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UPDATE

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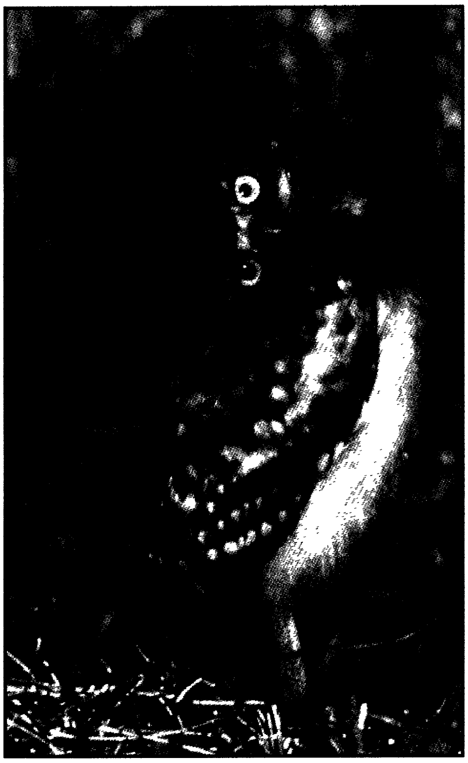

In this Issue

Where are Endangered Species Found in the United States?

Jon Paul Rodriguez, W. Mark Roberts,
and Andy Dobson

Public and scientific opinion is divided over the current Endangered Species Act (ESA). Many private landowners and real-estate developers see it as a major impediment to economic progress; conversely, many conservation biologists and natural resource managers see it as an only partially effective legal mechanism for protecting biodiversity. Both camps would like to see the ESA modified before its pending reauthorization by the current Congress, and both present arguments for strengthening or weakening the "civil rights" of the estimated one million resident species of the United States.

In an ongoing collaboration between Princeton University and the Environmental Defense Fund, we have been examining the geographical distribution of endangered species in the United States. Our ultimate goal is to provide a systematic analysis of the available information on endangered species distributions. We hope that this may reduce some of the antagonism surrounding the reauthorization of the ESA; at present, subjective and contentious opinions reign in the face of inadequate scientific understanding of threats to biodiversity. Furthermore, resources available for conservation are limited, and must be allocated where they will be most effective. We believe that maximizing the number of endangered species represented in a comprehensive network of protected areas in the U.S. is an effective way to maximize efficiency of conservation efforts. This principle underlies the analyses we describe below.

In the present paper, we draw extensively on our recently published results (Dobson et al. 1997) to answer three basic questions.

(1) Are endangered species distributed randomly across the United States, or are there "hot spots" with particularly high numbers of endangered species?

(2) If hot spots do exist, are they the same for different taxonomic groups?

(3) Do certain taxonomic groups of endangered organisms indicate the presence of endangered species from other groups?

Geographic distribution of endangered species

We used data provided in the Endangered Species by County Database of the Office of Pesticide Programs, United States Environmental Protection Agency (Washington, D.C.). This database lists the counties of occurrence of all plants and animals protected under the ESA in the 50 states, as well as all species, subspecies, and populations proposed for protection by this statute as of August 1995. The database includes 924 species distributed in 2,858 counties throughout the U.S. For comparative analyses, we divided the data into seven taxonomic groupings: plants, mollusks (which combines clams and snails), arthropods (arachnids, crustaceans and insects), fish, herptiles (amphibians and reptiles), birds, and mammals (Table 1).

The patterns in the distribution of endangered animals and plants in the U.S. are clearly non-random (Figures 1 and 2). Hawaii, southern California, the southeastern coastal counties (mainly in Florida and Georgia), and southwestern Appalachia emerge as hot spots, with large numbers of endangered species (see also Flather et al. 1994). Upon examining the association between the density of endangered species in each state with the intensity of human activities, climate, topology, and vegetative cover of each state, we found that the overall density of endangered species is strongly correlated with one anthropogenic and one climatic variable: the value of agricultural output and either average temperature or rainfall (stepwise multiple linear regression, $r^2=0.80$, $p<0.01$). Agricultural activities best predict densities of endangered plants ($r^2=0.61$, $p<0.01$), mammals ($r^2=0.68$, $p<0.01$), birds ($r^2=0.64$, $p<0.01$), and reptiles ($r^2=0.46$, $p<0.05$), groups which together make up close to three-quarters of the entire data set (Dobson et al. 1997).

Complementary county subsets

The selection of representative sites for the creation of a comprehensive network of protected areas for biodiversity conservation is currently an area of active research (e.g., Csuti et al. 1997; Pressey et al. 1993; 1996). One current approach bases its site-selection criteria on the principle of complementarity (Vane-Wright et al. 1991), which selects areas as follows: from a list of sites, we select the site with the largest number of species. Then, we remove all the species found in that

Taxon	Species	Counties	Area (%)	Power (SE)
Plants	503	136	9.61	1.63 (0.02)
Mollusks	84	38	1.15	2.92 (0.08)
Arthropods	57	37	2.38	2.44 (0.11)
Fish	107	57	4.76	1.24 (0.04)
Herptiles	43	28	0.97	3.26 (0.17)
Birds	72	19	1.59	4.00 (0.16)
Mammals	58	29	2.08	2.61 (0.08)

Table 1. Complementary county subsets for the different groups of endangered species of the United States: Species, number of threatened species in each taxon; Counties, number of counties in the complementary subset; Area, percentage of the total U. S. landmass covered by the complementary subset; Power, index that expresses how well each group indicates endangered species richness in other groups; SE, standard error. Power values are means of 200 bootstrapping runs (data taken from Dobson et al. 1997, please see this reference for additional details).

site from consideration in the remaining sites, and re-rank the sites according to the number of species not already sampled. Next, we select the site with the largest number of remaining species, and repeat this process until all species have been accounted for. The list of sites obtained in this fashion is the complementary subset, and minimizes the total area needed to sample all species at least once.

We applied this procedure to determine the complementary county subsets (CCS) for the endangered species in the U.S., where the number of species in each county (our approximation of a "site") was the basis for the analysis. The results of our complementarity analysis can be found in Table 1. Plants have the largest CCS (136 counties, 9.61 percent of the U.S. landmass), while herptiles have the smallest (28 counties, 0.97 percent of the U.S. landmass).

There are at least two reasons to be cautious about this procedure. First, the fact that a species has been recorded in a county does not mean that it occupies the county's entire area. Second, the presence of a species in a county does not mean that the county contains an entire viable population of that species. Our approach is biased in favor of range-restricted endemics, such as many of the plants in the database, and against widespread species, like the grizzly bear (*Ursus arctos horribilis*) and bald eagle (*Haliaeetus leucocephalus*). In the context of our analysis, the selection of a county implies that it possesses great value to the conservation of endangered species at the level of the whole country. This does not mean, however, that by creating one protected area within the boundaries of the chosen counties the conservation problem is solved. In the case of a range-restricted species, the protected area would have to be in the right place within the county (i.e., the range of the threatened species); in the case of a widespread species, the protected area would likely have to cross the boundaries of single counties—and perhaps state boundaries as well. We must add, however, that in the case of a widespread species, as the number of counties in a CCS increases, so will the likelihood that more than one population of the species will be included in the CCS.

What causes hot spots?

The endangered species hot spots depicted in Figure 1 probably represent the interaction between centers of endemism (e.g., clams in southwestern Appalachia [Banarescu 1992], or plants in Florida [Gentry 1986]) and anthropogenic activities (e.g., urbanization and agricultural development). Because different kinds of organisms have different habitat requirements and evolutionary origins, we should not expect them to share centers of endemism. At the same time, human activities may affect different taxa differently. Consequently, hot spots for different groups overlap in only a few areas. Aside from these locations, the key areas for most groups overlap only weakly, which suggests that endangered species hot spots for one group do not necessarily correspond with those of other groups (Dobson et al. 1997).

The extent of hot spot overlap for different taxa is a critical issue in assessing how suitable one group of endangered species might be as an indicator of others. Indicators would be useful in cases where knowledge about endangered species is poor (such as spiders and insects) and another, better-known group might be used as a surrogate for those species.

As there are many more species of endangered plants than of other groups, and plants' distributions tend to be restricted to one or two counties, the CCS for plants is large. Not surprisingly, then, the 136 counties necessary to sample all plants also include more species from other taxa than do the complementary subsets of any other groups. The plant CCS contains 73 percent of all other taxa combined, 94 percent of the birds, 76 percent of the mammals and 74 percent of the herptiles (Dobson et al. 1997). This observation might lead to the conclusion that saving all of the plants should be the main objective of a national conservation strategy, as many other taxa will also be included.

There are two problems with this approach. First, only 4.1 percent of the U.S. landmass is currently protected from all human activities (World Conservation Monitoring Centre 1992), and preservation of endangered plants by setting aside their CCS would more than

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Cover: Burrowing owl (*Athene cunicularia*) and wolverine (*Gulo gulo*). Owl photograph courtesy of The Canadian Nature Federation. Wolverine photograph © Susan C. Morse.

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double this area—a politically difficult task. Second, the plant CCS fails to include 45 percent of the fish, 46 percent of the arthropods, and 61 percent of the mollusks (Dobson et al. 1997).

Power analysis

We propose that the power of each complementary subset be used as a measure of how well a particular group indicates the presence of endangered species diversity in all other taxa. Power is calculated by dividing the number of endangered species from other groups present in the complementary county subset by the number of such species in an equivalent area of randomly selected counties. To do this, we used a bootstrapping algorithm that accumulated counties at random until their total area matched or just exceeded that of the complementary subset. Repeating this process 200 times allowed us to assign error bounds to our estimates (Table 1).

Fish and plants emerge as the worst indicators of number of species among other endangered taxa. For fish this is probably because there are not that many other threatened taxa within bodies of water. In the case of the CCS for plants, it would seem that it is hard to sample more species than those already included in their complementary county subset simply because the CCS is so large. Birds and herptiles, on the other hand, seem to be the best indicators for other endangered taxa. Their CCS are 4.00 and 3.26 times better, respectively, than randomly selected county sets of equivalent size.

The main point of this analysis is to demonstrate that a comprehensive, well-designed portfolio of protected areas should be able to include populations of most endangered species in the U.S., if these areas are located in the right places. Table 1 suggests that the critical minimum area to represent all currently endangered species is somewhere between 2 and 10 percent of the total U.S. landmass. Once again, we must emphasize that this might not assure their long-term conservation, but it is a reasonably good starting point. The next step is to evaluate the current system of protected areas and determine which endangered species are present in them and which are not. This will help prioritize areas in need of immediate protection, and the analysis would need to be updated as the number of species listed under the ESA changes.

Concluding remarks: Contributions to the discussion on the ESA

Recent government studies indicate that over half of the species on the federal endangered species list have more than 80 percent of their habitat on non-federal lands. Of these species, more than 80 percent are in the southern U.S. and in Hawaii. In contrast, a charismatic minority—such as grizzly bears, bald eagles and Northern spotted owls (*Strix occidentalis occidentalis*)—are found in the north (mainly northwest of the Rockies), with approximately 50 percent of their ranges on federal lands.

This variability in geographic distribution throws important light on discussions about the cost of the ESA both to the federal government and to private landowners. Recent studies have shown that the primary threats to endangered species on federal lands are recreation, grazing of domestic livestock, and timber and mineral extraction (Losos et al. 1995; Wilcove et al. 1996). Many of these activities are subsidized by the federal government, and as they tend to jeopardize the health of the ecosystem where many endangered and threatened species live, the federal government then has to foot the bill for activities that might reduce the risk of future extinctions. The government finds itself in the ironic economic position of subsidizing the activities that threaten species, while also paying for activities aimed at protecting them (Losos et al. 1995). In many cases, the intensity with which endangered species need be protected would be reduced and the costs would be at least revenue neutral if grazing and recreation rights were competitively priced on public lands, and subsidies for timber and mineral extraction were reduced.

The situation in the south is more subtle and would benefit from a more direct reform of the ESA. More than 90 percent of the listed endangered species in the U.S. are found in Hawaii, California, Florida, Texas and southwestern

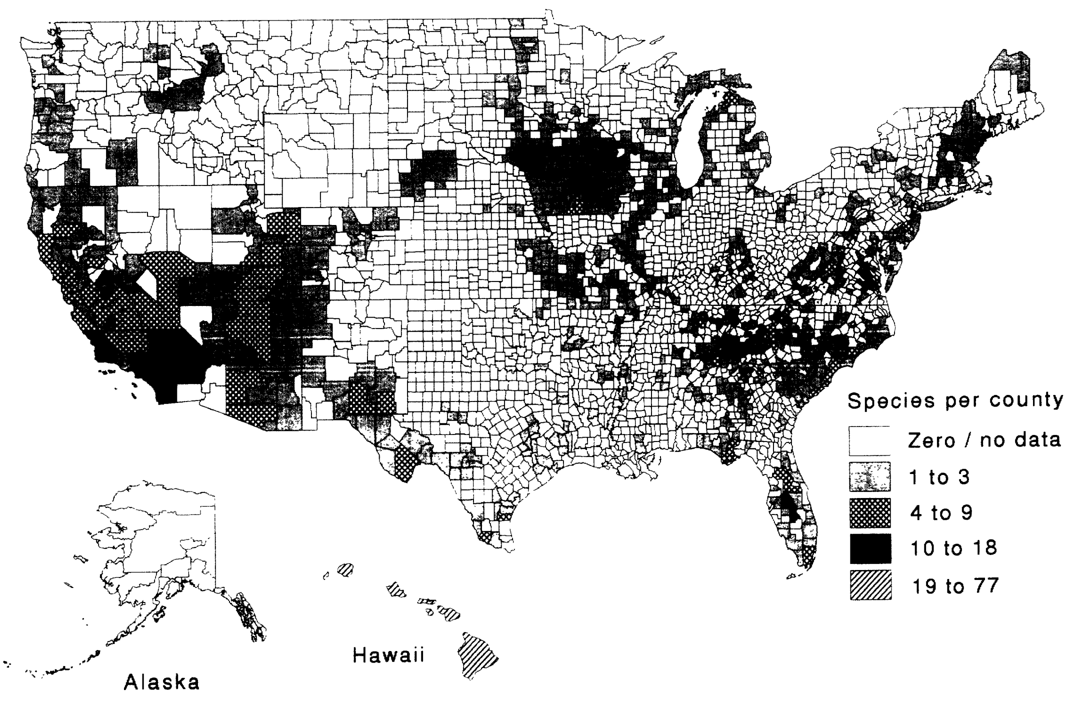

Figure 1. Distribution of endangered plants in the United States.

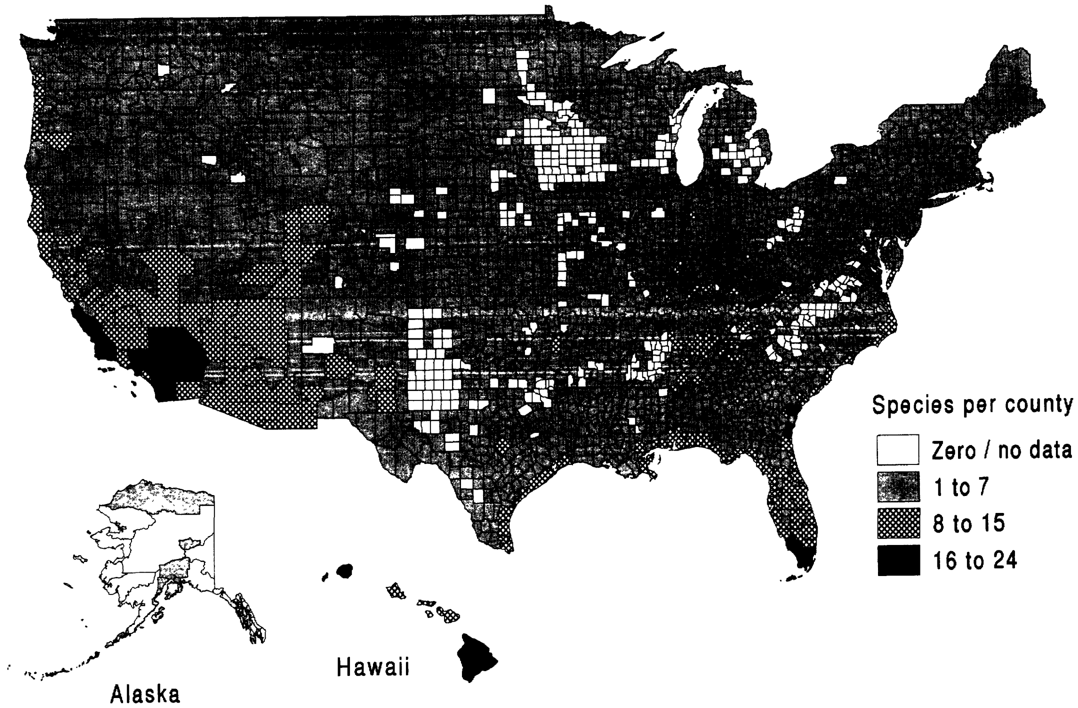

Figure 2. Distribution of endangered animals in the United States.

Appalachia, and more than 95 percent of the range of these species is on private lands. In these regions this puts constraints on development of that land, so many developers feel frustrated by the ESA's powers to restrict modification of habitat for endangered species. Furthermore, the presence of potentially endangered species on private land means that many species remain unprotected, lest attempts to list them lead to their "sudden disappearance" from areas which would then be protected from further development.

However, in these areas many other private landowners manage their lands in a way that either directly or indirectly encourages the presence of endangered species. The main threat to this habitat usually occurs when owners die and estate taxes must be paid. In many cases, the estate is subdivided and sold, or logged if the area is forested, in order to pay estate taxes. This suggests that tax reforms and easements would be a potentially valuable way to reward private landowners who manage their land in such a way that it protects endangered species.

Thus, two possible directions in which the ESA could move in the future are toward (1) tax relief for owners of private lands whose activities allow endangered species to persist on their land, and (2) competitive pricing of access to natural resources on federal lands. These legal mechanisms, combined with continued scientific analyses of existing and potential protected areas and species distributions, will help traditionally combatant groups move toward constructive solutions in the twenty-first century.

Acknowledgments

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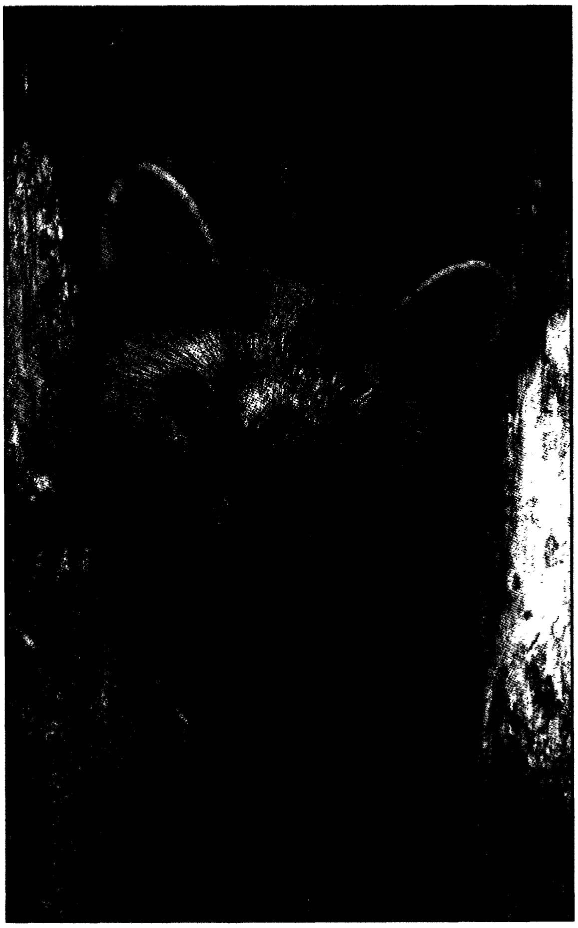
Evaluating the Proposed Canadian Endangered Species Act

Catherine Austen

Canada has historically taken an approach to species conservation that is quite different from the United States. The U.S. model has a federal Endangered Species Act, which is the strongest species protection legislation, usually superseding state laws. In Canada, however, provinces and territories have worked independently of and in cooperation with the federal government to protect and recover many of Canada's species at risk. All jurisdictions provide varying levels of protection to species at risk through bits and pieces of wildlife legislation. Currently four of Canada's provinces—Manitoba, Ontario, Quebec and New Brunswick—have endangered species laws in place. Newfoundland, Saskatchewan and the Northwest Territories are currently developing legislation; Nova Scotia recently introduced a Bill for an ESA in provincial Parliament.

Endangered species protection across Canada is thus a little like a patchwork quilt, with some pieces thinner than others. Unfortunately, the network of provincial laws and voluntary measures has proven insufficient to deal with growing threats to species. Canada's national list of species at risk has tripled over the past 10 years, with the 1996 list showing 255 species and populations as nationally endangered, threatened and vulnerable, and an additional 11 extirpated and 10 extinct. The need for a federal endangered species act has long been recognized by the Canadian public, with polls showing that 94% of Canadians support federal legislation.


The Newfoundland marten (*Martes americana*), one of Canada's most threatened populations, will receive little protection under the proposed act. Photograph courtesy of The Canadian Nature Federation.

The federal government also appeared to recognize this need almost five years ago when Canada was one of the first nations to sign the UN Convention on Biological Diversity, which commits signatories to developing legislative protection for threatened species. Only recently, however, after years of lobbying and consultations with the public, resource industries, environmental groups, and Canada's provincial and territorial governments, did the federal government take further action; the Canada Endangered Species Protection Act (CESPA), Bill C-65, was introduced into the House of Commons on October 31, 1996.

As of mid-April, Bill C-65 is stalled in Canadian Parliament and its future is unclear. As written, the CESPA is extremely weak and reflects the existing division of powers over wildlife management in Canada, with the strongest provisions applying only to a very small percentage of Canada's land area and species. Consequently, few conservation groups want to see it passed in its current form. The following description refers to the current Bill, as amended by the Standing Committee following public hearings, with discussion on how proposed government amendments would alter it.

What the Act will do

Definitions

The Canada Endangered Species Protection Act (CESPA) makes it illegal to kill, harm, harass or take a listed, extirpated, endangered, or threatened species or to destroy or damage its residence. "Species" currently refers to sub-species and geographically or genetically distinct populations, but a government amendment will remove genetically distinct populations. "Residence" is currently defined as a specific dwelling site such as a den, nest or other area occupied or habitually occupied by an individual or population during part of its life cycle, including breeding, rearing and hibernating. A government amendment, however, will delete the reference to populations, making the definition ambiguous (e.g., a calving ground is clearly occupied by a population of caribou, but only portions of it are habitually occupied by an individual).

Permitting

The CESPA includes a permitting process to exempt activities that may incidentally harm a listed species or its residence, but requires that alternatives be considered and all feasible mitigating measures be undertaken. Permits are publicly registered and may only be granted for activities that will not imperil the survival or recovery of a species. The CESPA also includes a blanket exemption from assessment, mitigation, and monitoring requirements for activities undertaken for national security, safety, and health, including plant and animal health (e.g., agriculture).

The swift fox (*Vulpes velox hebes*) has been reintroduced to the Canadian prairies. Under the proposed act the fox and its residence would be protected, but outside of federal lands its habitat would not be preserved. Photograph courtesy of The Canadian Nature Federation.

Activities in accordance with regulatory measures under aboriginal and land claims agreements are also exempted. The former blanket exemption is potentially a large weakness in the CESPA, as it suggests that activities such as low-level military flights and pesticide use would be pre-approved.

Listing

Listing of species at risk will be decided by federal Cabinet, based on the advice of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), a scientific committee which has been operating for 20 years. COSEWIC will prepare species status reports and will designate them as "endangered," "threatened," "vulnerable," or "not at risk." Cabinet's decisions are to be based on COSEWIC information, but the CESPA does not require that the scientific designations be adopted, nor does it require any form of justification for listing decisions that diverge from COSEWIC designations. Excessive political discretion in the listing process undermines the credibility of the CESPA and has plagued each of the four existing provincial endangered species acts in Canada. For example, the Quebec act is quite strong but lists only nine species, all plants, thus offering no protection to any of the province's endangered animal populations.

Recovery and management plans

The CESPA requires that recovery plans be developed within one year of listing for endangered species and within two years of listing for threatened and extirpated species. Management plans must be developed for vulnerable species within three years of listing. Recovery plans are well defined to include a description of the species, its critical habitat, threats to both, and an outline of measures to recover the species with a cost/benefit analysis of each. Management plans are less well defined; current language states only that measures for species conservation considered necessary by the responsible minister be included. Recovery and management plans are to be prepared with stakeholder involvement, including inter-jurisdictional cooperation where possible, and are subject to a 30 day public comment period. One hundred twenty days after the comment period, the federal minister is obliged to promulgate regulations needed to implement measures in a recovery plan, including regulations or prohibitions on activities that impact a species' critical habitat.

Although the CESPA protects species' "residences," it does not include an automatic prohibition against destruction of critical habitat. Habitat protection must instead be achieved through Recovery Plans. The CESPA also includes a provision for emergency orders to be issued to protect species and their critical habitats, upon the emergency designation or reclassification of a species by COSEWIC in the case of an imminent threat to a species.

Weakness of the Act

On the surface CESPA appears, despite some weaknesses, to be a good start towards species protection. The Act's main weakness, however, is that it does not apply throughout Canada. In Canada's ten provinces the CESPA's prohibitions, emergency orders and regulations under recovery plans will apply only on federal lands and waters, with two exceptions discussed below. Federal lands, which include national parks, military bases, native reserves, and crown corporations, comprise only 4% of the provincial land base. Only in the Yukon and Northwest Territories will the CESPA apply on all lands.

Even the CESPA's larger jurisdiction in the territories is somewhat undermined because the prohibition against harm to individuals of listed species will not apply to game species at risk such as polar bears (*Ursus maritimus*) and Peary caribou (*Rangifer tarandus pearyi*); protection of residences and habitats will, however, be provided. Should the territories inadequately enforce protective measures for game species at risk, the CESPA allows the federal government to enforce federal regulations in the future.

The only species which may receive habitat protection throughout their entire range under the CESPA are aquatic and marine species. In keeping with established federal powers under The Fisheries Act, the CESPA currently applies to aquatic species and their habitats throughout Canada. This application, however, caused substantial conflict with east coast fishing industry representatives and provincial governments, and, because of the conflict, a new government amendment specifically exempts the "unforeseen" incidental by-catch of listed species (e.g., a leatherback sea turtle (*Dermochelys coriacea*) or marbled murrelet (*Brachyramphus marmoratus*) caught in a fishing net). The exemption does not include any requirement to monitor or register such by-catch, nor does it include any incentive to avoid such by-catch through better gear technology. Therefore, despite full application of the CESPA to their habitats, aquatic and marine species will still face threats.

The exceptions to the limited application of CESPA in the provinces are for bird species listed under the Migratory Birds Convention Act (MBCA), and for other international animal species. In both of these cases the animals' residences will be protected, but habitat is not protected outside of federal lands.

The protection of international animal species comes under CESPA's contentious Section 33. The original language stated that the federal government could make future regulations to protect internationally ranging or migrating animal species and their residences wherever they are found. The Standing Committee made such regulations a requirement, also adding a provision to waive the federal regulations in a province which enforces equivalent regulations to protect international species. This new provision is based on the criminal code powers of the federal government regulating cruelty to animals; it therefore does not extend to plant species with an international distribution. For example, Furbish's Lousewort (*Pedicularis fubishiae*), endangered in both New Brunswick and Maine, will receive no protection under CESPA outside of federal lands.

Section 33, which is virtually the only part of CESPA that will affect provincial and private lands, has evoked a clear and unanimous negative response from Canada's provincial governments and most resource-based industries. All provinces find it an intrusion into their jurisdiction, despite the inclusion of a waiver in the case of equivalent provincial legislation. A British Columbia forestry sector spokesperson has suggested that the CESPA will collapse the western timber industry and shatter resource-based communities. The Canadian Cattlemen's Association wants Section 33 deleted and has advised landowners to stop voluntary efforts to protect endangered species if the CESPA is passed as is.

Despite the uproar, Section 33 is very weak because it does not allow for species' habitat protection. Outside of federal lands, recovery regulations and emergency orders—through which habitat protection can be provided— apply only to individuals and residences. A recovery regulation to protect a critical staging area on provincial or private lands cannot be implemented under the CESPA, regardless of whether the animal has an international range. A province may implement habitat protective measures in cooperation, of course, but a province may also choose not to.

The extent of protection of the northern spotted owl (*Strix occidentalis caurina*) and other species with ranges into the U.S. would depend on whether the Canadian population is considered to be genetically distinct. Photograph courtesy of The Canadian Nature Federation.

Specific examples

Animals found on federal lands

The endangered Aurora trout (*Balaena mysticetus*) currently suffers from lake acidification in northern Ontario. Under the CESPA, the animals and their residences would be automatically protected throughout their range. Habitat protection measures would likely be implemented through recovery plans, and the species and its habitat would also be eligible for emergency protection if required. Being found only in areas of federal jurisdiction, the CESPA would provide the Aurora trout with the full extent of protection available.

Animals not found on federal lands

The passage of CESPA will change virtually nothing for two of Canada's most critically endangered animals, the Vancouver Island marmot (*Marmota vancouverensis*) and the Newfoundland marten (a population of *Martes americana*). The Vancouver Island marmot is an endemic Canadian species with only 300-350 surviving individuals, all in colonies on private and provincial lands threatened by recreational developments. The Newfoundland marten is a population of the American marten, which has been isolated on the island of Newfoundland for about 10,000 years. The remaining population of about 250 individuals are provincially protected from direct killing, but live in old growth forests which are currently being logged. Only 25 martens, which were recently moved into Terra Nova National Park, will be protected by the CESPA.

Animals that range between the U.S. and Canada

For animal species shared by the U.S. and Canada, protection under CESPA will vary from species to species. For example, Canadian protection of grizzly bears (*Ursus arctos horribilis*) will depend on what is included in a management plan for the species. Because they are designated as a vulnerable species, grizzlies will not be protected anywhere in Canada through automatic prohibitions (indeed, cur-

The lynx (*Felis lynx*) is extirpated in parts of Atlantic Canada but is not listed as nationally at risk. Photograph © Susan C. Morse.

rently they are legally hunted). The species would have to wait three years after official listing for the preparation of a management plan and then await its implementation. If the plan recommends habitat protection measures, the Government of Canada will not be able to implement that protection outside of federal lands. Provincial cooperation must be sought but is in no way guaranteed.

For non-migrating internationally ranging species such as the eastern cougar (*Felis concolor couguar*; if any remain) or the northern spotted owl (*Strix occidentalis caurina*), protection would depend in part on whether the Canadian populations are listed as geographically distinct from the American populations. For example, if the eastern cougar is identified as part of an international population, then the CESPA will make it illegal to kill or harm an individual or destroy its residence anywhere in Canada. Also, the development and implementation of a recovery plan, in cooperation with provincial and U.S. governments if possible, would be required within 16 months of listing. Of course, any habitat protection regulations recommended in the recovery plan could only be implemented on federal lands, which would be virtually meaningless in this case because eastern cougars do not roam on federal lands in Canada. A provincial government could agree to implement recovery plans outside of federal lands, but no law obliges it to do so.

Alternatively, if the Canadian population of eastern cougar were identified as geographically distinct, then the CESPA would provide even less protection to the species. A recovery plan would be developed but on-the-ground protection would not be guaranteed in Canada, as the animals range only on non-federal lands. Not only would the cougars not have their habitat protected but, if not classed as an international population, they would not even have their dens or skins protected by the federal law.

Conclusion

Just prior to the October 1996 introduction of the CESPA, the federal Environment Minister announced that a preliminary agreement had been reached, among all ministers responsible for wildlife in Canada's provinces and territories, on a National Accord for the Protection of Species at Risk. The Accord commits all jurisdictions to developing complementary legislation that provides immediate protection to endangered and threatened species and to protection of their habitats. Some weaknesses of the CESPA can be explained by the anticipated development of cross-country endangered species legislation as promised in the Accord.

The Accord, however, does not specify that provincial laws have to be equivalent to the federal law, but merely complementary. With a weak federal law as a role model, the provinces are under little pressure to develop truly effective legislation, and the worth of the Accord shrinks accordingly. Also, after seven months, only six of Canada's 12 provinces and territories have even signed the Accord.

Canada and the U.S. share many species, including many species at risk. Cooperation between the two countries in species recovery has a long history and has helped keep species like the whooping crane (*Grus americana*) from extinction. International cooperation has also helped recover extirpated species in one nation by reintroducing individuals from the other—for example, sea otters (*Enhydra lutris*) in British Columbia and gray wolves (*Canis lupus*) in Yellowstone National Park. There remain numerous examples of species listed as endangered or extirpated in one country but not in the other (e.g., bald eagle (*Haliaeetus leucocephalus*) in the U.S., greater prairie chicken (*Tympanuchus cupido pinnatus*) in Canada). How recovery of such species will be coordinated remains to be seen, but it is likely that the stress on voluntary cooperation from all affected jurisdictions will remain. Canadian participation in international efforts toward species recovery will certainly continue to depend on the moods of affected provinces, for the CESPA in itself cannot guarantee nation-wide cooperation.

Catherine Austen is the coordinator of the Canadian Endangered Species Coalition. The Coalition was formed in 1994 by six of Canada's most influential environmental non-governmental organizations, and has over 100 supporting groups across Canada who share the goal of strong nationwide endangered species legislation.

Spider Conservation in the United States

Kevin L. Skerl

Spiders, like many other invertebrates, have traditionally suffered a lack of attention from conservation professionals and the general public. As more information becomes available, however, scientists are gaining a better understanding of spiders' integral role in natural systems and of the need to improve protection efforts.

Approximately 3,500 spider species, with an additional 350 yet undescribed, exist in the United States and Canada (Roth 1993). They are abundant predators in many terrestrial ecosystems, with estimates of populations in field habitats approaching one million individuals per hectare (Bristowe 1971). Almost all spiders are generalist predators, mainly eating insects and secondarily other spiders (Wise 1993); a few have become specialists (Nentwig 1986). Some larger species may even occasionally feed on small mice, birds, and lizards.

Individual spider species do not possess the characteristics of successful natural control species, since most are generalists and have long generation times in comparison to prey species (Riechert and Lockley 1984). However, when viewed as an assemblage, spiders may play an important role in stabilizing or regulating insect populations because they are one of the most numerous insectivores and exhibit a wide variety of lifestyles and foraging strategies (Nyffeler et al. 1994; for reviews see Riechert and Lockley 1984; Nyffeler and Benz 1987; Wise 1993). Spiders possess the characteristics of predators that can contribute to density-independent limitation of prey, including self-damping, high levels of polyphagy, and life cycles that are asynchronous to those of prey species (Riechert and Bishop 1990). While biological control by spiders has not been clearly demonstrated in natural systems, evidence in agro-ecosystems has been found in several studies (Riechert and Bishop 1990; Breene et al. 1993), and benefits to primary producers have been measured (Carter and Rypstra 1995).

Additionally, spiders are an important food source for birds, lizards, wasps and other animals. In a study of trunk arthropods, spiders provided a relatively constant food source throughout the year for bark-gleaning birds (Peterson et al. 1989). Hogstad (1984) demonstrated that spiders were a primary winter food source for goldcrests (*Regulus regulus*). Also, spider silk is important to bird species for nest building; 24 of 42 families of passerine birds and nearly all species of hummingbird depend on silk from spiders and caterpillars for nest construction (Hansel 1993).

Current conservation status

Several species of spiders have been recognized as rare or worthy of concern on three different lists of threatened species: the Endangered Species Act (ESA), IUCN Red Lists, and lists compiled by The Nature Conservancy and Natural Heritage Programs.

Only two spiders have been listed under the ESA, the Tooth Cave spider (*Neoleptoneta myopica*) of Texas and the spruce-fir moss spider (*Microhexura montivaga*) of Appalachia. Two species, Warton's cave spider (*Cicurina wartoni*) of Texas, and the Kauai cave wolf spider (*Adelocosa anops*) of Hawaii are considered candidates for listing; seventeen additional species were listed as C2 candidate species before this category was dropped.

The 1996 IUCN Red List of Threatened Animals includes eight U.S. spiders. One spider is listed as Endangered, three are considered Vulnerable, and five are listed as Data Deficient (without sufficient information to select an appropriate category).

The Nature Conservancy, in cooperation with the Network of Natural Heritage Programs (NHP) and Conservation Data Centers, maintains one of the most comprehensive biological databases in the Western hemisphere. This database includes global, national and state conservation priority ranks (Master 1991). Only 114 spider species are being tracked in these databases, with 57 assigned priority ranks, clearly illustrating the lack of compiled information on the status of spiders. Of these, 40 species are considered of national concern, with 29 species considered imperiled or critically imperiled (The Nature Conservancy 1997). The other 11 species are considered rare and not necessarily imperiled, but six of these have some uncertainty regarding their status.

The level of protection afforded to spider species is by no means fully documented or comprehensive. While only the two species listed under the ESA receive direct federal protection, several species that are considered rare or threatened are indirectly protected by other means. Some rare cave species in West Virginia, such as the Appalachian cave spider (*Porrhomma cavernicolum*), receive protection by virtue of being located in caves with the federally protected Virginia big-eared bats (*Plecotus townsendii virginianus*) (S. Blackburn, West Virginia NHP, personal communication 1996). Other species have populations within protected federal lands (e.g., *Microhexura montivaga* in Great Smoky Mountains National Park) (Harp 1992), lands managed by conservation organizations (e.g., McCrone's burrowing wolf spider, *Geolycosa xera*, in Lake Apthorpe Nature Conservancy Preserve, Florida) (Edwards 1992b), and other privately owned lands (e.g., the Rosemary wolf spider, *Hogna ericeticola*, in the University of Florida Ordway Preserve) (Reiskind 1987).

Threats to spiders

Habitat loss and degradation

Spiders, like most terrestrial invertebrates, are affected by habitat alteration such as deforestation, agriculture, grazing, and urbanization (Wells et al. 1983). For example, clear-cutting of forests reduces spider abundance and changes spider community composition drastically (Coyle 1981; McIver et al. 1992).

Habitat loss and degradation

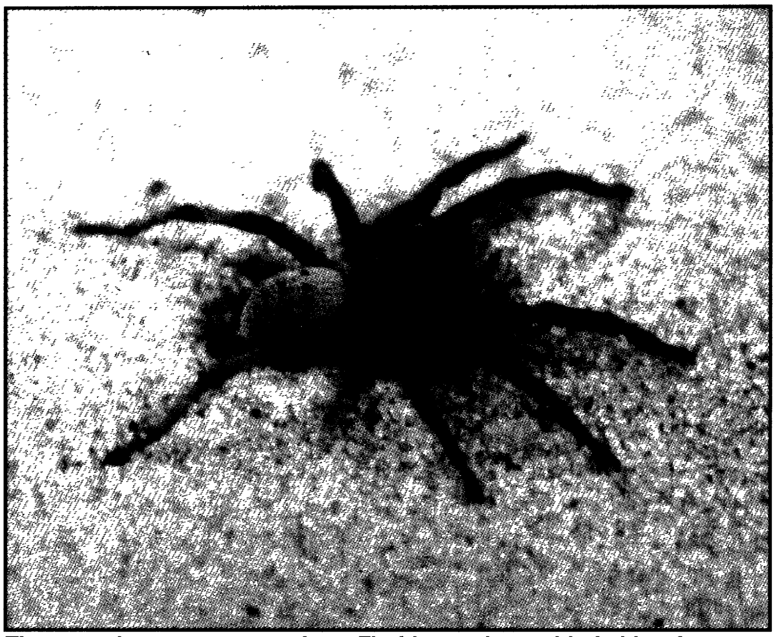
threaten the Kauai cave wolf spider, which lives in the lava-tube habitats of Hawaii (Howarth 1983b). Resort development and agricultural activities harm the species by polluting the groundwater and burying lava caves. The destruction of surface vegetation removes plant roots, which is an important food source for the cave fauna.

Cave invertebrates in Texas, including the endangered Tooth Cave spider, face similar threats as a result of development, such as the collapse or filling in of caves, flooding due to sewer overflow, and vandalism (Chambers and Jahrsdoerfer 1988). These are concerns for other, often rare, cave species (e.g., *Nesticus* spp. in Appalachia and *Cicurina* spp. in Texas) as well. Many Florida spiders, such as the Lake Placid funnel wolf spider (*Sossipus placidus*), McCrone's burrowing wolf spider, the red widow (*Latrodectus bishopi*), and the Escambia burrowing wolf spider (*Geolycosa escambensis*) are threatened by urban development and encroachment by citrus plantations (Edwards 1992a, b, c; Marshall 1992).

Evidence also suggests that paved roads and railway lines may act as linear barriers to dispersal, isolating some cursorial spider species into fragments of habitat (Mader et al. 1990). The magnitude of this effect depends upon other dispersal abilities (e.g., ballooning) of the species.

Alien species

The introduction of alien species can have serious direct and indirect consequences for native species. Alien ant species are perhaps one of the most invasive exotic species, with many reports of effects on native invertebrate species (New 1995). For example, Gillespie and Reimer (1993) demonstrated that endemic Hawaiian spider species (*Tetragnatha* spp.) are extremely susceptible to alien ant species attack and may be restricted from natural habitat by their presence. Other predatory species, such as sow bugs, cockroaches, and fire ants, which often accompany human development, may also be threats to the Tooth Cave spider and other endangered Texas cave fauna (Chambers and Jahrsdoerfer 1988; Stanford and Shull 1993).



Threatened ecosystems such as Florida scrub provide habitat for many endemic species, such as this subspecies of McCrone's burrowing wolf spider (*Geolycosa xera xera*). Photograph © Samuel Marshall.

Species introductions can have indirect effects on spider populations as well. The exotic balsam wooly adelgid (*Adelges piceae*) is decimating the spruce-fir forest in which the endangered spruce-fir moss spider exists, decreasing the forest canopy, which provides vital cover for the spider's sensitive moss mat habitat (Fridell 1995).

Pesticides and pollution

Pesticide use has decreased spider populations in agro-ecosystems, affecting the ability of spiders to control pest species (Riechert and Lockley 1984; Clausen 1990; Young and Edwards 1990). Fertilizers may change spider community composition and activity as well (Kajak 1978). Chemical contamination of groundwater can have especially deleterious effects on cave spiders, and has been cited as a threat to several endangered arthropods, including the Tooth Cave spider (Chambers and Jahrsdoerfer 1988; Stanford and Shull 1993).

Acid rain has been proposed as a factor contributing to the decline of the Appalachian spruce-fir forests, thus affecting the spruce-fir moss spider (Fridell 1995). Also, needle loss in spruce forests, due to air pollution, impacts spider species composition on spruce-living species (Gunnarson 1988).

Current conservation efforts

Federal protection efforts currently focus on the two ESA-listed spiders. The conservation strategies and actions implemented may be representative of those necessary for protection of other spider species and illustrate some challenges in invertebrate conservation.

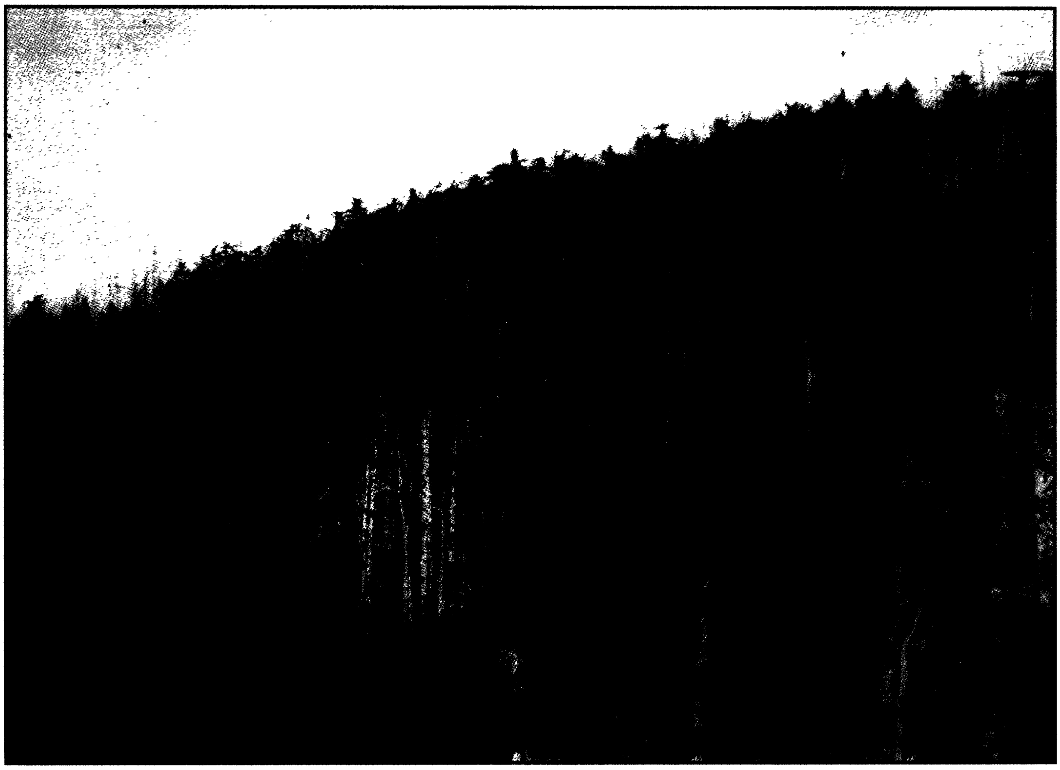
Tooth cave spider

The Tooth Cave spider is a small (1.6 mm length), whitish spider found in two (and possibly an additional two) caves in Travis County, Texas (O'Donnell et al. 1994). Imminent development in the vicinity of this cave and karst system prompted the listing of the spider as endangered along with four other Texas cave invertebrates in September 1988; a Recovery Plan for these invertebrates has been approved.

The secretive nature of most cave species makes assessing population size and distributions difficult, since many individuals may reside in humanly inaccessible spaces (Howarth 1983a). The special needs of cave and karst species, including high humidity (nearly 100%), stable temperatures, and a dependency on surface communities and inputs, create a complex conservation task (O'Donnell et al. 1994).

In addition to continued surveying to perhaps uncover additional populations, numerous other conservation measures are planned to protect the

Tooth Cave spider and associated fauna (O'Donnell et al. 1994). Habitat protection efforts are planned in areas around the inhabited caves in hopes of limiting contamination and nutrient depletion. A locked gate has been installed on Tooth Cave (the first cave in which the spider was found) in order to prevent vandalism. Several techniques to control the alien fire ant populations have been examined, including hot water and several chemicals, with additional research needed to determine effectiveness and any adverse effects on the spider. The development of these conservation techniques will hopefully aid in the future protection of numerous rare and threatened cave species.



The decline of the spruce-fir forest of Appalachia (above) due to exotic pests and air pollution threatens the moss mat habitat of the endangered spruce-fir moss spider (*Microhexura montivaga*) (above right). Photograph © Joel Harp.

Spruce-fir moss spider

The spruce-fir moss spider is a tiny (3-5 mm adult size) mygalomorph spider (a group of spiders commonly called 'tarantulas') that is restricted to moist but well-drained moss mat habitats in high-elevation spruce-fir forests of southern Appalachia (Harp 1992). The spider was listed as endangered in February 1995, after exhaustive assessments of population size and distribution revealed only four sites that harbored the species with only one relatively stable population identified (Fridell 1995). Another population has recently been discovered by a group led by Dr. F. Coyle of Western Carolina University (J. Harp, personal communication 1996). A Recovery Plan has yet to be completed, and major challenges to conservation include the complex threats to the spider's fragile habitat and limited information on the natural history, ecology, and genetics of the species.

To assess the threats to the spider's habitat by the balsam wooly adelgid, a monitoring study of the infestation was initiated on the site of the one viable spruce-fir moss spider population. Early results of this study indicate that the level of infestation may require a quicker management response than had been earlier thought (J. Thompson, NC Nature Conservancy, personal communication 1996). Possible responses to this threat include experimental techniques such as insecticidal soaping of trees and transplanting of spider populations to uninfested sites. The effectiveness and viability of these new techniques remains unknown, however.

Due to its secretive nature, little information has been collected on feeding and breeding habits, life span, or dispersal ability of spruce-fir moss spiders. This lack of knowledge contributes to the difficulty in relocation and pursuing another conservation technique: captive breeding. A captive breeding program was initiated in 1992 at the Louisville Zoological Park, and while techniques in maintaining the species in captivity have advanced, successful long-term captivity and reproduction has not yet occurred (J. Harp, personal communication 1996). Proper techniques might need to be learned through the use of a related, non-endangered species, *M. idahoana*.

Spider conservation needs

Education

A major obstacle for spider conservation is a lack of public support, possibly due to fears and ignorance. For example, in a survey asking whether participants would favor the protection of an endangered spider if it meant increased costs to an energy development project, only 34% of those surveyed said yes, while a bird, cougar, crocodile, plant, and snake fared more favorably (Kellert 1986). Fears can be addressed through pointing out that only a few easily identifiable species pose a threat to humans. By stressing beauty and interesting behaviors and qualities, attitudes towards these invertebrates may change (Robinson 1991).

Several public exhibits, for example the Louisville Zoo's Arachnid Exhibit and the traveling Smithsonian exhibit, "Spiders!," are helping to promote public interest and understanding. In addition, the Terrestrial Invertebrate Taxonomic Advisory Group of the American Zoo and Aquarium Association has an Arachnid Specialist Group which is

Photograph © Joel Harp.

developing both education programs and conservation plans for arachnids in North American zoos (Wolfe and Mason 1995).

Key development and systematics

A lack of keys for the identification of U.S. spiders remains a major impediment for conservation. Kaston (1978) provided a key to 223 genera, but no key to species. A key to the 515 genera in the U.S. has been completed by Roth (1993). A key to species by Kaston (1981) attempts to identify all species in the New England region. Information for other regions and species are buried in hundreds of technical taxonomic literature, much of which is unobtainable or rare with existing keys to species geographically limited, outdated or unreliable (Coddington et al. 1990). Development of identification keys will allow non-specialists to conduct spider inventories.

Riechert et al. (1985) and Coddington et al. (1990) both report that fewer than two dozen competent arachnid taxonomists are available for identification services of arachnids other than mites and ticks, few comprehensive museum collections exist, and little or no funding for systematic studies is available. For example, many Texas cave species that may be threatened and in need of conservation attention await taxonomic studies and names before actions can be taken; little funding is available to do this work (J. Cokendolpher, personal communication 1996).

Inventories and habitat protection

Without appropriate occurrence information, species in need of conservation may be overlooked. While most U.S. states have some type of spider species checklist, many lists are either outdated, difficult to obtain, or unreliable. Additionally, most of the checklists provide vague collection locations, little information on habitat use, and no discussion of abundance. Species are often known from only one or few localities. For example, of 621 species recorded in a checklist of Utah spiders, 265 (42.7%) were known from only one site, and 498 species (80.2%) were known from fewer than five localities (Allred and Kaston 1983).

While many states are conducting invertebrate surveys in their state, often including butterflies, dragonflies, beetles and mollusks, Ohio is specifically organizing a habitat-specific spider survey (R. Bradley, Ohio State University, personal communication 1996). This survey includes plans to sample a wide variety of habitats over ten years, including reconstructed prairies, oak savanna, and several forest types. Other states (e.g., Washington and North Carolina) have completed some habitat-specific inventories, but these are often the independent work of one scientist who is contracted for specific inventory projects (e.g., Crawford 1994). Even biotic inventories of existing protected areas, such as U.S. national parks, are severely inadequate (Stohlgren et al. 1995). In many cases focusing inventories on rare or threatened habitats could be most useful as it might provide data on associated rare and threatened species in need of attention.

Protection of rare or threatened ecosystems is arguably the best way to preserve the biodiversity that remains in them. Without the necessary inventories, however, it will be difficult to develop management regimes that benefit the most species. A good example of the approach necessary for proper protection is the work being done in Illinois, Iowa, Wisconsin, Minnesota, Ohio, and Indiana, which are each surveying arthropods to develop baseline information for management of midwest prairie ecosystems (K. Methven, Illinois NHP, personal communication 1996).

More specifically, spider inventories in these habitats are necessary for determining spider management needs. The recent studies on spiders in Appalachian caves (Dellinger and Hedin 1994), Florida scrub (Carrel 1995; Marshall 1995), mature and old-growth forests in Washington (Crawford 1994), fens in Missouri (Baltman 1992), and rare sand prairie in Illinois (Landes et al. 1995) are extremely important. Through continued spider inventories in rare and endangered habitats, efforts to preserve biodiversity through ecosystem protection can only be enhanced.

Appropriate ESA listings

Listings for invertebrates under the ESA are becoming more common, but this type of single-species approach to the conservation of such a diverse group of organisms results in protecting only a fraction of the fauna (Franklin 1993). The structure and implementation of the ESA are not well suited for invertebrates because of the strict and vertebrate-biased taxonomic requirements and the general lack of public support for such listings (Murphy 1991). Recently, the U.S. Fish and Wildlife Service expressed an explicit commitment to pursue a "multi-species, ecosystem approach" to listings (Glitzenstein 1993), which should result in more comprehensive and less expensive conservation.

This type of effort would benefit spiders. The first ESA listing of a spider was with four other cave invertebrates (Chambers and Jahrsdoerfer 1988), and this successful approach has been proposed for other cave communities (Ekis and Opler 1978; Stanford and Shull 1993). One possibility would be to list threatened spiders associated with Florida scrub habitats (e.g., *Geolycosa xera*) together with vertebrate species such as the threatened Florida scrub jay (*Aphelocoma coerulescens coerulescens*). This would increase public awareness of biotic communities and the specific needs of some of the smaller residents of these habitats. Due in part to limited dispersal abilities, many of these spiders may persist on smaller habitat fragments than vertebrates (Marshall 1995), resulting in increased ecosystem protection.

Captive Breeding

Undoubtedly, spiders are best conserved through habitat protection. However, in some extreme cases, species conservation may be accomplished only through the aid of *ex situ* breeding programs. This conservation tool remains largely unexplored for invertebrates, especially spiders. Invertebrates generally can be housed, maintained and bred relatively inexpensively in comparison to vertebrate species (Wilson 1987). Existing coordinated captive breeding programs for spiders have been small and have focused primarily on the CITES-listed Mexican red-kneed tarantula (*Brachypelma smithi*). The London Zoo has pioneered a program that developed preliminary breeding techniques and genetic management protocols for this spider (Clarke 1991). A similar program involving four U.S. zoos has also been developed (D. Hodge, Louisville Zoological Park, personal communication 1995). These two programs may serve as models for others involving endangered spider species.

While few coordinated captive breeding programs for spiders exist, information is available on general breeding techniques (Frye 1992) and nutritional ecology (Riechert and Harp 1986). Successful techniques may also be learned from amateur breeders, venom suppliers, and academic researchers. In fact, cooperation between dedicated amateurs and zoo professionals is an integral part of the London Zoo program (Clarke 1991).

Additional information is needed for successful breeding programs. The effects of long-term captive breeding of invertebrates remain largely unknown (Drummond 1995). Research on specific aspects of the physiological ecology of spiders and its effects on phenotype is in its infancy (Reichling 1995). While some studies in conservation genetics have been completed (e.g. Ramirez and Froelig 1997), research on genetic management is generally nonexistent. Also, since spiders may have high rates of reproduction in captivity, the problem of surplus individuals needs to be addressed (Clarke 1991).

Conclusion

Future conservation efforts for spiders and other arachnids will depend on increased cooperation and communication between arachnologists and conservation professionals. Little information is available to the conservation community regarding the status and distribution of spiders, due to the general difficulty in finding reliable or appropriate sources and an unfamiliarity with the taxa. Similarly, conservationists should make known information needs to researchers in order to encourage information exchange and promote scientific study.

Specifically, through continued public education, appropriately targeted inventories and habitat protection, and additional research in management needs and techniques, spider conservation efforts may be implemented with greater vigor. The incorporation of spiders in all levels of protection efforts, including focused ecosystem-based multi-species ESA listings, can result in better habitat protection. Ecosystem conservation can only be enhanced by focusing some energy on the needs of these diverse and fascinating creatures.

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AZA Taxon Advisory Group Profile: Felids

Jill Mellen
David Wildt

There are 37 species of cats worldwide. Virtually all are threatened or endangered in at least some portion of their original range. Historically, the population decline was due to hunting, specifically for the fur and pet trades. The primary threat now, however, is habitat loss due to conversion to agriculture and urban areas. In some Asian countries, the use of bones for traditional medicine has also severely impacted wild populations of felids. In the 1970s and 1980s, a major goal of captive propagation in zoos was for potential reintroduction. However, with the reality of habitat loss, expense of reintroductions, and the difficulty in preparing a captive-raised carnivore for release, the primary role of captive propagation in zoos has now shifted to a focus on education and research. Captive animals in zoos can and do serve as ambassadors for the species, serving to educate the public about the plight of felids in the wild. Additionally, research on behavior, reproductive biology, and population biology can be applied to management of species in the wild.

To facilitate captive propagation, zoos have established Species Survival Plans (SSP©s), which focus upon genetic and demographic analyses of captive populations and include individual-by-individual breeding recommendations. These programs strive to maintain maximum genetic diversity within a captive population. Demographic and genetic analyses suggest that to retain 90% of the genetic diversity in a population, that population must be comprised of about 200 breeding individuals. However, the limiting factor in virtually all captive breeding programs is the amount of enclosure space available among zoos for a given species. For example, for the 8 species of large felids, optimally, 1,600 zoo "spaces" should be allocated to larger cats. If sub-species are taken into consideration, even more "spaces" are required. Using these same criteria, the 29 species of smaller cats would require 5,800 "spaces." Given these obvious space limitations, zoos have been faced with prioritizing their spaces. Towards this end, the American Zoo and Aquarium Association (AZA) has established Taxon Advisory Groups (TAGs) to address these issues as well as issues common to the captive propagation within a taxonomic group (e.g., nutrition, disease, contraception, and environmental enrichment).

The Felid TAG was founded in 1991 under the umbrella of the AZA. The TAG is one of more than 40 such advisory groups that works to enhance the management and conservation of wildlife species in zoos and in nature. The TAG is comprised of more than 30 felid experts, including cat managers (zoo directors, curators and keepers) and research scientists representing the behavioral, reproductive, genetic, nutrition and veterinary sciences. In addition to ensuring that all available zoo space is managed properly for the cats deserving highest priority attention, the Felid TAG also promotes and conducts studies to (1) sort out taxonomy and subspecies issues; (2) develop and support research such as assisted breeding (artificial insemination); (3) develop safe contraceptive approaches; and, (4) support educational and training programs, especially in range countries. The TAG also promotes the development of new SSPs, Population Management Plans (PMP) and studbooks. The Felid TAG convenes three-day working group meetings annually, an event that includes updates of conservation and research projects conducted during the past year.

One key to the Felid TAG's success has been the AZA's association with the Ralston Purina Company, which six years ago developed a Big Cat Survival Fund. Portions of sales from cat food were provided to the AZA's Conservation Endowment Fund, and the Felid TAG assisted in identifying those projects most worthy of support. To date, more than $500,000 has been awarded through this process. Examples of projects include:

- Sao Paulo Zoo International Felid Breeding and Conservation Project (the building of a state-of-the-art felid breeding compound in Brazil);
- Safety Assessment of Melengesterol Acetate Contraceptive Implants (a project that has made us aware of the need to develop alternative methods of reproduction control for generic wild felids);
- Molecular Genetic Approach to Taxonomic and Phylogenetic Relationships in South American and Asian Felids (a study that is addressing questions of evolutionary relatedness, sub-speciation, and amounts of genetic variation, information essential to successful management of felids in zoos and in nature);
- *In Situ* Regional Captive Breeding Workshop and Facility for Sumatran Tigers in Indonesia (supporting survey activities and the building of a breeding compound for tigers in Indonesia);
- Reproductive Strategies for Understanding, Managing and Conserving Felids (a multi-institutional study that has enhanced artificial insemination techniques and has resulted in offspring produced in many cats, such as the tiger, clouded leopard, snow leopard, ocelot and cheetah (including cheetah cubs produced with frozen sperm transported from Africa);
- Production and Distribution of a Husbandry Manual for Small Cats (the first compilation of available

Large Cats	Conservation Rank
Tiger (*Panthera tigris*)	1
Snow leopard (*Uncia uncia*)	1
Cheetah (*Acinonyx jubatus*)	1
Clouded leopard (*Neofelis nebulosa*)	2
Lion (*Panthera leo*)	3
Leopard (*Panthera pardus*)	3
Jaguar (*Panthera onca*)	4
Puma (*Felis concolor*)	5

Table 1. Regional Collection Plan for large cats, 1997-1998.

data on the feeding, care and reproduction of endangered small cats, an invaluable resource for managers).

The Felid TAG maintains a Five-Year Action Plan, which is updated annually with the highest priority projects. Recommendations then are provided to AZA on those projects most deserving of Conservation Endowment Funding. At the most recent annual meeting held March, 1997 the Felid TAG identified the following projects as highest priority:

- Development of an Alternative Approach for Felid Contraception;
- Support of an *In Situ* Survey of Asian Leopards in Russia;
- Improving the Ability to Induce Ovulation in Tigers to Enhance Artificial Insemination Success;
- Impact of Improved Diet on the Reproductive Physiology and Behavior of Felids in Latin American Zoos.

To assist zoos in identifying which felid species should be managed for captive propagation, the Felid TAG also annually develops a Regional Collection Plan. Collection Plans are based upon a conservation rank assigned to each species based upon their level of endangerment in the wild, the relative genetic and demographic health of the captive population, and the potential for acquiring additional zoo-born individuals from other areas in the world. Because large cats are so charismatic, analysis of available space indicates that the allocated 1,600 spaces for big cats are nearly filled, although the species are not equally represented. For example, last year's analysis revealed 314 spaces filled by tigers; however, many of these animals are generic and of unknown origin and thus not part of the SSP program. In contrast, only 77 North American spaces were occupied by jaguars. With the exception of the puma, each species of large cat is intensively managed by an SSP or PMP. (Pumas are not managed as a PMP or an SSP because, with the exception of the Florida panther, the wild population appears healthy. Further, zoos can fulfill their needs for "educational" pumas by adopting unreleasable orphaned cubs.) Both PMP and SSP programs involve genetic and demographic analyses of their captive populations with individual-by-individual breeding recommendations updated annually. An SSP differs from a PMP in that the former promotes *in situ* conservation as well. Table 1 indicates the priority ranking for captive propagation of large cat species.

Small Cats	Conservation Rank
Black-footed cat (*Felis nigripes*)	1
Ocelot (*Leopardus pardalis*)	2
Sand cat (*Felis margarita*)	3
Passa' cat (*Otocolobus manul*)	4
Fishing cat (*Prionailurus viverrinus*)	5
Margay (*Leopardus wiedii*)	6
Caracal (*Caracal caracal*)	7
Serval (*Leptailurus serval*)	8
Lynx spp (*Lynx* spp.)	9
Bobcat (*Lynx rufus*)	10
Georffroy's cat (*Oncifelis geoffroyi*)	10
Jaguaraundi (*Herpailurus yaguarondi*)	11

Table 1. Regional Collection Plan for small cats, 1997-1998.

In contrast to the large cats, there are no SSPs in place for small cats, and only recently have PMPs been established for some of these species. If each of the dozen species of small cats routinely housed in zoos was allocated the theoretical 200 spaces for captive propagation, 2,400 spaces would be required. In reality, only 540 spaces were filled by small cat species in 1996. Thus, the Felid TAG is working intensively to determine which small cat species should be managed within this limited number of captive spaces. Table 2 identifies those species recommended by the Felid TAG for exhibition and, in some cases, propagation in North American institutions. As with the puma, the Felid TAG discourages North American zoos from breeding lynx and bobcat.

All the Felid TAG members are volunteers with full-time responsibilities elsewhere. Nonetheless, this group works hard and as a team, and now has a number of substantial products to show for its years of diligent effort. There is a great sense of reward to working in partnership with friends and associates who have common interests and goals in the conservation of this highly endangered and charismatic taxon.

Jill Mellen and David Wildt are Co-Chairpersons of the Felid Taxon Advisory Group. Jill Mellen is the Research Biologist at Disney's Wild Animal Kingdom; P.O. Box 10,000, Lake Buena Vista, FL 32830. David Wildt heads the Department of Reproductive Physiology and is a Research Director at New Opportunities in Animal Health at the National Zoo's Conservation & Research Center; Smithsonian Institution, 1500 Remount Road, Front Royal, VA 22630.

NEWS FROM ZOOS

Project Betampona: Lemures Re-stocking Project

Photo by David Haring

In cooperation with Malagasy authorities, the Madagascar Fauna Group (MFG), an international consortium of 30 zoological institutions, is moving forward with plans to re-stock black-and-white ruffed lemurs (*Varecia variegata variegata*) at the Natural Reserve of Betampona, a small (2,228 ha) reserve in eastern Madagascar. Betampona is the sole forested mountain range in a vast region where eastern lowland forest has been lost to cultivation. A small *Varecia* population, at least eight other lemur taxa, and many bird, reptile and other species will all benefit from increased protection brought by the project. Goals include the development and testing of reintroduction protocols for lemurs, and the integration of captive breeding programs with efforts to increase the viability of Betampona's remaining wild *Varcia* population. With preliminary behavioral, ecological and genetic research completed and most of the necessary funds raised (funded in part by a grant from the Walt Disney World Company through AZA's Conservation Endowment Fund), captive-bred animals from the Ruffed Lemur Species Survival Plan population have been selected for release by the AZA Prosimian Advisory Group. Pairs have been formed and are now in "boot camp" at Duke University Primate Center and the Wildlife Conservation Society's St. Catherine's Wildlife Survival Center, located in Georgia, to prepare them for life in the wild.

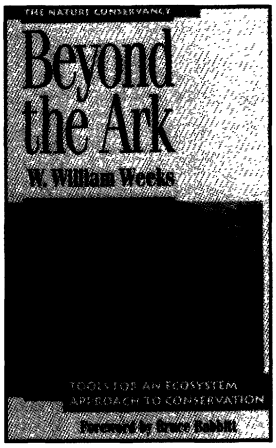
Multiple-Use Forest Study Funded in Sabah, Malaysia

Orangutans (*Pongo pygmateus*), the largest non-human primate species in Asia, have suffered a large decline in numbers, especially during the last ten years. This decline is primarily attributed to habitat loss, to which orangutans are very sensitive. Since it is believed that the majority of wild orangutans live outside protected forest areas, there has been great concern for the welfare of these animals. A consortium of North American and European zoos is funding a three year research project in Sabah, Malaysia to develop an understanding of the relationship of orangutans and altered habitat. To date, there has been no detailed study of orangutans in logged forest. Aerial surveys in altered and virgin forests of the Lower Kinabatangan region of Sabah have shown large numbers of orangutans. Researcher Isabelle Lackman-Ancrenaz, a research fellow at the Pittsburgh Zoo, and Marc Ancrenaz, with Hutan in France, will attempt to define requirements for the viability of orangutan populations in multiple-use forests. They will also investigate the seasonal use of different habitat types by individual orangutans, clarify the orangutan population status in this region, and provide training to Sabah Wildlife Department personnel. It is hoped that this research will provide crucial information, not only for effective regional management, but also for worldwide conservation of biological diversity in multiple-use tropical forests.

LIFE Magazine Features AZA's Species Survival Plan

The March 1997 *LIFE Magazine's* cover story "Miracle Babies" highlights the efforts of North American zoos and aquariums to conserve endangered species under the Species Survival Plan (SSP©). The SSP is the cornerstone of the American Zoo and Aquarium Association's (AZA) conservation programs, with 82 SSPs covering 134 species. There are 175 North American AZA accredited zoos and aquariums working cooperatively in the SSP. The *Life Magazine* article, written by Charles Hirschberg and photographed by James Balog, describes the SSP program and is illustrated by photos of a number of the "Miracle Babies." Among the several species highlighted in the cover story are the rhinoceros, gorilla, African penguin, and radiated tortoise. Additional information about AZA and its conservation programs can be found on AZA's website at www.aza.org.

Recent Publications



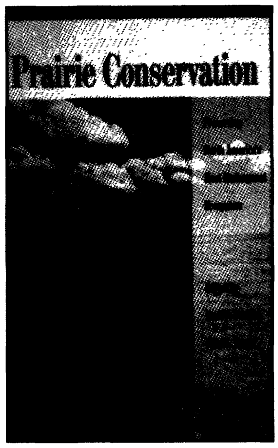
Beyond the Ark: Tools for an Ecosystem Approach to Conservation

by W. William Weeks. 1997. Island Press. 172 pp.

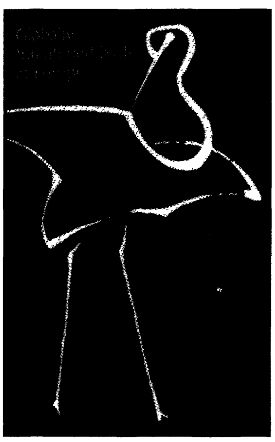
Beyond the Ark, by the director of The Nature Conservancy's Center for Compatible Economic Development, pins down the often vague notion of ecosystem management in a way that many conservationists should find useful. The book begins with a general introduction to conservation, conservation planning, the history and philosophy of The Nature Conservancy, and the popular yet nebulous concept of ecosystem management. It then goes into an in-depth description of the planning process framework that the Conservancy has developed for conservation planning through ecosystem management. This framework is made up of "five S's"—understanding the ecological System, identifying the Stresses to it, determining the economic and social Source of the problems, developing Strategies to deal with the stresses at their source, and defining and measuring Success.

Prairie Conservation: Preserving North America's most Endangered Ecosystem

Edited by Fred B. Samson and Fritz L. Knopf. 1996.
Island Press. 339 pp.



In *Prairie Conservation*, the editors argue that the decline of the native prairie in North America, which exceeds that of any other major ecosystem, constitutes an ecological and economic threat that should make prairie preservation of highest priority. The chapters—contributed by a variety of authors from government agencies, conservation organizations, and universities—cover numerous topics. These include an environmental history of the Great Plains, the economic value of the prairie, current and historical flora and fauna, and current conservation programs. The ecological information especially is covered in great depth, with separate chapters devoted to each of four prairie types (tall grass, short grass, mixed, and wetlands), and also to birds, mammals, amphibians and reptiles, fish and aquatic resources, and invertebrates The ecological review is followed by an equally in-depth policy section looking at the current state of regulations and partnerships in the United States and Canada. Several authors also address challenges for conservation of this imperiled resource and suggest recommendations for future actions.



Globally Threatened Birds in Europe: Action Plans

Edited by Borja Heredia, Laurence Rose, and Mary Painter. 1996.
Council of Europe Publishing and Birdlife International. 408 pp.

Of the roughly 10,000 birds in the world, 514 are found in Europe. Of these, 23 species are threatened globally and are considered at risk of extinction. Action plans, developed for each of these species, are meant to be a starting point for conservation activities, to form the basis for decisions at the international level, and to provide a framework for more detailed conservation planning at the national level. Each plan gives a summary of the biology, threats, and conservation priorities for the species; an in-depth discussion is also provided, including a country-by-country analysis of conservation measures. Action plans were developed through a joint effort among governmental and non-governmental organizations and individuals in hopes of encouraging rapid implementation.

Bulletin Board

Seventh International Symposium on Society and Resource Management

This biennial symposium focuses on the contributions of the social sciences to a better understanding of the environment and resource management. A commitment to understanding links between *culture, environment, and society* will be a guiding theme at the 1998 event, but any presentations bringing social science perspectives to resource and environmental issues will be welcomed. Symposium activities include concurrent paper and poster sessions, panel and round table discussions, film/video sessions, and various field trips. Hosted by the University of Missouri, the Symposium welcomes all researchers, managers, academicians, policy specialists, and students interested in the human aspects of resource management. For more information on participation and a call for proposals, visit the website at http://silva.snr.missouri.edu/issrm or contact Dr. Sandy Rikoon, ISSRM Co-chair, University of Missouri-Columbia, Rural Sociology, Sociology Building 108, Columbia, MO 65211. Tel: (573) 882-0861. Fax: (573) 882-1473. E-mail: ssrsjsr@muccmail.missouri.edu.

Plant Action Plans

The World Conservation Union and the Species Survival Commission have published two new plant conservation action plans for orchids and palms. The *Orchid Action Plan* chronicles threats to certain critical species, but more importantly to critical habitats that host high orchid diversity and endemicity. It explores and recommends specific ways that national and local legislators, scientists, and orchid conservationists and growers can help to reverse present trends.

Palms, Their Conservation and Sustained Utilization, identifies the most threatened palm species, presents recommendations for conservation programs that cater to their specific requirements and provides strategic guidelines for the conservation and sustainable use of the many palms that provide food, construction materials, and an important source of revenue for many people. Both plans are available through IUCN Publications Services Unit, 219c Huntingdon Rd., Cambridge CB3 0DL England; Tel: (44) 1223-277894; Fax: (44) 1223-277175; E-mail: iucn-psu@wcmc.org.uk; Website: http://www.wcmc.org.uk.

NGO Champions International Conservation

The Biodiversity Forum is a non-profit organization that pursues the following objectives: (1) to promote and encourage international public awareness and understanding of issues relating to the conservation of worldwide biological diversity; (2) to encourage cooperation among governments, international organizations, and the private sector in developing methods for the sustainable use of biological resources; and (3) to collect and disseminate information relating to international treaties and conventions designed to regulate the commercial or non-commercial use of biological resources. For more information on The Biodiversity Forum, its personnel, activities, and newsletter, visit their website at http://worldcorp.com/biodiversity.

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

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Q1773
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Endangered Species UPDATE
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