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What to Do About It**

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Six Biological Reasons Why the Endangered Species Act Doesn't Work—And What to Do About It

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Abstract: *Law plays an important role in shaping land management decisions. The success of efforts to conserve biodiversity thus depends to a large degree on how well scientific knowledge is translated into public policy. Unfortunately, the Endangered Species Act, the United States's strongest legal tool for conserving biodiversity, contains serious biological flaws. The statute itself, as well as agency regulations and policies that implement the law, include provisions that fail to account accurately for important biological concepts such as ecosystem conservation, patch dynamics, and the probabilistic nature of stochastic threats to a species' persistence. Moreover, the procedures of federal agencies charged with implementing the Endangered Species Act in some cases make it difficult for interested outside reviewers to evaluate the agencies' scientific findings and methodology. However, the Endangered Species Act also gives interested individuals and groups several opportunities to provide input into the process of managing threatened and endangered species. Conservation biologists should practice focused advocacy by taking advantage of such opportunities to steer law in a more biologically sound direction.*

Resumen: *Las leyes juegan un papel importante al darle forma a las decisiones sobre el manejo de la tierra. El éxito de los esfuerzos para conservar la biodiversidad depende en buena parte de que tan bien sea traducido el conocimiento científico dentro de las reglamentaciones públicas. Desafortunadamente, el Acta sobre las Especies en Peligro, la herramienta más fuerte dentro de los Estados Unidos para conservar la biodiversidad, contiene serias faltas biológicas. El estatuto en sí mismo, así como las regulaciones de las agencias y los reglamentos que implementan la ley, incluyen aspectos que fallan para tomar en cuenta certeramente importantes conceptos biológicos como la conservación de los ecosistemas, la dinámica de ecosistemas fragmentados y la naturaleza probabilística de amenazas al azar en contra de la existencia de una especie. Por otra parte, los procedimientos de las agencias federales a cargo de implementar el Acta de las Especies en Peligro, en algunos casos, hacen difícil la intervención de revisores externos interesados en evaluar los hallazgos y metodologías científicas de las agencias. Aún así, el Acta de las Especies en Peligro da, a los individuos y grupos interesados, varias oportunidades para ofrecer impulsos durante el proceso del manejo de las especies amenazadas y en peligro. Los biólogos de la conservación deben de enfocar su apoyo al tomar ventaja de estas oportunidades para orientar a la ley en una dirección que contenga bases biológicas sólidas.*

Introduction

Conservation biology is a unique discipline in that its practitioners not only study biodiversity, they also work to slow and ultimately prevent its erosion. As such, conservation biologists must wear many hats. Thomas and

Salwasser (1989) noted that to more effectively influence land and wildlife management, conservation biologists must also serve as teachers, biopoliticians, and even "gladiators" in the arena of land-use planning. This article adds another calling to that list—lawyers. Law plays a major role in shaping natural resource management, particularly (but by no means exclusively) on public land. Even the best biological advice has little practical effect if it does not fit within the legal con-

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straints imposed upon resource managers. Therefore, in addition to their other duties, conservation biologists must work to ensure that lawmakers and administrators accurately translate scientifically based conservation recommendations into public policy.

The Endangered Species Act remains the United States's strongest and most comprehensive species conservation strategy, as well as a model for other nations' protection efforts (Rohlf 1989). However, the Act has had very limited success in achieving its stated goal of halting and reversing the trend toward species extinctions. In the seventeen years since passage of the Act in 1973, only a handful of protected species have recovered to the point where they no longer face extinction. Meanwhile, Wilson (1988) estimates that human actions extirpate 17,500 species each year. Although its extremely limited influence over resource management outside the United States hampers the Act's ability to conserve global biodiversity, other factors contribute to the statute's domestic ineffectiveness. Politics and economic debates have interfered with efforts to conserve some species, as the recent bitter controversies surrounding shrimpers' use of turtle excluder devices and efforts to curtail logging in Spotted Owl habitat demonstrate. More fundamentally, however, some provisions of the statute itself, as well as key interpretations of the Act by administrators charged with its implementation, conflict with sound biological principles. Biological flaws in the law itself significantly contribute to its ineffectiveness in conserving biodiversity.

This article examines the interplay between the law and science of conserving imperiled species. After briefly describing how the Endangered Species Act works, I analyze provisions and interpretations of the Act that are inconsistent with basic tenets of conservation biology. I conclude with comments on how conservation biologists can and should influence policymakers in an effort to make law consistent with science.

How the Endangered Species Act Works

Congress enacted the Endangered Species Act to "provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, [and] to provide a program for the conservation of such . . . species. . . ." (16 U.S.C. Section 1531 [b]). To qualify for Endangered Species Act protections, a species must appear on the official list of endangered species, defined by law as those likely to become extinct within all or a significant portion of their range, or of threatened species, those likely to become endangered in the foreseeable future. The Secretaries of Interior and Commerce (acting through the U.S. Fish and Wildlife Service and National Marine Fisheries Service, respectively) have authority to add to and delete from these

lists based on whether a species faces extinction due to any variety of natural or human-caused factors (see 16 U.S.C. Section 1533 [a] [1]). The Secretaries must also draw up "recovery plans" for each listed species, which set forth conservation goals and specify actions necessary to achieve them. The current lists include over 600 species that occur within the United States and over 500 species that occur elsewhere in the world.

Section 7 contains some of the Act's principal substantive protections for listed species. It directs federal land managers and other federal agencies to insure that their activities do not jeopardize the continued existence of listed species or adversely modify habitat critical to those species. To provide federal agencies with expert biological advice to help them comply with this mandate, the statute requires agencies considering a specific action to consult with the Fish and Wildlife Service or the National Marine Fisheries Service before committing to a course of conduct. After this consultation, the service issues a written "biological opinion," which details the proposed activity's probable influence on protected species, suggests project alternatives or modifications that would avoid or lessen adverse effects, and sets forth the biological information upon which the opinion is based. Although the action agency makes the final decision on whether to proceed, agencies seldom go forward with a project if the biological opinion reports a likelihood of jeopardy to the species or adverse modifications of its critical habitat. Congress amended section 7 in 1978 after the famous snail darter case to allow a committee composed of Cabinet-level officials to grant exemptions to the absolute protections of this section. Rarely convened, the so-called "God Committee" has granted only one exemption in its history.

Unlike section 7, whose provisions apply only to federal agencies, section 9 applies to private individuals, corporations, and state and local governments as well. It prohibits anyone from "taking" a species listed as endangered. "Taking" includes not only direct infliction of physical harm on a member of an endangered species, but also alteration of an endangered species' habitat that in turn kills or injures members of the species. In addition, section 9 prohibits any sort of domestic or international commerce in endangered species and products made from those species, a particularly important provision for conservation of listed species that occur exclusively outside the United States. The Secretaries of Interior and Commerce have issued regulations that apply the above protections to the vast majority of threatened species as well.

Regulations and official interpretations of the Act play an important role in shaping the law. Regulations, issued by Fish and Wildlife Service and National Marine Fisheries Service, define terms in the Act that the statute does not explicitly define. They also interpret the Act's directives and set forth specific procedures for imple-

menting its provisions. Although a federal court has authority to set aside regulations it finds in conflict with the statute itself, this seldom happens. In practice, therefore, regulations greatly influence the scope and implementation of the Act's protections. Additionally, Fish and Wildlife Service and National Marine Fisheries Service receive legal advice to help them interpret the Act from the Solicitor's Office and Office of General Counsel within the Departments of Interior and Commerce, respectively. Regulations, solicitor's opinions, and internal Fish and Wildlife Service and National Marine Fisheries Service policies shape and define legal protections for endangered and threatened species.

Six Biological Reasons Why the Endangered Species Act Is Not an Effective Tool for Conserving Biodiversity

1. The Act Primarily Protects High-Profile Individual Species Rather Than Overall Biodiversity.

Legal experts as well as biologists have criticized the Act's single-species approach to biodiversity conservation. Smith (1984) notes that this approach has been a traditional element of conservation regulations due to the historical fact that overhunting and other forms of direct exploitation depleted or extirpated many species; he goes on to point out that species currently face greater threats due to habitat reduction, making ecosystem conservation preferable to single-species protection. Scott et al. (1987) argue that "Emergency Room Conservation" expends inordinate effort and resources on a few species that, by the time they are finally listed as endangered or threatened, may be too far gone to save.

Despite its focus on single species, the Endangered Species Act could play a significant role in protecting biodiversity on a broader scale. The Act could serve as an extremely useful tool for preserving keystone species, thus indirectly benefiting the many other life forms in some way dependent upon those species. Additionally, the law could systematically extend protections to indicator species whose relative abundance provides a measuring stick for overall health of entire ecosystems. Such strategies could substantially mitigate many of the shortcomings inherent in the Act's single-species approach.

Unfortunately, despite congressional statements favoring ecosystem approaches, policy-makers have tended to emphasize Endangered Species Act protection for high-profile single species rather than incorporate umbrella protections for biodiversity into the statute. In response to a 1979 amendment to the statute requiring Fish and Wildlife Service and National Marine Fisheries Service to develop priority systems to guide their listing decisions, Fish and Wildlife Service adopted a scheme

that favored what it termed "higher" life forms such as mammals and birds. Congress specifically disapproved of this priority system in 1982 when it again amended the Act. Moreover, in committee reports accompanying the 1982 amendments, lawmakers made clear that even though the Act focuses on individual species, its purposes are "far broader." Amplifying the Act's reference to ecosystem conservation, a conference committee report noted that protected species "must be viewed in terms of their relationship to the ecosystem of which they form a constituent element" (House of Representatives 1982), while a Senate report argued that it is biologically prudent to place emphasis on listing species that "form the basis of ecosystems and food chains" (U.S. Senate 1982). These pronouncements notwithstanding, Fish and Wildlife expressly refused to incorporate species' importance within ecosystems as a listing priority criterion when it rewrote its listing priority guidelines in 1983. The current guidelines instead concentrate primarily on the magnitude and immediacy of threats facing species, thus officially adopting an "emergency room" approach to biodiversity conservation. The National Marine Fisheries Service adopted a similar scheme in its listing priority system.

Species recovery priorities also reflect little consideration for maximizing overall biodiversity. Both Services base their guidelines for allocating resources for recovery efforts primarily on degree of threat as well as a subjective determination of "recovery potential." These agencies also have historically focused their recovery expenditures on a handful of high-profile species. Between 1982 and 1986, Fish and Wildlife Service spent almost half of the funds available to it for developing and implementing recovery plans on twelve species—only six of which the agency considered highly threatened. The General Accounting Office (1988) found that this imbalance resulted from the government's attempt to maintain a positive public perception of its recovery efforts by placing special emphasis on species with high public appeal. In an attempt to force more even resource allocations between listed species, Congress in 1988 amended the Endangered Species Act to require that recovery plan development and implementation proceed "without regard to taxonomic classification" (16 U.S.C. Section 1533 [f] [1] [A]). Although this amendment may encourage the Services to consider species other than "charismatic megafauna," it did not change the emphasis on degree of threat as a primary recovery priority criterion.

2 The Act Lacks Clearly Defined Thresholds to Delineate Endangered, Threatened, and Recovered Species.

Shaffer (1987) listed agreement on an appropriate level of security as an important element in systematic biodiversity conservation. The parameters one chooses to define a "secure" population have tremendous influence

on decisions concerning management of that population and its habitat. Greater security for a given species or population generally requires larger and more numerous habitat areas and in some cases more extensive monitoring and management.

Although the Act implicitly sets a standard for separating relatively secure species and populations from those facing extinction, the statute does not clearly define or even specifically describe its security standard. The threshold separating species listed as threatened and endangered from those considered "recovered" or not eligible for protection in effect constitutes a standard of security because it extends special protections to species on one side of this line. The Act and its regulations, however, simply describe endangered species as those in danger of extinction throughout all or a significant portion of their range; threatened species include those likely to become endangered. The law makes no reference to quantitative or even qualitative parameters of what constitutes a "danger" of extinction.

Ironically, advances in conservation biology have demonstrated that defining a "secure" population involves making policy choices as well as determining required habitat and population sizes. To describe a viable population, Shaffer (1981, 1987) noted that one must first establish a time frame of reference and desired degree of certainty of continued existence. As an example, Shaffer arbitrarily defined a viable population as the smallest isolated population with a 99% chance of remaining extant for 1000 years in the face of stochastic threats to its existence. However, he acknowledged that establishing these explicit criteria is a policy decision rather than a biological question; society in essence must choose the amount of "insurance" it wishes to purchase against the risk of extinction.

Although Congress's pronouncements about the importance of protecting imperiled species suggest that lawmakers made a policy decision to afford species a high degree of security, the Endangered Species Act's lack of explicit biological criteria leaves species security determinations to the Services charged with implementing the statute. However, the Services have failed to set specific time and certitude standards for systematically differentiating "secure" species from those facing extinction and thus eligible for protection under the Act. Instead, the Services have attempted to draw this distinction on a case-by-case basis in reference to qualitative factors such as a species' historic abundance and threats to its existence. As a result, the terms "endangered" and "threatened" have no uniform biological meaning. Although scientific uncertainty always limits the precision of objective standards, we use them in other forms of environmental regulation. The Environmental Protection Agency, for example, uses an objective estimate of the number of cancers caused to determine whether to allow use of specific pesticides. This

allows decision-makers, as well as the public, to perceive a clear policy choice: should we define "safety" as one additional cancer death per ten thousand people or one additional death per one million? Use of an objective standard of species security would permit a similarly clear choice.

Without explicit criteria to define a secure population, however, the degree of security afforded to species by the Act varies according to discretionary ad hoc determinations by the Services. This creates a risk that the security afforded to particular species in listing decisions or section 7 consultations may not correspond to the high value Congress placed on biodiversity protection. Absence of objective standards makes it very difficult to challenge the Services' decisions. Courts, which lack biological expertise, give these agencies a great deal of deference; without specific criteria by which to measure agency determinations, courts are unlikely to question the services' listing decisions and biological opinions.

Moreover, making species security decisions on a case-by-case basis without reference to objective standards necessarily injects political and economic considerations into the process of making what by law are supposed to be biological decisions. This occurs because without previously set, objective security parameters, the task of defining species security on a case-by-case basis involves making policy as much as making a scientific determination. In making a listing decision, for example, the service must first define the point at which a particular species is "in danger" of extinction—which Shaffer notes is essentially a policy choice—and then determine biologically whether the species' population has reached that point. In other words, determining which biological questions to ask involves making a policy choice. In the controversial Spotted Owl case, for instance, the GAO (1989) concluded that Fish and Wildlife had refused to list owls in part due to political pressure from Interior Department officials' concern over effects on the Northwest's timber industry. This lobbying probably played a significant role in how Fish and Wildlife chose to define "danger of extinction" in that particular case, thus influencing the agency's supposedly biologically based decision not to afford Spotted Owls protection under the Endangered Species Act.

Finally, the agencies' current ad hoc approach to determining species security under the Act virtually insures that security standards for different species will not be uniform. Such disparities raise problems similar to those inherent in the single-species approach to biodiversity conservation discussed above. For example, a Service may choose to give a highly visible or popular species a relatively high degree of security even though it does not play a particularly important ecological role. Differential standards of species security thus undercut efforts to systematically protect biodiversity.

3. The ESA Does Not Adequately Protect Metapopulations.

Metapopulation dynamics play an important role in the persistence of many species. The existence of several or many populations is critical for species that inhabit patches in a shifting mosaic of habitats (Pickett & Thompson 1978). Multiple populations also serve as a source of colonists and thus as a hedge against environmental stochasticity. Additionally, even minimal interbreeding between relatively isolated populations can be a key factor in maintaining such populations' overall genetic fitness (Gilpin 1987). Finally, metapopulation and patch dynamics are likely to become increasingly important as habitat areas become fragmented. In cases of extreme habitat fragmentation, artificial breeding exchanges between populations that have become completely reproductively isolated could be a vital future management tool.

The Endangered Species Act permits protection of populations as well as entire species by authorizing the Secretaries to list distinct population segments of vertebrate fish and wildlife as threatened or endangered. For example, grizzly bears in the lower 48 states are listed as threatened, whereas the relatively healthy Alaska grizzly population receives no Endangered Species Act protections. Thus, the Act prohibits actions that jeopardize the continued existence of grizzlies in the contiguous states even if such actions would not jeopardize grizzlies as a species.

When distinct population segments of a given species are not separately listed, however, they generally do not enjoy this type of protection. Under Fish and Wildlife Service policy, an action that jeopardizes or even wipes out a population of a listed species is not considered a section 7 violation of the Act unless the action jeopardizes the entire species. For example, assume that an imperiled species has five distinct population segments. If Fish and Wildlife Service separately listed each of the five populations as threatened or endangered, a federal action that threatened to destroy only one of the populations would violate section 7, since as a result of its separate listing the population would legally be considered a separate species. Separate listings for populations are exceptional, however. On the other hand, if the agency had declared the entire species—including all five populations—threatened or endangered in one listing decision, an action resulting in destruction of one population would probably not be precluded under section 7 since four others would still remain. In the latter case, each population would not legally constitute a separate species and thus would not be eligible for separate protection.

This legal shell game with the definition of species adversely affects conservation efforts by ignoring metapopulation dynamics. If an entire biotic species has declined to the point where it is considered threatened or

endangered, each remaining population could play a critical role in improving the species' chances for long-term persistence. However, barring limited exceptions and relatively rare instances of separate listings for each population, the Act does not protect distinct populations of listed species.

4. Many Biological Determinations Under the Act Are Not Adequately Documented, Preventing Meaningful Scrutiny and Participation from the Public and Scientific Community.

The Endangered Species Act directs federal agencies to use the "best scientific and commercial data available" to fulfill their responsibilities under the Act. Other provisions of the statute are designed to reinforce this requirement. Section 7 requires agencies to prepare written biological assessments that evaluate how proposed actions are likely to affect listed species. Additionally, the Services must include in their biological opinions summaries of the information upon which the opinions' conclusions are based.

Since biological assessments and biological opinions are public documents, they permit public as well as independent scientific scrutiny of federal decisions that affect threatened and endangered species. Such scrutiny plays an important role in assuring that agencies' decisions are biologically sound. Congress encouraged interested parties outside the government to take an active role in enforcing the Act's provisions by granting anyone the right to challenge in court agency actions alleged to violate the statute. Taking advantage of this right, plaintiff groups have overturned several federal agency decisions made without sufficient biological data.

However, current administrative interpretations of the Act have reduced the documentation required to accompany federal decisions that affect listed species, correspondingly limiting the public's and scientific community's opportunity to independently evaluate these decisions. In 1986, the Services adopted regulations substantially limiting application of the Act's consultation procedures. Prior to 1986, federal agencies were required to comply with section 7's "formal" consultation procedures—which result in preparation of a biological opinion—whenever they determined that a proposed activity could affect a listed species. Under current practice, however, agencies need not go through this process if they decide that a proposal will not "adversely affect" protected species. Predictably, the number of consultations resulting in biological opinions immediately dropped dramatically. In 1979, 1980, and 1981, the Services together conducted an average of about 3500 consultations and issued around 650 written biological opinions each year (U.S. House of Representatives 1982). However, while the number of consultations in 1986 alone soared to almost 11,000, the number of biological opinions issued dropped to 421.

Such a trend is troubling. Although the Services must concur with other federal agencies' "no adverse affect" determinations in writing, such concurrence statements—unlike biological opinions—need not discuss or even mention the information upon which the Services based their findings. This forecloses any outside scrutiny of the methods used to determine that a proposal will not adversely affect listed species, or of the information upon which such a determination is based. Further, Fish and Wildlife Service also greatly reduced the number of activities for which agencies must prepare biological assessments.

Public disclosure of biological conclusions and the information upon which those conclusions are based promotes decision-making based on sound science. Though the Act requires agencies to use the best scientific information available when making decisions—and encourages outside parties to enforce this provision—reduction of Act documentation requirements threatens to erode scientifically credible decision-making by driving science behind closed doors.

5. The Act Does Not Protect Habitat Reserves Sufficiently to Sustain "Recovered" Populations.

The Act ultimately strives to bring populations of listed species to the point where they are no longer endangered or threatened with extinction. To do so, the law recognizes that adequate habitat must exist to sustain so-called recovered population levels. Section 7 of the Act prohibits federal agencies from destroying or adversely modifying habitat that either service formally declares to be "critical" to protected species. Critical habitat, as defined by the Act, means specific geographical areas that contain those physical or biological features necessary for recovery of listed species. In light of this definition, section 7's prohibition against destroying critical habitat provides listed species with an important legal protection above and beyond the Act's prohibition against jeopardizing the continued existence of listed species, that is, legal protection for species' chances of recovery to healthier population levels.

For a few years after the Act was enacted, the services actively implemented the statute's protection of critical habitat, occasionally even declaring large areas critical habitat for listed species. In 1975, for example, Fish and Wildlife Service declared over 100,000 acres in Mississippi as critical habitat for sandhill cranes, a designation that later played a key role in forcing the U.S. Department of Transportation to reroute a highway planned to be built through the area. By the late 1970s, however, fierce opposition to critical habitat designations set off legislative as well as administrative actions to weaken Endangered Species Act habitat protections.

Congress dealt with the critical habitat issue when it amended the Act in 1978. Though lawmakers required

the Services to define—the extent "prudent" and determinable—critical habitat for a species at the same time it was added to the protected list, Congress also allowed these agencies to exclude areas from critical habitat status on economic or other grounds. This provision marked a significant departure from the Act's emphasis on biologically based decision-making.

The agencies charged with implementing the Act essentially responded to the controversy over critical habitat designation by avoiding the issue altogether. In 1979, Fish and Wildlife Service withdrew several proposed critical habitat designations, included a 10-million-acre critical habitat designation for grizzly bears. Moreover, by broadly interpreting Congress's exception that critical habitat need not be established if not "prudent" or determinable, the Services avoided designating critical habitat concurrent with listings. In 1986, for example, Fish and Wildlife Service listed 45 species as threatened or endangered, but made concurrent critical habitat designations for only four species.

Also in 1986, the Services made critical habitat designations essentially moot by reading out of the law section 7's protections for habitat sufficient to support recovered populations of listed species. The agencies interpreted section 7 to prohibit only those actions that diminish the value of critical habitat for *both* the survival and recovery of listed species. In other words, if a federal action hurts a species' chances for recovery but does not imperil its bare survival, the action does not violate section 7. Although this view of the law is questionable in light of the Act's language and intent, it has never been successfully challenged.

Webster (1987) notes that a similar standard apparently applies to habitat of listed species in private ownership. Although the Act's section 7 standards govern only federal or federally controlled activities, section 9 also applies to private as well as public land. It prohibits "taking" of listed species, and has been broadly construed to ban habitat alterations on private land that kill or injure protected species. However, in 1982 Congress created a process that allows private parties to apply for a permit to "incidentally" take threatened and endangered species in the course of otherwise lawful activities. To obtain such a permit, a party must submit a "habitat conservation plan"; Fish and Wildlife Service or National Marine Fisheries Service may grant the permit if it finds that the plan will not appreciably reduce the survival and recovery of listed species. As in their interpretation of the phrase "survival and recovery" in the context of section 7's critical habitat provision, the services apparently feel free to issue incidental "taking" permits unless a proposal threatens to appreciably diminish a species' survival—a deleterious impact on recovery alone is not sufficient grounds for permit denial. For example, Fish and Wildlife Service approved a habitat conservation plan for the threatened Coachella Val-

ley fringe-toed lizard that calls for development of 75% of the lizards' remaining habitat, with the remainder to be placed in reserves. Elimination of three-quarters of the species' habitat clearly will adversely affect its recovery chances. However, the permit was approved because it did not threaten both the lizard's survival and recovery.

6. Bodies Charged with Implementing and Enforcing the Act Tend to Discount Uncertain or Nonimmediate Factors in Their Decision-Making Processes.

Uncertainty plays a critical role in scientific study of the extinction process. Stochastic factors substantially influence population persistence; estimates of population persistence must therefore be expressed in terms of probabilities. Additionally, scientists do not completely understand many biological and ecological processes. Researchers often express this scientific uncertainty as a factor of error, which they report along with their conclusions.

Those charged with making decisions under the Act also must often deal with uncertainty. Rather than treating uncertainty in a probabilistic manner, however, decisions involving conservation of threatened and endangered species often ignore or discount uncertain threats to these species or use the existence of uncertainty to justify inaction.

Environmental stochasticity—chance events such as forest fires, drought, floods, and similar habitat disruptions—is an important factor influencing population persistence. Although scientists typically study stochastic natural events that affect habitat, environmental stochasticity has a human-related component as well. For example, a given population existing in a riparian habitat faces the threat of chance environmental events such as flooding. In addition, the population may be affected by future human-caused environmental changes such as construction of a dam or water pollution. However, entities that implement and enforce the Act's protections tend to overestimate species' chances of survival by discounting or ignoring natural as well as human-related stochastic threats to species' environments; as a result, listed species often receive less protection than is necessary to ensure their continued existence.

For example, Endangered Species Act regulations refer to future activities to be conducted by private entities or state and local governments in the same area as a proposed federal action as "cumulative effects." However, when either service prepares a biological opinion analyzing a federal action's effect on protected species, it considers only those cumulative effects that are "reasonably certain" to occur. Under this standard, the service accounts only for planned activities that have cleared all legal and financial hurdles and thus presently give every indication of taking place. Rather than considering all risks based on their probability of occur-

rence, this type of analysis ignores all human-related stochastic threats to a species save those that are virtually sure to occur. In effect, therefore, this procedure discounts the role environmental stochasticity plays in species persistence. Consequently, the services overestimate species' chances of survival and thus underprotect listed species.

These agencies have demonstrated a similar tendency when considering nonimmediate threats to listed species. For example, when Fish and Wildlife Service removed brown pelicans from protected status under the Act, it dismissed threats to the birds' habitat posed by manganese mining, not on the grounds that such operations posed no threat to the species, but because it determined that mineral development was unlikely to take place in the near future (USFWS 1985).

Courts too sometimes discount nonimmediate threats to listed species. In a case challenging offshore oil and gas leasing, for example, plaintiffs argued that leasing violated the taking prohibition in section 9 of the Act, which forbids actions that "harm" endangered species. The court, despite an admission by the government that future activities stemming from the leases could harm protected whales, refused to interfere with leasing because the harm was not "sufficiently imminent or certain" (*North Slope Borough v. Andrus* [1979]).

Such refusals to consider future risks to listed species' survival are particularly dangerous. Most human planning horizons span at most a few decades, a very short period from the standpoint of biological evolution. Thus, risks that seem far in the future from a human perspective can loom as significant threats to species' persistence. Conservation biologists take such risks into account when calculating a species' time to extinction by considering the biological consequences of an event, discounted by that event's likelihood of occurring. Ignoring uncertain future threats causes agencies and courts to overestimate species' chances of long-term survival and thus to underprotect those species in present-day decision-making.

A Note on Biopolitics

Reviewers who provided valuable comments on an earlier draft of this essay wondered whether reforms to address the Act's shortcomings are politically feasible. Their point in essence is that our efforts to protect biodiversity come up short due more to a lack of political will than to the Act's technical deficiencies. At first glance, this view seems incorrect. Congress apparently has already made a clear policy choice in favor of protecting species, even in the face of serious economic consequences. Lawmakers stressed that the Act gives listed species "the benefit of the doubt" and, despite persistent efforts by groups opposed to the Act's constraints, have consistently refused to significantly

weaken its provisions. Moreover, the U.S. Supreme Court construed the ESA as protecting listed species "at any cost" (*TVA v. Hill* [1978]).

Despite these pronouncements, efforts to strengthen protections for threatened and endangered species will indeed face serious political hurdles. At least initially, the greatest lies in separating policy from science. As is common in other contexts, Congress has said one thing about species protection yet actually done another. The Act makes general commitments to preserve biodiversity but transfers important policy decisions to those not directly accountable to the electorate. This permits politicians to point to their solid environmental voting record while at the same time pressuring administrative agencies responsible for implementing the Act not to make decisions that significantly curtail economic activities, particularly in their districts. Reduced protections for biodiversity are then passed off as "science" rather than conscious, politically driven policy choices.

Conservation biologists and others need to redouble their efforts to impress upon elected officials and the public the worth of saving imperiled species. However, until policy decisions—the degree of security to give listed species, for example—are taken away from administrative agencies and given to politically accountable decision-makers, such efforts will have limited influence.

A Call for Scientific Involvement in the Legal Process

This section encourages conservation biologists and other scientists to take on a role as focused advocates working to make the Act more effective at preventing human-caused species extinctions, and provides specific suggestions on how to do so. Salzman (1989) describes focused advocacy as a person (or group) reporting data concerning an area in which he or she has expertise as well as deeply held convictions, and pressing to ensure that the information is interpreted correctly and acted upon. It is entirely appropriate—and crucial—for scientists to become focused advocates for strengthening the Endangered Species Act. Congress has already made a policy decision to protect species facing extinction, even if such protection carries substantial economic or other costs. Conservation biologists have a strong incentive to support and further the Act's policy of preventing human-caused species extinctions. They also possess the biological knowledge and data crucial to strengthen current efforts to reach that goal. What are urgently needed are increased efforts to ensure that such knowledge and information are translated into the law and regulations that govern resource management.

The following are specific suggestions to facilitate such efforts.

1. Scientists should develop a degree of legal sophistication.

Law exerts a strong influence over wildlife and public land management, and to a generally lesser degree over management of private land, in two ways. First, it sets substantive standards for management activities and establishes incentives to comply with, or penalties for violating, those standards. Additionally, laws and regulations specify the procedures public agencies must follow in making decisions and biological determinations, often including procedures that give the public opportunities to participate.

It is important for scientists to understand the legal meaning of substantive terms, as well as how that meaning affects management. The legal meaning of a technical term can substantially differ from the term's scientific definition. For example, biologists generally broadly define "cumulative effects" acting on a species to include synergisms, "nibbling" or incremental effects, indirect effects, effects that overlap in time or space, and even delayed or remote effects (National Research Council 1986). However, as defined by regulations implementing the Act, cumulative effects include only those state and private activities that are reasonably certain to occur in the vicinity of a federal project (50 C.F.R. Section 402.02). Knowledge of such distinctions is critical to understand, evaluate, and influence efforts to protect threatened and endangered species. It is also vital for scientists to understand how legal terms actually affect management activities. As outlined above, for example, regulatory revisions in 1986 changed the standard for triggering section 7 consultation from "may affect" to "may adversely affect." This seemingly insignificant change drastically reduced the public's access to information for outside evaluation of federal agencies' biological determinations.

Attorneys have done a good job of convincing people that they play an indispensable role in making and deciphering the law. Unfortunately, this has tended to discourage scientists from participating in the legal process of formulating and implementing guidelines for managing threatened and endangered species. Left to their own devices, lawyers and policy-makers have committed critical biological errors that limit the effectiveness of such guidelines. To recognize and successfully work to correct these biological errors, conservation biologists need to increase their knowledge of the law. One need not attend three years of law school to develop a good working knowledge of laws that deal with biodiversity conservation. Simon (1988), for example, contains an excellent introduction to many federal land management statutes, as well as an excellent basic legal primer for nonlawyers.

2. Perform directed research.

The Endangered Species Act is "information forcing" in much the same way that antipollution laws are "technology forcing." The Clean Air Act, for example, re-

quires some pollution sources to employ the "best available control technology." Part of the thrust of this requirement is to encourage technological advances in pollution control by guaranteeing private developers of superior technology a market for their product. Similarly, the Endangered Species Act requires federal agencies to use the "best scientific and commercial data available" in fulfilling their responsibilities under the Act. This requirement simply refers to the best data available, not just to data produced by government scientists.

This legal requirement provides conservation biologists with broad opportunities to perform "directed research" to benefit species conservation. Salzman (1989) described how the Point Reyes Bird Observatory intentionally directed research efforts toward specific biologically sensitive areas and species. This research encouraged biopolitical decisions to protect the Point Reyes biota by providing decision-makers with data on bird and seal populations as well as biological information on threats to those populations. Similar research directed at specific endangered and threatened species and the threats they face could have significant influence over federal decisions that affect listed species and their habitat.

Federal agencies most commonly use outside biological studies in the context of section 7 consultation between Fish and Wildlife Service or National Marine Fisheries Service and other federal agencies proposing particular actions. Accordingly, the influence of a particular study varies in proportion with its specificity in relation to the project under consideration. For example, a study examining the effect of open-road density on grizzly bears' use of specific habitat types will have a greater impact on national forest management decisions than general studies of human-bear interactions. Researchers should thus practice focused advocacy by directing their research toward determining the likely impacts of ongoing or future federal actions on listed species of concern. By law, federal agencies must consider the resulting information.

3. Take full advantage of opportunities for participation.

The Endangered Species Act encourages public participation in the federal government's efforts to conserve endangered and threatened species by providing several opportunities for interested parties to give their input on questions of both biology and policy. Traditionally, environmental organizations, local, state, and federal agencies, and representatives of affected industries have comprised the overwhelming majority of outside participants in Endangered Species Act proceedings and policy-making. However, rectifying current biological deficiencies in legal guidelines for species protection will require widespread and effective participation from the scientific community.

The Act permits any interested party to petition ei-

ther service to add or delete species or populations from the threatened and endangered lists. Whenever a service concludes that a petitioned action may be warranted, or is considering listing a species or population on its own initiative, it conducts a status review. Notices of ongoing status reviews appear in the *Federal Register*. Immediately after such a notice is published, the listing agency solicits written comments from the public concerning the proposed action, and, if requested, a public hearing. Through use of the petition process and participation in status reviews, conservation biologists can exert powerful and desperately needed influence over the process of determining which elements of biodiversity need the Act's protections.

The agencies responsible for implementing the Act practice so-called "notice and comment" rule-making when formulating regulations and policies relating to conservation of listed species. Under these procedures, the agencies publish a notice of proposed regulations or policies in the *Federal Register* and invite public comments. Scientists, other than those affiliated with interest groups, seldom take advantage of these opportunities to provide input. As detailed in this article, however, biologically unsound regulations and policies detrimentally affect species conservation efforts. The participation of the scientific community in the Services' regulatory and policy-making procedures is thus particularly crucial.

Finally, the Act requires that a recovery plan for threatened and endangered species be prepared. Recovery plans set forth and prioritize actions deemed necessary to increase the numbers and security of listed species to the point where they no longer require protection under the Act. Since the law specifies that the Services base recovery plans solely on biological considerations, and that plans contain objective, measurable criteria, the public participation procedures for recovery planning also give scientists an important avenue for focused advocacy.

Conclusion

Because law wields considerable influence over the actions of resource managers, biological deficiencies in legal guidelines can adversely affect efforts to conserve species facing extinction. Both the Act itself and the regulations and policies of agencies charged with implementing the statute contain significant biological deficiencies. Fortunately, however, the Act's extensive public involvement provisions give conservation biologists many opportunities to practice focused advocacy for biodiversity conservation. Given the current precarious state of the earth's biological resources, conservation biologists can no longer afford to leave law solely to lawyers.

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