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Patterns of Behavior in Biodiversity Preservation

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In the United States, funds for the protection of biodiversity are spent disproportionately on such "charismatic megafauna" as bald eagles and grizzly bears, which are less endangered than many species with less charm. Big animals get funding; other fauna, and all flora, get short shrift.

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Summary findings

Conservation budgets are limited, so it is right to ask of biodiversity programs, What should be preserved? How much should be preserved? Where?

Recent papers on optimal preservation policy have tried to integrate three considerations: the relative uniqueness of different species or habitats, the degree of risk to their continued survival, and the opportunity cost of the resources needed to enhance their prospects for survival.

It is natural to ask, How are we doing? Have biodiversity conservation resources been optimally allocated? What determines government decisions about the preservation of endangered species? Metrick and Weitzman submit the first report card, an empirical analysis of U.S. species preservation policy, the best-documented country experience currently available.

Metrick and Weitzman discuss the most common normative justifications for biodiversity preservation and identify measurable proxies for a subset of those justifications. Proxies include "scientific" species characteristics, such as "degree of endangerment" and "taxonomic uniqueness," as well as "visceral" characteristics, such as physical size and to what extent a species is considered a "higher form of life." They find that both kinds of characteristics, but especially "visceral" characteristics, influence government decisions on whether to protect a species under the Endangered Species Act.

Metrick and Weitzman find that "visceral" characteristics — especially physical size and taxonomic class — are also important in explaining how much is spent on endangered species. Perhaps more surprising is their finding that more is spent on animals with lower risk of extinction than on animals with higher risk of extinction.

Metrick and Weitzman's results are sobering. Many millions have been spent on species preservation, but neither uniqueness nor risk has weighed heavily in resource allocation. Instead there has been a heavy bias toward "charismatic megafauna" — large, well-known birds and mammals ("higher forms of life," in the human value system). Other classes of fauna — including, say, eels or wild toads — and all flora, have gotten extremely short shrift.

Prominent examples of species with high charisma, high attention, and relatively low endangerment are the bald eagle, the Florida scrub jay, and the grizzly bear. Other species may have less charisma but could have more scientific value or species risk.

This paper — a product of the Environment, Infrastructure, and Agriculture Division, Policy Research Department — is part of a larger effort in the division to see what lessons can be learned about environmental protection from the U.S. experience. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Anna Maranon, room N10-033, extension 39074 (28 pages). September 1994.

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PATTERNS OF BEHAVIOR IN BIODIVERSITY PRESERVATION

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FOREWORD

International institutions have begun responding to the clear threat of a global extinction spasm in the twenty-first century. At the World Bank, biodiversity preservation is now central to the mandate for environmentally sustainable development. During the coming decade, billions of dollars for conservation will be channeled through the Global Environment Facility, development banks, and international aid agencies.

While concern for global environmental issues may well have expanded the total international development budget, it may also have reduced the allocation for more traditional projects. The opportunity cost of any such diversion would be extremely high, since over one billion people still subsist in conditions of absolute poverty. It is therefore imperative to assure that conservation resources are optimally employed.

What is optimality in this context? Until recently, it has fallen to environmentalists, conservation biologists, and other concerned scientists to define biodiversity and recommend strategies for its preservation. Their scientific contribution has been and will remain indispensable, for economists and project managers in institutions like the World Bank cannot hope to attain more than elementary knowledge of the relevant scientific and taxonomic principles. Because conservation budgets are limited, however, biodiversity policy cannot avoid some important resource allocation questions: What should be preserved? How much should be preserved? Where?

In this domain, economists have something useful to say. Recent theoretical and empirical papers on optimal preservation policy have attempted to integrate three considerations: the relative uniqueness of different species or habitats, the degree of risk to their continued survival, and the opportunity cost of the resources needed to enhance survival prospects. With these new additions to the economist's toolkit, it is natural to ask: "How are we doing? Have biodiversity conservation resources been optimally allocated to date?" Answers require careful empirical analysis of actual policy choices and resource allocation decisions. In this innovative paper, Professors Andrew Metrick and Martin Weitzman submit the first report card. They have begun with an empirical analysis of U.S. species preservation policy, which is the best-documented country experience currently available for study.

Their results are sobering. From a scientific perspective, U.S. performance to date does not appear to warrant a passing grade. Many millions have been spent on species preservation, but neither uniqueness nor risk has weighed very heavily in resource allocation. Instead, there has been a very heavy bias toward "charismatic megafauna" -- relatively large, well-known birds and mammals. All other classes of fauna, and all flora, have gotten extremely short shrift.

In the World Bank, of course, our concerns are not focused on the success or failure of particular policies in wealthy societies like the U.S. But the U.S. has arguably devoted more scientific, technical and financial resources to the species conservation problem than any other nation. If U.S. performance is distinctly subpar, how are our client countries doing at this point? For that matter, what about the major NGO's which also invest many millions in conservation? Most critically from our perspective, how are the World Bank and other multilateral agencies doing? This paper makes an extremely valuable contribution by providing a model for further empirical analysis. It will be difficult to improve biodiversity conservation policies without clear assessments of their current direction. Future work by PRDEI will pursue this issue in the global context.

David Wheeler*

*Although Professors Metrick and Weitzman have kindly allowed me to write this introduction, the views expressed here are my own. They do not necessarily reflect the views of the authors.

1. Introduction

As a society, we seem to have made a generalized commitment to conserving biodiversity. But how do we spend our limited resources on this commitment? What *should* we be doing, what do we *say* we are doing, and what *are* we doing? Such questions are easy to pose but difficult to answer. In this paper, we set a more modest goal than providing a single comprehensive answer. Our hope is to tease out hints of answers by studying actual decisions made by the U.S. government about which species to protect and how much to spend on them.

Narrowly, this paper is about determining what explains the species-by-species protection and spending decisions of certain relevant U.S. federal and state government organizations.[1] To perform this analysis, we have combined several distinct datasets from different government and scientific sources. We think that the resulting combination offers a rare opportunity for empirically-based insights into preferences about biodiversity conservation. Decisions about endangered species reflect the values, perceptions, and contradictions of the society that makes them. Thus, more broadly, this paper addresses some very general issues about man's relation to nature and about human choice when confronted by competing and often unquantifiable objectives.

The Endangered Species Act of 1973 gave the federal government the power to protect U.S. species from extinction. Simply by listing a species as endangered, the government can cause many development projects to be delayed or canceled, and millions of dollars in opportunity costs to be incurred. Indeed, once a species is placed on the endangered species list, cost-benefit analysis is practically precluded. Additionally, all listed species are eligible to have funds spent directly on their recovery, with the eventual goal of

[1]Readers interested in other studies of revealed preference of government decision-making are referred to McFadden (1975) and (1976), Weingast and Moran (1983), Thomas (1988) and Cropper et.al. (1992). The most closely related work to our own is Mann and Plummer (1993).

having their endangerment reduced to levels that would allow them to be removed from the list. Overall, the relevant government agencies face difficult problems of, first, deciding which species to place on the endangered species list and, second, deciding how much to spend on the recovery of each listed species. In the sections that follow, we examine these two decisions in detail. We believe this subject deserves serious attention from economists because the direct and indirect costs of this type of environmental protection are already substantial, and such expenditure is growing more rapidly than almost any other comparably sized item in the national economy.[2]

The remainder of the paper is organized as follows: Section 2 contains a discussion of various normative justifications for the preservation of biodiversity and of the difficulties of constructing a single objective function that the government might be expected to follow. We then identify a subset of these normative justifications that can be defined operationally and quantified, and we describe the data that we use for them. This subset includes 'scientific' characteristics such as "degree of endangerment" and "taxonomic uniqueness" as well as more 'visceral' characteristics such as "physical size" and the degree to which a species is perceived as a "higher form of life". In Section 3, we describe the Endangered Species Act and the listing process in more detail, and then estimate a regression to determine the relative importance of these species characteristics in the listing decision. We find that both 'scientific' and 'visceral' elements play an important role in determining whether a species becomes listed. In Section 4, we focus on the government's direct spending to improve the condition of listed species. First, we describe the available spending data and the method by which it was collected. Then, using the same independent variables as in Section 3, we estimate a regression with "species-by-species" spending as the dependent variable. We find that the 'visceral' characteristics play a highly significant role in explaining the observed spending patterns, while the more 'scientific' characteristics appear to have little influence. Next, in Section 5, we extend the analysis to include explanatory variables of a more openly bureaucratic nature. The goal here is to determine how closely

[2]One illustration of this growth is the dramatic rise in direct expenditures on species-by-species preservation. These figures are studied in Section 4.

the government is following its own system for prioritization of spending. Results are mixed; while the formal priority system is followed to some degree, there is evidence that its least important component plays a disproportionate role. Finally, Section 6 concludes with a summary of the results and a discussion of some broader themes which we believe are suggested by the analysis.

2. Objectives in Biodiversity Preservation

A. Overview

In this section we attempt to identify all relevant variables which might influence endangered species policy. Before getting into any details of what the actual policies are, we model the government as facing a choice of possible species to preserve and ask, "What characteristics *should* matter when deciding where to put our scarce conservation resources?" In an ideal study of this subject, we would have a well-defined objective function for society as a whole, and the observed government behavior could be judged on the basis of how well it satisfied such a standard. In the case of biodiversity preservation, however, the most striking feature is the almost complete lack of any such anchor. Even in fields as contentious as health policy or environmental risk management, there is some 'currency' around which the analysis can be framed. In biodiversity preservation, however, no such measure has yet been agreed upon, and decision-making bodies are left with a shopping list of objectives that are not easily comparable to each other. In our opinion, it is essential to recognize this "lack of an anchor" as a central feature of biodiversity preservation, and we do not propose a complete solution to such a difficult problem. Instead, we study only the elements that are both *relevant* and *measurable*: relevant because they usually show up in the "shopping list of objectives", and measurable because it is possible to identify quantifiable proxies. Then, we attempt to determine which of these elements is actually important for explaining the patterns of behavior in the data.

Throughout our discussion, we use the conservation of *species* as the main vehicle for biodiversity preservation.[3] In this species-oriented approach, we find it useful to divide arguments for the preservation of biodiversity into four broad classes. First, species may have *commercial* value in uses such as food, medicine, clothing or tourism. This may sometimes be referred to as "use" or "utilitarian" value. Second, *existence* value represents the pleasure people derive from simply knowing that a species exists in the wild, even if representatives are never actually observed directly. This is a component of aesthetic value that, by definition, cannot be captured in tourism or other commercial measures; for this reason, it is sometimes referred to as "non-use" value. Third, it is sometimes argued that if we allow biodiversity to deteriorate below (currently unknown) critical levels, then ecosystems may collapse, thus causing significant repercussions in other spheres. We refer to this as *ecosystem* value. If we believe that this value is important, then we should act to preserve species that may be important "keystones" for their respective ecosystems. Fourth, there is a *moral* argument, originating ultimately from religious and philosophical convictions, that we have an ethical obligation to preserve species, notwithstanding any direct benefits to humans.

Within each of these four types of arguments, there may be several components that provide motivation for current government policy; in the next subsection we attempt to isolate those which seem to be both relevant and measurable. These "relevant and measurable" components fall exclusively within the category we have labeled existence value. This is not to say that the other three categories are not valid motivations; rather, it is that there are no measurable components of these other categories that can be used to understand current policy. The reasons are different in each case. First, although there are some

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[3]We recognize that some conservation professionals would argue that the proper unit of measurement is not species, but ecosystems. At an extreme, researchers who hold this view might question the entire foundation of a species-oriented approach. There are two reasons why we feel that the species-oriented approach used in this paper is justified. First, the species concept has a long history as being the most defensible basic unit of biology, or even ecology. Conversely, the ecosystem concept, while perhaps valuable in principle, simply does not have a comparable status to the species as an operational biological measure. Second, a desire to use ecosystems as the basic unit does not obviate the need to perform an economic analysis; actually, the same underlying issues about how to make conservation choices under a limited budget must be faced in either case.

exceptions, most endangered species have little or no commercial value, so this category can be effectively ignored as a significant motivation in government spending.[4] Next, the ecosystem value is not understood well enough to be useful for making decisions about individual species and, therefore, is not likely to explain any of the patterns in our data.[5] Moral values are always very difficult to quantify, and we break no new ground here. However, we do feel that the results shed some light on what might reasonably be called "moral preferences", and we reflect upon this possibility later.

B. "Relevant and Measurable" Objectives in Biodiversity Preservation

As stated previously, there are many components which might on principle be included in society's objective function for biodiversity, but only a subset are both relevant and measurable at this time. Below, we describe the three components of this subset that we have been able to identify, all of which fall into the class of existence values. Because it is not possible to obtain reliable measures of any component for all species of plants and animals, we confine our analysis to cover only vertebrate species, which in effect constitute a single phylum of the animal kingdom. The importance and implications of this restriction are discussed further in the following sections.

1) People often speak of the large amount of attention paid to "charismatic megafauna". Just knowing that elephants and pandas exist in the wild has value to some people, even if they never actually witness the wild elephants and pandas first hand; this effect is likely to be less pronounced for species of wild toads or eels. Since existence value of a species may indeed be a function of its charisma and physical size, we would ideally like some good measure of both. We capture the "megafauna" part by using the physical

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[4]Some fisheries fall into the class of exceptions, with whale species perhaps the most obvious examples. Since, as is explained later, our analysis does not include marine species, the importance of commercial value in our sample seems minimal.

[5]In rejecting inclusion of an "ecological significance" variable in the government's priority system, Fay and Thomas (1983), p.43101, state that "this kind of information is seldom available at the time a species is considered for listing ..."

length of an average representative of the species.[6] At this stage, we have not obtained a satisfactory measure of "charisma", although we have received many creative suggestions.[7]

2) Another possible component of existence value is the degree to which a species is considered to be a "higher form of life". In many contexts, it seems obvious that human beings care about other people in proportion to the degree to which they can identify with them. We might believe that this feeling extends to "higher forms of life" as well. We are not suggesting that this is an ideal ethical criterion to use; in fact, we are making no normative judgement at all. Instead, we want to recognize that if people do actually make distinctions among species in this way, then it will necessarily be a component of existence value.[8] To test for the possible role of such a component, we have divided the data set into the five broad classes of vertebrates: mammal, bird, reptile, amphibian and fish. In the regressions of the following sections, we include dummy variables for each of these classes to see if current policy discriminates among them.

3) Since we also may have existence value for "biodiversity" as a whole, some measure of the amount that a species adds to this diversity should play a role in deciding how much to spend on it. As a measure of such added diversity, we might use a species' taxonomic distinctiveness, or difference, from other species.[9] Other things equal, the more unique a species is, as measured by distance from its closest living relative, the more

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[6]Lowe et.al. (1990) and Mosely (1992) give fairly precise length ranges for all species on the U.S. endangered species list. For non-listed species, we consulted several standard biological references to obtain length estimates. A complete listing of these sources is contained in the bibliography. In some cases, we were not able to obtain a published length for a species and it was necessary to form an estimate by using data from closely related species.

[7]Among the suggestions are: eye-size or eye-body ratio, number of times the animal's name appears in children's books or in articles in *The New York Times*, space devoted to the animal in zoos, and subjective charisma ratings from an as yet unperformed psychology experiment. Our judgement at this time is that none of these measures would be useful enough to justify their inclusion.

[8]It is also possible to interpret this type of existence value as an example of a *moral* value, as in the previous section. Such a theme is developed in Nash (1989). We comment on the implications of this interpretation later in the paper. For now, however, we think of the "higher form of life" effect as an anthropocentric value that can explicitly be placed inside a cost-benefit analysis.

[9]This theme is developed more fully in Weitzman (1992) and (1993).

attention we should pay to its preservation. As a measure of taxonomic uniqueness, we use dummy variables to discriminate among three possibilities. First, a "Full Species" is our term for a genuine species in the generally accepted biological sense.[10] Next, a "Monotypic Genus" is a full species that constitutes the sole representative of its genus.[11] Finally, we use the term "Subspecies" to mean any taxonomic unit below the level of a full species. Of these three types, "Monotypic Genus" is the most taxonomically distinct, while "Subspecies" is the least.

Finally, a fourth factor to be considered does not relate directly to species value, but rather to the probability of preventing extinction.

4) Any preservation decision should pay some attention to the actual level of endangerment of the species in question. Other things equal, preservation dollars should go to recover the more endangered species.[12] Our data for endangerment comes from the Nature Conservancy (NC), which tracks an exhaustive subset of all vertebrate "full species" in the U.S. and provides "global endangerment" ranks on a scale of 1 (most endangered) to 5 (least endangered). Overall, the NC ranking system is by far the most comprehensive and objective measure of species endangerment that we could find. Each of the interval rankings

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[10]The "generally accepted" biological-species definition is typically ascribed to Ernst Mayr: "Species are groups of actually or potentially interbreeding natural populations reproductively isolated from other such groups".

[11]The Genus is the taxonomic level just above species.

[12]In a formal model of biodiversity preservation, such as Weitzman (1993), a more appropriate statement is something like the following: other things equal, we should spend more money on species with higher marginal decreases in extinction probability per dollar spent. In practice, there probably is a high correlation between a species' "absolute" and "marginal" levels of endangerment, so the two concepts may actually turn out to be similar. Throughout this paper we finesse the possible distinction between marginal and absolute levels of endangerment.

of 1 through 5 has a well-defined meaning, and a serious effort is made by the NC to apply the rankings consistently.[13]

These four factors make up the subset that we feel is both relevant and measurable. In order to adjust for the importance of any relevant but *unmeasurable* factors, we later define a "residual" component of existence value and attempt to estimate the effect of its omission from the regressions. This artificial construction will be explained in Section 4, where it plays an important role in interpreting the pattern of spending decisions.

3. The Listing Decision

A. Background: The Endangered Species Act of 1973

The Endangered Species Act of 1973 ("the Act") created a framework for the preservation of endangered plants and animals in the United States. This framework is administered primarily by the United States Fish and Wildlife Service (FWS), an agency of the Department of the Interior, which oversees the recovery of all terrestrial and freshwater species of plants and animals.[14] The term "species", although having a fairly precise technical meaning to taxonomists, is defined in the Act to include subspecies, varieties (for plants), and populations (for vertebrates), in addition to 'true' species in the technical

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[13]The Nature Conservancy distinguishes between global ranks, called "G-ranks", which are given to full species, and "T-ranks", which are given to subspecies or populations. In our data set, we use the ranking relevant to the taxonomic unit being studied, i.e. G-ranks for full species and T-ranks for subspecies. The definitions of G-ranks given by the NC are: G1 - critically imperiled throughout their range and typically have fewer than 6 occurrences in the world, or fewer than 1000 individuals; G2 - imperiled throughout their range and typically have between 6 and 20 occurrences, or fewer than 3000 individuals; G3 - vulnerable throughout their range and typically have fewer than 100 occurrences, or fewer than 10000 individuals; G4 - apparently secure throughout its range (but possibly rare in parts of its range); G5 - demonstrably secure throughout its range (however, it may be rare in certain areas). See National Heritage Data Center (1992) and (1993a).

[14]The National Marine Fisheries Service is responsible for the administration of the Act for most marine species. In this paper, we focus our attention exclusively on the species monitored by the FWS. We focus on the FWS because the National Marine Fishery Service does not publish data comparable to our FWS sources. Since the vast majority of recovery programs are managed by the FWS, this restriction does not play a role in our results.

biological sense.[15] Where not otherwise specified, we follow this biologically-imprecise terminology and use the word "species" to refer to any taxonomic unit eligible for protection under the Act.

The process of listing a species for protection begins when the species is proposed by FWS as a "candidate". During its period of candidacy, FWS gathers data from internal and external scientific sources in order to determine whether the species warrants listing and protection. The process stalls here for most candidates; out of over 3600 candidates for listing in 1993, there is insufficient scientific data to make a decision on about 3000.[16] If sufficient scientific data exist and the data are judged to warrant listing, then FWS can place a formal proposal in the Federal Register. After a public comment period, FWS makes a final decision. A species may be listed as "endangered" or "threatened". An "endangered" species is "in danger of extinction throughout all or a significant portion of its range". A "threatened" species is "likely to become endangered in the foreseeable future".[17] Both types are considered to be "listed" and, while there are some legal distinctions, in practice they are given the same protection under the Act. For the remainder of the paper, we ignore the distinction between endangered and threatened species and we refer to all listed species as "endangered".

For good reasons, the decision to list a species is given considerable attention by the FWS. Once protected, endangered species can cause large disruptions and force developers to delay or even cancel projects that might harm the species. For expositional purposes, we can effectively divide the stipulations of the Endangered Species Act into 'protective' and 'recovery' measures. 'Protective' measures are restrictions on activities which harm listed species. These restrictions are more stringent for public, especially federal, activities than for private activities. On federal land or in projects requiring federal permits, species are

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[15]A vertebrate "population" is a taxonomic group below the subspecies level. Our analysis combines subspecies and populations in the same category.

[16]This total includes invertebrates and plants as well as the vertebrates studied in this paper.

[17]The background and definitions are drawn from the Endangered Species Act of 1973 and from the FWS publication, "Placing Animals and Plants on the List of Endangered and Threatened Species", U.S. Fish and Wildlife Service (1993). This publication also includes a detailed description of the listing process.

protected from any adverse effect of an activity, including habitat alteration. The most prominent examples of such activities are dam or other construction, and mining or logging on federal land. On private land, it is primarily forms of direct harm that are restricted. Direct harm is defined specifically in the Act and includes such obvious examples as shooting, trapping, and selling. 'Recovery' measures give the government the power to improve the condition of listed species. The Act provides FWS with the authorization to develop and implement plans to preserve and improve the condition of listed species. More importantly, the Act gives FWS and other federal agencies the authority to purchase significant habitat sites and to aid state agencies that have agreements with FWS.

B. Regression #1: Factors in the Listing Decision

Since listing a species is the crucial first step in its protection, it would be helpful to gain a better understanding of the determinants of the government's decision. What role, if any, is played by the "relevant and measurable" objectives discussed in the previous section? To answer this question, we constructed a sample of all vertebrate "full species" which might possibly be considered for listing. This sample excludes all taxonomic units below the "full species" level; that is, we do not include any subspecies or populations. Such a sample is possible because the Nature Conservancy database contains an exhaustive list of *all* U.S. vertebrate (full) species.[18] We restrict our sample to all full species, listed and unlisted, that meet a minimum threshold of endangerment -- the NC endangerment rank of 3 or lower. This leaves us with a sample of 511 full species, of which almost half are fish. Using this sample, we estimate a logit regression with a dependent dummy variable, LISTED, which is set to 1 if the (full) species was listed as of March 1993 and to 0 otherwise. The independent variables are Nature Conservancy degree of endangerment rank (NCRANK), log of physical length (LNLENGTH), dummies for the taxonomic class (MAMMAL, BIRD, REPTILE, and AMPHIBIAN -- fish is the benchmark), and a dummy for monotypic genus (MONOTYPIC).

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[18]We exclude subspecies from this analysis because the NC does not track a complete list of U.S. subspecies. We do not even know how many non-listed subspecies exist, much less what they are.

REGRESSION #1 - THE LISTING DECISION

LISTED	Coef.	Std. Err.	t	P>|t|
MAMMAL	1.11	.42	2.679	0.008
BIRD	1.21	.38	3.224	0.001
REPTILE	.92	.44	2.102	0.036
AMPHIBIAN	-1.51	.45	-3.339	0.001
NCRANK	-1.47	.16	-9.238	0.000
LNLENGTH	.25	.14	1.713	0.087
MONOTYPIC	.84	.39	2.177	0.030
CONSTANT	1.07	.42	2.550	0.011

Dependent variable is LISTED. Method of estimation is logit. 511 observations.

These results indicate that many forces play a role in the listing process.

1) The coefficient on LNLENGTH is positive and significant at the 10 percent level; other things equal, a 1 percent increase in physical length translates into approximately a .05 percentage point increase in the likelihood of listing.[19]

2) Similar translations yield statistically significant estimates for mammals, birds, reptiles and amphibians (relative to fish) of 20, 22, 17 and -27 percentage points, respectively. All of these results are significant at the five percent level.[20]

[19]As a first approximation, logit coefficients can be translated into probability terms by multiplying by p(1-p), where p is the mean of the dependent variable. In this case, p ≈ .24 and p(1-p) ≈ .18.

[20]Readers may notice that the order of listing preference suggested by this regression places fish ahead of amphibians, while an evolutionary tree would place humans closer to amphibians than to fish. We are not sure that an evolutionary tree is the correct measure of what constitutes a "higher form of life", and the main reason we ran the regression with dummies rather than a single ordered "evolutionary" variable was to remain agnostic on this issue. Nevertheless, the overall pattern of the coefficient estimates is consistent with a loose evolutionary interpretation of "higher" as being "more closely related to humans".

3) Monotypic genera show a statistically significant increased listing likelihood of 15 percentage points.[21]

4) NCRANK has the expected influence on listing. The negative coefficient implies that a low NCRANK -- which implies high endangerment -- results in a higher likelihood of listing. A translation of the coefficient into probability terms implies that a one unit increase in NCRANK results in an approximate 26 percentage point rise in the likelihood of listing.

Most of these coefficient values are not surprising. As mentioned in Section 2, a species becomes listed only after there is significant scientific evidence on its endangerment. Thus, we would expect that well-studied species would have a greater chance of meeting the necessary scientific standard and passing from being a candidate for listing to becoming listed. Since humans allocate their scarce scholarly resources for many of the same reasons cited for preservation, our results may indicate which species we like to study as much as they indicate which species we want to preserve. This complication is unavoidable. Nevertheless, the results of this regression certainly show that species are listed for more than just 'scientific' characteristics such as uniqueness and endangerment; 'visceral' components of existence value, like size and the degree to which a species is considered a "higher form of life", seem to affect the listing decision as well.

4. The Spending Decision

A. Background: Spending Data and the 1988 Amendment

Once a species has been listed under the Act, FWS is charged with the creation of a

[21]Although we are only able to study the MONOTYPIC dummy in this regression, we would ideally like to know if subspecies are treated differently from full species in the listing process. Since an exhaustive list of all vertebrate subspecies does not exist, it is impossible to answer this question formally. We can, however, make an educated guess by using some simple ratios. Tear et.al. (1993) estimate that the ratio of subspecies to full species in North America is 6.9:1 for mammals and 4.9:1 for birds; in the sample of listed species, the ratio of subspecies to full species is 2.4:1 for mammals and 1.1:1 for birds. Although these ratios consider only one factor and cannot be calculated for all vertebrate classes, the disparity at least suggests that full species are given preference to subspecies at the listing stage.

"recovery plan", which sets out the steps to be taken to improve the condition of the species. Internal audits by the U.S. Department of the Interior estimate that the potential direct costs implied by the recovery plans of all listed species are about $4.6 billion.[22] Since the total available budget falls far short of this figure, all agencies with spending programs must make choices among projects.[23] During the 1980's, some members of Congress seemingly became concerned that a disproportionate share of these limited conservation dollars were being used to preserve a small number of species. Apparently, there was sufficient interest in this issue to pass an Amendment to the Act in 1988 requiring FWS to prepare annual reports on the amount of federal and state spending broken down by species. The data collected by FWS was first published for fiscal year 1989, and has subsequently been published for FY 1990 and FY 1991.[24] Spending from these three years is the main object of study in this section. In the following paragraphs, we explain the nature of this data, how it was collected, and what types of spending are and are not included.

The 1988 Amendment specifically charged FWS with making a "good faith" effort to calculate all expenditures that were "reasonably identifiable" to an individual species. If spending cannot be broken down by species, then it is not included in the final total. Although the definition "reasonably identifiable" may seem somewhat imprecise, in practice it seems to cover fairly broad classes of expenditures that are more or less operationally defined. Examples of expenditures usually included are habitat acquisitions designed primarily for a single species, captive breeding programs, operating expenses of wildlife preserves mostly dedicated to a single species, population censuses, and scientific study. Examples of expenditures that are typically not identifiable to a single species are salaries of

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[22] U.S. Fish and Wildlife Service (1990b), p.7.

[23] Calculating the total budget available for recovery projects is not straightforward. There are several sources of discretionary funds that can be used for many purposes in any year, with biodiversity preservation only one possibility. Any way that it is calculated, however, the budget is much less than $4.6 billion.

[24] The relevant sources are U.S. Fish and Wildlife Service (1990a), (1991) and (1992a). We plan to update this dataset to include FY 1992 spending when FWS releases this information, but we do not anticipate major changes in our results.

FWS personnel, operating expenses of general wildlife preserves, multi-species habitat purchases and the opportunity costs of legal restrictions on development.

Since the published expenditure figures exclude some public as well as all private expenditures, they do not completely account for the overall cost of wildlife preservation. As a result of this incomplete data, and for other reasons, we do not envision ourselves here as doing any kind of formal, comprehensive, society-wide cost-effectiveness analysis of current policies. Basically, we think of the reported spending figures as a noisy reflection of some underlying measure of concern for the various species. In studying reported species-by-species spending, we seek only the modest goal of finding patterns in the data which may reflect underlying preferences of the relevant decision-making organizations.

As for mechanics of the spending decision, the first thing to note is that the aggregate government spending figures we use come from many different agencies, at both the federal and state levels. Some of the spending is on items specifically mandated in the budget of a relevant agency. In essence, the legislative branch controls this mandated expenditure directly. Another part of spending is discretionary and comes from funds managed by FWS or appropriated by FWS from other government sources. To guide these discretionary spending decisions, FWS has developed a system for prioritizing species; we discuss this prioritization system in Section 5. In our opinion, it would be an oversimplification to ascribe some fraction of spending to Congress and the remainder to other relevant agencies, because many of the decisions are made with input from both sides. Therefore, we treat all of the spending as if it comes from "the government" in general, although this clearly leaves many subtle political factors beyond the scope of our analysis.

The spending figures published in the annual expenditure report are collected from three sources. First, FWS calculates its own spending. Second, expenditures by the states are reported to a central conservation organization, which then passes the totals along to FWS. Third, each federal agency reports its expenditures individually to FWS. Since its inception in the 1989 fiscal year, the process has become more efficient and agencies have become more adept at identifying conservation expenditures from within their budgets. (In the early years, for example, the state numbers are somewhat incomplete.) Some of the remarkable growth in total reported expenditures, which have risen from $43 million in 1989 to $102 million in 1990 to $177 million in 1991, is attributable to this improvement in data gathering. The bulk of the spending is done by the federal government, with FWS itself comprising about half of the federal total. For all three years, the federal total of conservation expenditures is $248 million, while the state total is $74 million. Expenditure data is collected on all listed plant and animal species. However, as already noted, we confine our attention to the vertebrates. Since approximately 95 percent of the identifiable conservation budget is spent on vertebrates, we are confidant that any patterns uncovered here would be robust in the complete sample of listed species.

B. Regression #2: Determinants of Spending

Regression #2 uses the log of total spending from 1989 to 1991 (LNTOTAL) as the dependent variable. Since we only observe spending on a species when it is greater than $100, the dependent variable is censored at ln(100) and the appropriate estimating procedure is a Tobit regression.[25] The independent variables are the same as those in Regression #1, with the addition of a SUBSPECIES dummy for listed taxonomic units below the full species level.

Before discussing the regression results, it is helpful for the exposition to introduce a hypothetical variable which we call "CHARISMA". We think of this variable as the unmeasurable part of existence value, and we mechanically define it to be orthogonal to all of the independent variables used in Regression #1.[26] Although it may seem to be an unorthodox construction, CHARISMA is just a statistically harmless fiction that enables us to discuss a possible bias in our estimates. In writing about this hypothetical variable as if it actually exists in the real world, we seek only to simplify the exposition. For this purpose, we treat CHARISMA as a 'real' variable omitted from the right-hand-side of Regressions #1

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[25]Because there are only two censored observations, the results of the Tobit estimation are practically identical to those of an OLS regression using the same variables.

[26]We can do a thought experiment to envision what the CHARISMA variable represents. First, imagine that we could create a perfect measure for the existence value of each species. Next, regress this perfect measure on the set of independent variables used in Regression #1. Define the residuals from this regression to be the CHARISMA variable.

and #2, and we assume that its coefficient would have been positive in both regressions. We then discuss how the estimated coefficients on the other regressors would be biased by this omission.

In Regression #1, we could think of the sample as being randomly selected from the population of all vertebrate full species. By construction, CHARISMA is uncorrelated in this population with the right-hand side variables: LNLENGTH, NCRANK, MONOTYPIC, and the taxonomic class dummies. Hence, in principle, there is no omitted variable bias introduced in Regression #1. The sample used in Regression #2, however, consists only of *listed* species, and thus is specially selected by the listing process. If CHARISMA has a positive influence on listing likelihood, then within this sample it may well be correlated with other variables found to affect the listing decision. For example, since the estimated coefficient on LNLENGTH is positive in Regression #1, then, other things equal, a species with high CHARISMA would require *lower* LNLENGTH to achieve the same listing likelihood. Therefore, in a sample of only listed species, CHARISMA and LNLENGTH are likely to be inversely correlated. Analogous reasoning can be used on each of the other regressors -- in general, each variable's correlation with CHARISMA will be opposite to the sign of its respective coefficient in Regression #1. Thus, if we make the natural assumption that CHARISMA also has a positive influence on the spending decision, then the direction of the omitted variable bias on each coefficient in Regression #2 will also be opposite to the sign of the respective coefficient in Regression #1. This bias is discussed below on a case-by-case basis.

REGRESSION #2 - THE SPENDING DECISION

LNTOTAL	Coef.	Std. Err.	t	P>|t|
MAMMAL	.75	.44	1.717	0.087
BIRD	.27	.37	0.721	0.472
REPTILE	-1.72	.50	-3.443	0.000
AMPHIBIAN	-.94	.66	-1.422	0.156
NCRANK	.65	.19	3.423	0.000
LNLENGTH	1.03	.15	6.747	0.000
MONOTYPIC	-.37	.50	-0.736	0.462
SUBSPECIES	-.35	.30	-1.177	0.240
CONSTANT	7.69	.45	16.959	0.000

Dependent variable is LNTOTAL. Method of estimation is Tobit. 237 observations.

The results of Regression #2 suggest several patterns in spending behavior.[27]

1) The coefficient on LNLENGTH is highly significant, statistically and quantitatively. This coefficient may be interpreted here in a normal fashion as an elasticity; it implies an approximate 1 percent increase in spending for a 1 percent increase in length. Since our analysis suggests that LNLENGTH and CHARISMA are negatively correlated in the sample of listed species, the omission of CHARISMA from Regression #2 should bias the coefficient on LNLENGTH downward. This further strengthens our finding of a highly significant positive effect.[28]

2) The taxonomic class dummies, as a group, seem to have a significant effect on spending. Since the fish dummy is left out, all of the other taxonomic class coefficients

[27]The patterns discussed below are not driven by a small subset of the sample. For example, if we exclude the ten species with the highest spending, which together comprise more than half of all spending, then the same qualitative results are found.

[28]To support a reproductively viable population, physically large species typically require more habitat than do physically small species. Hence, it is conceivable that the significant positive coefficient on LNLENGTH is capturing different species' "needs". We think the explanatory power of this argument is small. Nevertheless, as with all other plausible explanations, we would gladly return to this question if relevant data on species' "needs" become available.

measure spending on that class relative to fish. The results show that the MAMMAL dummy enters positively and the REPTILE dummy enters negatively. The coefficients on BIRD and AMPHIBIAN are of the expected sign, but the magnitudes are not significantly different from zero. The overall pattern to the coefficients is fairly consistent with the one-time official policy of FWS to give spending preference to the "higher" animals in the following order: mammal - bird - fish - reptile - amphibian. This policy was officially abandoned in 1983, when Congress explicitly directed the FWS to implement a priority system that *ignored* the distinction between "higher" and "lower" life forms. However, as the regression results suggest, such a policy may actually reflect underlying preferences.[29] The effect of omitted variable bias would mostly support this interpretation. Since MAMMAL and BIRD are probably negatively correlated with CHARISMA in this sample, their estimated coefficients should be biased downward. Conversely, the coefficient on AMPHIBIAN should be biased upward. Adjusting for this bias would tend to reinforce the pattern already found. Only for the coefficient on REPTILE would the omitted variable bias possibly change the coefficient sign, since it is likely to be biased downward in this estimate.

3) Since the "Full Species" dummy is left out, the other two taxonomy dummies measure spending relative to this class. Our qualitative prediction from the discussion in Section 2 is that taxonomic uniqueness should have a positive influence on spending, so that we should find a positive coefficient on MONOTYPIC and a negative coefficient on SUBSPECIES. Actually, we find estimated coefficients on both to be negative but statistically insignificant. Adjusting for bias due to the omission of CHARISMA yields inconclusive results. It is likely that the MONOTYPIC coefficient is biased downward and the SUBSPECIES coefficient is biased upward. This bias could conceivably be sufficient to mask a small role for taxonomic uniqueness.

4) A surprising and counterintuitive result is the highly statistically significant positive coefficient on NCRANK. At face value, this means that a *decreased* level of

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[29]There is an issue here, and throughout the paper, about taking the spending on species at face value. For example, spending on fish living in rivers might be a proxy for our desire to preserve rivers, and have little to do with a desire to preserve fish per se. This kind of problem occurs often in empirical work and, at some level, it is impossible to eliminate completely. We have no reason to believe that the problem is particularly acute in this case.

endangerment -- thus, a higher NCRANK -- implies *more* spending. The appropriate interpretation of this result depends on the size of the bias from the omission of CHARISMA. Suppose, at one extreme, that the omitted variable bias is small or negligible. Then, we would conclude that NCRANK actually plays a perverse role in spending decisions. We consider it to be an implausible conclusion that, controlling for all other observable factors, a more truly endangered species actually gets less money spent on it; nevertheless, such an interpretation cannot be excluded by our results. At the other extreme, suppose that the omitted variable bias is large. Under this scenario, the 'true' NCRANK coefficient could be negative, but the omitted variable bias would be large enough to turn a significant negative coefficient into a significant positive coefficient. If this is indeed the explanation for the positive coefficient on NCRANK, then it is a powerful illustration of the role CHARISMA is playing in the spending decision. In this case, we would conclude that any influence of NCRANK in its "expected" direction is more than outweighed by the role of CHARISMA. We believe that this conclusion is probably correct. Since NCRANK plays a very significant role in the listing process, it is likely that CHARISMA and NCRANK are highly correlated in the population of listed species and that the omission of CHARISMA from Regression #2 severely biases the NCRANK coefficient upwards. There is also considerable casual evidence to support this conclusion. Species with the highest spending include many "charismatic" species with very low endangerment -- the Bald Eagle, Florida Scrub Jay and Grizzly Bear among the most prominent examples. Adjustments for other characteristics fail to explain why these species receive high spending, as each also has large positive residuals in Regression #2.

It seems fair to conclude that spending choices are determined much more by 'visceral' than by 'scientific' characteristics; LNLENGTH and taxonomic class play significant roles, while the effect of taxonomic uniqueness and NCRANK are, at best, overshadowed by bias due to the omission of CHARISMA. Indeed, the results are even more striking when we realize that the inclusion of taxonomic class dummies essentially restricts LNLENGTH to the role of explaining "within" class variation of spending; absent taxonomic class dummies on the right-hand-side, the coefficient on LNLENGTH would be even greater, as length explains some of the "between" class variation as well. Overall, the one-line message to take away from our study of spending behavior is "size matters a lot". Again, we should note that this is not necessarily 'wrong', since "size" might justifiably be included in a society's objective function. However, it should also be noted that such heavy weighting of 'visceral' elements seemingly goes against the language and spirit of current FWS policy, which strongly stresses 'scientific' characteristics. For example, the FWS numerical priority system is based entirely on 'scientific' elements. In the next section, we study this priority system in more detail, and test for its relative importance in the spending decision.

5. The FWS Priority System

A. Background and Discussion

In 1983, FWS created a formal "priority system" to serve as a guide in their listing and spending decisions.[30] In this section, we describe the official system adopted for spending decisions and we discuss several aspects that can yield insights into underlying preferences towards conservation. Then, we test for the priority systems's role in explaining the observed pattern of spending. Overall, the system is intended to be used as a guide rather than a strict set of rules; nevertheless, if the government were using the system as it was designed, we would expect the data to show some evidence of successful implementation.

To study this issue, Regression #3 includes a regressor called PRIORITY, a variable which is equal to FWS's published priority rank. PRIORITY ranges from 1 (FWS's highest rank) to 18 (FWS's lowest rank). There are three components of this number. In strictly decreasing lexicographic order of importance, these components are "degree of threat" (3 grades), "recovery potential" (2 grades), and "taxonomy" (3 grades), making a total of 18 combinations. "Degree of threat" is a similar concept to NCRANK, as both attempt to measure the absolute endangerment level of the species. Also, each is on a three-point scale

[30]The official FWS description and defense of their priority system is contained in Fay and Thomas (1983).

in our sample. Despite this conceptual similarity, the two measures are not highly correlated - an issue we return to later. "Recovery potential" is a measure of the ease or difficulty of improving a species' condition. Species with a "high" recovery potential are perceived to have well-understood threats which do not require intensive management to be alleviated. The three "taxonomy" grades are the same as we used in Regression #2: monotypic genus, full species, and subspecies. In addition, the priority system recognizes species seen to be in "conflict with construction or other development projects or other forms of economic activity".[31] Species in "conflict" do not receive a higher priority number than those not in conflict, but they are given a tie-breaking preference between species with the same (#1-18) ranking. We include a dummy variable, CONFLICT (1 if species is in conflict, 0 if not), to recognize this additional distinction.

It is not part of our purpose here to have a complete discussion about the merits and faults of the priority system described above. Nevertheless, there are several observations about this system which may yield insight into the attitudes and preferences of its creators. First, it is notable that a lexicographic ordering is used in creating the ranking. This ordering means, for example, that any species with the highest grade of "degree of threat" will always be assigned a higher priority than any other species with the middle grade of "degree of threat", even if the latter species has higher grades of "recovery potential" and "taxonomy". Such a method effectively precludes any possibility of trade-offs among the three criteria. This rigidity suggests a very extreme objective function. Second, the inclusion of "recovery potential" could be viewed as an attempt to quantify the cost-effectiveness of recovery. But, by placing "degree of threat" prior to "recovery potential" in the ordering, FWS is essentially making the statement that "cost issues are dominated by endangerment issues". Our final observation concerns the use of "conflict" as a positive tie-breaker for species priority. It seems more reasonable to suppose that, other things equal, it is more cost-effective to spend money on species that are *not* in conflict with development, since species in conflict are already imposing opportunity costs on society. The stated

[31]Fay and Thomas (1983), p.43104.

preference for preserving species in "conflict" may reflect some underlying desire to pay attention to high-profile species.

B. Regression #3: The FWS Priority System

Regression #3 is identical to Regression #2 except for the addition of PRIORITY and CONFLICT and the subtraction of MONOTYPIC and SUBSPECIES from the list of regressors. MONOTYPIC and SUBSPECIES are dropped for statistical reasons because they are included as components of PRIORITY.

REGRESSION #3 - THE SPENDING DECISION WITH FWS PRIORITIES

LNTOTAL	Coef.	Std. Err.	t	P>|t|
MAMMAL	.54	.40	1.354	0.177
BIRD	.46	.34	1.342	0.181
REPTILE	-1.62	.47	-3.470	0.000
AMPHIBIAN	-1.19	.62	-1.917	0.057
NCRANK	.80	.18	4.398	0.000
LNLENGTH	.85	.14	5.944	0.000
PRIORITY	-.10	.04	-2.716	0.007
CONFLICT	1.20	.29	4.177	0.000
CONSTANT	7.99	.47	17.126	0.000

Dependent variable is LNTOTAL. Method of estimation is Tobit. 237 observations.

The coefficient on PRIORITY is negative and statistically significant. Other things equal, high priority species, i.e. those with a low numerical PRIORITY, receive more spending than do low priority species. At first glance, this suggests successful implementation of the priority system. Such a conclusion is mitigated, however, by the size of the estimated coefficient on CONFLICT. Recall that CONFLICT is intended to be the least important component of the priority system, as it acts only to break ties between species with the same priority number. In spite of this ostensibly small role, the estimated coefficient on CONFLICT is more than ten times the estimated coefficient on PRIORITY, and its t-statistic is greater than 4. Since ten units of PRIORITY -- moving up from 14 to 4 result seems difficult to explain within the framework of the FWS system.[32] It is possible, however, that the CONFLICT variable is capturing other influences which are playing a major role in the spending decision. Specifically, species in conflict may generate extra political attention. Then, through a variety of mechanisms, such political attention might translate into increased spending.

There are also indications that species in conflict receive higher priority numbers than they objectively deserve. As mentioned earlier, the NC endangerment rank (NCRANK) and FWS's "degree of threat" component of PRIORITY attempt to measure the same thing. Nevertheless, the correlation between the two measures is far from perfect, and some of the deviation can be explained by the existence of conflict. To illustrate this point, we estimate an OLS regression of the FWS degree of threat (DEGREE) on independent variables NCRANK and CONFLICT.[33]

REGRESSION #4 - DETERMINATION OF DEGREE OF THREAT

DEGREE	Coef.	Std. Err.	t	P>|t|
NCRANK	.20	.05	4.333	0.000
CONFLICT	-.41	.07	-5.637	0.000
CONSTANT	1.28	.47	15.394	0.000

Adjusted R^2 = .17
Dependent variable is DEGREE. Method of estimation is OLS. 237 observations.

The coefficient on NCRANK is positive and significant, but considering that a coefficient of 1 would indicate a perfect correlation, the size of the coefficient seems low.

[32] Mann and Plummer (1993) were the first to indicate the importance of the CONFLICT variable. Their results motivated us to include CONFLICT in our analysis.

[33] An OLS regression implies that we take the actual numerical DEGREE rankings seriously. If we believe that DEGREE rankings are only ordered classes, then the proper estimation procedure would be ordered logit. Since, in this case, the results of an ordered logit estimation are very similar to OLS, we only report the latter. In either case, the indicated choices of independent and dependent variables are natural because DEGREE is a somewhat subjective measure created by the FWS, while NCRANK and CONFLICT are more objectively determined. No specific standards have been published by the FWS to explain why species receive different DEGREE ranks. NCRANK, by contrast, has fairly specific guidelines summarized in National Heritage Data Center (1992). Also, CONFLICT is the most objective of the FWS ranks; the published guidelines state that "Any species identified ... as having generated a negative biological opinion which concluded that a given proposed project would violate Section 7(a)(2) of the Endangered Species Act or resulted in the recommendation of reasonable and prudent alternatives to avoid a negative biological opinion would be assigned to the conflict category...". Fay and Thomas (1983).

The coefficient on CONFLICT is negative and significant; this implies that species in conflict are considered to be more endangered by the FWS than they are by the NC. Since the NCRANK measure is designed to take into account any conflict that threatens the global survival of a species, the results of Regression #4 suggest that FWS may be inappropriately factoring individual findings of local conflict into its supposedly objective endangerment ratings. Thus, not only does CONFLICT have a disproportionate influence on the spending decision, but it may also subtly influence the rest of the priority system as well.[34]

6. Conclusions

How do we spend our limited resources on preserving biodiversity? In the introduction, we proposed to analyze this issue from three directions: what *should* we be doing, what do we *say* we are doing, and what *are* we doing?

The normative evaluation of endangered species policy is problematic, because it is difficult to give a clear answer to "what should we be doing". In the paper, we discussed the basic reason: lack of a common currency to serve as an "anchor". Since it has not been possible to frame preservation policy around a unifying concept, it should come as no surprise that the actual policy choices do not conform to any specific criterion. Until progress is made on this methodological problem, it will be very difficult to provide any evaluation of whether we are preserving biodiversity efficiently. Indeed, the simple insight that "no usable anchor has been provided for evaluation" goes a long way towards explaining the core dilemma of endangered species protection. Furthermore, it is our sense that such inherently fuzzy objectives are found in a growing number of policy areas, and thus the central methodological problem encountered here is increasing in importance.

To better understand "what we say we are doing", we looked at the government's current system for setting spending priorities. The analysis finds that, while the priority system is being implemented to some degree, the least important component of the system

[34]It is also possible to explain the results of Regressions #4 by positing that CONFLICT contains some superior information on the part of FWS. Because NCRANK is continually updated while DEGREE is not, we feel that this explanation is unlikely to be correct.

had an influence which far exceeded its prescribed role. This component, a fairly 'objective' measure of whether a species is in "conflict" with development, is also found to influence the priority system itself. Such influence suggests that it might be useful to have a more formal separation between an agency making policy and an agency gathering the scientific information necessary for the setting of priorities. Without such a separation, even a well-intentioned government is prone to mixing these two distinct activities.

We analyzed "what are we doing" by examining the actual listing and spending decisions of the relevant government agencies. The overall pattern to these results is clear: visceral characteristics of species, such as their physical size and the degree to which they are considered to be "higher forms of life", explain a large part of both listing and spending decisions. More scientific characteristics, such as endangerment or uniqueness, play a role at the listing stage but are overpowered by strong visceral elements at the spending stage. The evidence indicates that we pay more attention to species in the degree to which they are perceived to resemble us in size or characteristics. A provocative interpretation is to summarize current preservation policy as an expansion of rights and obligations towards species that remind us of ourselves. As such, this would represent continuation of a trend that mirrors an analogous broadening of the coverage of human rights in recent history. Although it remains highly speculative, this "moral" interpretation of our results may indeed be the best single explanation.

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