The Performance of the Endangered Species Act

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Abstract

Arguably the most notable success of the Endangered Species Act (ESA) is that listed species improve in status through time. More species are downlisted than the converse; more species transition from stable to improving status than the converse. Although some listed species have gone extinct, this number is smaller than expected. Given modest recovery funding, the fraction of listed species responding positively is remarkable. Several factors have been linked to improving species status including recovery expenditures, critical habitat listing, and time spent under protection. The inability of government to fully empower the agencies to implement the law has been the most notable failure of the ESA. Listing of species has not matched need, recovery expenditures do not match need or agency-set priorities, and critical habitat determinations have lagged. Alternative protection strategies to listing may be having a positive effect, but are difficult to assess because of sparse data.

INTRODUCTION

ESA: Endangered Species Act

Agency: For brevity, either the U.S. Fish and Wildlife Service (FWS) or National Marine Fisheries Service (NMFS, also know as NOAA Fisheries)

Critical habitat: Specifically designated areas, occupied or not, deemed essential for listed species conservation

Recovery plan: A federal agency document that defines threats, recommended management activities, and criteria to downlist or delist a species, and includes cost estimates and a timeline

No legislation empowering government agencies to protect biodiversity has created as much controversy as the Endangered Species Act (ESA) (Bean & Rowland 1997, Goble 2007, Scott & Wilcove 1998, Stokstad 2005). The ESA emerged from a rich history of legislation defining state ownership of wildlife and empowering government to regulate wildlife (Bean & Rowland 1997, Svancara et al. 2006). Building on the Endangered Species Preservation Act of 1966 (Scott et al. 2006), President Nixon asked the 93rd Congress to provide stronger legislation to protect endangered species. The ESA passed in the U.S. Senate (92–0) and in the House of Representatives (355–4) in 1973 with broad bipartisan support. Since then, the ESA has been labeled the world's most powerful environmental legislation (Bean & Rowland 1997, Gosnell 2001).

The impact of the ESA has been both broad and diverse. State-level endangered species legislation exists in 45 states. Habitat Conservation Planning, a proactive conservation tool of the ESA, drove the formation of California's Natural Community Conservation Planning process, which is now being applied to long-range planning by several counties. Similarly, large collaborative ecosystem management programs (e.g., Columbia River Basin, The Everglades, The San Francisco Bay–Delta) (Gerlak & Heikkila 2006) are emerging because of difficulties negotiating shared resource use in the face of ESA restrictions (e.g., Beatley 1992, Benson 2004, Doremus & Tarlock 2003). Finally, the ESA drives scientific progress. For example, tension over what constitutes a listable entity stimulates research on a legally defensible species concept (Cronin 2006, George & Mayden 2005, Haig et al. 2006, Waples & Gaggiotti 2006). The impact of the ESA has been profound at many levels.

Turbulence during the 35 years of ESA administration has weakened the original bipartisan support for the ESA. Lambasted by private property rights advocates (Dwyer et al. 1995, Reitan 2004) and the focus for several nongovernmental conservation organizations (CBD 2008, Kareiva et al. 2006), the ESA is a social, legal, and political battleground. A frequent target for legislative modification (Bean 2006, Svancara et al. 2006), divergent political views and public support for a conservation ideal have led to a 20-year legislative impasse (Svancara et al. 2006).

Aside from these social and political aspects of the ESA, the scientific question of whether the ESA works effectively to protect species remains open. Scientific attention to the fate of endangered species, in general, continues to garner increasing attention. An ISI Web of Science search on the term "Endangered Species Act" for the decade from 1998 to 2007 returned an average of 49.8 publications per year. In this review, I consider two distinct issues associated with ESA performance: governmental performance in fulfilling the obligations of the ESA, and the biological responsiveness of species to listing.

THE ADMINISTRATIVE PERFORMANCE OF THE ENDANGERED SPECIES ACT

There are several administrative tasks required by the ESA. The agencies [the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS)] systematically report on several of these tasks (e.g., U.S.F.W.S. 2008c), making assessment of governmental performance possible. The first task is listing endangered species. The Secretary of the Interior (Commerce, for marine species) is required to determine species that are at risk of extinction and move to protect them under the ESA (Doremus & Pagel 2001). This determination is to be based solely on the best available science. The second task requires that listed species be designated critical habitat (Hagen & Hodges 2006, Suckling & Taylor 2006). The third task requires a recovery plan that, among other things, defines criteria to downlist or delist species (Clark et al. 2002, Suckling &

Taylor 2006). The fourth task is that the agencies must engage in consultation to prevent "take" that jeopardizes listed species.

Since its inception, the ESA has been underfunded. As a consequence, the agencies must choose to allocate resources among competing needs. Presidential administrations request budgets; Congress passes budgets; the agencies are forced to implement the ESA with the resources that they are provided. Incomplete or inefficient ESA implementation can emanate from any of the aforementioned sources, but more generally represents a failure of public interest to demand full ESA implementation.

Take: "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" — ESA

Listing Endangered Taxa

The Department of Interior published a list of 78 endangered species in 1967 (Wilcove & McMillan 2006) and expanded this list to 135 species by 1975. These first years of endangered species protection focused exclusively on vertebrates. The list of endangered taxa has subsequently grown to 1351 taxa, diversifying to include a numeric majority of plants ($n = 744$), with listed invertebrates ($n = 238$) closing in on the fraction of listed vertebrate taxa ($n = 369$) (**Figure 1**).

Expansion to the current list of 1351 taxa, however, does not match estimated listing need. An assistant director of the FWS reported to Congress in 1975 that the listing of upward of 3500 species is likely warranted (Greenwald et al. 2006). By 1983, listing petitions for more than 4000 taxa had been submitted to agencies alongside the publication of internally generated listing

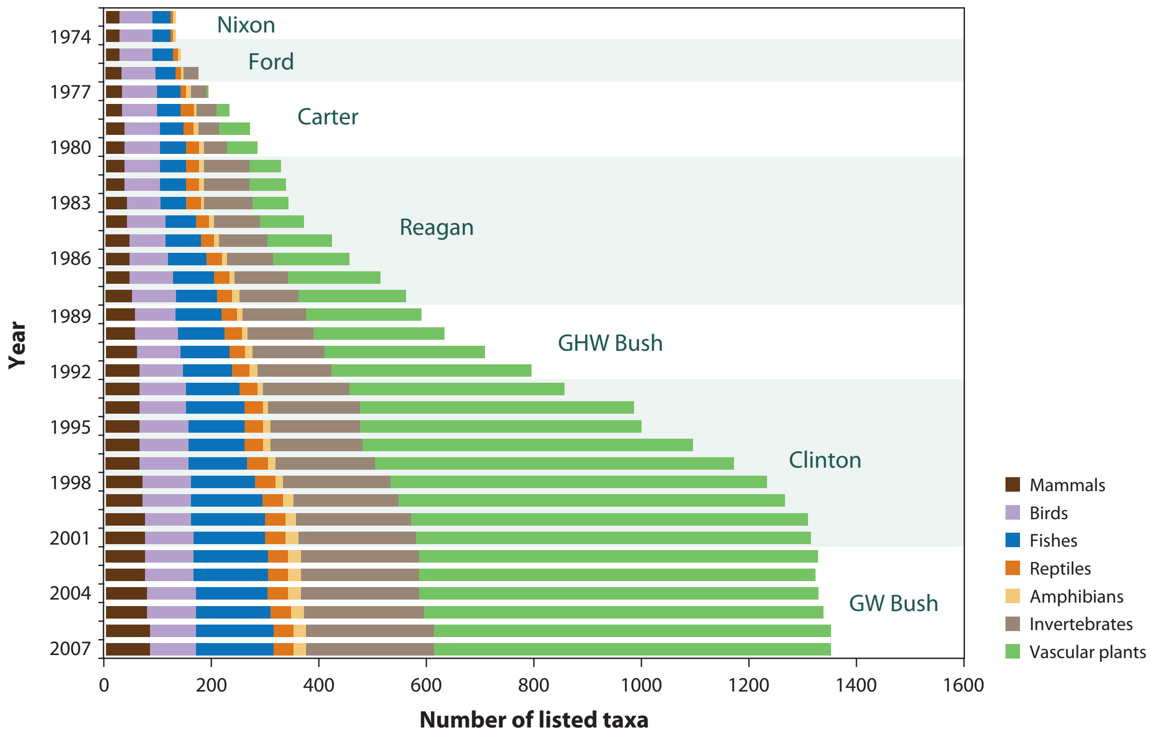

Figure 1

The number of listed taxa through time, segregated by taxonomic group. Presidential administrations are identified by the gray and white shaded bars. Data are based on the U.S. Fish and Wildlife Service Threatened and Endangered Species System (TESS) database (U.S.F.W.S. 2008c).

proposals for more than 2000 taxa (Greenwald et al. 2006). These numbers underscore longstanding agency knowledge of the extensive need for listing action, as well as agency willingness to accomplish the task.

Legislative modifications between 1978 and 1982 requiring more documentation for listing, along with more rapid decisions, resulted in the FWS withdrawing 1876 proposed listings (U.S.F.W.S. 1979). These changes, however, made it more difficult to halt valid listing action, and listing rates increased through the late 1980s. The rate of listing peaked at 127 taxa in 1994. Agency rules adopted in the 1990s allowed the use of a "warranted but precluded" category, meaning that the agencies opted to allocate limited budget toward other priorities. Listing of species, which slowed toward the end of the Clinton administration, virtually ceased during the G.W. Bush Administration (Greenwald et al. 2006).

Wilcove & Master (2005) use NatureServe data to examine taxonomic patterns of threat, reporting 339 imperiled vertebrates. This number compares favorably to the 313 listed vertebrate full species. This simple comparison, however, masks important distinctions between the ESA and the NatureServe database (NatureServe 2008). For example, there are nine ESA listings of Chinook salmon (*Oncorhynchus tshawytscha*) (U.S.F.W.S. 2008c), while NatureServe counts species. In fact, fewer than half of vertebrate species ranked as vulnerable by NatureServe are listed under the ESA. The task of vertebrate protection under the ESA remains largely unfinished. Listing action of plants and invertebrates is considerably less thorough. The total of 744 listed plants is just over a quarter of 2708 imperiled plant species. Considering threat among vertebrates and plants as relatively well known, Wilcove & Master (2005) estimate 25,000 at risk invertebrates, resulting in sparse (<1%) listing coverage. Biological and political geographies interact such that the likelihood of a rare species being listed is a function of both taxonomy and location (Laband & Nieswiadomy 2006).

New listings have all but ceased far short of all estimates of need. The agencies have never fully addressed the backlog of need for listing (Greenwald et al. 2006, U.S.G.A.O. 1993), relegating many species to the "warranted but precluded" pool. Cooperative conservation action is advertised as the new alternative to listing, but the program is new and data are not yet adequate to evaluate the success of individual agreements. There are fewer cooperative conservation agreements (n = ~120) than there are unlisted but threatened taxa (1000s), suggesting that cooperative alternatives have not adequately protected unlisted but endangered taxa.

Recovery Planning

Recovery plans are one of the few required tasks associated with listed species that foster proactive management. Recovery plans pull together published data and expert opinion to specify threats to species, management priorities, and the criteria for downlisting or delisting a species. These criteria typically include metrics of some number of populations, or some number of habitats, that are protected and shown to meet some measure of persistence and stability. Recovery plans, however, obligate neither funding nor actions. Nevertheless, a well-constructed recovery plan can be an important focal document for species management (Crouse et al. 2002) and drive funding support from a variety of federal, state, or private entities. The recovery plan for the Showy Stickseed (*Hackelia venusta*) was approved and posted in late 2007, making it the 1140th species (of 1351, 85%) to be covered by a recovery plan. Performance with respect to plan completion, lagging severely by 1990, improved considerably under the Clinton administration.

Evaluating the quality of recovery plans themselves has garnered considerable effort (Clark et al. 2002; Dixon & Cook 1989; Foin et al. 1998; Good et al. 2007; Tear et al. 1993, 1995). Among these, a working group sponsored by the Society for Conservation Biology (SCB) was

STRUCTURAL CHANGES TO RECOVERY PLANS

The FWS seems responsive to recommendations that emerged from the SCB review. Among new recovery plans in 2006 and 2007, 21 of 27 species are covered by single species plans; the remaining 6 taxa are covered in 2 species plans (U.S.F.W.S. 2008c). There has been no new recovery plan approved containing more than 2 species since mid-2005. The very large multispecies plans (e.g., the 1999 south Florida recovery plan covering 68 species) appear to be a thing of the past. Progress on plan revision is much slower; a revised recovery plan for 18 Hawaiian birds issued in 2006 retained the multispecies structure.

Assessing 16 draft and final plans in 2007 for domestic U.S. species (U.S.F.W.S. 2008c) shows additional improvement. New plans are written by diverse teams (number of people: 5–80, average = 27; number of agencies 3–21, average = 7.9; university experts participated in 69% of plans examined). In addition, 87.5% of these plans explicitly link monitoring tasks to all threats described in the plan. These are positive trends. However, many plans require revision (Harvey et al. 2002). With a lack of clear guidelines for triggering plan revision, there are few tools enabling an assessment of agency performance on plan revision. An on-going effort for 5-year reviews of all listed species may trigger future plan revisions (D. Crouse, personal communication).

the most comprehensive empirical review (Boersma et al. 2001, Hoekstra et al. 2002a). Several important conclusions emerged from the SCB assessment (Clark et al. 2002, Crouse et al. 2002). Multispecies plans were assessed to be a poor idea because, rather than providing a synthetic ecosystem basis for recovery, they result in plans that lack adequate detail or, in some cases, a unifying ecosystem (Clark & Harvey 2002). Leonard (2003), however, points out that lack of knowledge for species in multispecies plans might not be resolved by singling species out, but reflects a real lack of data independent of the number of species in a plan. Recovery plans tend to underemphasize monitoring threats to species and biotic interactions relative to monitoring population trends (Campbell et al. 2002). Recovery plans, however, are improving through time, with increases in quantitative assessment targeted toward critical threats and species performance in more recent plans (Gerber & Hatch 2002, Morris et al. 2002, Schultz & Gerber 2002; see sidebar, Structural Changes to Recovery Plans).

An interesting observation with respect to recovery plans lies in an examination of the taxa that lack approved recovery plans. Among the 20 taxa that represent 50% of all endangered species expenditures in fiscal year (FY)2004 (U.S.F.W.S. 2006a), seven (red-cockaded woodpecker, Southwestern willow flycatcher, West Indian manatee, pallid sturgeon, right whale, and the eastern and western Stellar sea lion populations) have approved recovery plans. In contrast, Bull trout (FWS) and 12 salmonids (NMFS) have draft recovery plans. Together, these thirteen taxa represent 37% ($298 million) of FY2004 recovery spending (U.S.F.W.S. 2006a). Foregoing spending while politically difficult plans are approved could have an adverse affect on species, so investment in these species may indicate foresight rather than a lack of planning. This pattern, however, indicates that some of the catching up on recovery planning appears to result from the very difficult task of planning for species with conflict.

Critical Habitat

Critical habitat designation has generated enormous social, political, and scientific controversy (Hagen & Hodges 2006, Hoekstra et al. 2002b, Sinden 2004, Suckling & Taylor 2006). Since 1982, the listing agency has been required to designate critical habitat at the time of listing (Suckling & Taylor 2006). Critical habitat does not preclude a property from being developed. However, it does

Table 1 The distribution of listed plant species by FWS region along with a listing index[1] and critical habitat relative to the distribution of listed plants

Region	Listed plants (T/E only)	Listing[a] index	Species with critical habitat designations
Region 1[2] (OR, ID,WA)	17	0.085	3 (0.176)
Hawaii	273	0.434	239 (0.875)
Region 2 (southwest)	58	0.133	8 (0.137)
Region 3 (north central)	13	0.220	0 (0.00)
Region 4 (Southeast[b])	111	0.266	3 (0.027)
Region 5 (northeast)	26	0.220	0 (0.00)
Region 6 (mountain-prairie)	41	0.109	5 (0.122)
Region 7 (Alaska)	1	0.019	0 (0.00)
Region 8 (California/Nevada)	186	0.236	53 (0.271)

[a]Listing index. NatureServe Explorer lists species endangerment using a ranking system from G1 (critically at risk) to G5 (secure), along with GX (presumed extinct) and GH (historic distributions only). The listing index is the ratio of how many species are actually listed relative to the number of taxa in that geographic region returned on a search for G1 or G2 species.

[b]The Pacific and Southeast regions contain regions outside the 50 states. These were excluded from both FWS and NatureServe databases for this analysis.

affect consultation with federal agencies under Section 7. Because of this, property rights advocates have favored revising the ESA to eliminate critical habitat designations (Hagen & Hodges 2006), and they have posed a major stumbling block via the courts in establishing the designations. At present, a total of 494 listed taxa have critical habitat designations (U.S.F.W.S. 2008c), many of which are a consequence of legal action (Hagen & Hodges 2006, Hoekstra et al. 2002b). For perspective, it took 19 years (1973–1987) to list 500 taxa and 18 years (1978–1995) to write 500 recovery plans, and the agencies have yet to achieve 500 critical habitat designations after 32 years (1976–2007) (**Table 1**). These numbers suggest a procedural failure in designating critical habitat. The more important question, however, is whether procedural impediments to critical habitat designation represent substantive failures to achieve ESA objectives.

The rationale for critical habitat listing is straightforward. If habitat loss and degradation are leading causes of endangerment (Wilcove et al. 1998), then designating habitat that is critical for the survival and recovery of a species is essential for reducing extinction risk. Proponents of critical habitat assert that listing critical habitat aids the protection of endangered species (Hagen & Hodges 2006). Suckling & Taylor (2006) argue that there are additional reasons to list critical habitat. Specifically, critical habitat designation can streamline Section 7 consultations, provide positive incentives for land management, and provide guidelines for habitat conservation planning (Suckling & Taylor 2006). As evidence that critical habitat works, species with critical habitat are more likely to have improving status than those that do not (Suckling & Taylor 2006). In contrast, Kerkvliet & Langpap (2007) found that once recovery spending is accounted for, critical habitat does not have an apparent effect on species status. Thus, the biological consequences of failing to designate critical habitat remain far from clear.

Section 7 consultation: The consultation process whereby an agency makes a determination whether a federal action will jeopardize a listed species or adversely modify or destroy critical habitat

There is concern that critical habitat is excessively burdensome on the private landowner. Economic models have suggested that critical habitat designation increases property values and thereby drives increased private development pressure near endangered species (Zabel & Paterson 2006). Analyses have also suggested that these increased land values driven by critical habitat designation benefit private landowners (Quigley & Swoboda 2007). Increased costs are passed on to consumers, and evidence suggests that these consumers are willing to bear those costs (Quigley & Swoboda 2007). Assessments of private landowner impacts that result from critical habitat designation would benefit from a distinction of the kinds of stakeholders that gain and lose from these decisions.

The FWS has indicated that it believes that critical habitat is not a cost effective strategy for endangered species protection (Sinden 2004). Their argument is based on logic and practicality. If agency consultations are required for endangered species impacts irrespective of critical habitat listing, then critical habitat does not reduce workload, nor does it change the process of endangered species protection. It can be argued that this agency perspective on critical habitat derives from an overly narrow regulatory definition of adverse modification of critical habitats that results in little positive benefit and that broader application of critical habitat protection may change the consequence of these designations. Nevertheless, the agency is forced to spend limited resources fighting critical habitat issues in court (Sinden 2004; Suckling & Taylor 2006). Because economics can play a role in the decision to designate critical habitat, the decisions are always difficult, are debatable, and usually compromise biological recommendations (Sinden 2004).

Critical habitat designations are highly nonrandom. For example, among 309 domestic plant taxa with critical habitat designations as of January 2008, 75.9% ($n = 239$) were found in Hawaii, representing 87.5% of listed plants in this state. Most of the rest of plant taxa with critical habitat are in California, representing a small fraction of that state's listed plants (**Table 1**). Three plant species (<2%) had critical habitat designations in the eastern United States (**Table 1**). This distribution of critical habitat designations is likely linked to lawsuits on behalf of these designations along with agency priorities and expediency in critical habitat listing. With respect to plants, the few critical habitat designations likely also reflect the diminished capacity of ESA to protect populations on private lands.

The geographical distribution of critical habitat designation parallels that of listed plants. I used the NatureServe Explorer (NatureServe 2008) database of rarity ranking to estimate the number of imperiled (G1 and G2) species by the FWS region. I then defined an index of listing need as the number of listed species divided by the number of NatureServe-defined imperiled species for a region (**Table 1**). Treating Hawaii as a separate unit from the remainder of Region 1 (Oregon, Washington, Idaho), one sees a positive correlation between listing index and critical habitat designation ($r^2 = 0.55$, $n = 9$, $p = 0.02$). Places where a higher fraction of species in need of protection have been listed also have a higher fraction of plant species with critical habitat designations. Political representation is not independent of listing decisions (DeShazo & Freeman 2006). It stands to reason that politics influences critical habitat designation as well.

Recovery Expenditures

An important metric of ESA performance is how recovery funds are distributed on behalf of endangered species. Fiscal year 2004 was much like any other year; the top 100 taxa garnered nearly all recovery funding (89.05%) and the bottom 478 taxa garnered $5000 per species or less (U.S.F.W.S. 2006a). With a 1000-fold difference in spending between the tenth and 90th percentile species in funding rank, two critical issues emerge: Are expenditures sufficient and is this observed funding disparity warranted?

A complete analysis of recovery expenditures is not available. Allocation toward the least funded species (e.g., the 38% of taxa receiving <$5000) is clearly inadequate for recovery management and task accomplishment. Supporting this contention, Lundquist et al. (2002) report that most recovery tasks for most species remain unaccomplished. Allocation at the upper end of expenditures is more difficult to assess. Among the top twenty taxa in terms of FY2004 expenditures, estimated recovery costs are readily extractable for just two species: the West Indian manatee and Southwestern willow flycatcher. The West Indian manatee received 98% of its recovery plan–estimated costs for 2004; the Southwestern willow flycatcher received 73% of its 2004 estimated costs. Complete analysis of expenditures versus need remains a research need.

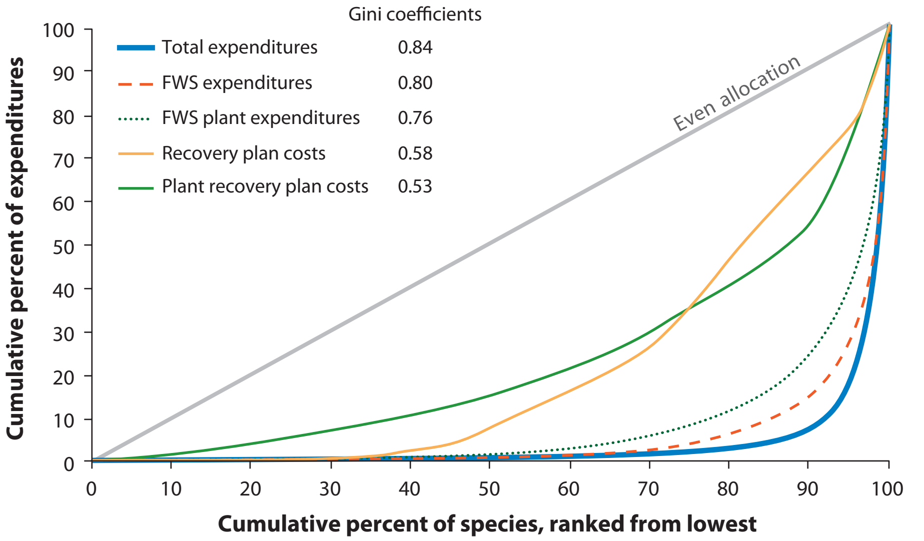

Figure 2

The allocation of endangered species expenditures as described by three curves of the cumulative percent of species ranked from those receiving the fewest recovery dollars to highest plotted against the cumulative fraction of those expenditures. These expenditures include all state and federal expenditures (*bold blue line*), U.S. Fish and Wildlife Service (FWS) expenditures (*dashed line*), and U.S. FWS expenditures on plant taxa (*dotted green line*). Data are from fiscal year 2004 as reported by the FWS (U.S.F.W.S. 2006b). In addition, two curves represent recovery plan statements of per annum financial need. One curve represents all types of taxa and is based on summaries from 87 species described in recovery plans published between 2005–2007. Plant recovery costs are estimated from a random selection of 35 recovery plans approved since 1992.

The disparity in expenditures is more readily assessable. Economists use the gini coefficient to describe disparity in wealth among people or nations (Cok & Urban 2007). Briefly, a gini coefficient measures area under a curve plotting cumulative wealth versus the cumulative fraction of the population, ranked from lowest to highest (**Figure 2**). The coefficient varies between 0 and 1, where 0 represents an equal distribution of wealth and 1 represents all wealth concentrated in a single entity. These metrics show a strong disparity in recovery funding (**Figure 2**). For FY2004 total federal and state endangered species expenditures were strongly concentrated toward few species (gini = 0.84, **Figure 2**) as were the FWS expenditures (0.80) and the FWS expenditures on plants (0.76) (**Figure 2**). I singled out plants because there are many listed plants, they receive the lowest per species funding of any group and they may be less politically volatile.

Not all species require the same funding in order to implement recovery actions. I examined species need by assessing per species annual recovery requests specified in recovery plans. Recovery plans have changed substantially in how funding is requested; I extracted per annum costs for species with recovery plans published in 2005 to present (n = 87, gini = 0.58). Restricting an analysis to plants, I randomly chose species with recovery plans published since 1992 that included cost estimates (n = 35, gini = 0.53). These estimates suggest that the observed disparity in expenditures deviates from need. If we equally valued all species, then 80% of the funding should go to the top 40% or so of species, rather than the top 10–20% (**Figure 2**).

Congress charged the FWS to develop a species priority ranking system based on threat and potential for recovery funds to make a significant impact on species condition. Metrick & Weitzman (1996, 1998) analyzed endangered species expenditures and noted that spending was not related to the FWS endangerment risk priority ranking. Dawson & Shogren (2001) update and re-evaluate expenditures and come to a similar conclusion: Stated agency priorities do not match expenditures. Metrick & Weitzman concluded that the skewed funding was linked to the charisma of species and political influence. A study of recovery expenditures on birds found that priority ranking was correlated with spending, but explained a small fraction of total expenditures (Restani & Marzluff 2001). Congressional earmarks, for example, can redirect money away from agency priorities. DeShazo & Freeman (2006) demonstrate a clear link between recovery funding and congressional representation on the relevant oversight committees. In a related study, Lundquist et al. (2002) found that species listed by the FWS with a conflict designation have much more of their recovery plan tasks accomplished. This latter assessment suggests that despite politics, or maybe because of it, species in conflict get more recovery attention.

Jeopardy: The finding that an action by a federal agency places a species at significantly greater risk of extinction

The bald eagle epitomizes this conundrum. In FY2004 the bald eagle received $9.8 million in recovery funding (U.S.F.W.S. 2006a). Thus, three years prior to delisting this low priority species [ranked 14c of 18 in 2004 (U.S.F.W.S. 2008b)], the bald eagle received more recovery funds than did the accumulated total of the 894 species (67%) with the least funding. Nevertheless, it is difficult to argue that this iconic species of national pride should not receive management attention. Right or wrong, social interest and politics retain the capacity to trump strict biological consideration when it comes to recovery expenditures.

Section 7 Consultation

Section 7 prevents take of endangered species that jeopardize listed species. Section 7 consultation is intended to consider cumulative impacts of federally authorized activities on the potential of endangered species to persist. One of the least satisfying aspects of evaluating agency performance with respect to the ESA is the record of consultation decisions. Data are sparse. The U.S. Government Accountability Office (GAO) issued a report in 1993 assessing the consequences of Section 7 consultations and reported that 90% of the FWS inquiries by federal agencies led to informal resolution (U.S.G.A.O. 1993). Among the remaining cases that resulted in a formal consultation, 90% were found to result in no jeopardy (U.S.G.A.O. 1993).

Following up on this report, Senator Crapo, the presiding chair of the subcommittee on Wildlife, Fisheries and Water during the 108th Congress, reported that FWS Region 1 (the far western United States) completed 14,004 Section 7 consultations in 2001. Among those consultations, 6% ($n = 863$) were formal consultations, with 0.02% ($n = 3$) resulting in a finding of jeopardy (U.S.G.P.O. 2003). These statistics have been used to argue that Section 7 consultation does not place an undue constraint on development (Houck 1993, Steiger 1994). This interpretation is less than entirely satisfying because it does not take into account the unmeasured impact on projects altered during the consultation process or the costs imposed as a consequence of these changes (Shogren & Hayward 1998). A measure of jeopardy finding rate also does not account for federal projects withdrawn, or not proposed, because of the likelihood of denial through consultation.

The high rate of project approval under Section 7 consultation may suggest that the FWS is too ready to compromise the security of endangered species. Opponents claim that the agency uses compromise incentives, rather than scientific findings, to negotiate settlements in the consultation process (U.S.G.P.O. 2003). Unfortunately, there are no satisfactory tools to evaluate this accusation.

Habitat Conservation Planning

Incidental take permits are the mechanism that allows private landowners to pursue development activities despite the presence of listed species habitat. Habitat conservation planning, like recovery plans, have been subject to scientific scrutiny (Bean et al. 1991, Harding et al. 2001, Moser 2000, Peterson et al. 2004, Raymond 2006, Shilling 1997, Smallwood et al. 1998, Wilcove et al. 2004, Wilhere 2002). The first Habitat Conservation Plan (HCP) was approved for the San Bruno Mountains near San Francisco in 1983 (Harding et al. 2001). Since that time the number, size, and complexity of HCPs have steadily risen (Thompson 2006). Initially conceived as a tool for private developers to establish mitigation criteria in order to receive incidental take permits, local governments began to view HCPs as a way to link county development planning to take and mitigation (Shilling 1997, Smallwood et al. 1998). A systematic assessment of 43 plans found that HCPs, in general, utilized appropriate ecological data in plan construction, but that assessing whether or not these were good for conserving species remained elusive (Harding et al. 2001). The principal conclusion of this review was that many HCPs lack adequate detail to accurately assess appropriate conservation targets (Harding et al. 2001).

Habitat Conservation Plan (HCP): Agreements between private landowners or public agencies and the agency to protect endangered species in exchange for a take permit

Safe Harbor Agreement (SHA): A voluntary agreement between the agency and private parties encouraging proactive conservation management while providing assurances against future restrictions

Candidate Conservation Agreement (CCA): Voluntary conservation agreements between the FWS and public or private entities to protect populations of candidate species in lieu of listing

The flexibility of HCPs is both a strength and a weakness. Creative partnerships among developers, conservationists and local governments are fostered under the HCP process in order to achieve protections that would otherwise be impossible. Alternatively, HCPs can be ill-informed stopgap documents that fail to accomplish species protection (Harding et al. 2001). The negotiated aspect of HCP agreements appeared to take scientific assessments of habitat needs as a starting point for negotiation, rather than as an unbiased scientific assessment. As such, habitat protection levels often fell below levels recommended by participating scientists.

Social scientists have gravitated toward HCPs as a bounded conflict problem (Peterson et al. 2004). Bounded conflict negotiation is a means to develop advocacy coalitions that work toward an optimized solution to achieve the disparate goals of disagreeing parties (Lee 1994). Raymond (2006) uses HCPs to evaluate how environmental agreements can build cooperation without trust. The primary problem, according to Raymond, is that effective conservation planning at the ecosystem scale frequently entails multiple ownerships and that HCPs at this scale require collection action agreements. Cooperative efforts to solve tough ESA problems often fall apart (Doremus & Tarlock 2003). However, an emerging set of case studies suggests that complex HCP agreements can work when (*a*) local political leadership assumes the initial transaction cost of initiating the agreement and (*b*) there is a high cost of nonparticipation (Suzuki & Olson 2007). A systematic HCB database for plan assessment should be an agency priority.

Cooperative Endangered Species Act Conservation Agreements

With a slowed rate of species listing, the FWS has signaled an interest in creating cooperative solution alternatives to listing species and litigating management decisions. A primary objection to the ESA is that it places too much burden on the private landowner; the cost of conservation is too high (Dwyer et al. 1995, Shogren 1998, Shogren & Hayward 1998). Safe Harbor Agreements (SHA, $n \sim 60$), Candidate Conservation Agreements (CCAs; $n \sim 100$) and Candidate Conservation Agreements with Assurances (CCAAs; $n = 17$) are vehicles for federal agencies to enter into agreements with both public and private parties to encourage proactive conservation management. Although SHAs are for listed species, the goal of CCAs and CCAAs is to provide incentives for biodiversity management in order to avoid the need for listing species. Assessments of the potential for positive incentives to facilitate conservation on private land suggest that success is attainable (Langpap 2004, Wilcove & Lee 2004). Private landowners appear to fear repercussions of ESA action (Langpap 2006, Langpap & Wu 2004). Knowledge of species listing appears likely to harm species survival on private lands as much as help (Brook et al. 2003). Private users of public lands, similarly, fear negative consequences of the ESA on leased lands despite an overall positive attitude toward conservation and a willingness to work toward conservation goals (Conley et al. 2007).

These studies suggest that positive conservation incentives may be a more constructive way to engage private landowners in conservation, particularly for younger landowners (Langpap 2004). As of yet, however, there are few analyses of voluntary conservation agreements and nonlisting solutions to conserving biodiversity (Thompson 2006).

Land Acquisition

Finally, an often overlooked ESA program of the FWS is one of land acquisition. The FWS National Wildlife Refuge System plays a critical role in endangered species protection. Davison et al. (2006) report 57 refuges established specifically for the protection of endangered species. With a median size of 415 ha, the FWS refuges for endangered species tend to be small. It is somewhat disquieting, then, that the more wide-ranging species (e.g., mammals, birds, reptiles) appear to be considerably more likely to occur in a FWS refuge than do other taxa (Davison et al. 2006). In particular, a large number of listed plants are narrowly endemic species that may stand a better chance of long-term survival despite small refuge size (Lawson et al. 2008, Schwartz et al. 2002). Yet, habitat for these species is poorly captured in current federal agency reserves.

Summarizing Governmental Performance

Despite improvement and success in several aspects of ESA implementation, it is difficult to escape the conclusion that overall effort has been insufficient. To summarize:

- Thousands of species warrant listing but remain unlisted.
- Critical habitat has not been designated for the majority of listed taxa.
- Recovery plans remain unfinished on some of the most highly funded species.
- Funding for species recovery is insufficient to complete recovery tasks.
- Funding for species recovery is highly skewed with no obvious mechanism by which to justify this distribution.
- With limited staff and high rates of Section 7 consultation, the agencies are under strain to adequately fully consider potential impacts for timely review.
- Emerging voluntary ESA measures, although likely favorable steps, are not systematically, or adequately, assessed.

These criticisms of ESA implementation derive directly from the lack of ESA funding. With this modest record of ESA implementation, expectations for successful recovery of species should be low.

THE PERFORMANCE OF LISTED ENDANGERED SPECIES

Confounding patterns of taxonomy, geography, time since listing, threats to species, management actions accomplished, funding, and funding needs make assessment of the responsiveness of species to ESA protection difficult. The data lack the appropriate controls to allow straightforward analysis. For example, a simple analysis of recovery progress relative to time spent under protection assumes that species listed at different times are equally endangered, or equally likely to recover. This is a poor assumption. Species that have been on the list the longest are a strikingly nonrandom selection of listed species. The list of taxa adopted initially by the ESA (Wilcove & McMillan 2006) consists of the most endangered vertebrates as viewed through the political lens of the 1960s. These species were often endangered by exploitation and pesticides. Early listed species are more charismatic and carry more political clout for protection than those listed subsequently (Ferraro et al. 2007). In contrast, the majority of the last several hundred taxa listed are narrowly endemic plants threatened by habitat loss and invasive species (Wilcove et al. 1998).

Outcome-Based Performance

A primary objective of the ESA is to prevent extinction. Using crude estimates of extinction likelihoods of species considered critically endangered (Mace & Lande 1991), the ESA may have shielded as many as 227 species from extinction during its first 30 years (Schwartz 1999, Scott et al. 2006). Even the seven extinctions of listed species can hardly be pinned on the ESA (Abbitt & Scott 2001). The Amistad Gamusia (*Gambusia amistadensis*), for example, was a spring endemic fish listed in 1980 by which time its entire habitat was silt covered and at the bottom of a reservoir (U.S.D.I. 1978). At the time of listing the species was known only from captivity. With no habitat restoration possible, the species was declared extinct in 1987. The ESA had no opportunity to help this species. Other ESA extinctions were in similarly desperate condition upon their listing.

An alternative approach is to compare the number of species that have probably gone extinct while unlisted versus those that probably went extinct while listed. Suckling et al. (2004) document a list of 107 taxa that lost their last known occurrence between 1973 and 1994. These researchers used 1994 as a cutoff, counting species missing by having no observed occurrences in the ten years between 1994 and 2003. Among these species, 79% (85 species) were never afforded the protections of the ESA; 67 species never became listed, 18 were listed after their last known occurrence had disappeared. For example, *Cyanea truncata* is a Hawaiian tree whose last known wild population was extirpated five years before listing (U.S.F.W.S. 1998). By contrast, a much smaller number, 23 listed species, lost their last occurrence while listed. Suckling et al. (2004) correctly observe that some extinctions are expected: species discoveries can occur after a species is already virtually extinct. However, this comparison suggests that listing has a positive effect on the likelihood of persistence among species with chronically small populations.

Extinction prevention, however, is just one of three goals of the ESA (Suckling & Taylor 2006). The second objective of the ESA, species recovery, is difficult to accomplish. Critics of the ESA point to the paucity of recovered species to suggest failure (Gordon et al. 1997, Mann & Plummer 1995). One fundamental and simple metric to evaluate recovery is to examine patterns in changes in species status. The record, although modest in number, is strongly favored toward recovery rather than extinction. Recovery outnumbers extinction 14 to 7 among the species delisted because of population change (U.S.F.W.S. 2008c). Similarly, nearly three times as many species have changed listing status toward recovery (endangered to threatened, $n = 20$) compared to those changed toward extinction (threatened to endangered, $n = 7$) (U.S.F.W.S. 2008c). These data suggest that positive outcomes far exceed negative ones. These data do not speak to the issue of what our expected rate of species recovery ought to be.

Status-Based Performance

Several researchers have tried to evaluate the issue of whether listed species are recovering from the brink of extinction using the FWS and NMFS reports to Congress on population status as a baseline for recovery (U.S.F.W.S. 2008b). These reports classify species as increasing, stable, decreasing, or unknown based on population size and threat status. Data are published in alternate years.

Agency status reports have been cited in asserting both ESA success and failure. These conflicting interpretations of the same data result from the few simple categories into which taxa are classified for the purpose of congressional reporting. Male & Bean (2005) found that slightly more than half of all listed taxa were stable or improving across a 14-year time window (1988–2002). These researchers noted, however, that reports of declining taxa (48.2%) far outnumber increasing populations (9.6%). Just over 40% of taxa were listed as unknown in any given report, and 173 taxa were categorized as unknown in all reports. Nevertheless, time since listing was associated with positive population trends (declining to stable or stable to improving). Rachlinski (1997) also reports that status improves with time and the application of proactive conservation measures through the ESA (e.g., critical habitat).

Funding for recovery programs had a strong positive effect on continual positive population trends (Male & Bean 2005). Fish, birds, and mammals were less likely to be declining than amphibians, reptiles, invertebrates, and plants (Male & Bean 2005). These improving groups were also those that, on average, were listed earlier and received the most recovery funding. It is difficult to clearly assert whether it is time, money, or taxonomy that influences improving status.

Further analyzing reports to Congress, Taylor et al. (2005) assert that critical habitat, dedicated recovery plans, and time predict increased likelihood of improving status among the over 1000 listed taxa examined from 1990 to 2002. Using logistic regression, these researchers do not include recovery spending in their analysis. In examining these data, the researchers defined dedicated recovery plans as those with single species plans. This analysis reiterates the findings of Boersma et al. (2001), who found that species listed in multispecies recovery plans were more likely to be declining. The assertion that multispecies recovery plans are detrimental to recovery progress, however, assumes that recovering status and the type of recovery plan for species are independent. This assumption is unlikely to be true. The largest multispecies recovery plans cover a suite of relatively poorly known species in southern Florida (68 species) and Hawaii (7 plans, 262 species). These are difficult landscapes for recovery given the large numbers of endangered species, their very small population sizes at the time of listing, and the large fraction of private lands in both states.

Kerkvliet & Langpap (2007) applied an ordered probit econometric model to assess multiple factors (geography, time, money, critical habitat listing) on the likelihood of a species decreasing as opposed to remaining stable or increasing. These researchers limited their assessment to vertebrate taxa and incorporated funding time lags in their assessment of species status change among seven status reports (1990 to 2002). The strongest predictors of improving status were (*a*) having an approved recovery plan and (*b*) significant progress toward the goals of the recovery plan. Critical habitat, in this study, did not emerge as a significant variable explaining status. Focusing on financial resources, the researchers concluded that spending significantly decreases the likelihood of a species declining or going extinct, but did not significantly predict improving status. This result may emerge from the fact that there are considerably more declining species than improving species (Male & Bean 2005). Thus, the study has more power to detect factors that affect declining taxa than those that affect improving taxa.

Abbitt & Scott (2001) compared 48 recovering to 37 declining species to examine attributes that can be linked to the success of recovering species. The strongest result observed is what we should expect: Recovering species have, on average, more of their recovery objectives achieved. This result highlights the simple point that recovery costs are not equal among listed taxa and achieved recovery tasks are a more meaningful metric of success than simple expenditures. Analyzing the impact of money spent on species recovery, shown to be positively linked to recovery, should be standardized relative to recovery plan stated financial need, which is a considerably more difficult analysis.

Trend-Based Performance

Male et al. (2006) attempted a more specific analysis using funding to identify the 75 taxa that received the largest financial support toward recovery, and then searched for population data on these taxa. These researchers assert that funding endangered species is successful, based on the evidence that range-wide positive population growth was observed across a 20-year span (1985 to 2005) for 23 of the 30 species (17 birds, 10 mammals, 2 fish, and a sea turtle) for which data were available. In fact, compound annual growth rate exceeded 5% for half of the species, suggesting strong positive performance for many species (Male et al. 2006). This approach of narrowing the search to compare groups to ask a specific population performance question is promising.

Summary of Species Performance

Collectively, analyses of status change demonstrate the challenges inherent in assessing the success rate of recovery efforts for listed species. For example:

- Given the modest governmental expenditures toward implementation of the ESA—stranding many species with few proactive conservation efforts—recovery and delisting are often not the expected outcomes.
- Given the extremely small population sizes and few remaining habitats of many species by the time they are listed, a nondecreasing population may be the best outcome for many listed taxa.
- Few studies have addressed the issue of time lags. For many listed species, the lag time between applying conservation tools and recovery is likely to be slow. We do not expect dramatic recovery of recoverable species in one or few generations of the listed taxa (Hayward et al. 2001).
- Analyses have not adequately controlled for the fundamental problem that the attributes of interest (listing, money, recovery costs, time, critical habitat, recovery plans, recovery actions) are applied nonrandomly to species as a consequence of social values expressed through political processes. The result is that the predictor and response variables are inextricably confounded.

Despite these concerns, the preponderance of evidence is positive.

- Fewer species have gone extinct than expected without protection.
- More species have gone extinct waiting to be listed than have gone extinct once listed.
- Changes in species status are more likely to be improving than deteriorating.
- Application of the fundamental species protection tools is linked with improving status.

However, just as there may be time lags for recovery progress, there may be time lags in species collapse. Species with chronically low population size, little habitat, and a low change of recovery may still take a long time to reach extinction. Some of the most desperate species, with little remaining habitat, were listed rather late in the process. We might find that in the future these species might not improve as well as those listed earlier.

IMPROVING THE PERFORMANCE OF THE ESA

Critics maintain that the record of few listed species recoveries is a sign of failure. This is an egregious misinterpretation of the available information. There is clear evidence that more species improve as a consequence of protection than decline. One fundamental problem in debating the performance of the ESA in helping species recovery, however, is that there is no scientifically objective benchmark of how species should respond to protection. Is modest recovery acceptable performance? Consider, for example, the large fraction of listed species for which recovery funding has been virtually nil. For these species, the consultation process may be the only mechanisms that is helping to protect these listed species. The consultation can only slow loss; it does not provide recovery. Thus, for this suite of largely unfunded species the best expected result is few extinctions coupled with few recoveries. This is, in fact, the result we find. Based on this interpretation, we could assert that improving the performance of the ESA principally lies in the challenge of improving funding for ESA activities ranging from listing through land acquisition and recovery action.

Evaluating success as a measure of how many species are delisted is a noninformative metric if one accepts the notion that delisting, like listing, is a political choice motivated, but entirely dictated, by the supporting science. The ESA provides no specific definition of endangered or recovered (Vucetich et al. 2006). Assessing ESA performance is made difficult in part by the lack of uniform recovery criteria. Recovery genuinely varies among taxa, and this is reflected in variation in recovery criteria among taxa. Not surprisingly, adequately achieving recovery is open to subjective interpretation. As a consequence, delisting actions have been viewed as recovery successes as well as politically motivated bad decisions (Rosen 2007, Tadano 2007). Nearly every ESA listing decision becomes controversial in this politically charged environment.

A significant weakness in the capacity for conservation scientists evaluating ESA performance is a lack of data. The FWS and NMFS deserve considerable commendation for progress in posting Federal Register documents and recovery planning documents online. The agencies have made significant progress in data availability during the past decade. Nonetheless, significant gaps remain. Most of these data gaps appear to be the result of limited agency resources available to obtain more detailed data on our protected taxa. There are, however, improvements that could be made in the available data. For example, online data (e.g., status, expenditures, recovery plan tables, critical habitat) should be published as independent pdf files. Other ESA documents (e.g., biological opinions) are not broadly available. This is a shortcoming. Comparing expenditures to recovery goals achieved and species status, for example, requires extensive data re-entry. Although researchers may like data to be linked in a synthetic database for analytic purposes, linking these data may be even more useful to agency resource managers in order to coordinate management actions.

Further, if it is the position of the administration that there are species that warrant listing but are precluded from listing by other higher priority actions, then it is incumbent to provide data on these unlisted but warranted species. A critical component of evaluating the capacity to protect species requires an independent assessment of how well volunteer agreements are actually capturing and protecting unlisted at-risk species. At present, the best data available for this suggest that unlisted taxa are going extinct in the wild at an unacceptably high rate (Taylor et al. 2005).

Public resistance to the ESA is greatest from private landowner groups in the public lands-rich western United States (Sheridan 2007). A looming concern is distinguishing the many ways in which conflict regarding the ESA is one of private ownership versus public lands management. With 80% of listed species occurring somewhere on private lands, the private landowner is unquestionably integral to the protection of biodiversity. Most listed species occur in these western states; most volunteer conservation agreements are in the west. Three fourths of SHAs and two thirds of CCAs are west of the Great Plains. These western CCAs are strongly dominated by public landowners (U.S.F.W.S. 2008a). Species found exclusively on federal lands are more likely to be improving than those with mixed or private ownership (Hatch et al. 2002). An accounting of the fraction of endangered species that are effectively a public lands management issue could considerably clarify future conservation strategies and help resolve public ESA debate. Clearly distinguishing the performance of the ESA on private versus public lands is much needed.

The protection of biological diversity requires approaches above and beyond the current ESA. At the very least, application of the ESA should be a last resort of conservation and not a first step. With lack of a general federal framework for ecosystem conservation, it would be difficult to assess whether the need to use the ESA as a last resort of conservation is becoming more pressing because of continued habitat threats or abating because of systematic large-scale conservation efforts. Nevertheless, it seems clear that employing the ESA as a very late last resort, when a species is down to its last few individuals, has not been successful.

Joining a call for ESA change are scientists that suggest that one way forward requires additional investment in proactive cooperative conservation efforts (e.g., Langpap 2004, 2006; Wilcove &

Lee 2004). Initiated by the agencies as a conservation alternative that can be applied prior to the ESA, these programs may represent a considerable success of the ESA. Unfortunately, data to assess this assertion are lacking. Equally unfortunately, the number of these agreements remains modest.

The ESA needs a terminology overhaul. Claims of ESA failure stem, in part, from the inability of the agencies to justly claim a success that does not lead to delisting. If delisting is the only mechanism for success, then ESA may be doomed to an appearance of mediocrity. Scott and colleagues (2005) define conservation-reliant species as those for which conservation actions has secured habitat, but which will remain dependent on protection measures because of low abundance or lost habitat. Echoing this sentiment, Doremus & Pagel (2001) argue that leaving species on the endangered list should not be viewed as failure. For many listed species there may never be the potential for a true recovery where the species is free of substantial extinction risk. A large number of currently listed species, such as the Tiburon jewelflower (*Streptanthus niger*) (U.S.F.W.S. 2008c) in California, are single county endemics. Protection of 100% of current habitat is as good as can be expected, but is not adequate to consider this species secure. As a consequence, protecting existing populations may be the best possible outcome for these species. Such a conclusion is not a failure of the ESA (Doremus & Pagel 2001). Creating a formal conservation-reliant status would allow species for which no future agency activities (recovery planning, recovery expenditures, HCP agreements, and Section 7 consultations) are expected, to be classified as the successful effort that they actually represent.

Protecting endangered species from the medley of threats, current and future, will remain a politically charged and controversial enterprise. There have been, and will continue to be, both successes and failures. The fact that progress takes a long time is to be expected. The capacity of protected species to rebound and thrive is apparent though not universal. The pattern that protected species generally respond positively to proactive conservation management is reason for optimism for the future of biodiversity.

FUTURE ISSUES

Congressional recovery assessments define status as a function of population size and threat; analyses generally assume that recovery is defined by population size. Rather than population size, extinction risk might be the better metric for recovery (Gerber et al. 2007). However, most species lack adequate population data for viability assessment. Further, most recovery plans do not use a population viability assessment to evaluate recovery (Morris et al. 2002). A more common metric of recovery progress is securing remaining wild populations of endangered species and making sure that these populations remain extant for some period of time. Assessment of progress on securing habitat for at-risk populations may be the most robust measure of progress toward recovery for many species. Unfortunately, these data are not readily available.

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The author is not aware of any biases that might be perceived as affecting the objectivity of this review.

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RELATED RESOURCES

For further related glossary terms, see **http://www.fws.gov/endangered/glossary.html**

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