Building a Scientifically Sound Policy for Protecting Endangered Species

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The primary legislative tool for protecting imperiled species in the United States is the Endangered Species Act (ESA) of 1973. The pending reauthorization of this law has sparked a fierce debate on the science, economics, and ethics of protecting vanishing species; the outcome of the debate will influence domestic and international conservation policies for years. Recent advances in our scientific understanding of biodiversity have underscored the importance of species protection for human welfare. Each species, by virtue of its genetic uniqueness, is the source of information we can learn from no other source. Species can provide us with novel molecules and new understanding of genetic capacities, which can be used to fashion new agricultural products, medicines, and other chemicals of direct benefit to humans. Indeed, prospecting for biogenetic information could well become a major scientific exploratory venture of the 21st century. Species also provide essential ecological services to humanity by regulating climate; cleansing water, soil, and air; pollinating crops; maintaining soil fertility; and performing other life-sustaining functions (*1*).

Despite the importance of species to people, a significant fraction of the biota of the United States is at risk of extinction or already lost. Somewhat in excess of 100,000 native species (terrestrial and freshwater) have been described from the United States, including 22,750 vascular plants; 3110 vertebrates; and (very roughly) 75,000 insects. Within those taxa most carefully classified and studied to date, about 1.5% of the species alive at the turn of the century are now considered to be certainly or probably extinct. Extinction estimates range from 0 in reptiles and gymnosperms to 8.6% in freshwater mussels. In these groups, the overall percentage of species ranked as imperiled or rare is 22.2%, with a peak of 60.1% in freshwater mussels (*2*).

Recent scientific discoveries and assessments provide valuable insights about endangered species protection (*3*). We focus on three issues: (i) Does the act protect the right elements of diversity? Should the limited resources available for conservation be targeted toward the protection of higher ecological levels of diversity, such as ecosystems, rather than toward the protection of individual species? Should protection encompass categories below the species level (that is, to subspecies and populations)? (ii) Have decisions to classify particular plants and animals as endangered been based on sound science? (iii) Can ecological and biogeographic knowledge be used to increase the efficiency of the ESA?

What Should Be Protected?

Although the stated purpose of the ESA is "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved," it attempts to do so by protecting individual species, subspecies, and, in the case of vertebrates, distinct population segments. This focus on individual taxa has come under increasing criticism from those who believe it to be an inefficient and ineffective means of safeguarding biological diversity (*4*). The sheer number of species present in most regions of the country and the lack of ecological information about most species are cited as the primary reasons for shifting conservation activities to higher levels of biological organization. There are four strong reasons for not abandoning the traditional focus on individual species. (i) Because ecosystems are less discrete entities, species provide a more objective means of determining the location, size, and spacing of protected areas necessary to conserve biodiversity. (ii) Population declines of individual species (for example, freshwater mussels, peregrine falcons) may indicate the presence of stress to an ecosystem before it is obvious system wide. (iii) Individual species are the source of new medicines, agricultural products, and genetic information useful to humans. (iv) Although ecological services are provided by ecosystems, individual species often play pivotal roles in the provision of these services (*1*). Efforts to protect declining species are consistent with the goal of protecting ecosystems. We strongly concur with recent reports from the National Research Council (NRC) and the Ecological Society of America that emphasize the need to protect both species and habitats; neither is a complete substitute for the other (*3*).

Subspecies and distinct population segments of vertebrates have been protected by the ESA since its inception and currently constitute about 20% of listed taxa (*5*). Legislation to reduce protection for units below the species level has been introduced in Congress and will be debated in the forthcoming reauthorization. Advocates of this measure argue that it will reduce the number of ESA-related conflicts by reducing the number of listed taxa and will allow the federal government to focus limited resources on the protection of full species. Although sympathetic to both concerns, we believe the current policy is sound because it facilitates the protection of genetic diversity within species and encourages people to act earlier to protect declining species, rather than waiting until all subspecies or populations of a given species are imperiled. Moreover, as noted in the NRC report, there is no scientific justification for protecting populations only of vertebrates. Plants, for example, may differ chemically at the population level, reflecting genetic differences that may prove useful to humans (*6*).

Criteria for Listing

Under the act, protected species are classified as either "endangered" or "threatened." The former includes "any species which is in danger of extinction throughout all or a significant portion of its range"; the latter includes "any species which is likely to become an endangered species within the foreseeable future. . . ." These vague statutory definitions provide the Secretary of the Interior with considerable latitude in determining which taxa warrant protection. Critics of the act allege that numerous taxa have been accorded protection based on incomplete or inaccurate information.

There is, however, little evidence that the Department of the Interior has abused its authority by listing taxa that are not at risk of extinction. Since passage of the ESA, only 4 of more than 950 protected taxa have been removed from the endangered list because subsequent studies showed them to be more abundant than previously thought (*7*). In fact, most species are listed when their populations are close to extinction. A recent study found that the median population sizes of taxa at time of listing were only about 1000 individuals for animals and 120 individuals for plants; at least 39 plants were listed when 10 or fewer

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individuals were known to survive (5).

Where to Protect Endangered Species?

The fear that the presence of endangered species will lead to restrictions on the use of private lands has spawned much of the backlash against the ESA. It is reasonable, therefore, to ask how important private lands are to endangered species protection. Approximately 50% of listed taxa occur only on state and local public lands, tribal lands, and private lands (8).

The current pattern of federal land ownership is imperfectly suited to protecting biodiversity. Federal lands are concentrated in the western United States, including some areas with few imperiled species. Other regions that harbor high concentrations of localized, rare species contain little or no federal land. A carefully designed program of land exchanges between the federal government, other public landholders, and private landowners could improve the federal portfolio from a biodiversity perspective while providing private landowners with relief from their endangered species obligations and compensation in kind at little or no federal cost (9). Such a program would not negate the need to protect endangered species on private lands, but it would reduce the impact of doing so.

Improving the Process

To argue that species conservation must remain a central goal in conservation is not to say how that goal should be met. New approaches with respect to both the science and economics of protecting biodiversity could significantly improve the performance of the ESA.

Priorities for protection. Some ecosystems are more endangered than others and contain a large number of species found nowhere else. Such hot spots are critical to conservation efforts because many (but far from all) endangered species will occur within them. It is therefore most effective for the Department of the Interior to give priority to the identification and protection of such places by expediting the formal listing of imperiled species associated with them. Examples in the United States include the rain forests of Hawaii, the sand ridge scrublands of central Florida, the desert wetlands of Ash Meadows in western California and eastern Nevada, and the rivers of the Cumberland Plateau and southern Appalachians (*10*). The 50 counties in the United States with the largest number of federally listed species, which together comprise about 4% of the nation's land area, contain populations of approximately 38% of all listed species (*12*).

When ecosystems are in a natural or seminatural state, the number of species, S, expected to persist is systematically related to area, A. This species-area relationship is represented as $S = cA^z$, where z is usually in the range of 0.2 to 0.4, depending on the group and place. This relationship implies that a tenfold increase in habitat area approximately doubles the number of species within it. An important consequence of the species-area relationship is that lands protected on behalf of animals with large home ranges or low population densities will provide de facto protection for numerous other species with smaller home ranges or higher densities. The Department of the Interior can maximize the efficiency of its listing duties by targeting such taxa, commonly referred to as "umbrella species" (*12*). Other useful criteria for determining priorities for protection include the species' ecological role, taxonomic distinctiveness, and recovery potential (*3*).

Incentives for protection. The ESA relies on fines and jail sentences to punish or deter harmful conduct, but it provides no incentives to encourage or reward beneficial conduct, such as restoring habitats for endangered species. Changes in both the federal tax code and existing subsidy programs could be used to this effect.

For example, to pay federal estate taxes, inheritors of large land holdings are occasionally forced to sell, subdivide, or develop the property, resulting in loss of wildlife habitat. In cases where the property contains endangered species, the heirs could be given the opportunity to defer part of the estate taxes by entering into an endangered species management agreement with the Department of the Interior. In other cases, endangered species will persist on a site only if the habitat is actively managed on their behalf. The expenses associated with habitat management (for example, prescribed fire) are not currently tax deductible; if they were, more landowners would likely participate in efforts to recover endangered species.

The federal government funds a number of incentives programs aimed at encouraging farmers, ranchers, and small woodlot owners to protect wetlands, forests, soils, and water quality (*13*). To date, no effort has targeted these programs to areas where endangered species are likely to benefit. This could be done by simply modifying the criteria for eligible lands or by paying a premium for lands harboring endangered species. Such measures cannot wholly supplant the regulatory requirements of the ESA, but they can limit the need for, and increase the flexibility of, such requirements.

The ESA is scientifically sound. A continued focus on species protection is necessary and appropriate and complements the protection of ecosystems. The effectiveness of the act can be improved by emphasizing the protection of hot spots and umbrella species, by protecting disappearing species and ecosystems earlier, and by supplementing the law's regulatory requirements with economic incentives.

REFERENCES AND NOTES

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2. Data on numbers of species at risk of extinction or recently extinct were taken from the National Heritage Central Databases of The Nature Conservancy, June 1992. The count for the total number of known species is only an estimate, due to the imperfect nature of summary databases for U.S. biota. Our estimate is a conservative one, especially in view of the lack of clear estimates for groups such as fungi and microorganisms. See also E. T. LaRoe, G. S. Farris, C. E. Puckett, P. D. Doran, M. J. Mac, Eds., *Our Living Resources: A Report to the Nation on the Distribution, Abundance and Health of U.S. Plants, Animals and Ecosystem* (U.S. Department of the Interior, National Biological Service, Washington, DC, 1995).
3. National Research Council, *Science and the Endangered Species Act* (National Academy Press, Washington, DC, 1995); C. R. Carroll *et al.*, *Ecol. Appl.*, in press.
4. J. F. Franklin, *Ecol. Appl.* **3**, 202 (1993); G. Easterbrook, *A Moment on Earth* (Viking, New York, 1995).
5. D. S. Wilcove, M. McMillan, K. C. Winston, *Conserv. Biol.* **7**, 87 (1993).
6. T. Eisner, *BioScience* **42**, 578 (1992).
7. The four taxa include three plants (*Tumamoca macdougalii, Astragalus perianus*, and *Hedemoa apiculatum*) and one amphibian (Florida population of *Hyla andersonii*).
8. B. A. Stein, T. Breden, R. Warner, in *Our Living Resources* [see (*2*)].
9. An example is the Collier land exchange approved by Congress in 1988, in which the Department of the Interior will trade 111 acres in Phoenix, Arizona, for 122,000 acres of private land in Florida. The Florida land will become part of Big Cypress National Preserve and two national wildlife refuges and will protect habitat for the endangered Florida panther. Land exchanges are complex; for recommendations, see National Research Council, *Setting Priorities for Land Conservation* (National Academy Press, Washington, DC, 1993).
10. D. W. Lowe, J. R. Mathews, C. J. Moseley, *The Official World Wildlife Fund Guide to Endangered Species of North America* (Beacham, Washington, DC, 1990).
11. Data on county occurrences of threatened and endangered species obtained from U.S. EPA's Office of Pesticide Programs' Endangered Species-By-County List, 31 March 1995. Our analysis is based on known occurrences of federally listed species in each county.
12. The northern spotted owl (*Strix occidentalis caurina*) is an example of an umbrella species. One study concluded that 280 species of plants (vascular and nonvascular) and vertebrate animals closely associated with old-growth forests in the Pacific Northwest would be protected in a reserve system established for the owl. See J. Thomas *et al.*, "Viability assessments and management considerations for species associated with late-successional and old-growth forests of the Pacific Northwest" (USDA Forest Service, Washington, DC, 1993).
13. Examples of such programs include the Conservation Reserve Program, Wetlands Reserve Program, Water Quality Incentives Program, and Forest Legacy Program.

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