangered vespertilionids in the U.S. (Fish and Wildlife Service 1994b) include two races or subspecies of

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Cover: Pallid bat (*Antrozous pallidus*) capturing a large desert centipede. Photograph by J. S. Altenbach.

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Townsend's big-eared Bat (*P. townsendii ingens* and *P. t. virginianus*), Indiana bat (*M. sodalis*), and gray bat (*M. grisescens*). The Hawaiian hoary bat (*Lasiurus cinereus semotus*) also is listed as federally endangered. In 1994 the Fish and Wildlife Service (1994b) listed an additional 14 taxa (species or subspecies), mostly *Myotis* or *Plecotus* (and its relatives) as Category 2 Candidate Species. Thus, at most sites in the United States where one encounters bats, probably half or more of the vespertilionid species are formally listed as Endangered or as Species of Concern.

The fourth family of bats occurring in the U. S. and Canada is the Molossidae, or free-tailed bats. Six species of molossids are known from North America. The most common is the Brazilian free-tailed bat (*Tadarida brasiliensis*), best known from Carlsbad Cave, New Mexico. This species historically formed huge roosting colonies numbering millions of bats across Texas, New Mexico, and Arizona. For example, as late as 1963 up to 30,000,000 Brazilian free-tailed bats roosted in Eagle Creek Cave, Arizona; within six years colony numbers were reduced to about 30,000 (Tuttle 1988), apparently by human vandalism and disturbance in the cave. This species currently reaches its largest aggregations in Texas, on the Edwards Plateau, where large colonies still exist (Schmidly 1991). Other North American molossids include the pocketed free-tailed bat (*Nyctinomops femorosaccus*) and the big free-tailed bat (*N. macrotis*) as well as three species of mastiff bats (*Eumops*). For the most part these species occur along the U.S.-Mexico border, although the big free-tailed bat is more widespread. Among North American molossids, all three species of *Eumops* and *Nyctinomops macrotis* were listed as Category 2 Candidate Species. All these molossids have long, narrow wings and are capable of flying great distances. Most of these species migrate to the south in the winter but there are non-migratory populations of *T. brasiliensis* in California and across the southern sunbelt states.

Threats to North American Bats

It is generally believed that bat populations have declined in recent decades in the United States and elsewhere (Kunz and Pierson 1994). Because bats have low reproductive rates and long generation times, and gather in large, vulnerable aggregations including significant portions of entire regional populations, they are very susceptible to elevated mortality or depressed recruitment. Disturbance to roost sites, vandalism, and habitat change have contributed to declines in populations of some species (Gillette and Kimbrough 1970). Contaminants have also played a role in bat declines (Clark et al. 1978, Clark 1981), and Pacific Island populations of some species have been severely affected because of their use as a human dietary item (Wiles and Payne 1986). Habitat modifications such as urbanization, agriculture, and other land use practices may affect local insect populations and thus food resources of bats.

The five species of endangered North American bats roost in caves and owe their current plight to disturbance while in the roost and destruction or closure of roost sites (Kunz and Pierson 1994). For cavern-dwelling bats in North America, roosts are critical at two times of the year: in the summer when females often form large maternity colonies where they give birth and nurse the young; and in winter when the bats (both sexes) use caves as hibernating sites. Even if the disturbance is accidental, it can be life-threatening for bats, who enter hibernation with a finite energy reserve in the form of stored fat. Every disturbance that arouses a bat from hibernation consumes a portion of that stored energy. Frequent disturbances may result in bats being forced from hibernation before adequate insect resources are available to sustain them. Recognition of the importance of such roosts, followed by the development of gates that are "bat-friendly" but impervious to humans, have allowed some bat populations to begin to

Spotted bat (*Euderma maculatum*) captured at a site in northern Colorado. Photograph by L. Riedel.

recover from previous population lows.

Whether due to disturbance of roosts in caves or simply because of opportunistic exploitation, bats also form large colonies in abandoned mines. Due to the human safety hazard that abandoned mines represent there are active programs, many supported by state and federal funds, to close such mines. Hundreds, if not thousands, of these mines have been closed with no assessment of seasonal use by bats. Such closures, often involving the total sealing of a mine entrance, likely represent the primary threat to bats in some areas of the U. S. Fortunately, this situation is slowly changing and rigorous conservation programs are underway in several states, including Colorado (Kirk Navo, Colorado Division of Wildlife, personal communication) and New Mexico (J. Scott Altenbach, University of New Mexico, personal communication). Surveys for bats and bat sign should be done at different times of the year and if evidence of significant use is found the mine can be closed with a gate that allows bats, but not humans, to enter. Sheffield et al. (1992) have provided additional guidelines for the protection of bat roosts.

More recently, and with the aid of miniaturized radio transmitters, we have begun to learn the extent to which many species of bats depend on crevices and cavities in mature trees and snags in forests (for example, see Horst 1995). It appears that males of many species may roost solitarily within cavities or under the bark of trees, but females frequently form maternity colonies in tree cavities. Forest-management practices should strive to preserve some significant portion of mature, senescent, and dead trees. Even-aged stand management in which all old and dead trees are removed may result in a near-total loss of roosting habitat for forest-dwelling bats.

Bats also frequent human dwellings where they can present a challenging management situation. Bat colonies in buildings, especially historic structures, pose problems ranging from the merely aesthetic (stains and odors) to potential degradation of the structure. Bat experts should be consulted in such cases for information on non-lethal methods of exclusion, as the use of poisons to remove bats also may be harmful to humans.

The Need for Information

Conservationists and researchers specializing in bats have drawn attention to a need to develop bat inventory and monitoring programs nationwide, and considerable activity related to bat monitoring and conservation is developing at the state level. For many bat species we still do not have adequate information on distribution and occurrence and thus baseline surveys are necessary. For the great majority of the Species of Concern (former FWS Category 2 Candidate Species) we have little information on whether these species are actually declining and, if so, what the cause is. Thus, we have little or no guidance on the management or conservation actions that should be taken to protect bat species. It is particularly critical to begin to assemble information on the status of existing colonies of bats and on population trends. Site- and species-specific data may help avoid controversies about the status of species that can arise as a result of decisions based on incomplete information (e.g., Cockrum and Petryszyn 1991).

Bat Interest Groups Reflect Growing Public Concern

For many years, the only "bat group" in North America was the North American Symposium on Bat Research. This informal but committed group, composed primarily of professional bat researchers, has held annual meetings since 1971 to report research findings and publishes a quarterly newsletter entitled *Bat Research News*. The preeminent bat conservation group in North America, and perhaps the world, is Bat Conservation International (BCI, P.O. Box 162603, Austin, TX 78716). Formed in 1982 by Dr. Merlin Tuttle, this organization has been a leader in providing educational material on bats to the public (e.g., Tuttle 1988), addressing threats and concerns facing bats, helping to develop conservation plans, and in helping to halt actions that are detrimental to bat populations. BCI publishes a newsmagazine called *Bats* that provides current information worldwide on bats and bat conservation. In recent years, organizations focused primarily on local concerns have been formed in several states. There also is now an electronic list server called Batline, from the University of New Mexico, for the exchange of information on bats.

Current Efforts by the National Biological Service

The National Biological Service (NBS), soon to be merged with the U.S. Geological Survey, works with others to provide the scientific understanding and technologies needed to support the sound management and conservation of the nation's biological resources. Recognizing the increasing concern for bat conservation, the NBS has moved forward with several initiatives to help in addressing problems faced by bats. In 1995 the NBS sponsored a joint initiative of Bat Conservation International and the former U.S. Bureau of Mines to develop a Geographic Information System (GIS)-based analysis on the overlap of distribution ranges of 15 bat Species of Concern that were dependent at least in part on abandoned mines for roosts. The GIS also included locations of thousands of abandoned underground mine sites from the Bureau of Mine's mine location data system. The combined database produced maps showing areas of maximum overlap in numbers of bat species and mine locations throughout the United States. As various agencies embark on mine closure programs due to safety concerns, such information can help target regions for greater on-the-ground investigation and possible alternatives to closure, such as installing specialized gates that allow

(Bats *continued on UPDATE p. 14*)

Report from the Field

The Breeding Biology Research and Monitoring Database (*BBIRD*) Program

Thomas E. Martin
Charles R. Paine
Wes Hochachka

Conservation of biodiversity depends on identification and preservation of habitat conditions that support healthy populations of coexisting species. Healthy populations are those that have sufficient breeding productivity to offset mortality and thereby sustain themselves and sometimes less-healthy populations as well. Data on habitat-specific breeding productivity and survival of individual species and groups of coexisting species are needed to identify land-use and habitat management practices that will support healthy populations, avoid crisis management situations, and promote biodiversity. Yet, this critical and basic information is lacking for many species, including most nongame birds.

Currently, our primary information on population status of nongame birds comes from survey programs designed to detect relatively large changes in population size over broad geographic regions. Such coarse population changes typically reflect problems that have developed over large areas and long time periods and clearly are important, but may be difficult to correct. Moreover, correction is hindered because survey programs do not provide needed information on habitat conditions and sites that support healthy populations. Indeed, population change is a relatively insensitive measure of population health, particularly at local scales, because population size can be maintained in unhealthy local populations by immigration of recruits from healthy populations (see Fig. 1). Detection of population problems earlier in their development when problems are more localized, and identification of population health by specific localities and habitats, can allow more effective targeting and execution of management solutions.

Study of demographic characteristics (breeding productivity and survival) that determine population health can allow early detection of local population problems and identification of their proximate causes (e.g., low breeding productivity, low adult survival, high nest predation rates). More importantly, studies of habitat-specific demography can identify habitat conditions that support healthy populations and potentially identify the ultimate (environmental) causes of unhealthy populations by relating nest survival and productivity to environmental conditions. In this way, demographic studies potentially can identify environmental problems, habitat conditions, and geographic locations for targeted management action. Yet, the intensive nature and small scale of most demographic studies have limited their scope of inference.

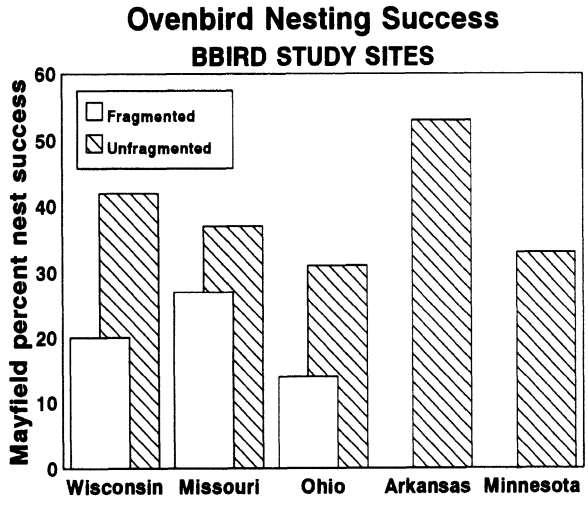

Figure 1. Ovenbird nesting success is consistently low at Midwestern study sites that are in fragmented forests, suggesting that these populations may act as "sinks" (i.e., breeding productivity does not offset mortality) and depend on immigrants from "source" populations in unfragmented forests, where breeding productivity exceeds mortality.

The Breeding Biology Research and Monitoring Database (*BBIRD*) program was initiated in 1992 to establish a national data-sharing network to increase the geographic scope of inference of demographic studies. Growing recognition of the importance and necessity of demographic information, along with improving information for locating nests (e.g., Martin and Geupel 1993), has led to increasing numbers of demographic studies. The *BBIRD* program harnesses this burgeoning awareness and activity by establishing a network for collaboration and data-sharing among independent scientists and natural resource agency personnel studying avian breeding productivity at sites across North America. *BBIRD* participants adopt standard field protocols for monitoring nesting productivity, measuring vegetation, and counting birds to allow comparisons across local sites. Cooperators submit copies of their data to a central repository at the Montana Cooperative Wildlife Research Unit, where overview analyses are conducted to identify regional and continental trends in the data. Collection and analysis of data from each local site are overseen by independent investigators, ensuring high data quality and allowing rapid identification of important local results. Information in the shared database is available to all program participants (with some restriction to protect publishing rights). Access to the shared data allows participants to place their results in a regional or national context and to conduct larger scale analyses that go beyond what is possible for single site studies. For example, the program includes studies in large blocks of minimally-disturbed habitat that can act as controls to compare with sites that are impacted by various land uses.

The *BBIRD* protocol is adaptable to a wide range of study objectives. Current *BBIRD* projects include investigations of forest fragmentation, grazing, forestry practices, breeding biology, sexual selection, and life history evolution. The program now includes 32 sites in 23 states

including Puerto Rico (Fig. 2), and is growing rapidly. Over 17,000 nests of more than 150 bird species were monitored during the first 3 years of the program and data on up to an additional 7,000 nests are anticipated for 1995, the fourth year of the program.

BBIRD Objectives

- Determine and monitor population health of North American landbirds.
- Provide baseline data in large blocks of relatively undisturbed habitat.
- Identify causes of nesting failure (e.g., nest predation, cowbird parasitism, weather).
- Identify environmental elements across the range of a species that may represent key factors influencing habitat selection.
- Determine habitat conditions at multiple spatial scales (e.g., nest site to landscape) associated with successful nesting of individual species, and identify habitat conditions that will support healthy populations of coexisting species.
- Predict effects of existing and changing land-use practices on bird populations.
- Examine species distribution, habitat use, and demographic response to climatic conditions to project long-term population response to global climate change.
- Encourage breeding biology studies that address both conservation issues and more theoretical questions in behavioral ecology and evolutionary ecology.

Methods

The *BBIRD* protocol includes the three following elements. Participants in the program are encouraged to follow the entire protocol, but the first element is the only requirement for participation.

(1) Nest location and monitoring

We have had excellent success training individuals with little or no prior field experience to locate and monitor nests. At most *BBIRD* sites 4-5 person field crews locate and monitor more than 250 nests per year, and at some sites over 700 nests. The basics of this training are outlined in Martin and Geupel (1993).

(2) Measuring vegetation at various spatial scales

Vegetation characteristics are measured in forested habitats using a modified and enhanced version of the James and Shugart (1970) method, and details are provided in a protocol manual that is available upon request. Other sampling methods are being developed for shrub and grassland systems. Vegetation is measured at: 1) nest sites and associated non-use sites, 2) a stratified random sample of points within each nest search plot, and 3) four sites surrounding each census point. The ability to measure landscape level habitat characteristics of the area surrounding all BBIRD plots is currently being developed by the national program.

(3) Point counts on nest search plots

Nest search plots are censused 3 times per season using 10-minute, 50m fixed-radius point counts. Censuses are used to provide a yearly index of population size.

Participants meet annually, generally in late February or early March, to allow: 1) presentation of recent results by participants, 2) increased collaboration and interaction among participants with relevant data, and 3) discussion of any suggested modifications to the program. In 1996 there will be a meeting in late October in Fort Collins, CO. In short, this is a constantly-evolving program.

Advantages of the BBIRD Approach

The *BBIRD* approach documents population health and causes of reproductive failure and relates these measures to habitat and landscape conditions. By replicating intensive local studies at sites across North America, *BBIRD* allows local researchers to compare their results with other sites with differing land use regimes (including relatively undisturbed sites) and facilitates identification of regional and continental trends. Ultimately, these data can be used to develop land management practices that will maintain healthy populations of non-game birds.

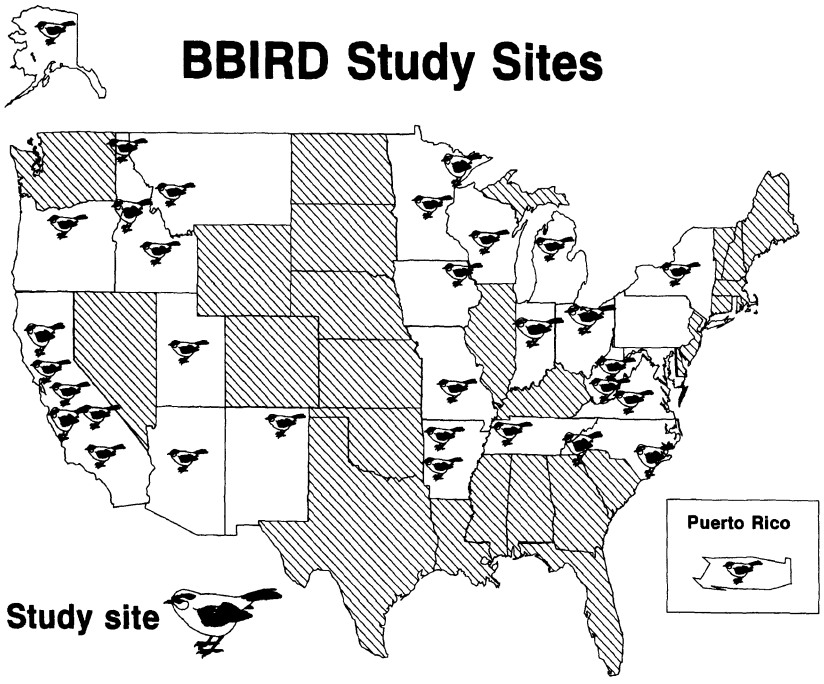

Figure 2. *BBIRD* study sites across the continental U.S. in 1994.

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Report from Washington

Habitat Trading for Red Cockaded Woodpeckers: Enhancing Recovery, Reducing Conflicts

Robert Bonnie
Michael Bean

The endangered red-cockaded woodpecker (*Picoides borealis*) was once a common inhabitant of the pine forests of the southern United States. Red-cockaded woodpeckers (RCWs) are cooperative breeders that excavate nesting cavities in living, mature southern pines and require the sparse midstory conditions created by periodic, low-intensity fires. While RCW groups can be found in most species of southern pine, the bird prefers longleaf pine (*Pinus palustris*), once the dominant tree species on some 74 million acres of forestland (Frost 1993; Hooper 1988). Reasons for the RCW's decline include loss of nesting habitat, fire suppression, and habitat fragmentation.

Recovery efforts for the RCW are focused on 15 recovery populations designated by the U.S. Fish and Wildlife Service (USFWS) and corresponding to the distribution of federal lands in the southeast. However, private lands can and should play a role in recovery of the species for two important reasons. First, for some designated recovery populations the federal land base is insufficient to support the 500 active groups necessary for recovery. Second, in several recovery areas there are gaps between populations on public lands where the intervening land is private. For example, in the Sandhills of North Carolina, the populations on Fort Bragg Military Base and the state-owned Sandhills Game Lands are separated by several miles of private land.

While many private lands provide critical RCW habitat, preservation costs for some landowners can be significant. Thus, the dilemma facing the USFWS is how to balance the needs of both RCWs and private landowners.

This paper proposes a habitat "trading" scheme for RCWs that will reduce private land conflicts while advancing recovery efforts in a cost-effective manner. Under this proposal, landowners who wish to "take" existing RCW habitat will mitigate the loss by purchasing the rights to habitat created or restored on other private lands. The proposal focuses habitat protection efforts on recovery populations while at the same time insuring that the costs of mitigation are relatively low so that habitat trading is an economically viable alternative.

Opportunity Costs of RCW Preservation

The cost of RCW preservation is an opportunity cost because the landowner often must forgo revenue from the most profitable use of a forest property. Opportunity costs equal the development and/or timber value of a property minus the value as constrained by RCW preservation. On land where forestry is the profit maximizing land use, the opportunity costs of RCW preservation are a function of a number of mostly site dependent factors, including tract size, stand age, timber prices, site quality, and management objectives (EDF 1995; Cleaves et al. 1994; Roise et al. 1991; Lancia et al. 1989; Judge et al. 1984). Costs of RCW management on some tracts may be small where management is directed at sawtimber production and/or where landowners capture significant non-timber values from older stands of fire-maintained southern pine.

Previous studies have demonstrated that RCW preservation has rising marginal costs (Boyd and Hyde 1989; Judge et al. 1984); that is, costs to protect individual RCW groups in some forest stands will be small while costs in others will be larger. Of course, opportunity costs can change over time depending on landowner objectives, timber markets, development pressure, and other factors. Nonetheless, the variability in landowner opportunity costs has important policy implications. A policy that exploits the cost differences among landowners will achieve RCW preservation on private lands in a far more cost-effective manner than one that ignores differences.

Safe Harbor

A common complaint about the Endangered Species Act (ESA) is that it penalizes landowners who practice good stewardship on their lands by imposing land use restrictions should threatened or endangered species take up residence. In the case of RCWs, landowners have both an incentive to harvest timber prematurely and a disincentive to burn their forestland lest woodpeckers colonize their property (EDF 1995). In response to this criticism, the Environmental Defense Fund and the USFWS developed a "safe harbor" habitat conservation plan to remove the disincentive to improve or restore habitat for listed species.

Safe harbor was developed for RCWs in the Sandhills of North Carolina and is now being applied in other regions and for other species. Under the voluntary program, landowners agree to maintain the baseline habitat conditions on the property at the time of the agreement and to implement management measures aimed at restoring or improving RCW habitat. These measures can be as simple as agreeing to lengthen rotations and/or to burn portions of the property. In return, the USFWS confers upon the landowner the ability to incidentally take all habitat above the property's baseline conditions. For example, if the landowner has two groups present at the time of the agreement, then s/he has a baseline comprised of the nesting and foraging habitat requirements for two groups. If in the future, the landowner should have three groups present, s/he is free to incidentally take one group. Thus, a

safe harbor agreement essentially freezes a landowner's legal obligations under the ESA, thereby removing any regulatory impediment to habitat restoration.

Under safe harbor, those landowners who are willing to provide additional RCW habitat can do so and still maintain the right to harvest timber or develop their property. A safe harbor agreement, however, does not solve the dilemma of private landowners and developers who have high preservation costs per group and who therefore wish to incidentally take RCWs pursuant to a habitat conservation plan (HCP) under section 10 of the ESA.

Some landowners have been allowed to mitigate the destruction of RCW habitat simply by paying for the cost of translocating birds to nearby federal lands. Such a policy is flawed for several reasons. First, given the responsibility of the federal government to recover listed species, private landowners should not pay the costs of provisioning RCW cavity trees on federal lands. Second, merely shifting birds from one location to another does not address the fundamental problem of the woodpecker: lack of suitable habitat. Third, translocation will in fact undermine efforts to preserve habitat on private lands by reducing mitigation costs to such an extreme that landowners will have no incentive to maintain or preserve habitat through the safe harbor program.

An alternative to the translocation strategy is to expand upon the safe harbor program by allowing landowners who wish to take RCW habitat to purchase the rights to safe harbor groups created on other private lands. Once purchased, these groups would be granted protection under the ESA. Habitat trading would complement federal efforts to protect RCWs, provide incentives to create new RCW habitat on private lands, and lower the costs of the RCW recovery.

Habitat Trading

Transferable credit programs have been used frequently as a market-based alternative to traditional command-and-control environmental regulation. Perhaps the best known example of a transferable credit program is sulfur dioxide emissions trading instituted as a part of the 1990 Clean Air Act amendments. Under the program, companies can choose to meet sulfur dioxide emission standards through self compliance or by purchasing pollution credits from other utilities which have exceeded pollution control requirements. Underlying such a program is the fact that different utilities have different compliance costs per ton of pollution. Companies with high costs of compliance are likely to purchase credits from utilities with lower compliance costs. The end result of transferable rights programs is that environmental objectives are met at a reduced cost to the regulated community.

Similar to electric utilities, landowners with RCWs on their property have varying costs of compliance. And, just as some utilities with more modern pollution abatement technology may be able to meet sulfur dioxide standards with room to spare, landowners with low RCW opportunity costs may be willing to produce additional RCW habitat under the safe harbor program. Given the right price, these safe harbor landowners will also be willing to relinquish their incidental take rights for RCW groups created under safe harbor. Thus, a landowner seeking an incidental take permit can purchase rights from a safe harbor landowner whose baseline responsibilities are increased accordingly.

The underlying principle for RCW habitat trading is that the "take" of private land habitat should be permitted only when there is a comparable habitat gain made elsewhere; recovery of RCWs should not be adversely affected by such trades. Since maintenance of RCW habitat requires prescribed fire, the recipient landowner would agree to periodically burn the property as a part of the mitigation agreement. The costs of such management would be embedded in the purchase price of the safe harbor groups. Since landowners are not legally required to implement proactive management for listed species, habitat purchased through this proposal would actually receive a higher level of protection than that afforded under the ESA.

Trading among landowners outside of or within recovery populations would require a 1:1 ratio—one new group protected for every group lost. However, for mitigating landowners outside of designated recovery populations, a mitigation ratio of less than 1:1 might be permitted for trades into recovery populations. For example, a landowner who wishes to remove two groups from a property located outside a designated recovery population might be permitted to purchase a single group from a landowner whose property is within a recovery population.

While a mitigation ratio of less than 1:1 would necessarily cause a net loss of habitat, such a ratio is justified where mitigation improves the probability of survival and recovery of a designated recovery population. Thus, the gain of a single group within a recovery population may more than offset the loss of two groups outside a recovery population.

Reducing the mitigation ratio for habitat purchases within a recovery population will increase the demand for private land habitat in these areas. This will in turn create an incentive for landowners within a recovery population to engage in habitat restoration. Moreover, a less than 1:1 ratio will reduce the costs of mitigation. This is important not only because it reduces conflicts under the ESA, but also because it provides incentives for landowners with high preservation costs to choose mitigation rather than simply "waiting out" the loss of RCWs through passive neglect or fire suppression.

Two other strategies will further reduce mitigation costs without adversely affecting RCWs. Increasing the number of landowners enrolled in the safe harbor program will increase competition for mitigation dollars and thus reduce the mitigation price. Also, allowing interstate trades will increase the number of possible mitigation sites and thereby increase competition for mitigation dollars.

RCW habitat trading will not work if transaction costs and landowner uncertainty are high. In order to keep transaction costs low, the USFWS should consider an overarching HCP

for the entire range of the RCW which establishes a simple protocol for habitat trading. This HCP would negate the need for individual HCPs for each trade. Such an overarching HCP will also assure landowners that the USFWS is committed to trading and this will in turn reduce landowner uncertainty. The USFWS could also facilitate trading by implementing a competitive bidding process for mitigation dollars. Finally, the USFWS would reserve the right to prohibit trading away groups it deemed critical to recovery efforts.

Some private lands with RCWs may have other listed species present. Under the proposal outlined here, the loss of multiple species habitat would have to be met by protection of comparable habitat created through a multiple species safe harbor agreement on some other parcel. In practice, this would be difficult to implement because the recipient safe harbor property would have to have the same habitat conditions as the property seeking incidental take permits. Even so, a landowner with multiple species could choose to mitigate the destruction of RCW habitat by purchasing RCW safe harbor rights. Such a trade would be only one component of a broader HCP which addressed the habitat losses of other listed species found on the property. As the safe harbor program is expanded to other species, it may be possible to mitigate the loss of multiple species by purchasing habitat on several properties if a single suitable property cannot be found. Until this happens or until there is a mechanism under the ESA to conduct interspecies habitat trading, a multiple species trade may be beyond the scope of the framework presented here.

Conclusion

Several statewide coalitions comprised of a broad array of interests are currently discussing habitat conservation planning for RCWs. As these coalitions formulate strategies for dealing with RCWs on private lands, they will need to examine a framework for mitigating the loss of private land habitat. One such strategy, translocation of birds from private onto public land, reduces landowner conflict at the expense of RCW recovery and private land conservation efforts. The habitat trading proposal outlined here also reduces ESA conflicts by lowering the costs of RCW mitigation to private landowners. However, more importantly, this habitat trading proposal complements federal recovery efforts by giving landowners enrolled in the safe harbor program, especially those within recovery populations, an incentive to restore and protect habitat.

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Robert Bonnie and Michael Bean are, respectively, Economist and Chairman for the Wildlife Program at the Environmental Defense Fund, a national, non-profit, research and advocacy organization that seeks practical solutions to a broad range of environmental problems.

This issue's AZA section profiles the Bear Taxon Advisory Group, in addition to the Conservation Spotlight and News from Zoos on the following pages.

AZA Taxon Advisory Group Profile: Bears

Utilizing captive populations of bears for public education and to support conservation of wild populations

The Bear Advisory Group (BAG) was one of the first Taxon Advisory Groups (TAG) formed by the American Zoo and Aquarium Association (AZA) in 1990. Each TAG, which examines the conservation needs of an entire taxon, consists of AZA Species Survival Plan coordinators, studbook keepers, and other individuals with special expertise on one or more of the species covered by the TAG. The BAG has added other professionals who will help in bear conservation, such as wildlife biologists, education coordinators, marketing/public relations personnel, a librarian, veterinary advisors, nutritionists, and pathologists. Our current committee consists of 21 members, representing many different organizations including zoos, federal and state wildlife agencies, and even a professional football team.

Goals of the Bear Advisory Group

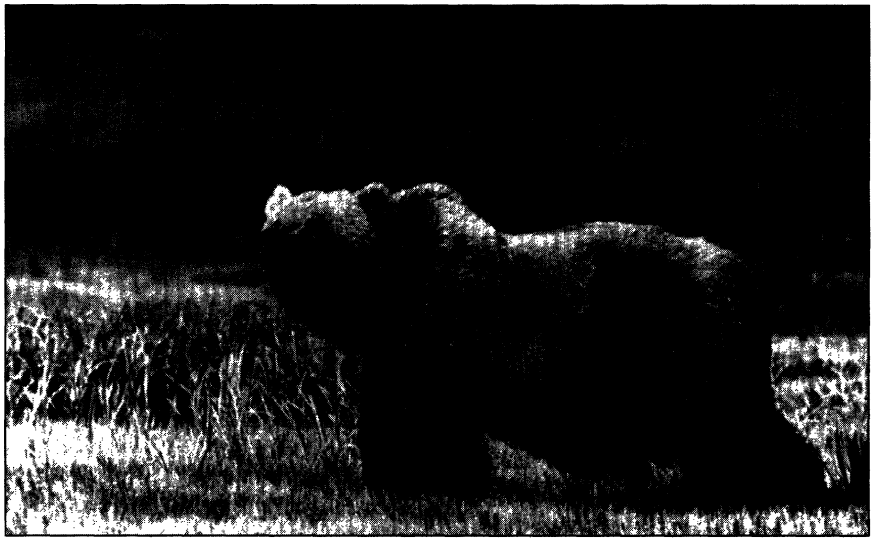
The Bear Advisory Group (BAG) is responsible for developing long- and short-term recommendations for ways to utilize captive bear populations in North America to support the conservation of wild bears. In order to do this, the BAG aims to:

- define the conservation roles of the captive bear population;
- develop a conservation-oriented Regional Collection Plan (see below);
- develop representative conservation programs for bear species maintained in North American zoological institutions; and,
- educate zoo educators with a message that can be conveyed to many people through public education programs.

Conservation roles of captive bears

A tremendous opportunity exists to utilize captive bears as conservation ambassadors for their free-ranging counterparts. Because bears are large, charismatic, and widely recognized animals, there is excellent potential for captive bears to generate public support and interest for conservation programs. The BAG identifies the following four conservation roles for the captive bear population:

1. Provide an interactive mechanism for conservation education, through raising funding for a bear conservation education packet for zoo educators. For zoos exhibiting native species of bears, the BAG has recommended incorporating interactive educational displays developed in conjunction with other conservation organizations and agencies such as the U.S. Fish and Wildlife Service or state wildlife agencies.
2. Promote exhibit design that encourages bears to display typical bear behaviors and activities (i.e., play, food foraging, etc.). To enhance the educational component of bears, exhibits must be designed and enriched to allow bears to display natural behaviors. In addition, space must be available for a normal social structure to occur (i.e., mother with cubs for a period similar to that found in the wild).
3. Provide linkage for *in situ* bear conservation programs in the countries of origin. This linkage is a high priority when any program is attempting to bring in new founders.
4. Provide research populations to increase our



Grizzly bear (*Ursus arctos horribilis*) in the wild. Photograph by Gene Colling.

understanding of bear reproduction, contraception, health, nutrition, and other information that will aid in the overall management of bears.

Regional Collection Plan for bears

The Regional Collection Plan (RCP) prioritizes which species are in the greatest need of a zoo-based conservation program (such as a Species Survival Plan) and determines how to use the limited exhibit space most effectively. This is a difficult task due to bears' longevity and space requirements. In developing this plan, the BAG takes into account the limited amount of exhibit space and the need to maintain a viable healthy population large enough to ensure long term survival of a species. Zoo collections in the past were based on easy availability of animals or the desires of the zoo administrators. Zoo collections today, however, are based on the needs of conservation programs.

Three population management categories were developed by the BAG to cover seven of the eight bear species under the RCP.

- Species Survival Plans (for the spectacled, sun, and sloth bears). Captive self-sustaining populations exist for these species. The SSP goal is to retain 90% of the heterozygosity of the current wild population for 100 years.
- Conservation Education Population (American black, brown, and polar bears) This management category encompasses taxa that are native to North America. Animals in this category should not breed in captivity, and instead are replaced in zoo collections with orphan or "problem" animals from the wild.
- Phase-Out population (Asiatic Black Bear). In this case the current captive population is not being replenished in order to provide zoo space for SSP populations. These animals should be used in conservation education programs until they are phased out. (It should be noted that due to the issues facing this species, i.e., the bear parts trade, the BAG is reevaluating this category in the 1996 draft of their RCP.)

The giant panda has been excluded from this plan due to a special conservation program designed by the AZA to meet the special issues facing this species at this time.

Conservation Linkage Programs

The BAG recommends a conservation-linkage program with each bear species maintained in captivity. The program should ultimately include field research and management; captive management associated with conservation education programs; and local involvement and public education.

Special Concerns

A special concern of the BAG is the trade of bear parts for medicinal use. While it is known that Asian bear populations are rapidly declining because of the trade, all bears are being impacted, including our native bears. The BAG has examined this topic from several aspects, focusing on education in our own country, the values of animals in other cultures, and the conditions of "bear farms" in China and Korea. These "farms" drain bile from bears through a fistula implanted in the gall bladder. The BAG would like to conduct research into the economics of these farms, the volume of the trade, and the continuing trends that suggest that sustainable populations are possible in our country as well as others.

As bear populations decline in Asia and South America, North America now has 75% of the world bear population. While the American black bear populations are healthy, zoos are being asked to know their state laws, and to work for the improvement of these laws. There is a pressing need for more consistency so that law enforcement agencies can protect bears. Zoos also need to encourage federal laws that protect native bears before there is a significant problem.

The Second International Symposium on the trade in bear parts for medicinal use will be held July 26-28, 1996, in Seattle, Washington. The IUCN Bear Specialist Group and WWF/Traffic will coordinate this effort. For more information contact Judy Ball, Bear TAG Co-chair, Woodland Park Zoo, 5500 Phinney Road N., Seattle, WA 98103; fax 206-684-4834.

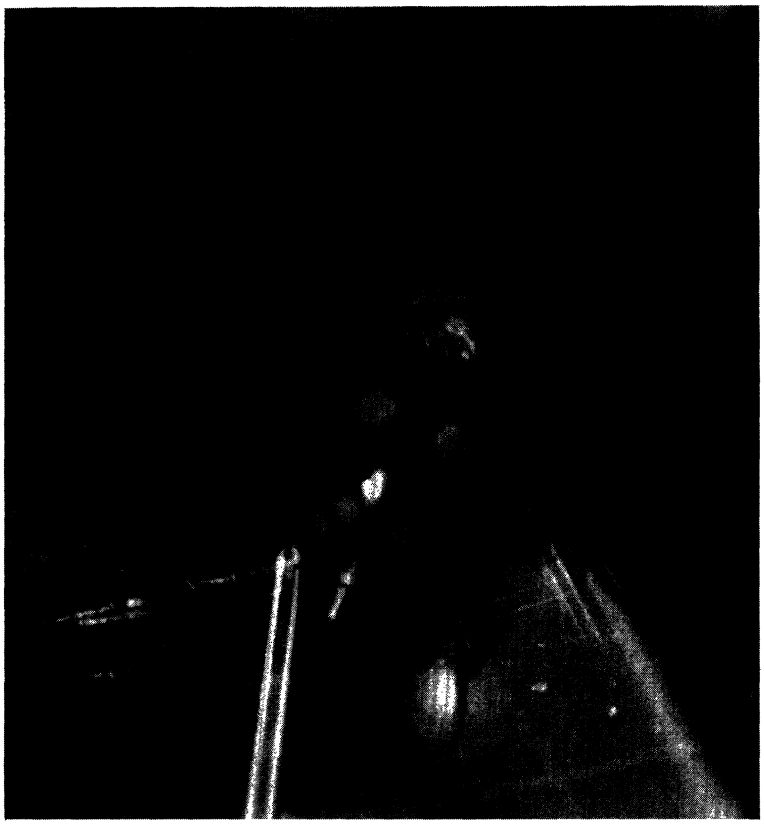
The Next Five Years

The plan for the conservation of bears over the next five years is ambitious. Field projects involving the spectacled, sun, and sloth bear are just beginning; the BAG has offered financial and technical support to these projects. The Bag will also produce a newsletter for all zoological institutions that exhibit bears, and a management manual compiled by captive bear experts that includes results of a comprehensive survey of zoo management practices. Educational initiatives include a WEB page, teacher's guide, zoo educators' workshop, slide shows, and nationwide public presentations by BAG members. The goal of these efforts will be to make bear conservation issues known to the general public and to illustrate the problems in our own country and around the world.

Conservation Spotlight: American Burying Beetles Make a Home at Roger Williams Park Zoo

The American burying beetle, a member of the carrion beetle family, is an endangered species found only in isolated populations in Rhode Island, Oklahoma, Arkansas, and Nebraska. The Roger Williams Park Zoo (RWPZ) in Rhode Island is working with the U.S. Fish and Wildlife Service, Rhode Island State Fish and Wildlife, Massachusetts Fish and Wildlife, Cincinnati Zoo and Botanical Garden, and Boston University to establish a captive population of American burying beetles.

Andrea Kozol of Boston University provided the RWPZ staff with the initial protocol for breeding and raising burying beetles. Once paired and placed in a container with soil and a carcass, the beetles usually mate within a few minutes. They then dig a hole beneath the carcass' head and bury the carcass. During the burying process, the mated pair remove the fur, feathers, or fins from the carcass and roll it into a ball. The pair coats the carcass with secretions to slow down the decay process and then the female lays eggs near the carcass. Once the eggs hatch, the larvae feed on the carrion, at first with assistance from the parents and then on their own. Forty-five to sixty days after the burial, pupation takes place and the beetles begin to emerge.



Photograph by Adrienne Miller, Roger Williams Park Zoo.

The RWPZ has successfully raised close to 400 beetles to date. The captive breeding program has allowed the staff to observe the behavior of the beetles more closely. The size of the carcass is critical to the success of the breeding program; if the carcass is too large, it may be too difficult for the pair to bury. If the carcass is too small, there is not enough flesh on which the larvae can feed. This can result in the pair cannibalizing some of their offspring.

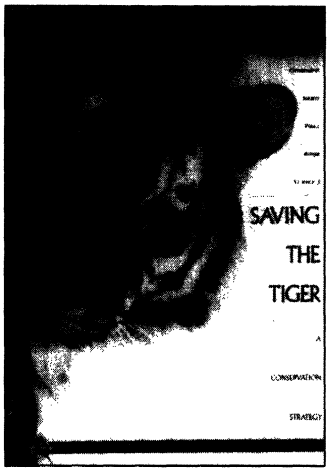
The reason for the decline of the beetle remains unknown. Theories include DDT poisoning, loss of sufficient carrion supply, an unknown disease, habitat alteration, and bug zappers. RWPZ conducted their first release of beetles to the wild (a total of 56 pairs and 19 single males) on Nantucket Island in July 1995. Even if the release is not completely successful, they hope to gain a better understanding of factors that are contributing to the decline of the species. The next release is scheduled for July 1996 on Nantucket. Other suitable release sites in Ohio and the east coast are being investigated.

For more information, contact:

David Wetzel
General Curator
Roger Williams Park Zoo
1000 Elmwood Avenue
Providence, RI 02907-3600
Phone (401) 785-3510
Fax (401) 941-3988

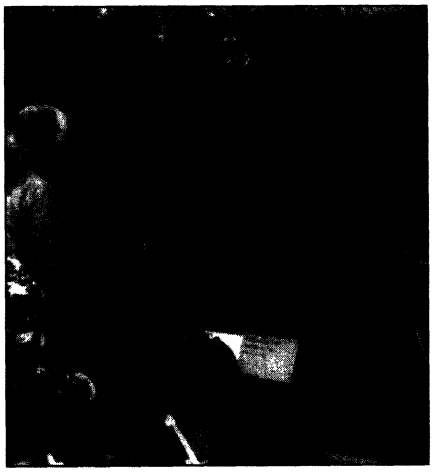
Excerpted from K. Swaringen, AZA Communique, October 1995.

NEWS FROM ZOOS



Exxon and the National Fish and Wildlife Foundation join with AZA in Tiger Education Program

In late 1995, the AZA Department of Education received a $150,000 grant from the Exxon Corporation's *Save the Tiger Fund* to create a travelling exhibit on tiger biology and conservation. The Exxon program is administered through the National Fish and Wildlife Foundation. The travelling exhibit will be called "Habitats in Crisis: The Shrinking World of the Tiger" and should be available in early 1997. This exhibition, which will be presented at AZA member zoos throughout North America, will examine the different species of tigers and their natural habitats, threats to their survival, and information on what individuals can do to help. The educational program will also include information about the AZA's Species Survival Plan for the tiger. (*From AZA Education Department.*)



New York Zoological Society Photo

Roper Organization Poll Reveals Continued Public Support for Zoos and Aquariums

Nine out of ten Americans believe zoos and aquariums are essential to educating the public about animals, according to a recent Roper Organization survey. The study, conducted earlier this year for Sea World and Busch Gardens, also revealed that 92% of Americans agree that professionally-managed zoological institutions educate people about animals they might not otherwise know about. Most people (87%) agree they would never have the opportunity to see living wild animals if it were not for zoos and aquariums. In addition, 77% agreed that the most success in saving endangered/declining species has come from work done by professionally-managed zoological institutions and their partners. More than one third of Americans have visited a zoo or aquarium in the last year. The Roper Organization surveyed a nationally representative sample of 1,987 people regarding their attitudes toward aquariums, animal theme parks, and zoos. The survey was conducted in January of 1995.

Calendar

September 17-21, 1996:
The AZA Annual Conference will be held in Honolulu, Hawaii. For further information, contact Ken Redman, Honolulu Zoo, 151 Kapahulu Avenue, Honolulu, HI 96815. Phone (808) 971-7174; Fax (808) 971-7173.

July 26-28, 1996:
The Second International Symposium on the trade in bear parts will be held in Seattle, WA. For more information, contact Judy Ball, Bear TAG Co-chair, Woodland Park Zoo, 5500 Phinney Road N., Seattle, WA 98103. Fax (206) 684-4834.

Correction: In the January/February issue we incorrectly reported the location of the birth of the first test tube gorilla. The birth took place at the Cincinnati Zoo and Botanical Garden.

(Bats *continued from UPDATE p. 4)*
access by bats but exclude humans. Additionally, expansion of new open pit operations in historic mining districts could reduce the availability of underground roosts in areas of high bat use, and identification of such regions with the GIS can facilitate experimentation with alternative artificial roosts in cooperation with the mining industry.

As part of its Species-at-Risk program, the NBS provided support in 1995 for a collaborative project to document bat biodiversity and habitat use in mature bottomland hardwood forests of North and South Carolina. Cooperators included the North Carolina Museum of Natural Sciences, North Carolina Natural Heritage Program, the Audubon Society, and The Nature Conservancy. The project focuses in particular on determining the relationship of foraging and roosting needs for the Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) and the Southeastern Myotis (*Myotis austroriparius*), with emphasis on the Roanoke River Basin in North Carolina and the Francis Beidler Forest in South Carolina.

Finally, the Midcontinent Ecological Science Center of NBS has several ongoing studies examining aspects of bat distribution, ecology, roosting habits, and status and trends. In 1995 the center began an effort to investigate the feasibility of establishing a national bat status and trends program through the use of existing data on bat populations. This project will assemble records on colony size and other population-related data for all species of bats in the U.S. and its territories. This database will consist of published information, museum records, unpublished data supplied by biologists and others with such interests, and databases maintained by state and federal agencies and other organizations. These data will be analyzed for their ability to determine overall trends for a potential nationwide monitoring effort, and will provide recommendations for the design of future coordinated efforts in a final report summarizing what is known about the status of bat populations in the U.S. We are interested in hearing from readers who can provide records on bat colony sizes for this database and analysis. For further information, please contact the principal investigators via e-mail (MBogan@unm.edu, Tom_O'Shea@nbs.gov, or Laura_Ellison@nbs.gov) or in writing (see addresses below).

Bats currently face severe and multiple threats to their continued existence, both in the U. S. and elsewhere. However, through refinements in technology and well-designed research and monitoring programs, coupled with the increasing number of people concerned about bats, many of the answers we need to begin developing meaningful conservation and recovery plans are becoming available. For many species, we know what needs to be done to conserve bat populations. What is needed is a mutual agreement that bats, and the ecosystems of which they are a part, are worth saving. That commitment, plus a willingness to share knowledge, overcome institutional barriers, and reach objective rational compromises, will help ensure that bats remain a functional part of worldwide ecosystems.

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Bulletin Board

New International Biodiversity Forum

The Biodiversity Forum is a new non-profit organization that seeks to advance the conservation and sustainable use of biological diversity at the international level. The Biodiversity Forum is committed to encouraging cooperation among governments, international organizations, and the private sector in developing methods to advance this goal. The Forum consists of experts in biology, international policy, and environmental law who closely monitor and participate in the activities of international fora related to biological diversity. Summaries and analysis of recent events in such fora are presented in a quarterly newsletter available at no charge. For more information visit The Biodiversity Forum WEB site at http://www.worldcorp.com/biodiversity/. Or, write to Jay Gruner, Executive Director, The Biodiversity Forum, 8000 Towers Crescent Drive, Suite 1350, Vienna, VA 22182. Phone (703) 847-3686, fax (703) 760-7899.

Environmental and Energy Study Institute 1996 Briefing Book

The Environmental and Energy Study Institute (EESI) has released its revised 1996 Briefing Book on environmental, energy, and natural resource issues and legislation. The Book is a comprehensive reference tool covering issues such as clean water, Superfund, Clean Air, Endangered Species, and Public Lands. Over 30 revised issue papers provide analysis on the impacts of new environmental and energy priorities in Congress and background on each issue. The Briefing Book also includes a legislative summary on major environmental laws, a guide to congressional committees, and an outlook report which examines priority issues for the second session of this Congress. The Briefing Book is $75, and can be ordered from Jennifer Schilling at EESI at (202) 628-6500, fax (202) 628-1825, or e-mail at <wb_subscribe@eesi.org>.

End of the Moratorium on Listing of Species

As we go to press there are reports that the moratorium on listing of threatened and endangered species has been lifted as part of the final budget agreement for fiscal year 1996. The budget agreement, which eliminated or repealed many of the environmental riders, did not directly repeal the listing moratorium. However, it gave the President the authority to suspend the moratorium, which he did soon after signing the budget agreement. The suspension is effective immediately, meaning that the Fish and Wildlife Service and National Marine Fisheries Service are again able to list species.

Announcements for the Bulletin Board are welcomed. Some items from the Bulletin Board have been provided by Jane Villa-Lobos, Smithsonian Institution.

Endangered Species UPDATE

School of Natural Resources and Environment
The University of Michigan
Ann Arbor, MI 48109-1115

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