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Decision-Making in Endangered Species Management

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This paper examines decisions made by the Fish and Wildlife Service (FWS), part of the U.S. Department of the Interior, to protect species under the Endangered Species Act (ESA) and to fund their recovery. Using a data set that includes scientific, economic, and political variables on vertebrates from 1989 to 1997, this paper estimates a variety of regression models of the listing and funding decisions. Although required by law to consider only scientific factors such as species' vulnerability in its decision-making, FWS appears instead to favor visceral characteristics, such as species' taxonomic class and size. Both criteria are defensible. Nonetheless, the paper recommends that FWS and its partner agencies acknowledge and try to resolve the inconsistencies between their legal obligations and their actual behavior to ensure more effective implementation of this important piece of environmental legislation.

Introduction

The rare and fragile [piping plover], protected by federal law, has been caught in the middle of an expensive and nasty legal crossfire in this pleasant coastal town about 20 miles south of Atlantic City. On one side are town officials, boaters and many taxpayers. On the other are the United States attorney for New Jersey and two other federal agencies determined to protect nesting plovers on a barren peninsula at the southern

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> tip of town.... The federal Fish and Wildlife Service has been zealous in protecting any of the plovers spotted along the Atlantic Coast since they were placed under the safeguards of the United States Endangered Species Act in 1986. In 2002, 138 pairs of the birds were seen along the Jersey Shore (*The New York Times*, May 7, 2003).

> A coalition of environmental groups sued the National Marine Fisheries Service over its decision not to list the struggling Puget Sound killer whale population under the Endangered Species Act. The service had ruled that while the orcas are genetically distinct and could be extinct within a century, they did not constitute a "significant population segment" and were not eligible for endangered-species protection. The service has proposed listing the orcas as a "depleted species" under the Marine Mammal Protection Act, but the environmentalists say only the endangered-species law would ensure protection of the whales' habitat in Puget Sound. The suit contends the service ignored important aspects of killer whale biology and culture (*The New York Times*, December 19, 2002).

The 1973 Endangered Species Act (ESA), a landmark piece of environmental legislation, has been the principal weapon in the quest to preserve the nation's biodiversity. Not surprisingly, it has generated a significant amount of controversy. Why, for example, does the piping plover deserve protection but not the killer whale? And, once protected, why should the federal government devote substantial time and resources to help the piping plover and not, say, the imperiled clear creek gambusia? More generally, in a world of scarce resources, how do we decide what creatures to protect and how much to spend on protection? These questions are particularly important today, as environmental causes take a backseat to issues of national security, compounded further by spending constraints from a growing federal budget deficit.

The paper is descriptive, not normative: I do not focus on how best to conserve biodiversity, but instead provide insights into bureaucratic decision-making under the ESA. I extend the analysis of two previous studies, Metrick and Weitzman (1996, 1998) and Cash (2001), in two important ways: I use a larger, more recent, and more complete data set, and I consider the issue of sample selection. The first section provides background information about the ESA and the data used in this paper. The second and third sections present the results of my re-estimation of the models developed by Metrick and Weitzman and Cash. The fourth part departs from the earlier studies and proposes a selection model to examine these issues. The last section concludes with several policy recommendations for the management of endangered species.

Background and Data

Congress passed the Endangered Species Act at a time of heightened concern about the degradation of the natural environment. "Regarded as one of the most comprehensive wildlife conservation laws in the world," the ESA aims to conserve and promote vulnerable plants and animals and the ecosystems upon which they depend (Fish and Wildlife Service 2002). Species[1] listed under the ESA are entitled to numerous protections. For example, neither federal agencies nor private landowners can undertake activities that jeopardize species' survival, even if those activities would otherwise be legal. The government is also authorized to purchase and set aside important habitat areas for listed species. And, perhaps most significantly, federal and state governments spend sizable amounts of money—on the order of $250 million annually—developing and implementing recovery plans to restore species' populations to sustainable levels.

The Fish and Wildlife Service (FWS) in the Department of the Interior and the National Marine Fisheries Service (NMFS) in the Department of Commerce are responsible for implementing the ESA. But since NMFS handles only the relatively few marine species such as salmon, this paper focuses primarily on FWS.

Decision-making under the ESA is a two-stage process. The first stage is the listing decision. A species can be nominated for listing by either FWS experts or any interested member of the public, regardless of expertise. FWS then evaluates the species' status and, if appropriate, officially proposes that it be listed as either "endangered" or "threatened" (likely to become endangered in the future). The public is provided a sixty-day window to comment on the proposed listing. At the same time, FWS solicits the opinions of three "appropriate and independent species experts" to peer review its assessments. If the review process upholds the listing, it is published in the *Federal Register*. The second stage is the funding decision. This is a complex process, as dozens of federal and state agencies may be involved in recovery efforts for listed species.

This paper examines both the listing and funding decisions using data from the Database on the Economics and Management of Endangered Species (DEMES), supplemented by expenditure data collected from FWS annual reports. DEMES includes scientific, economic, and political variables for nearly 2,000 species relevant to decisions made under the ESA. The data originate from sources such as FWS and The Nature Conservancy, a private conservation group, and cover the period from 1989 to 1997. Not all variables appear for each species, and data for vertebrates—mammals, birds, reptiles, amphibians, and fish—are more complete than data for invertebrates and plants. Thus, I restrict my analysis to this class of species. Because I include species listed after 1989, add expenditure data from 1994 to 1997, and fill in many missing values for key variables, my dataset is over 25 percent larger than those analyzed in similar previous studies.

The Listing Decision

By law, the decision to list a species under the ESA must be made purely on scientific grounds. Given this dictate, the most vulnerable creatures should be afforded the greatest protection. Yet the data suggest otherwise. Figure 1 shows the breakdown of vertebrate species listed under the ESA by taxonomic class. More species of fish are listed than any other class, and reptiles and amphibians seem shortchanged. Of course, this does not take into account the raw number of species of each type. In fact, the United States contains many more fish species than reptiles and amphibians. To correct for this, Figure 2 shows the proportion of each taxonomic class listed under the ESA, and Figure 3 shows the proportion of "vulnerable"[2] species in each taxonomic class listed under the ESA. Birds, mammals, and reptiles are best protected; well over half of the most imperiled among them are listed. Conversely, imperiled fish, and particularly amphibians, seem neglected. If scientific criteria solely determine listing status, why are unequal proportions of vulnerable species in each taxonomic class afforded protection? These simple graphs suggest that the decision to list a creature might depend on factors other than vulnerability.

Metrick and Weitzman and Cash investigated this question. They hypothesized that the decision to list a species might depend on three broad classes of factors: how vulnerable the creature actually is, how much it contributes to overall biodiversity (its "scientific" or "genetic" value), and how much society appreciates or values it viscerally (its "utility").

I estimate the same regression models they did; the variables I used are described in Table 1. A species' vulnerability is captured by the variable *NC-RANK*, which is The Nature Conservancy's ranking of population status on a scale of one (dangerously imperiled) to five (stable). Scientific value is captured by the dummy variable *MONOTYPIC*, which equals one if a creature is the sole member of its genus and thus more genetically unique and biologically valuable. Visceral characteristics are represented by a set of variables. First, dummy variables for taxonomic class (*MAMMAL*, *BIRD*, *FISH*, *AMPHIBIAN*, and *FISH*) suggest whether society cares for certain creatures because they come from certain (perhaps "higher") taxonomic classes. Second, a continuous variable *LN-LENGTH* suggests whether society places higher value on larger species, the so-called "charismatic megafauna." The dependent variable is the dummy variable *LISTED*, which equals one if a species is listed under the ESA as endangered or threatened. The sample includes all vertebrates considered "vulnerable," defined as having a value of *NC-RANK* of three or less. Although the regressions that follow repeat the analyses conducted by Metrick and Weitzman and Cash, this sample is larger and more complete than those analyzed in their studies. Table 2 provides descriptive statistics for this sample.

The results, summarized in Table 3, generally confirm those of earlier studies. Consider regression (1), a probit regression using a sample of all vertebrate species considered vulnerable. A species' vulnerability appears to matter: the lower the value of *NC-RANK* (and thus the more imperiled the species), the more likely it is to be listed. But also important are a species' visceral characteristics. All else equal, mammals, birds, and reptiles are more likely to be listed than fish, the base case, while amphibians are less likely listed. Furthermore, longer (and presumably larger) creatures are also more likely to be listed. All these results are highly significant. Interestingly, more genetically unique species, represented by the variable *MONOTYPIC*, do not appear to enjoy a greater probability of listing. FWS does not seem to be concerned with the genetic value of candidate species in its listing decisions.

Consider a numerical example: a non-monotypic creature of mean length (55.4 cm) and vulnerability ranking of 2. According to this model, a bird with these characteristics has a 71.6 percent chance of listing; a reptile, 64.2 percent; a mammal, 58.7 percent; a fish, 38 percent; and an amphibian, 17 percent. For an amphibian to enjoy the same probability of listing as a bird with a vulnerability ranking of 3, it must have a vulnerability ranking of 1.25; a fish must have a ranking of 2. This considerable bias against amphibians and fish is compounded when taking into account species' lengths. Fish and amphibians are, on average, much shorter than birds and reptiles. Thus, the probability that an average fish or amphibian is listed is reduced not only by its taxonomic class, but also its shorter length. Indeed, visceral characteristics seem to matter.

Regression (2) estimates the same equation as regression (1) using a linear probability model. The linear probability model does not capture the non-linear "shape" of a probability function. In particular, it permits probabilities to be less than zero or greater than one. Nonetheless, its advantage is that its coefficients are easy to interpret directly.

Cash pointed out that before 1982, FWS was permitted to favor the so-called "charismatic megafauna" in its listing decision. Thus, he suggested, it is no surprise that large mammals and birds—those "cute and fuzzy" creatures that look great in photographs—have a greater chance of listing. A series of amendments to the ESA in 1982, however, instructed FWS to consider only scientific criteria in its decisions, the same criteria FWS cites in its literature today. Therefore, Cash advocated excluding from the regression sample those creatures listed prior to 1982. Regression (3) does this: 152 species are removed. Nonetheless, the results generally hold. Vulnerability and taxonomic class still matter, although a creature's size does not. This paper's results are inconsistent with Cash's; he found that taxonomic class matters much less and genetic uniqueness matters more. The larger size and completeness of the sample used here, rather than a difference in statistical technique, likely account for the difference.

FWS claims that "listings are made solely on the basis of the species' biological status and threats to its existence" (FWS 2002). The analysis here suggests otherwise. For vertebrates at least, visceral characteristics play as important a role as vulnerability in the probability of becoming listed.

The Funding Decision

Once a species is listed under the ESA, FWS and other federal and state agencies contribute money to develop and implement recovery programs for it. Each year, FWS submits to Congress a breakdown on a species-by-species basis of all "reasonably identifiable expenditures" made on behalf of each species. The data reveal great disparities in funding levels across species. Tables 4 and 5 show the fifteen best and worst funded species during the nine-year period from 1989 to 1997. Several points are remarkable. Most obviously, some species receive several millions of dollars each year while others get barely one thousand. More importantly, consider the status of the creatures on each list. Though one might expect the best-funded species to be the most imperiled, this does not appear to be the case. Only five of the best-funded have the most serious vulnerability ranking of one, meaning "critically imperiled," and nine of the fifteen are listed as threatened, a much less serious classification than endangered. Similarly, although we might expect the least-funded species to be those least imperiled, ten of fifteen are listed as endangered, and all but three have a vulnerability ranking of one. Of course, some or all of these differences in funding may arise because of the natural differences in the cost of rehabilitation; it may simply be more expensive to save one of the threatened creatures in Table 4 than one of the endangered creatures in Table 5. This paper will be unable to address differences in these per capita rehabilitation costs, but it will try to account for this unobserved heterogeneity by controlling for the size of the creature.

Figure 4 examines the data from a different viewpoint; it shows the mean and median values of average annual expenditures for each taxonomic class. While fish and birds enjoy the greatest mean funding, particularly high expenditures on some species inflate the means. Nonetheless, the median expenditures still suggest some species bias: reptiles and amphibians receive especially little money. These simple tables and figures suggest that FWS and its partner agencies channel significant funds to some well-known species (such as salmon and owls) that are relatively less imperiled, while neglecting other lesser-known species (such as madtoms and darters) that are on the verge of extinction.

Metrick and Weitzman and Cash also investigated this issue. Metrick and Weitzman presented a simple model of the funding decision using many of the same regressors used in the listing regression; Cash extended the model by including sets of variables to capture FWS's internal prioritization rubric and several important political processes. I re-estimate their models here, with three major differences. My data include expenditures from 1989 to 1997, four more years than used by Metrick and Weitzman and six more years than used by Cash. I use a different dependent variable, *LN-AVGEXP*, or the natural log of the average annual expenditure during the years the creature was listed, in constant 1990 dollars. Using average annual expenditure instead of total expenditure is more appropriate because some species were not listed for the entire nine-year period covered by the sample. Finally, I use regular OLS instead of tobit or truncated regression, because the data do not appear to be censored or truncated here.

Table 6 presents descriptive statistics for the variables used in the regressions and Table 7 summarizes the results. Consider regression (4), the basic regression first modeled by Metrick and Weitzman. It includes the familiar variables for visceral appeal (taxonomic class and *LN-LENGTH*) and vulnerability (*NC-RANK*). To capture genetic uniqueness, it supplements the *MONOTYPIC* dummy variable with a dummy variable *SUBSPECIES*, which equals one if a creature falls below the level of full species. *MONOTYPIC* and *SUBSPECIES* are measured against a left-out dummy variable for full species; creatures that are monotypic are more genetically unique than a full species, and creatures that are subspecies are less genetically unique. The results are intriguing. Taxonomic class does seem to matter: while the coefficient on *REPTILE* is the only one statistically different from zero (and thus from *FISH*, the left-out base case), many of the others are statistically different from each other. In other words, species from different taxonomic classes appear to receive different amounts of funding. The coefficient on *LN-LENGTH* is also statistically significant, but perhaps this is not surprising, since larger creatures may require more recovery money per capita than smaller creatures. The coefficients representing genetic uniqueness do not seem to matter; as in the listing decision, FWS and its partners do not seem to take into account species' genetic value. Most surprisingly, the coefficient on *NC-RANK* is significant but in the opposite direction as expected: more endangered species receive less funding. Metrick and Weitzman and Cash discovered the same curious result; the former attributed it to an omitted variable capturing species' charisma that would bias the coefficient on *NC-RANK* upward and reverse its expected (negative) sign. This is a provocative suggestion. To work, such a charisma variable would have to be positively correlated with *NC-RANK*, which means it would be associated with species that are less vulnerable. This is possible if society takes better care of more charismatic species to begin with, so that even if such species make it onto the endangered species list, they are less vulnerable than their less charismatic counterparts. Unfortunately, DEMES does not include any variable or variables that could help resolve this issue.

Another explanation is an omitted variable for "awareness." As with charisma, to bias the coefficient on NC-RANK in a positive direction, awareness would have to be associated with species that are less imperiled. This is possible if awareness influences listing under the ESA. If creatures whose plight is better-known to society are more likely to receive protection under the ESA, then those species would be expected to be less imperiled overall. On the other hand, if creatures whose plight is lesser-known are less likely to receive protection under the ESA, then to make it onto the endangered species list, they would be expected to be a rather imperiled lot. Unfortunately, DEMES does not include any proxy variables for charisma and awareness that would help resolve these issues.

Regression (5) retains the variables for visceral appeal and vulnerability while substituting the genetic uniqueness variables with variables used by FWS to formally allocate resources for recovery efforts. Reproduced in Table 8, *PRIORITY* is an eighteen-point scale used to rank species for funding: one gets the highest funding priority and eighteen the lowest. Ties on the scale are broken by the dummy variable *CONFLICT*, which equals one if a species is in conflict with economic development; such species receive higher priority. The results are striking. The visceral and vulnerability variables matter as before. Furthermore, as expected, species with lower *PRIORITY* rankings (and thus supposedly greater priority in funding decisions) receive more funding, as do those in conflict with development. But the magnitudes of the coefficients contradict FWS's stated intentions. Although it is meant to be merely a tiebreaker among species with equal *PRIORITY* rankings, the coefficient on *CONFLICT* is over twenty-five times larger than the coefficient on *PRIORITY*. All else equal, a creature with the lowest *PRIORITY* ranking but in conflict with development receives more funding than a species with the highest *PRIORITY* ranking and no conflict with development.

Regression (6) tries to sort out this odd result by disaggregating the *PRIORITY* ranking into its components: the degree of threat posed to the species (*DEGTHREAT*), its recovery potential (*RECPTNT*), and its genetic uniqueness *(MONOTYPIC* and *SUBSPECIES*). The only regressor statistically different from zero is *RECPTNT*: species judged to have a higher probability of recovery receive more funding. Neither genetic uniqueness nor *DEGTHREAT*, supposedly the most important criterion, matter. And *CONFLICT* still dominates. Although the signs on the coefficients are all as expected, FWS does not appear to value the different criteria as its priority funding system dictates.

Cash included a number of political variables that might play a role in resource allocations. Several of the variables he used, however, are problematically coded in DEMES, and others do not seem helpful. Nonetheless, in regression (7) I include two, *INT-SCM* and *EARMARK*, which are clearly coded in the data and might be expected to have important effects on funding for threatened species. *INT-SCM* is a dummy variable equal to one if any state that is home to that species has a U.S. Senator on the Interior Subcommittee of the Senate Appropriations Committee; the hypothesis is that a species with "representation" will receive more money. *EARMARK* is a dummy variable equal to one if Congress ever earmarked any funds for that species' recovery between 1989 and 1997. Both regressors are statistically significant. Species with "representation" on the Interior Subcommittee receive more money, and, perhaps not surprisingly, species receiving earmarked funds for their recovery receive more money overall. The only other difference in this regression is that the coefficient on *DEGTHREAT* is now statistically different from zero, though barely.

These regressions show that the allocation of public resources to recovery efforts for endangered species is driven as much by visceral characteristics and political processes as by "objective" scientific and cost-benefit criteria. The process is no doubt complex. It would be interesting to collect more variables capturing the politics and economics of endangered species recovery efforts and include them in analyses of this type.

Joint Estimation of the Listing and Funding Decisions

The regressions above show the effects of certain variables on the amount of resources allocated for a species, given that the species is listed. In other words, these regressions describe how funds are allocated to a specific subset of creatures. This is certainly an interesting issue. But we may also be interested in investigating how funds are allocated to all creatures in general, listed and unlisted. As such, we must confront the so-called "selection problem." The situation here is similar to the famous example of women's wages. In that example, wages are only observed for women who choose to work, and the same variables that determine wages if wages are observed also determine whether wages are observed. Not accounting for this selection problem results in biased and inconsistent estimates of the determinants of wages that are ultimately misleading.

The problem here is analogous. Whether funding is observed for a species depends on whether that species is listed. No funding data is observed for unlisted species. Thus, we must be concerned about our estimates in the funding equation if we do not correct for the initial listing decision. The standard solution, proposed by Heckman, is to consider jointly the regression equation and the selection equation. Specifically,

$$\mathbf{Y}_1 = \mathbf{X}_1\beta_1 + u_1 \qquad \text{regression equation}$$

$$\mathbf{Y}_2 = 1[\mathbf{X}\delta_2 + v_2 > 0] \qquad \text{selection equation}$$

where

$$u_1 \sim N(0,\sigma^2)$$

$$v_2 \sim N(0,1)$$

$$corr(u_1, v_2) = \rho$$

A crucial aspect of this setup is that the set of independent variables X_1 in the regression equation is a subset of the set of independent variables X in the selection equation. Ideally, X_1 should be a strict subset of X; that is, there should be one or more variables that affect the probability of listing but not the funding allocation. X_1 can equal X, but then we must rely on functional form—specifically, the non-linearity of the inverse Mills ratio or the "selectivity effect"—to identify the model. This issue poses a significant problem here. DEMES includes many more variables for those species listed under the ESA than for all species in general. Thus, our funding regressions can, and do, include many more regressors than our listing regression does. This is exactly the opposite of what the selection model requires, and, unfortunately, the variables available in DEMES are not helpful.

Wooldridge (2002) suggests a solution to this problem. Any regressor that appears in the second-stage equation that does not appear in the first-stage selection equation can be thought of as an endogenous variable, for which one could instrument. These instruments, then, should also be included in the selection regression. While this would theoretically solve the problem faced here—namely, the fact that the funding regressions altogether include seven variables not found in the listing regression—I would have to identify instruments for these variables that are available for all species, listed and unlisted, so I can include them in the listing regression. But I run into the recurring dilemma: DEMES does not include any such variables available for all species beyond the ones already introduced. In other words, the most attractive methodological solution is constrained by limited data, so this paper is restricted to analyzing the simplest case.

Table 9 presents the results of a basic selection model. The listing regression is the same as in all three regressions in Table 3. The funding regression is the same as the basic regression (4) in Table 7, except that the variable *SUBSPECIES* is dropped to meet the requirements of the selection model; now the set of regressors X is the same for both stages—an acceptable, though not ideal, situation. Consider regression (8), a maximum-likelihood estimate of the selection model. In the listing stage, taxonomic class, size, and vulnerability all matter as before. The results of the funding stage are also similar to before: taxonomic class, size, and vulnerability all matter, genetic uniqueness does not, and the coefficient on vulnerability has the opposite sign expected. Perhaps it is no surprise that the results are the same: the coefficient on *lambda*, the inverse Mills Ratio or selectivity effect, is not statistically different from zero, and thus selection appears not to be a cause for concern. Regression (9) is the same model analyzed using the Heckman two-step procedure, and the results hold generally. The main differences are that the marginal effect of vulnerability (*NC-RANK*) is nearly twice as great, and the coefficient on *lambda* is statistically different from zero at the nine percent level (which is still probably not significant enough to be concerned about selection). Finally, regression (10) follows up on listing regression (3): it repeats the maximum-likelihood selection model with a sample that excludes species listed before the 1982 ESA amendments. The results, however, are not much different. Species' size no longer matters in the listing decision, while genetic uniqueness barely matters in the funding decision. And, once again, selection does not seem to be present.

Concluding Remarks and Policy Recommendations

It is important to recognize that the regressions presented in this paper lack an underlying structural model of decision-making about endangered species management, and thus the conclusions about the roles of scientific, political, and visceral factors should not be interpreted causally. Furthermore, the variables included here have been measured at different points in time, and yet all the models are static. A more appropriate extension of this work would be to track listing and funding decisions over time using panel data techniques. Unfortunately, DEMES does not include enough data to do so. Nonetheless, the results presented here provide a window into the preferences of public managers of endangered species.

Despite lawmakers' and bureaucrats' intentions to let science govern, this paper demonstrates that visceral characteristics—the taxonomic class and size of a species—are associated with differential probabilities of listing under the ESA and differential funding levels once listed. Such preferences are understandable: people often make decisions based, in part, on looks. But such a strategy does little to minimize extinction or to preserve genetic richness.

Of course, decisions made with regard to one species affect others too, and no individual listing or funding decision is made in a vacuum. One explanation for this apparent "visceral bias" in the listing and funding decisions is that wildlife managers especially target high-profile species to increase public awareness and benefit other species in the same habitat (FWS 1994). This "trickle-down" strategy may have real merit. Yet it conflicts with the supposed "scientific" decision rules mandated by law and routinely publicized by FWS.

The purpose of this paper is not to suggest a strategy for endangered species management; that is ultimately a scientific and political question. It merely points out the apparent contradictions in the management of the nation's wildlife resources. Consequently, the following policy recommendations primarily address these contradictions, with the hope that greater understanding of the issues and tradeoffs inherent in endangered species management will enable managers and the public to better pursue their desired objectives.

Recommendation 1: Update the Analysis

FWS, in conjunction with other agencies responsible for endangered species management, should commission a study similar to this one, but that analyzes more recent data. The data used in this paper cover listing and funding decisions made only until 1997. Before making any policy changes, policy makers should explore whether the trends described here have persisted under subsequent administrations and changing budgetary situations.

Recommendation 2: Confront the Contradiction

This paper's primary lesson is that the FWS and its partner agencies have not chosen to protect creatures based on their vulnerability and genetic uniqueness, as required by law and affirmed by FWS. Rather, they appear to favor the "cute and fuzzy." Either objective is defensible, but they are not compatible, legally or analytically. Consequently, FWS and its partners should convene a panel of stakeholders to address this inconsistency. The panel should include not only experts but also politicians who represent the wishes of the public. They should discuss the tensions between the agency's actions and its legal obligations and should revisit the question of how best to achieve the goals set forth in the Endangered Species Act.

These policy recommendations are modest. Yet perhaps they begin to address the contradictions in the management of endangered species—contradictions that must be sorted out if we are to make the most of our scarce resources.

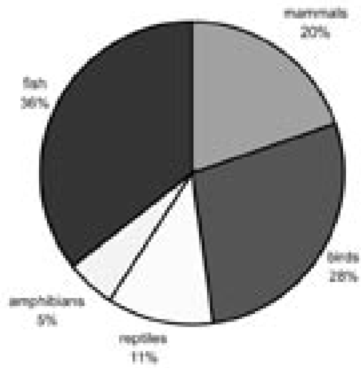
Notes

[1] Here and throughout the paper, the term species is used loosely to refer to full species in the standard biological sense, subspecies, or geographically distinct populations of a species or subspecies. All three types can be listed and funded under the ESA.

[2] Vulnerable is defined as a ranking from The Nature Conservancy of three or less. This means the species is "vulnerable throughout [its] range" and typically has "fewer than 100 occurrences, or fewer than 10,000 individuals" (Cash et. al. 1998).

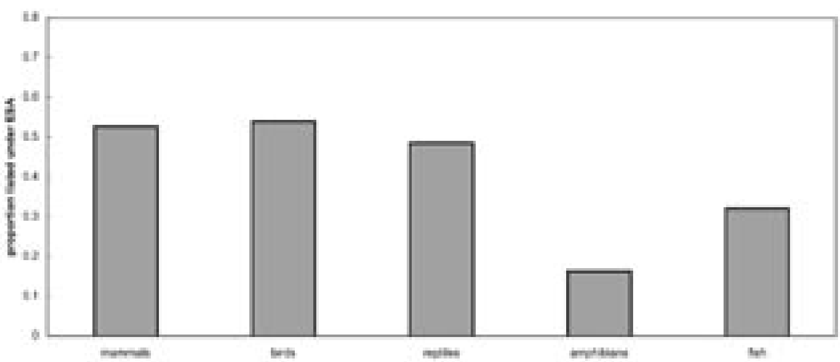
Appendix

Figure 1: Listed Vertebrates by Taxonomic Class



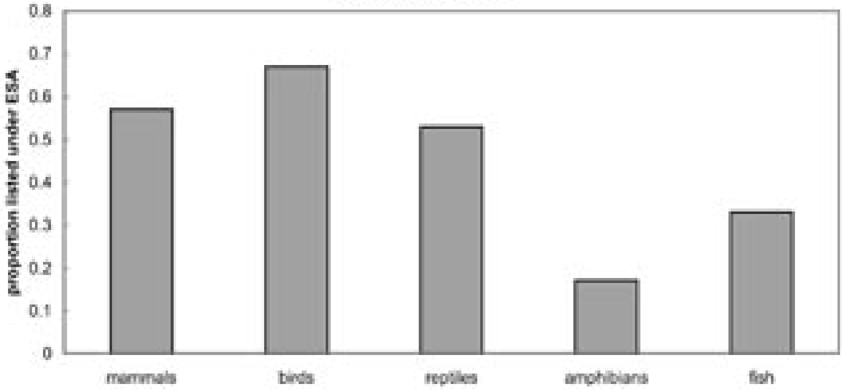
Source: DEMES, supplemented by data collected by the author.

Figure 2: Proportion of Species Listed Under ESA, by Taxonomic Class



Source: DEMES, supplemented by data collected by the author.

Figure 3: Proportion of "Vulnerable" Species Listed Under ESA, by Taxonomic Class



Source: DEMES, supplemented by data collected by the author.

Table 1: Variables Used in the Analyses

Variable	Description
LISTED	1 if a species was listed under the ESA. 0 otherwise.
AVGEXP	Average annual expenditure on a listed species, 1989-1997, during the years it was listed, in thousands of constant 1990 dollars.
LN-AVGEXP	Natural log of AVGEXP.
MAMMAL	1 if a species is a mammal. 0 otherwise.
BIRD	1 if a species is a bird. 0 otherwise.
REPTILE	1 if a species is a reptile. 0 otherwise.
AMPHIBIAN	1 if a species is an amphibian. 0 otherwise.
FISH	1 if a species is a fish. 0 otherwise.
LENGTH	Length of a representative individual of a species, in centimeters.
LN-LENGTH	Natural log of LENGTH.
NC-RANK	The Nature Conservancy's Conservation Status ranking. The average of the 1993 and 1996/97 ranks, unless only one rank is available. 1 is "critically imperiled." 5 is "demonstrably secure."

MONOTYPIC	1 if a species is the sole representative of its genus. 0 otherwise. A component of the PRIORITY ranking system.
SUBSPECIES	1 if a species falls below the level of full species. 0 otherwise. A component of the PRIORITY ranking system.
PRIORITY	An eighteen-point ranking system used by FWS to prioritize funding for recovery. 1 is the highest rank. 18 is the lowest.
CONFLICT	1 if a species is in conflict with economic development. 0 otherwise. A tiebreaker in the PRIORITY ranking system.
DEGTHREAT	Degree of threat posed to a species. 1 is high. 2 is medium. 3 is low. The first component of the PRIORITY ranking system.
RECPTNT	Species' potential for recovery. 1 is high. 2 is low. The second component of the PRIORITY ranking system.
INT-SCM	1 if at least one Senator from the state in which a species exists sits on the Interior Subcommittee of the Senate Appropriations Committee, 101st and 102nd Congresses. 0 otherwise.
EARMARK	1 if a species ever received funds by a special congressional earmark between 1989 and 1997. 0 otherwise.

Table 2: Descriptive Statistics for Variables in Listing Regressions

Variable	No. of Obs.	Mean	Std. Dev.	Min	Max
LISTED	678	0.426	0.495	0	1
MAMMAL	678	0.147	0.355	0	1
BIRD	678	0.177	0.382	0	1
REPTILE	678	0.091	0.288	0	1
AMPHIBIAN	678	0.128	0.335	0	1
FISH	678	0.456	0.498	0	1
LENGTH	678	55.43	217.37	2	3050
LN-LENGTH	678	2.879	1.153	0.693	8.023
NC-RANK	678	1.999	0.839	1	3
MONOTYPIC	678	0.059	0.236	0	1

Table 3: The Listing Decision

Regression #	1	2	3
Dep Var	LISTED		
MAMMAL	**0.527**	**0.156**	**0.468**
	0.004	0.003	0.025
BIRD	**0.878**	**0.265**	**0.758**
	0.000	0.000	0.000
REPTILE	**0.670**	**0.198**	**0.385**
	0.001	0.002	0.131
AMPHIBIAN	**-0.648**	**-0.168**	**-0.684**
	0.001	0.000	0.003
LN-LENGTH	**0.158**	**0.051**	**0.039**
	0.005	0.002	0.582
NC-RANK	**-0.872**	**-0.267**	**-0.748**
	0.000	0.000	0.000
MONOTYPIC	**0.175**	**0.046**	**-0.092**
	0.443	0.531	0.757
CONSTANT	**0.806**	**0.744**	**0.623**
	0.000	0.000	0.012
sample	full	full	1982 & after
N	678	678	526
R^2 / pseudo-R^2	0.276	0.326	0.19
method	probit	linear	probit

Coefficient estimates in bold.
Non-Bonferroni-adjusted p-values beneath.

Table 4: 15 Best-Funded Species, 1989-1997, in constant 1990 dollars

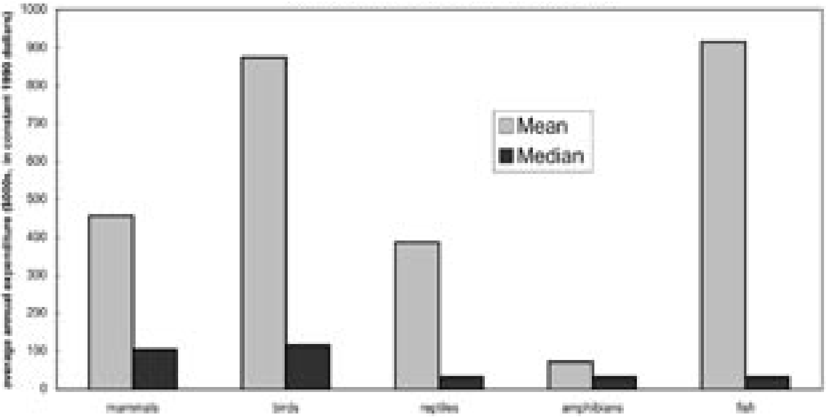
Species	Taxonomic Class	Listing	Vulnerability Ranking	Average Annual Expenditure ($000s, constant 1990 dollars)
Salmon, sockeye	fish	E	1	19858
Salmon, chinook, snake river spring/ summer run	fish	T	1	19040

Salmon, chinook, snake river fall run	fish	T	2	15737
Woodpecker, red-cockaded	bird	E	2	14152
Owl, northern spotted	bird	T	3	13605
Salmon, central california coast coho	fish	T	3	12043
Salmon, chinook, sacramento r. winter run	fish	T	1	6684
Murrelet, marbled	bird	T	3	5998
Tortoise, desert (mojave)	reptile	T	3	4279
Squawfish, colorado	fish	E	1	4113
Manatee, west indian (florida)	mammal	E	2	4099
Falcon, american peregrine	bird	E	3	3610
Gnatcatcher, coastal california	bird	T	2	3348
Sucker, razorback	fish	E	1	3109
Turtle, loggerhead sea	reptile	T	3	3068

Table 5: 15 Worst-Funded Species, 1989-1997, in constant 1990 dollars

Species	Taxonomic Class	Listing	Vulnerability Ranking	Average Annual Expenditure ($000s, constant 1990 dollars)
Gambusia, clear creek	fish	E	1	0.76
Snake, copperbelly water	reptile	T	2.5	0.81
Anole, culebra island giant	reptile	E	1	0.82
Darter, bluemask	fish	E	2	1.03
Vole, florida salt marsh	mammal	E	1	1.36
Snake, atlantic salt marsh	reptile	T	1	1.44
Madtom, pygmy	fish	E	1	1.85
Sculpin, pygmy	fish	T	1	2.61
Madtom, scioto	fish	E	1	3.31
Lizard, st. croix ground	reptile	E	1	3.56
Cavefish, alabama	fish	E	1	3.69
Darter, relect	fish	E	1	3.90
Warbler (wood), bachman's	bird	E	1	4.12
Salamander, red hills	amphibian	T	2	4.19
Silverside, waccamaw	fish	T	1	4.39

Figure 4: Mean and Median Average Annual Expenditure, 1989-1997, by Taxonomic Class ($000s, in constant 1990 dollars)



Source: DEMES, supplemented by data collected by the author.

Table 6: Descriptive Statistics for Variables in Funding Regressions

Variable	No. of Obs.	Mean	Std. Dev.	Min	Max
AVGEXP	289	711.10	2393.94	0.757	19858
LN-AVGEXP	289	4.48	2.00	-0.278	9.896
MAMMAL	289	0.20	0.40	0	1
BIRD	289	0.28	0.45	0	1
REPTILE	289	0.11	0.32	0	1
AMPHIBIAN	289	0.05	0.22	0	1
FISH	289	0.36	0.48	0	1
LENGTH	289	89.40	311.38	2	3050
LN-LENGTH	289	3.19	1.31	0.693	8.023
NC-RANK	289	1.56	0.70	1	3
DEGTHREAT	257	1.41	0.57	1	3
RECPTNT	257	1.30	0.46	1	2
MONOTYPIC	289	0.07	0.26	0	1
SUBSPECIES	289	0.56	0.50	0	1
PRIORITY	260	5.70	3.43	1	17
CONFLICT	260	0.37	0.48	0	1
INT-SCM	229	0.37	0.48	0	1
EARMARK	283	0.25	0.43	0	1

Table 7: The Funding Decision

Regression #	4	5	6	7
Dep Var	LN-AVGEXP			
MAMMAL	**-0.149**	**0.093**	**0.091**	**0.324**
	0.660	0.723	0.731	0.207
BIRD	**0.427**	**0.660**	**0.698**	**0.693**
	0.135	0.003	0.002	0.025
REPTILE	**-1.703**	**-1.541**	**-1.613**	**-1.245**
	0.000	0.000	0.000	0.000
AMPHIBIAN	**-0.290**	**-0.526**	**-0.589**	**-0.176**
	0.497	0.216	0.204	0.671
LN-LENGTH	**0.655**	**0.617**	**0.594**	**0.430**
	0.000	0.000	0.000	0.000
NC-RANK	**0.640**	**0.852**	**0.777**	**0.655**
	0.000	0.000	0.000	0.000
DEGTHREAT			**-0.215**	**-0.328**
			0.185	0.041
RECPTNT			**-0.653**	**-0.550**
			0.001	0.005
MONOTYPIC	**0.441**		**0.180**	**-0.144**
	0.258		0.566	0.617
SUBSPECIES	**-0.020**		**-0.252**	**-0.167**
	0.930		0.230	0.405
PRIORITY		**-0.055**		
		0.031		
CONFLICT		**1.412**	**1.402**	**1.229**
		0.000	0.000	0.000
INT-SCM				**0.838**
				0.000
EARMARK				**0.712**
				0.006
CONSTANT	**1.486**	**0.960**	**2.109**	**2.267**
	0.000	0.004	0.000	0.000
N	289	260	257	225
R^2	0.301	0.504	0.516	0.565
method	linear regression			

Coefficient estimates in bold.
Non-Bonferroni-adjusted p-values appear beneath.

Table 8: U.S. FWS Priority Ranking System

Degree of Threat	Recovery Potential	Taxonomic Uniqueness	Priority Rank	with Conflict
High	High	Monotypic	1	1
				1C
		Species	2	2
				2C
		Subspecies	3	3
				3C
	Low	Monotypic	4	4
				4C
		Species	5	5
				5C
		Subspecies	6	6
				6C
Medium	High	Monotypic	7	7
				7C
		Species	8	8
				8C
		Subspecies	9	9
				9C
	Low	Monotypic	10	10
				10C
		Species	11	11
				11C
		Subspecies	12	12
				12C
Low	High	Monotypic	13	13
				13C
		Species	14	14
				14C
		Subspecies	15	15
				15C
	Low	Monotypic	16	16
				16C
		Species	17	17
				17C
		Subspecies	18	18
				18C

Source: Cash (2001).

Table 9: Listing and Funding Decisions Jointly

Regression #	8	9	10
Funding Decision	LN-AVGEXP		
MAMMAL	**-0.334**	**-0.850**	**-0.818**
	0.348	0.137	0.141
BIRD	**0.151**	**-0.658**	**0.094**
	0.637	0.371	0.873
REPTILE	**-1.930**	**-2.617**	**-2.678**
	0.000	0.000	0.000
AMPHIBIAN	**-0.021**	**0.734**	**0.915**
	0.965	0.339	0.315
LN-LENGTH	**0.606**	**0.458**	**0.995**
	0.000	0.006	0.000
NC-RANK	**0.946**	**1.821**	**1.267**
	0.000	0.013	0.016
MONOTYPIC	**0.403**	**0.265**	**1.057**
	0.275	0.590	0.040
CONSTANT	**1.683**	**2.322**	**1.112**
	0.000	0.000	0.083
Listing Decision	LISTED		
MAMMAL	**0.512**	**0.527**	**0.423**
	0.003	0.004	0.043
BIRD	**0.897**	**0.878**	**0.790**
	0.000	0.000	0.000
REPTILE	**0.694**	**0.670**	**0.390**
	0.001	0.001	0.118
AMPHIBIAN	**-0.638**	**-0.648**	**-0.674**
	0.001	0.001	0.004
LN-LENGTH	**0.167**	**0.158**	**0.057**
	0.008	0.005	0.483
NC-RANK	**-0.871**	**-0.872**	**-0.749**
	0.000	0.000	0.000
MONOTYPIC	**0.168**	**0.175**	**-0.122**
	0.491	0.443	0.707
CONSTANT	**0.773**	**0.806**	**0.58**
	0.000	0.000	0.038
lambda	**-0.613**	**-2.380**	**-1.311**
	0.139	0.088	0.182
sample	full	full	1982 & after
N	678	678	526
method	ML	Heckman	ML

Coefficient estimates in bold.
Non-Bonferroni-adjusted p-values appear beneath.

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