Endangered Species UPDATE

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THE UNIVERSITY OF MICHIGAN
School of Natural Resources

In this Issue:

Using Natural Heritage Data to Monitor Great Lakes Ecosystem Health

by

Susan Crispin

Among the first warning signs of the environmental crisis in the Great Lakes was the failure of bald eagle populations to recover despite the banning of DDT. By the late 1960's, eagles had completely disappeared from the lower lakes, and continued to decline along the upper lakes. Such declines were also documented for other fish eating birds in the region (Gilbertson 1988). These observations focussed public attention on toxic pollution in the food chain and their potential human health risks; regulations were established to reduce pollution inputs to begin restoring the health of the Great Lakes Ecosystems.

Monitoring populations of known or potential indicator species is valuable in assessing ecosystem health with respect to toxic contaminants and other pollutants. Damage that may not seem significant at the level of individual organisms may have serious implications for populations (Moriarty 1978). Population declines have been directly or indirectly attributed to the effects of toxic pollution in mammals (Harris 1988), fish (Hartman 1988), reptiles and amphibians (Bishop 1989), and invertebrates (Havlick and Marking 1987). General water quality degradation due to chemical pollution, nutrient loading, turbidity, and sediment loading has been cited as a major factor in the decline of aquatic macrophytes (Stuckey 1989).

Despite the recognized value of population-level indicators in signalling ecosystem dysfunction and the demand for such indicators at various levels of the food chain, ongoing censusing is limited to a few species of fish eating birds, and there is no system to coordinate the data collected. Many species undoubtedly affected by toxic pollution and aquatic habitat degradation are not being monitored, and hundreds more remain unevaluated for their usefulness as population-level indicators. Insects and crustaceans have been shown to be among the most sensitive to toxic contaminants in laboratory tests (Mayer and Ellersieck 1986), yet their study as biomonitors in natural systems has just begun. Calls have gone out for the systematic collection and centralization of data on indicator species such as top carnivores (Harris 1988) and other organisms at various levels in the food chain (Williams et al. 1989).

Rare or threatened species have been recognized as particularly good candidates for biomonitoring: they are typically more niche-specific than common species and therefore respond quickly to habitat change, and they can often be readily subjected to comprehensive monitoring because of their more isolated occurrence and restricted population numbers. This is also true of more common species that occur sparsely at the margins of their ranges, at which they can be highly sensitive indicators.

given environment can signify habitat loss and ecosystem dysfunction. For example, of the eight pollution-intolerant fish species that Hocutt (1981) cites as indicators of habitat degradation, six are considered rare in at least one state or province within the Great Lakes Basin. In addition to signifying declining habitat quality, the loss or decline of a rare indicator should stimulate a closer look at associated species for subtle effects not yet detectable in large populations.

Although plants are known to be highly sensitive indicators of airborne pollution, there is little documentation on the effects of waterborne toxics on higher vascular plants. Research has shown that toxics impact photosynthesis and growth of plankton (Hundling and Lange 1978) and there is some indication that loss of sensitive species from a pollution-stressed system is an early indicator of ecosystem dysfunction (Schindler

Lake trout (*Salvelinus namaycush*), a dominant native predator, attacked by an exotic sea lamprey (*Petromyzon marinus*) Photo by US Fish & Wildlife Service

Aquatic biologists have long used fish community diversity as a measure of habitat quality. The disappearance of intolerant or sensitive species from a

1987). While numerous studies have documented the uptake of chemical pollutants by aquatic and wetland vascular plants resulting in improved water quality, few have considered the potentially detrimental effects this may have on the plants themselves as well as the subsequent transfer of toxic chemicals into the food chain.

The effects of pollution on individual species are probably best observed at the community level; broad changes in the relative abundance and distribution of species in a community, as reflected in community structure and composition, are often more readily detected and monitored than the status of individual plant or animal populations. Wetland vegetation is negatively affected by heavy pollution inputs which alter structure and composition and thus the function of the wetland ecosystem (Kraus 1987). Plants with higher metabolic rates and shorter life spans tend to replace the original vegetation, leading to reduced species diversity and increased dominance of generalist species (Hunding and Lange 1978). Habitat damage from increased sedimentation, turbidity, and nutrient loading can lead to the disappearance of sensitive plant and animal species with narrow ecological tolerances (Stuckey 1989) and impair the life processes of others (Johnston 1989). The need for community-level monitoring is greatest in the highly productive Great Lakes coastal areas, where pollutants are most concentrated, the effects of toxics are most easily detected (Willford 1988), the least work has been conducted to date (Hartman 1988), and where aquatic or wetland macrophytes tend to dominate (Hunding and Lange 1978).

Monitoring rare species and high quality communities will also help identify serious ecosystem dysfunction from biological as well as chemical pollutants. The recent population explosion of the zebra mussel (*Dreissena polymorpha*) in the Great Lakes, especially from Lake St. Clair to Lake Erie, is thought to be causing ecosystem dysfunction and economic damage to power plants, water supply facilities, coastal industries, commercial and recreational fisheries and boating, etc. Monitoring the response of indicator species to proliferating zebra mussel populations will provide information on potential ecosystem-wide effects, and predictions of impacts in areas into which the mussel is likely to spread. Most of the world's unionid mollusk species, endemic to eastern North America, may be at risk from the spread of the zebra mussel.

Contribution of the Natural Heritage System

Natural Heritage Data Centers, initiated by the Nature Conservancy in partnership with state and provincial governments, have been collecting and managing data on the distribution and status of hundreds of rare species and natural communities in the Great Lakes Ecosystem. The heritage data network manages information pertinent to population- and community-level bio-monitoring, e.g. incorporating annual census data on bald eagles, osprey, and colonial nesting birds, as well as assessing the distribution and status of hundreds of other species and natural communities that have declined as a result of environmental degradation in the Great Lakes ecosystem. In 1989, a grant from the Joyce Foundation enabled the Nature Conservancy of Canada and the USA to begin utilizing this data system as a resource for Great Lakes biomonitoring.

These data can help identify and provide information on a set of population- and community-level biomonitors to function as indicators of change in ecosystem health related to water quality. In this case, the continued vigor of one or more "indicators" (measured on a basis of population size/trends, or community integrity) signifies a degree of ecosystem health. Conversely, an indicator's decline, deterioration, or disappearance (in the absence of a natural cycle or event) may denote a breakdown in ecosystem function. Synthesizing this information on a regional level will form the basis for tracking an integrated, multi-level set of biological indicators of overall ecosystem health.

The natural heritage data system also manages information on the biology and ecology of species and communities, information necessary to interpret observed changes in an ecological context and to further evaluate individual elements' effectiveness as indicators. Data on the usefulness of various species as

Endangered Species UPDATE

A forum for information exchange on endangered species issues
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Instructions for Authors:
The Endangered Species UPDATE welcomes articles related to species protection in a wide range of areas including but not limited to: research and mangement activities for endangered species, theoretical approaches to species conservation, and habitat protection and preserve design. Book reviews, editorial comments, and announcments of current events and publications are also welcome.

Readers include a broad range of professionals in both scientific and policy fields. Articles should be written in an easily understandable style for a knowledgeable audience. Manuscripts should be 10-12 double-spaced typed pages. For further information, contact the editors at the number listed below.

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Cover:
Satellite Image of Great Lakes Basin
Imagery by US Geological Survey

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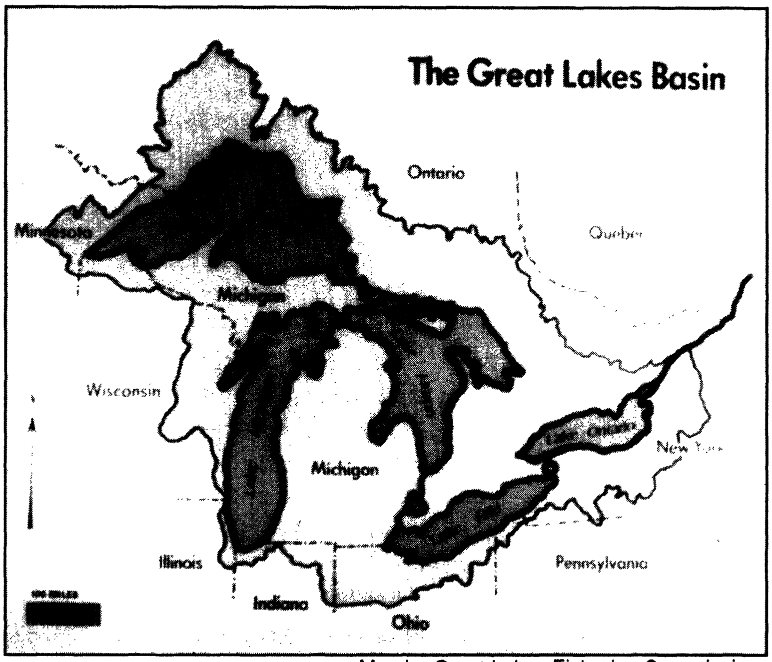
biomonitors are stored in element characterization and stewardship records.

Assessing Elements as Biomonitors

Rare species and community types tracked by the Natural Heritage data system can be evaluated as potential indicators of Great Lakes water quality on the basis of their functional and spatial relationship to the Great Lakes aquatic ecosystem. The Nature Conservancy has developed broad categories for identifying the potential of rare species and natural community elements as indicators of water quality and ecosystem health. Indicators, for the purposes of this project, are considered to signify, by their <u>healthy</u> presence, a high level of ecosystem function. Their declining status (numbers or vigor), deteriorating state, or absence where historically present, signals a significant loss of ecosystem function. As components of the Great Lakes ecosystem, their health is also key to the maintenance of a properly functioning ecosystem.

Category 1: *Fish-eating animals (mostly birds) feeding from waters of the Great Lakes.* Animals feeding at high trophic levels, as discussed above, have been shown to be some of the best monitors of the effects of toxic contaminants on the Great Lakes food chain. These species — mostly fish-eating birds — are subject to maximum biomagnification of contaminants and thus occupy a unique position as the most affected organisms in the ecosystem. Several mammals also fall into this category, especially otter and mink. However, in addition to being less amenable to biomonitoring (Harris 1988), no fish-eating mammals are currently considered rare in Great Lakes states or provinces. Should they become rare, the Heritage system will commence monitoring their occurrences as Category 1 indicators.

Category 2: *Animals living or feeding from waters of the Great Lakes basin; plants growing in waters of the Great Lakes basin; lacustrine (especially littoral) and riverine communities of the Great Lakes coastal marshes and estuaries.* Aquatic and semi-aquatic animals living/reproducing in or feeding at middle and lower trophic levels from the waters of the Great Lakes basin are also strong candidates for use as indicators of



Map by Great Lakes Fisheries Commission

toxic contamination and other water quality problems in the Great Lakes ecosystem. Species tracked by the Heritage system that fall into this category include many unionid mussels, some turtles, aquatic gastropods, crayfishes, and aquatic insects. Plant species in this category include both submergent and emergent macrophytes; they are directly exposed to toxic contaminants through biouptake from the sediment layer, and to the effects of nutrient enrichment, sediment loading, turbidity, etc.

The response of species to contaminants in turn produces changes in composition and structure of the aquatic community of which they are part. Shallow-water aquatic communities (littoral and riverine) are strongly affected, although most state Heritage data bases have limited information on aquatic communities per se. Heritage data are comparatively rich, however, for coastal marshes and estuaries, which concentrate pollutants through the process of sedimentation and biouptake, thus passing them into the food chain.

Category 3: *Animals living or feeding from wetlands of the Great Lakes basin; plants growing in wetlands of the Great Lakes basin; all other wetland communities in the Great Lakes basin.* Wetlands of lakes, streams, and isolated basins are subject to the effects of pollutants from upland runoff, incoming surface waters, and groundwater migration. These communities, and the species which inhabit them, can thus function as early warnings of the effects of pollutants in the Great Lakes ecosystem by flagging problem areas within the Great Lakes watersheds.

Category 4: *Upland communities and taxa that are dependent on major Great Lakes ecosystem processes not related to water quality (e.g. lake currents and associated patterns of erosion/ deposition; water level fluctuations; sand movements and dune-building, temperature and moisture microclimate effects).* Ecological processes associated with the waters of the Great Lakes extend beyond living in or feeding from the waters themselves. The lakes generate distinctive climatic effects and geomorphic processes along their shores, producing conditions to which many organisms are adapted and upon which entire communities depend. The hydrological dynamics of Great Lakes water levels also play a crucial role in the maintenance of certain coastal communities. The health of these communities and of sensitive component species can reflect the integrity of these significant Great Lakes ecosystem functions.

Category 5: *Species and communities not directly related to aquatic eco-*

systems or to major Great Lakes processes. The value of the above-described elements as potential indicators of Great Lakes water quality depends heavily on where in the ecosystem a given population or community occurs. For instance, eagles nesting along the Great Lakes coast and feeding primarily from Great Lakes waters will directly reflect the quality of those lake waters, while eagles nesting high in the watershed and feeding from distant inland lakes will reflect pollution inputs largely from the local watersheds and upstream. Thus, individual occurrences of elements assigned to Categories 1 through 3 (potential water quality indicators) will be further evaluated and ranked on a site by site basis, according to their hydrological position within the Great Lakes watershed (e.g. estuary or coastal wetland versus upstream tributary versus isolated basin) and thereby the degree to which their health reflects that of the Great Lakes waters themselves.

Application of the Regional Natural Heritage Dataset

Not all species or communities within these categories will prove to be effective or practical subjects for biomonitoring of water quality. Each element possesses a unique set of biological or ecological characteristics, and will respond in a different manner and degree to the stress imposed by toxic

"The value of establishing a recognized repository for data on population status and biological characteristics of indicator species should not be underestimated."

contaminants and other pollutants. The dataset created through regional synthesis of state and provincial Natural Heritage databases is intended as a starting point for identifying a broad suite of elements that can be used as effective biomonitors of water quality in the Great Lakes ecosystem. Potential indicators can also be evaluated according to desirable characteristics outlined by various authors (e.g. Harris 1988).

Population- and community-level monitoring through the Heritage data system cannot in itself provide documentation for the cause and effect relationships of toxic contaminants and other pollutants to degradation in the status of elements. That will require highly focussed research efforts. However, the Heritage data can point researchers in promising directions, provide a multitude of potential subject species/community research sites, and valuable historical data to facilitate such research. The value of establishing a recognized repository for data on population status and biological characteristics of indicator species should not be underestimated. Although the Heritage data system presently acquires and integrates a broad spectrum of data from diverse sources through the state heritage programs, the process is more efficient when data sources play an active role in contributing relevant information rather than providing it on request. The ability to draw upon a single comprehensive data base is a major dividend to the participants. The Heritage data system already serves in this capacity on a state by state basis for the environmental review process, endangered species protection, and natural area conservation.

Heritage data also provide a good basis for identifying baseline areas where indicator species and communities exhibit minimal effects of toxicity and ecological dysfunction. Such areas have great research value as "controls" for comparison with the effects of toxics at more highly polluted sites against which to evaluate and establish benchmarks for changes potentially attributable to pollutants (Schindler 1987). Relatively pristine areas also serve as genetic reservoirs and as models of restoration. As part of this project, protection plans will be developed for a number of such areas representing remaining healthy populations of indicator species and relatively pristine examples of aquatic and wetland community types, within each natural region. One further benefit of monitoring sensitive species and communities is the early identification of population declines and community degradation, thereby providing the best chance to avert catastrophes both locally and in the basin as a whole.

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Book Review

Conserving the World's Biological Diversity

1990. IUCN, WRI, CI, WWF-US, and the World Bank.

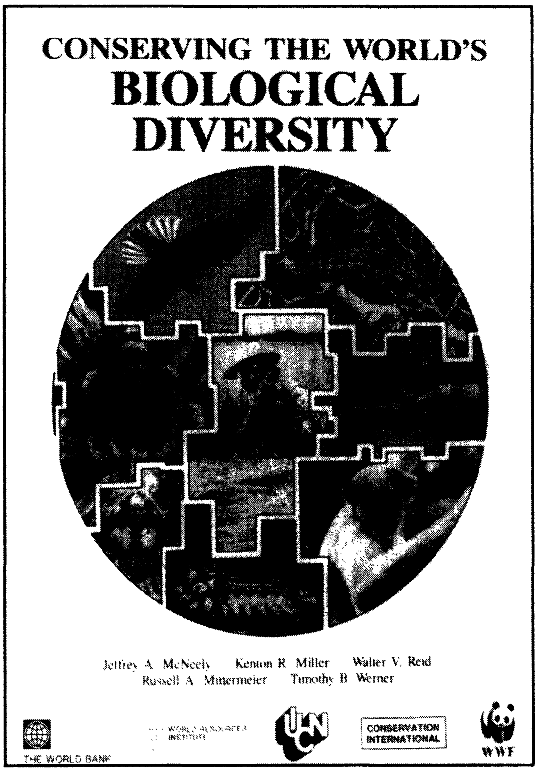
by J. A. McNeely, K.R. Miller, W.V. Reid, R.A. Mittermeier and T. B. Werner

Within our lifetimes, an unprecedented wave of human induced extinctions will eliminate countless lifeforms throughout the world. Biologists and conservationists generally recognize and understand the gravity of the situation, however, most others are only vaguely aware that a problem exists. This book presents nonscientists with a comprehensive overview of issues related to conservation of biological diversity, especially in the tropics where most species are found. The decided emphasis on policy rather than ecology clearly identifies the intended audience as policy analysts, development planners, nongovernmental organizations, managers, administrators and politicians. However, many biologists could also benefit from a more sophisticated appreciation for the complexities of conservation in the economic and political spheres where problems affecting society are ultimately addressed.

"...presents nonscientists with a comprehensive overview of issues related to conservation of biological diversity..."

The greatest strength of this volume is its organization which intuitively progresses from basic questions to advanced strategies. "Boxes" are used to explore specific topics and enable the reader to go beyond the executive summary without searching for key points in the body of the text. The text is composed of nine chapters, followed by six annexes. The first chapter, "Biological Diversity: What It Is And Why It Is Important," defines the problem in the context of human population growth and economic development. "The Values Of Biological Diversity" are examined in the second chapter from ethical and economic perspectives in a clear readable style. The next chapter, "How And Why Biological Resources Are Threatened" explores the magnitude of the problem in the context of its social, economic and political roots. The fourth chapter, "Approaches To Conserving Biological Diversity," looks at the roles of policy, the species versus habitat debate and ex situ mechanisms. In this chapter, the authors go on to address the pervasive impacts of pollution and challenges posed by global warming. "Information Required To Conserve Biological Diversity," addressed in the fifth chapter, examines the kinds of information and degree of specificity needed to affect management and legislation. Chapter six, "Establishing Priorities For Conserving Biological Diversity" emphasizes an international perspective when making critical decisions to commit scarce resources. Chapter seven, "The Role Of Strategies And Actions Plans In Promoting Conservation Of Biological Diversity" addresses the need to have a coordinated approach to conservation activities. Next, "How To Pay For Conserving Biological Diversity" gets to the core of the problem of generating funds and to conclude, "Enlisting New Partners For Conservation Of Biological Diversity" explores potentially innovative synergistic alliances to enhance effectiveness and limit conflicting activities. Six annexes include: an outline of basic taxonomy, the World Charter for Nature, related international legislation, The Bali Action Plan, World Bank Wildlands Policy and a glossary. The Bibliography is thorough and current, providing a good foundation for further research.

Despite the excellent organization and comprehensible explanation of the issues related to biodiversity, the book does not quite convey the difficulty of the task at hand. The strategies presented do not fully acknowledge the strength of opposition from international market forces, vested interests and, in many cases, multitudes of impoverished peasants. The role of western oriented specialists and organizations dominates



this volume. A discussion of the extent to which conserving biodiversity is a western scientific and aesthetic construct that may be of little concern to people in other cultural settings would have greatly strengthened the impact of the volume. In spite of this weakness, *Conserving the World's Biological Diversity* brings together a wealth of useful information on the problems of conserving biodiversity in the real world. This book can be an informative and persuasive resource for decision makers, scientists and lay people alike.

Reviewed by Matt Wunder, Doctoral Candidate in the School of Natural Resources, University of Michigan, Ann Arbor, MI 48109-1115.

Opinion

Bio-monitoring: How Much is Enough?

by David Zaber

Perhaps the most controversial aspects of today's environmental protection efforts center not around their need per se, but rather on the extent to which they should be implemented. For example, while few people argue against cleaning up the 43 Great Lakes Areas of Concern, or for the unrestrained destruction of forests and wetlands in the Great Lakes Basin, significant disagreements do arise when decisions regarding degree of cleanup or the stringency of habitat protection laws are made. In other words, questions of how much is enough are rarely amenable to quick and easy solutions.

Historically, very few pollution control or conservation efforts were based on ecologically relevant standards or criteria. Most efforts essentially focussed on the protection of human health and were undertaken to the extent to which human health was deemed "protected". However, as environmental issues now increasingly focus on such goals as the protection of biodiversity within an ecosystem, or the protection of ecosystems, endpoints by which to measure their success or failure become much more complicated as well as controversial. Consequently, it often appears that environmental controversies can be solved only on a case by case basis, with few if any objective parameters for guidance.

Basing environmental protection decisions on ecologically relevant criteria or standards offers a rational method for dealing with today's environmental problems. Specifically, I believe environmental goals should be based on ecologically relevant indicators of ecosystem health rather than on the attainment of what are often poorly defined, albeit desirable, goals such as "clean lakes" or "healthy forests". In a strictly theoretical sense, ecosystem-based environmental quality standards would be a desirable goal for which to strive. However, the current state of our understanding of ecosystem processes precludes the development of such criteria; we lack even the most basic terminology for characterizing the health or status of an ecosystem, let alone the capability for estimating long-term ecological viability. Measurement of ecosystem properties or processes often, if not always, requires long-term monitoring and adequate baseline information, thereby making acquistion difficult and time consuming. In areas where the ecosystem has been severely degraded (e.g. the former tallgrass prairie of Illinois) adequate baseline information may be impossible to acquire. Because general standards for ecosystem health would necessarily require measurement of functions critical to maintenance of biological integrity, few existing environmental protection standards (or programs) are truly ecosystem-based.

Given the difficulty in setting accurate ecosystem protection standards, increasing the efficacy of our environmental programs requires the protection of suites of species selected for their ability to represent certain environmental characteristics. Because they effectively integrate the myriad of natural and anthropogenic stress factors present in the environment, some wildlife species currently offer to us the best available option for ecological indicators. However, environmental programs must include protection or restoration of selected wildlife indicators as enforceable regulatory endpoints. For example, water quality criteria for the Great Lakes Basin ecosystem would include the restoration of minimal numbers of breeding pairs of bald eagles nesting along the lakes and feeding on Great Lakes prey species. Additional criteria might include an ongoing program of controlled feeding of Great Lakes fish to ranch-raised mink. This, with the explicit (and enforceable) regulatory goal of reaching the point whereby mink would be able to consume regular quantities of Great Lakes fish without adverse effects (not currently the situation in the Great Lakes).

In a regulatory context, total mass loads of persistent and bioaccumulative pollutants (e.g. PCB's, dioxins, etc.; the pollutants responsible for reproductive problems in Great Lakes mink) entering the lakes would need to be reduced to the point where these and other wildlife criteria were achieved. Without these types of regulatory endpoints, we essentially have few, if any, enforceable benchmarks for gauging the success of existing environmental efforts, or for guiding us on future programs. We also lack an efficient basis for deciding on the necessity of remediation of contaminated ecosystems or need for protecting more natural areas.

"... environmental programs must include protection or restoration of selected wildlife indicators as enforceable regulatory endpoints."

Although it is intuitively logical that because of the difficulty of monitoring every species within an ecosystem, we should focus on the protection of suites of environmental indicatory species, adding the necessary regulatory components to indicatory species programs will still be controversial. Why? Because wildlife species are often more sensitive to environmental stressors than are humans, and because they currently indicate severe and profound ecological dysfunction worldwide. Therefore, individuals and organizations that continue to degrade our environment would have serious problems if we were to monitor and protect indicators which tell the truth about today's environmental problems.

David Zaber is a PhD Candidate at the University of Michigan, School of Natural Resources, Ann Arbor, MI 48109-1115.

Proposed African Elephant Reclassification

The US Fish and Wildlife Service proposes to reclassify most populations of African Elephant from threatened to endangered, except those found in Botswana, Zimbabwe and South Africa, where they will remain classified as threatened. The Service seeks relevant data on elephant populations, and comments from the public, to be evaluated for the formulation of a final rule. Comments must be received by July 16, 1991. For information, contact: Dr. C.W. Dane, Chief, Office of Scientific Authority (703) 358-1708.

Job Opportunity

The International Council for Bird Preservation (ICBP) is seeking an experienced professional to join its Pan American Program in Washington, D.C. ICBP is a global federation of 350 member organizations and representatives in 111 countries whose aim is to preserve the world's birds and their habitats. The position involves management and coordination of NGO activities related to the Neotropical Migratory Bird Intitiative. For more information, contact: Martha Van der Voort, Pan American Program Officer, ICBP, 1250 24th Street NW, Suite 500, Washington, D.C.; Fax: 202-293-9211.

Who Gives a Hoot? Friends of the Owls

Friends of the Owls is a non-profit group working to protect owl habitat throughout the American Southwest. Membership, which includes the newsletter Owl Voices, is $20 per year. Contributions of any size are welcome. For more information, write: Friends of the Owls, PO Box 11152, Prescott, AZ 86304.

Canadian Biodiversity Bulletin

Beginning in Winter 1991, the Canadian Museum of Nature began publishing a newsletter containing information about biodiversity with informative articles by scientists, environmentalists, and concerned citizens. Yearly individual rates are US $15 and library rates are US $30; for lesser developed countries, individual rates are Can $5 and library rates are Can $10. Orders may be sent to: Canadian Center for Biodiversity, Canadian Museum of Nature, PO Box 3443, Station D, Ottawa, Ontario, K1P 6P4, Canada; fax: (613) 952-9693.

Attention All Quilters

The Wild Canid Survival and Research Center is creating a quilt to help celebrate its 20th anniversary. They ask that personally designed blocks be donated in exchange for six free raffle tickets. Blocks should measure 14" x 14" plus at least 1" seam allowance. Proceeds from the sale of raffle tickets will be used to help care for red and Mexican wolves housed at the center. For more information, contact: Eleanore Endebrock, Wild Canid Survival and Research Center, PO Box 760, Eureka, MO 63025.

Of Interest for Plant Protection

The International Union for the Conservation of Nature and Natural Resources (IUCN) has published its 24th Environmental Policy and Law Paper, the 214 page volume "Wild Plant Conservation and the Law" (1990) by Cyrille de Klemm. This comprehensive book is divided into three parts: Species-specific legislation, General Habitat Conservation Legislation and Guidelines. The book is of use to planners and biologists alike. This and other IUCN publications are available from: IUCN Publications Services Unit, 219c Huntington Road, Cambridge CB3 ODL, United Kingdom.

Bulletin board information provided in part by Jane Villa-Lobos, Smithsonian Institution.

Announcements for the Bulletin Board are welcomed.

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