Economies of Scope in Endangered-Species Protection: Evidence from Interest-Group Behavior

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Abstract

This paper looks for positive spillovers from the legal protection of one species to the welfare of others, and for evidence of economies of scope in the costs associated with protecting species under the Endangered Species Act. The analyses use data on the intensity of interest-group comment activity in response to proposals to protect new species. The results suggest that these phenomena are significant, strengthening arguments that wildlife-protection policy should be shifted towards species groups or ecosystems. However, the findings are also consistent with diminishing public willingness-to-pay for protected species in a given area, a pattern which also has public-policy implications.

Key Words: economies of scope, endangered species, political economy, interest groups

Table of Contents

List of Figures and Tables

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Amy Whritenour Ando[1]

I. INTRODUCTION

Wildlife law in the U.S. has focused historically on the task of protecting individual species. That focus emerged at a time when charismatic individual species like the bald eagle were in danger of becoming extinct, and after a number of species, like passenger pigeons and wolves, had been eliminated or driven to the brink of extinction by deliberate human activity. The Endangered Species Act of 1973 (ESA) has, despite several rounds of amendments, officially maintained its approach of protecting individual species, rather than ecosystems or clusters of related species.

That approach is, however, under attack. Research in natural sciences like ecology and conservation biology has highlighted the inter-connectedness of species that share habitat. The successful rehabilitation of one species may require that attention be paid to the species around it. Similarly, efforts to protect one species may inadvertently help its neighbors. Dobson et al. [7] make a related point in their analysis of the geographic distribution of endangered species in the U.S. They find counties that are homes to relatively large numbers of distinct species, and claim that conservation policy conducted in a way that exploits those overlaps should be able "to conserve endangered species with great efficiency."[2]

Changes in the administration of the ESA have been occurring that are consistent with this new emphasis. Species are often bundled into multi-species packages during the process of adding species to the list of those protected under the act; such packages are often comprised of species that come from the same region and/or habitat type. Also, a growing number of the Habitat Conservation Plans developed under the act have been designed for groups of endangered

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[1] Fellow, Quality of the Environment Division, Resources for the Future. I thank Dick Schmalensee, Paul Joskow, Shelby Gerking, and anonymous referees for helpful comments and advice, and the people at the Fish and Wildlife Service for data and information. All errors remain, of course, my own.

[2] [7] p. 553

species that occur in the same region. Recent ESA reauthorization bills formalized and extended those administrative trends, requiring the administrative agencies actively to encourage multi-species conservation plans.[3]

This approach to conservation has gained momentum despite the fact that we have little idea of the magnitude of the economies of scope involved in adopting a multi-species approach to species conservation. The costs and benefits of species protection are often difficult to quantify; the costs are usually indirect opportunity costs, and the benefits include elusive non-use values. Thus, there are no data available to estimate explicitly the benefits to society of taking an integrated approach to species protection.

We do, however, observe extensive variation in the intensity of interest-group responses to government proposals to add new species to the list of those protected under the ESA. Cropper et al. [6] find empirical evidence that, at least in the case of decisions to ban pesticides, "participation by interest groups in the regulatory process is motivated by the risks and benefits ... that an unbiased 'social planner' would consider."[4] Costs and benefits probably play a prominent role in determining how fervently interest groups pressure the Fish and Wildlife Service (FWS) over a particular listing proposal. High-cost proposals are likely to generate heightened opposition, and support is probably positively correlated with the benefits expected to be generated by a listing.

Thus, this paper uses data on interest-group comment activity to looks for positive spillover effects from the legal protection of one species to the well-being of others. Similarly, the analysis evaluates the importance of economies of scope to the costs to land-owners and -users of the restrictions associated with adding new protected species to the list. The study controls for a number of other factors that may influence the strength of interest group response to a listing proposal.

The results do confirm Cropper et al.'s finding that interest groups respond to at least some costs and benefits when deciding how much effort to exert in their attempts to influence a regulatory agency. There is evidence that legal protection for one species benefits other species in the same area. The results also indicate that there are some economies of scope associated with protecting more than one species when the species overlap. These findings lend support to

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[3] S. 1180 actually made it out of committee in 1997, while H.R. 2351 got bogged down in committee negotiations. Neither bill was successful as a vehicle for ESA reauthorization.

[4] [6] p. 192.

the argument that our wildlife protection policy should be shifted away from individual species and towards species groups or ecosystems.

II. FRAMEWORK

The ESA calls for the administering agencies[5] to maintain a list of endangered and threatened species. The agencies are directed by the law to use scientific evidence of endangerment alone in deciding which species to put on the list; economic considerations are not supposed to play a role in the listing process.[6] Once a species is officially on the list, it becomes illegal for anyone to "take" that species, where the definition of "take" encompasses a range of harmful and harassing activities. This proscription often yields restrictions on how land can be used, both private and public. Those restrictions are the source of most of the costs of endangered species protection.[7]

Before an official addition to the list (or "listing") can be made, the agency must publish a listing proposal in the *Federal Register*. A public comment period ensues; the agency must make some response to all comments received during that period. At the end of the period, a final listing decision is announced. Ando [1] shows that while almost all species proposed for listing are eventually listed, interest-group pressure can affect how long the species waits to be listed (and hence protected); support shortens the wait, and opposition drags it out. Since delay postpones the costs and reduces the benefits of a listing[8], these groups have something to gain from pressuring the agency.[9]

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[5] The FWS shares that role with the National Marine Fisheries Service (NMFS). However, NMFS is only in charge of marine species and anadromous fish; those species comprise a small fraction of the endangered species list. This paper focuses exclusively on interest-group responses to proposals made by the FWS.

[6] Economic considerations may, however, play roles in other parts of ESA administration, such as the determination of critical habitat and the allocation of funds for active species recovery efforts.

[7] In the case of the few species that are collected (e.g. butterflies), hunted for fur or other body parts (e.g. bears), or shot to protect livestock (e.g. wolves), the actual prohibition of direct harm may impose some costs in addition to the opportunity costs of land-use restrictions.

[8] Land users can take irreversible actions (like cutting trees or laying the foundation for a building) during the delay that would have been precluded had the species been listed more promptly. The species may become extinct while it waits to be protected. Less dramatically, its numbers may dwindle to where recovery is made very difficult.

[9] Interest-group pressure may also affect decisions made by the FWS after the species has been listed, such as how much critical habitat (land subject to special restrictions) to designate for the species.

When the FWS proposes to add a species to the endangered species list, interest groups coalesce on both sides of the issue. Support comes from local, and sometimes national, environmental groups who feel that species should be protected for moral, aesthetic, and practical (e.g. ecosystem health) reasons. Scientists are often found in this camp, for many of the same reasons. In addition, local citizens will sometimes contribute to the support a species attracts because they want to preserve ecosystems and open space in the area, and protection of a species under the ESA may incidentally contribute to that goal. Opposition comes from diverse sources, but nearly all are local. Developers and land-owners often object if their development plans are jeopardized by the listing. In addition, opposition may come from natural-resource related industries, such as logging or mining, the activities of which will be curtailed by the presence of protected species.

The intellectual framework pioneered by Stigler [13] and Peltzman [11] points out that interest groups will have incentives to try to influence government actions when the benefits to them of doing so are high. This principle implies that two observable features of listing proposals which capture species-protection interaction effects might influence the amount of pressure exerted by the public to delay or hasten the consummation of the proposed listings.

The first measure is of whether proposed species are in counties that have a relatively large number of endangered species that have already been added to the list. If a newly proposed species is already receiving some protection as a result of its proximity to species that are currently protected[10] under the act, the benefits of the new listing may actually be relatively small. In other words, if there are beneficial spillovers from the protection of one species to that of a neighbor,[11] then there are diminishing marginal benefits to endangered species listings in a given area. This hypothesis implies that proposals in counties with a high density of previously-listed species per acre may receive relatively little support.

Beneficial spillovers may produce economies of scope in the costs of concurrent species protection. In other words, the costs of protecting N different species in the same county may be less than the total cost of protecting each of the N species in isolation, because one set of land-

[10] Note that legal protection does not guarantee survival. The benefits of protection are only an increase in the probability that a species does not go extinct.

[11] Note that this assumption is implicit in the analysis conducted by [7].

use restrictions may protect multiple species.[12] This creates the possibility of declining marginal costs of listings in a given area over time. If newly proposed species overlap spatially with currently protected ones, then the new listing may generate relatively small additional costs and thus attract light opposition. However, if the use of much of the land in a county is restricted because of existing endangered species, and the new listing will fetter the use of previously unregulated land, opposition is likely to be heightened. The net effect in the data of the density of previous-listed species on the intensity of opposition is uncertain.

The second variable exploited by this paper captures the fact that listing proposals are made in packages that contain anywhere from one to thirty species. The species in multi-species proposals are often grouped together by the FWS because they share habitat (e.g. mussels in the Pearl River watershed, vernal pool plants in California). If the FWS groupings exploit the beneficial spillovers and resulting economies of scope just described, we may expect to see a proposal for *N* species attract less than *N* times the amount of support and opposition than would a single-species proposal in the same area.

A variety of other characteristics of proposed species and the lands they inhabit may affect the expected costs and benefits of listings, and thus induce variations in the intensity of opposition and support proposals attract. This paper's analysis of interest-group responses to listing proposals controls for: the proposed status of the species (threatened or endangered), the life-form type of the species (vertebrate, invertebrate, or plant) the prevalence of federal-government-owned land in the states occupied by the species, whether or not the species are in conflict with development, and the species' taxonomic distinctness (full species versus sub-species[13] or populations of vertebrate species[14]). It also includes features of the counties inhabited by proposed species: the value of land, the strength of environmentalism, and median income.

Any of these factors might shift around the propensity for groups to exert pressure in support of or in opposition to a proposal to list an endangered species. There is also the

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[12] The driving concept here is cost sub-additivity. See [14] pp. 18-20 for a brief discussion, or [3] chapters 2-4 for in-depth treatment.

[13] The Northern spotted owl and Mexican spotted owl are both sub-species.

[14] Only the populations of the bald eagle found in the continental U.S. were ever on the endangered species list; bald eagles are plentiful in Alaska.

possibility raised by Becker [4] that the interest groups compete strategically with one another. That sort of strategic interaction is incorporated, for example, into Crone and Tschirhart's [5] analysis of interest-group influence on National Forest Service decisions.

If Becker's theory is relevant to this policy forum, then the intensities of supporting and opposing pressure are the outcomes of a political equilibrium. Figure 1 gives two examples of best-response functions and Nash equilibria that might obtain when opposing interest groups exert pressure on the agency in a simultaneous-move game. As the panels show, when the levels of political pressure are determined simultaneously, a given observed level of support (for example) might reflect relatively high willingness to pay for protecting the species (as in the left panel), or a response to high anticipated opposition (as in the right). In this situation, simple analysis of the factors influencing support and opposition would yield coefficient estimates for reduced-form equations rather than the structural equations.

Other work [2], however, has used econometric techniques from the empirical industrial organization literature to test the hypothesis that these interest groups compete strategically for influence with the FWS by submitting comments regarding listing proposals. That analysis provides no support for the theory that these groups engage in strategic competition. Thus, this paper will maintain the assumptions that observed levels of comment intensity are not the product of Cournot Nash equilibria, and that each group's behavior is unaffected by the other's.

III. DATA

This study uses data on 114 proposals to add species to the endangered species list that were promulgated during 1989-1994. Species found only outside the United States are dropped from the sample, since the commenting milieu is likely to be qualitatively different for those types of candidates. In addition, fish, bivalves and snails are excluded from the sample due to the nature of the measures often needed to protect them. This is because the models of beneficial spillovers and economies of scope used in this paper are predicated on the notion that species which are found in the same places can benefit from the same set of protective regulations. Since many of these species[15] live in rivers, efforts to conserve them may require changes to land- and water-use

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[15] There is no comprehensive data indicating whether a species lives in water or on land. The selection rule was chosen in an attempt to eliminate as many aquatic species as possible without relying on a large number of subjective judgement calls. The result is probably good, but not perfect. Some members of non-excluded species

patterns throughout the relevant watersheds, even (and sometimes very importantly) in counties where the species do not officially "occur." Thus, protection granted to previously-listed terrestrial species near a river may confer insignificant benefits to the endangered species that inhabit that river.

Figure 2 shows the number of packages that received a given number of comments for and against the proposals at hand. These counts exclude comments that the FWS identifies as having arrived after the initial 90-day comment period, in order to measure only the initial pulse of pressure. In addition, multiple identical comments (usually the product of mass mailings organized by a single entity such as an environmental group) are compressed to count only as a single comment.

As the figure shows, the raw comment data provide challenges for the analysis of the determinants of interest-group pressure. It contains a large number of zeros; thus, it is inappropriate to perform linear regression using the actual number of comments as a simple proxy for pressure intensity. The numbers of comments might be analyzed with count-data or Tobit techniques; however, the raw data also contains a substantial number of very large outliers, and the results from both of those methods prove to be sensitive to those outliers. Therefore, the numbers of comments are treated as proxies for intensity of pressure, which is only recorded as an ordered categorical variable.

Each observation is categorized according to whether the pressure exerted by supporters and detractors of the listing proposal was "low", "medium-low", "medium-high", or "high". This analysis assigns a value of "low" if no comments were submitted; "medium-low" if one or two comments came in; "medium-high" if between three and ten comments were submitted; and "high" if more than ten comments were submitted. Those cutoffs were chosen to yield adequate observations in each category, and to preserve "zero comments" as a separate category (since the point masses there are the result of left censoring). Table I provides cross-frequencies for the two dependent variables. There are few observations in the off-diagonal cells, implying that the two variables are positively correlated.[16]

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categories (herptiles, plants) are aquatic, though the majority are land-dwelling. Conversely, some fish live in small enough bodies of water (cave pools isolated springs, etc.) that their conservation needs might be quite similar to those of species that live on land.

[16] This is not necessarily evidence that the groups really are competing strategically. There may be features of species which raise both the costs and the benefits of species protection, leading to support and opposition to be

The basic data were gathered from notices and rules published by the FWS in the *Federal Register*. These publications yielded information on the number of comments that were submitted in support and opposition of the proposal and how many (and which) species comprised each proposal package. They also provided a variety of facts about those species: whether they were proposed to be listed as "endangered" or as "threatened" (a lower level listing); the life-form type of the species (plants, vertebrates, or invertebrates); and the taxonomic distinctness of the species ("high" meaning full species, "low" meaning sub-species, variety, or distinct population).

Additional species information came from the index of endangered species maintained by the FWS on the Internet. Their published data on listed species that contains, among other things, the recovery priority index for most species. A component of that index is the designation "in conflict with development" for those species that meet that description. Because there are a substantial number of missing values for this variable, there are three categories that a package may fall into: in conflict with development, not in conflict with development (the excluded category in the analyses), and conflict status unknown.

This paper aims primarily to study the importance of economies of scope in endangered species protection. Thus, substantial effort was spent constructing a measure of the number of previously-listed species per unit of land area in the counties inhabited by new candidate species. The variable is one-hundred times[17] the number of previously-listed species[18] per square kilometer in the counties that comprise the habitat of the newly-proposed species at the time of the new proposal. This density was constructed using data from three sources. The *Endangered Species by County Database* maintained by the Office of Pesticide Programs in the Environmental Protection Agency was used to identify the counties in which all listed species are found.[19] Where needed, those data were supplemented with information from FWS's Internet site, which also

high.

[17] This scaling factor has no real impact on the results.

[18] The density variable includes all previously-listed species, including fish, snails, and bivalves. The fact that aquatic species protection can generate wide-ranging restrictions on land and water use means that there may well be beneficial spillovers from them to their neighbors, even if the effect is weak in reverse. In addition, around one in five of the fish in the species-location data set live in ponds, caves, pools and isolated springs rather than rivers, and thus the model for their protection may not be much different than that of terrestrial species.

[19] The data set contains a large number of counties where species occurrence is designated to be extremely uncertain. It might be desirable to drop "uncertain" counties from species' ranges. However, a fair number of listed species appear in the data set only with uncertain occurrences, so that exclusion was not performed.

provided the dates of final listing for all species. Census data from 1990 provided the land area of each county.

Other variables are developed for the sample by matching standard data to the states and counties that comprise the ranges of the species in each package. First, statistics on conservation-group membership (by state) are used to proxy for the ideological climate in the region encompassing proposed endangered-species' habitat. The exact measurement is the number of members per 100 residents of the Sierra Club, Greenpeace, and the National Wildlife Federation.[20] Second, Census data give the average county-level median income of households in the area relevant to a proposed listing at the time of the proposal. Third, data from *Public Lands Statistics* for 1989[21] yield the average state-level fraction of land owned by the federal government. Fourth, a measure was constructed of the average value of land in the counties occupied by proposed terrestrial species. That measure draws on the average values (in nominal dollars per acre) of agricultural land by county in 1992 compiled by the U.S. Department of Agriculture [16].[22]

Summary statistics for the independent variables are found in Table II.

IV. ECONOMETRICS

Two continuous latent variables Y_f^* (for) and Y_a^* (against) represent political pressure exerted on the FWS by the two interest groups. For a given observation n, they are specified according to:

$$\begin{aligned} Y_{fn}^* &= \beta_f' X_{fn} + \varepsilon_{fn} \,, \\ Y_{an}^* &= \beta_a' X_{an} + \varepsilon_{an} \end{aligned} \qquad \textbf{(1)}$$

This econometric analysis will allow for heteroskedasticity and for correlation between the errors of the equations. Thus, ε_f and ε_a are assumed to be distributed bivariate normal:

[20] These data are from [9].

[21] These data are presented in [9].

[22] The published data do not contain land values for Alaska and Hawaii; data for those two states were obtained directly from the Economic Research Service.

$$\varepsilon_{fn}, \varepsilon_{an} \sim N(0, 0, w_{fn}^2, w_{an}^2, \rho) \quad \textbf{(2)}$$
$$where \quad w_{fn} = \exp(\gamma_f' Z_{fn}) \ , \ w_{an} = \exp(\gamma_a' Z_{an})$$

The X and Z matrices contain explanatory variables; the β and γ vectors are parameters to be estimated. Note that the homoskedastic case is nested in this model, corresponding to $\gamma_f = \gamma_a = 0$. If the errors are homoskedastic, then ε_f and ε_a are distributed bivariate standard normal.

Variables are included in the Z matrices which might influence the magnitude of the variance in the random errors associated with latent intensities of pressure. The particular variables chosen are: the number of species in the proposal package, since the variance may be greater for multi-species packages; the prevalence of federally-owned land in the area, since regions with much government land may have more of a tradition of commenting behavior, affecting the potential variance in the error; and whether or not the species are in conflict with development, on the grounds that more members of the public may be aware of species that are in conflict, and thus the variance may be greater.

Actual pressure levels, as represented by the latent variables, are not directly observable. Instead, we observe qualitative ordered discrete indicators of pressure intensities, Y_f and Y_a , each of which can take on four values (low, medium-low, medium-high, high). For an observation n, these discrete indicator variables are related to the latent variables of Equation 1, Y_f^* and Y_a^*, as follows:

$$Y_{in} = j \quad if \quad c_{i,j-1} < Y_{in}^* \leq c_{i,j}, \quad where$$
$$i = a,f; \quad j = 1,2,3,4; \quad c_{i,j-1} < c_{i,j}; \quad c_{i,0} = -\infty; \quad c_{i,4} = \infty \quad \textbf{(3)}$$

The c_{ij} parameters are cutpoints that divide the Y_f^* / Y_a^* plane into 16 regions; for a given observation, the values of Y_f and Y_a are determined by which of those regions Y_f^* and Y_a^* happen to fall into.

Given that ε_f and ε_a are distributed bivariate normal , we can use the information contained in Y_f and Y_a to estimate the parameters of the model using bivariate ordered-probit methodology, modified to allow heteroskedasticity.[23] Let P_{jkn} be the probability of observing Y_f equal to j and Y_a equal to k for observation n. Also define

$$I_n(j,k) \;=\; \begin{cases} 1 & if \;\; Y_{fn} = j,\; Y_{an} = k \\ 0 & otherwise \end{cases} \tag{4}$$

Then the likelihood contribution of observation n will be constructed according to

$$L_n \;=\; \sum_{j=1}^{4} \sum_{k=1}^{4} I_n(j,k) \cdot P_{jkn} \tag{5}$$

Using Equations 1 and 3, we find that

$$\begin{aligned} P_{jkn} \;&\equiv\; Prob\left(c_{f,j-1} < Y_{fn}^{*} \le c_{f,j} \;,\; c_{a,k-1} < Y_{an}^{*} \le c_{a,k}\right) \\ &=\; Prob\left(c_{f,j-1} - \beta_f' X_{fn} < \varepsilon_{fn} \le c_{f,j} - \beta_f' X_{fn} \;,\; c_{a,k-1} - \beta_a' X_{an} < \varepsilon_{an} \le c_{a,k} - \beta_a' X_{fn}\right) \\ &=\; Prob\left(\frac{c_{f,j-1} - \beta_f' X_{fn}}{w_{fn}} < \mu_{fn} \le \frac{c_{f,j} - \beta_f' X_{fn}}{w_{fn}} \;,\; \frac{c_{a,k-1} - \beta_a' X_{an}}{w_{an}} < \mu_{an} \le \frac{c_{a,k} - \beta_a' X_{fn}}{w_{an}}\right) \end{aligned} \tag{6}$$

where

$$\mu_{fn} = \frac{\varepsilon_{fn}}{w_{fn}} \;,\quad \mu_{an} = \frac{\varepsilon_{an}}{w_{an}} \;,\; and\;\; \mu_{fn}, \mu_{an} \sim N(0,0,1,1,\rho) \tag{7}$$

If Φ_2 denotes the c.d.f. of the bivariate standard normal distribution, then

$$\begin{aligned} P_{jkn} \;=\; &\Phi_2\left(\frac{c_{f,j} - \beta_f' X_{fn}}{w_{fn}} \,,\, \frac{c_{a,k} - \beta_a' X_{an}}{w_{an}} \,,\, \rho\right) - \Phi_2\left(\frac{c_{f,j-1} - \beta_f' X_{fn}}{w_{fn}} \,,\, \frac{c_{a,k} - \beta_f' X_{an}}{w_{an}} \,,\, \rho\right) \\ - &\Phi_2\left(\frac{c_{f,j} - \beta_f' X_{fn}}{w_{fn}} \,,\, \frac{c_{a,k-1} - \beta_a' X_{an}}{w_{an}} \,,\, \rho\right) + \Phi_2\left(\frac{c_{f,j-1} - \beta_f' X_{fn}}{w_{fn}} \,,\, \frac{c_{a,k-1} - \beta_a' X_{an}}{w_{an}} \,,\, \rho\right) \end{aligned} \tag{8}$$

This formula is implemented using the knowledge that

$$\Phi_2(-\infty, x, \rho) = 0 \quad ; \quad \Phi_2(\infty, x, \rho) = \Phi(x) \tag{9}$$

[23] For background reading see [8]: the ordered probit is discussed on pp. 703-706; the bivariate probit (easily extended to the bivariate ordered probit) is outlined on pp. 660-664; the consequences of heteroskedasticity for simple probit models is summarized on p. 684.

where Φ is the c.d.f. of the univariate standard normal distribution. Finally, the log-likelihood for the data is simply

$$LL = \sum_{n=1}^{N} \ln\left(L_n\right) \tag{10}$$

Maximum-likelihood estimation yields estimates of several groups of parameters. The coefficient vectors of primary interest, β_f and β_a (from Equation 1), interact with explanatory variables to determine the expected amounts of unobserved pressure for and against a proposed listing. Other coefficients, γ_f and γ_a (from Equation 2), interact with covariates to determine the variance of the error terms for the latent pressure variables, while an estimate of the correlation coefficient ρ (also see Equation 2) captures the correlation between those error terms. Finally, three c_{ij} cutpoints are estimated for each type of pressure; they translate latent continuous pressure into observed discrete indicators of pressure intensity (see Equation 3).[24] Note that if ρ is set equal to zero, the estimates are the same as those obtained from two separate univariate ordered probit analyses. Also, since none of the c_{ij} values is normalized, the X matrices do not contain constants.

V. RESULTS

Two analyses were conducted of the data. The first includes only the covariates that are designed to explore the existence of economies of scope. The second includes all the covariates, in order to see whether the results of the first analysis hold up when other factors are controlled for. The results are found in Table III. Likelihood-ratio tests reject hypotheses of homoskedasticity, and the correlation coefficient is significantly positive in each set of results. Hence, the full model with jointly distributed errors and heteroskedasticity is appropriate.

[24] As stated in Equation 3, each cutpoint (c_{in}) in an equation must be strictly greatly than the one preceding it in order for the likelihood function to make sense. In addition, the correlation coefficient ρ must lie in the interval [-1,1]. Thus, these parameters are estimated in two steps. First, the maximization is performed in terms of a parameter r such that ρ is the hyperbolic tangent of r and threshold parameters $\{k_{in}\}$ such that $c_{i1} = k_{i1}$, $c_{i2} = k_{i1} + \exp(k_{i2})$, $c_{i3} = k_{i2} + \exp(k_{i3})$. This procedure guarantees that the restrictions on ρ and $\{c_{in}\}$ are met regardless of the values given to $\{k_{in}\}$ and r during the log-likelihood maximization process. Once the maximization routine has converged, a final iteration is performed where the cutpoints and ρ are specified without transformation; those results are the ones reported.

Even though the categories of pressure intensity were defined in the same fashion for support and opposition, the estimated cutpoints are not the same for the two types of political pressure. Regardless of the choice of independent variables, the cutpoints for support are shifted to the left on the real line relative to the cutpoints for opposition. Since latent pressure intensity is normalized to have mean zero in both cases, the patterns in the cutpoints are entirely consistent with the data shown in Table I; low-intensity pressure is much more common for opposition than for support, while pressure defined as high-intensity is found more frequently in support than in opposition.

The two variables relevant to our exploration of economies of scope and beneficial spillovers are the density of previously-listed species and the number of species contained in the proposal packages. The restricted model runs the analysis including only those two measures as explanatory variables; the full model includes ten additional variables to control for other influences on the intensity of interest-group commenting. The results clearly indicate that the analysis suffers from omitted-variable bias if only the main covariates are included. A likelihood-ratio test of the significance of the control variables soundly rejects the hypothesis that the coefficients on the control variables are zero.[25] Furthermore, some of the results on the core variables change significantly with the inclusion of the control variables. The point estimate of the coefficient on the density of previously-listed species is cut in half in the equation for support, and rendered insignificant in the equation for opposition.

Thus, the remainder of this discussion will focus on the results from the full model. Before we plunge into a detailed analysis of the coefficient results, it should be noted that the model performs reasonably well at predicting into which categories of pressure intensities the observations fall. For intensity of support, 50% of the observations have predictions that are correct, and 40% of them are off by only one category. The predictions of opposition intensity are even slightly better, with 55% exactly right, and 34% off by only one degree.

The coefficient on the density of previously-listed species is negative and significant in the equation for the intensity of supporting pressure. This finding is consistent with the hypothesis of diminishing marginal benefits of endangered species listings in the same area; as more species are

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[25]The test statistic is $\chi^2_{20} = 53.894$; the critical value for 1% significance is 37.57.

protected in an area, the gain from the next listing is smaller, and thus that proposal generates lower levels of support. That story is further bolstered by the finding that the intensity of support for a proposal is not significantly influenced by the number of species in the proposal. This could reflect success by the FWS in forming proposal packages comprised of species which have significant ecological and/or spatial overlap, such that the incremental gain (and resulting support) associated with officially protecting more than one of the species is small.

Diminishing marginal benefits to listings may be a product of beneficial spillovers from the protection of species currently on the list to the species that are newly being proposed for protected status. It may also be, however, that public willingness-to-pay for actual biodiversity in a given county is itself declining, and that interest-group support reflects that.[26] These two explanations are observationally equivalent in these data.

In the equation for opposition intensity, the coefficient on the number of species in the listing proposals is insignificant. This finding supports the joint hypotheses that economies of scope can exist in species protection, and that the FWS creates proposal packages that do, in fact, economize on opportunity costs per species protected. If the cost of protecting a given number of packaged species is not much greater than the cost of protecting one of them, then it makes sense for the opposition to a package containing more than one of those species to be no more intense than the opposition that gets stirred up by a proposal to list just one.

On the other hand, the density of previously-listed species is insignificant in the equation for opposing pressure. One would expect that coefficient to be significantly negative if the restrictions on economic activity generated by ongoing protection of species in a county contributed substantially to the protection of the newly proposed species, reducing the need for new costly restrictions to accompany the new listing. The result that emerges from the analysis may reflect the presence of a number of cases where, for example, counties have much land tied up by pre-existing species-related restrictions, but the newly proposed species occupy land that has hitherto been unfettered. Species in the FWS proposal packages may more reliably and meaningfully overlap with one another than do species which simply happen to inhabit the same county, yielding the strong result already noted that opposition is unaffected by the number of species in such a package.

[26] [12] summarizes the debate over this phenomenon in the contingent-valuation literature. It provides simulations that back up the idea that such a pattern can be consistent with traditional economic theory of preferences.

The intensity of opposition is not affected by whether the species is proposed to be listed as "endangered" or "threatened." The former category implies greater danger of extinction, and thus restrictions associated with "endangered" listings have less potential for compromise than those that accompany a "threatened" species. Nonetheless, it seems that the opportunity costs associated with protecting the two categories of species are too similar to have any noticeable effect on the opposing pressure such proposals stimulate.[27]

On the other hand, vertebrate species do seem to attract significantly more opposition when proposed for addition to the endangered species list. Vertebrates tend to have much larger ranges than either of the other two life-form types. Thus, more land is likely to be subject to costly restrictions as a result of a vertebrate listing; it seems that opposition is heightened in response.

It is somewhat surprising that life-form type does not appear here to be a significant factor in the intensity of support. To the extent that some endangered-species support is really driven by a desire to protect the land on which the species live, the same features of vertebrates that incite opposition might be expected also to stimulate greater support. In addition, vertebrates could be more charismatic and familiar, and thus might be expected to receive more support on those merits alone. It is even more strange that support is estimated actually to be weaker for packages of species proposed to be listed as "endangered" rather than "threatened;" Wilcove et al. [20] confirmed that species listed as "endangered" are consistently more rare than those listed as merely "threatened," and we might expect support to be greater for those species more desperately in need of protection. It is possible that supporters view "endangered" species as "basket cases," too far gone for legal protection to be of use. However, it should be noted that while the main results of this study are robust, the coefficients in the equation for support on both life-form type and proposed status are somewhat sensitive to specification details in the modeling of heteroskedasticity. Thus, much weight probably ought not to be placed on them.

Taxonomic distinctness does not have a statistically significant effect on either support or opposition. There is no particular reason to expect opposition to be a function of taxonomy, but full species contribute more to biodiversity than do other taxonomic units counted as "species" under the ESA. Either supporters are not widely aware of such distinctions, or their actions are not affected by that source of variation in the benefits to society of protecting a given species.

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[27] This is consistent with the argument put forth by Metrick and Weitzman [10] that the legal protection given to the two types of listed species is very similar.

Proposed listings attract more opposition if the species involved are in conflict with development. In a situation where a species and/or its habitat is threatened by some particular economic activity (development, construction, logging, etc.), opportunity costs will be incurred as soon as a species is listed, and since a well-defined project is at risk, those costs may well be unusually easy for those in support of the development to identify, quantify and fight. Thus, it makes sense that we see a more substantial outcry from those who expect to bear the costs. There is also weak evidence that support may be greater for species that are in conflict with development. That finding could be taken to imply that supporters are "out to get" activities like new construction and logging. A more generous interpretation is that support for a listing rises with the benefit from that listing, and that ESA protection is particularly effective when a species is threatened by a well-defined human activity. Note that data on whether a proposed species is in conflict with development is more likely to be unavailable for species that receive large amounts of opposition. This may well be because opposition slows down FWS actions on the species once it is listed, making it more likely that a conflict designation had not been chosen at the time the data were gathered.

There does not seem to be any significant relationship between the intensity of support and opposition and whether the proposed species occur in areas comprised largely of federal lands. Public and private lands are treated differently under the law, in ways that might make listings on government lands both more costly and more beneficial.[28] Those legal differences may simply not have a consistent impact on interest-group expectations of the costs and benefits associated with listings on those lands. In addition, since public lands are used by many private agents, the opportunity cost of given land-use restrictions may not vary much between private and public areas.

Opposition does not increase significantly with the measure of land values used in this paper. This is probably because the measurement used is a noisy proxy for the opportunity costs of a listing. The variable in question is the average value of agricultural land in the counties where the proposed species occur. The land affected by a listing may not, however, be agricultural. Even if it is (or if non-agricultural land values are highly correlated with agricultural values), there

[28] Restrictions on private land use are authorized under the ESA, but it is usually easier to identify the presence of species on public than on private land. Furthermore, Section 7 of the act effectively requires all actions taken on public land to be evaluated and, if necessary, altered to prevent harm to listed species.

is likely to be great variation of land values around the mean. True opportunity costs may be much larger or smaller than the value captured by the land value variable; that measurement error could account for the insignificant result.

The two variables included to control for characteristics of the humans with whom species share their habitat are not estimated to have significant effects. Demand for species protection, as proxied for by intensity of support, does not appear to be strongly affected by income. In addition, intensity of interest-group commenting seems invariant to the fraction of the population belonging to the three national environmental groups measured here. It should be noted that other measures of political ideology have been tried in this analysis, including county voting outcomes in the 1992 presidential election. Ideology may play a role in interest-group response to listing proposals, but the relevant ideology appears to be difficult to capture in quantifiable variables.

In order to evaluate the importance of some of these relationships, Table IV gives the estimated marginal effects of some of the significant variables. These numbers represent the average (over observations) changes in the probabilities that an observation falls into each of the four categories (for each type of pressure) that are induced by a change in the specified independent variable. For dummy variables, the comparison is a change from a value of 0 to 1. For continuous variables, the effect is calculated for a marginal increase in the variable from its true value in the data. By definition, the effects for a given variable in each of the equations must sum to zero.

Overall, Table IV serves to show that the statistically significant effects captured in these analyses can also be reasonably large. In order to understand the marginal effects on support ascribed to changes in the density of previously listed species, it is useful to note (from Table II) that the density ranges in the data from 0.0 to 32.81 hundred species per square kilometer, with a mean of 4.79. Going from 0 to 4.79 reduces the probability of high-level support by .07; that reduction is compensated for largely by equal increases in the probability of low and medium-low support of .04 and .03, respectively. These changes are moderate at most. Going from the minimum (pristine Alaska) to the maximum (Kauai) density in the sample, however, has a very large effect. The average probability of high-level support is decreased by .49, while low and medium-low probabilities rise by .26 and .23 respectively.

The effect of vertebrate identity on opposition is just as large. If a proposal is for vertebrate species, the chance that it attracts no opposing comments is reduced by .52; the probabilities of receiving medium-high and high-level opposition are raised by .14 and .41. Conflict with development also induces sizable increases in opposition, though not as large as those associated with vertebrates. The presence of conflict reduces the probability of low-level opposition by .29; the probabilities of medium-low, medium-high, and high-intensity opposition rise by .04, .08, and .16. The effect of conflict on support is similar. The probability of high-level support is raised by .24; the three lower categories become correspondingly less likely.

VI. CONCLUSIONS

This analysis reveals that there are some reasonable patterns to the pressure exerted on the government by opponents and supporters of endangered-species listings. Opposition seems to rise with the expected costs of a given listing, and support is positively correlated with at least some measures of the expected benefits of a listing. Since pressure from both sides has quantifiable effects on at least the timing of listing decisions made by the FWS, those of us concerned with the allocation of society's scarce resources might take heart in the finding that comment submissions act as a vehicle for some cost-benefit concerns to find their way into listing process (albeit through a tortuous route). We may, however, worry that some of the benefits of species preservation do not get adequate representation in the process, since the public seems not to respond to level of endangerment or contribution to biodiversity. Furthermore, factors such as political ideology may also influence the intensity of public pressure generated by proposals to protect new species. This analysis does not provide any evidence of such patterns, but those results may simply be due to the lack of good proxies for ideology and institutions.

Taken together, results from the analyses of opposition and of support indicate that there probably are declining marginal costs and benefits to legal species protection in the same area due to beneficial spillovers from the protection of one species to the welfare of its neighbors. This suggests that a move towards an ecosystem (or at least regional) approach to species protection may make sense.

However, while the intensity of support declines with the number of previously-listed species per acre in the relevant counties, the intensity of opposition does not. This carries the implication that counties may simply be too large to be useful geographic units for use in "hot-spot" analysis.[29] Even if multiple species are protected in the same county, their ranges may not necessarily overlap, or the protective actions and restrictions needed to preserve the species may be qualitatively different in nature. Thus, while a cluster of endangered species may be located in the same county, conservation activities in that county are not guaranteed to benefit from economies of scope. Efforts to prioritize the acquisition of protected areas are likely to be more successful if based on an analysis of the distribution of species among smaller units of land, or among land units defined on the basis of geographic and ecological features rather than county borders.

The response of support to the presence of previously-listed species may indicate that the public's willingness to pay for species actually (as opposed to legally) protected is declining in any given area. If so, there is a real need to rethink the objectives of U.S. wildlife protection policy. Under the current ESA, we are implicitly maximizing the number of species listed for protection, subject to agency budget constraints. Critics have often objected to this strategy on the grounds that the net social benefit of protecting a given species varies with factors such as the species's taxonomic distinctness and the size of its range. The results of this paper highlight another source of variation in the net social benefit of adding a species to the national list of protected species. The marginal cost of protecting another species in Hawaii, for example, may be very low, but the public's willingness to pay for that increment of species protection could be even lower.

Scientists and policy makers are busy re-thinking our approach to legal protection for endangered species. The current movement towards multi-species conservation makes sense; since economies of scope do seem to exist in species protection, we would do well to try to exploit them. However, the re-thinking of this area of public policy should not stop there. More research needs to be done about the costs and benefits of wildlife conservation to understand whether the public interest would be better served by designing national public policy to protect bio- or eco-diversity rather than individual species.

[29] For an example of such analysis, see Dobson, et al. [7].

Figure 1: Reaction Functions for Interest-Group Pressure

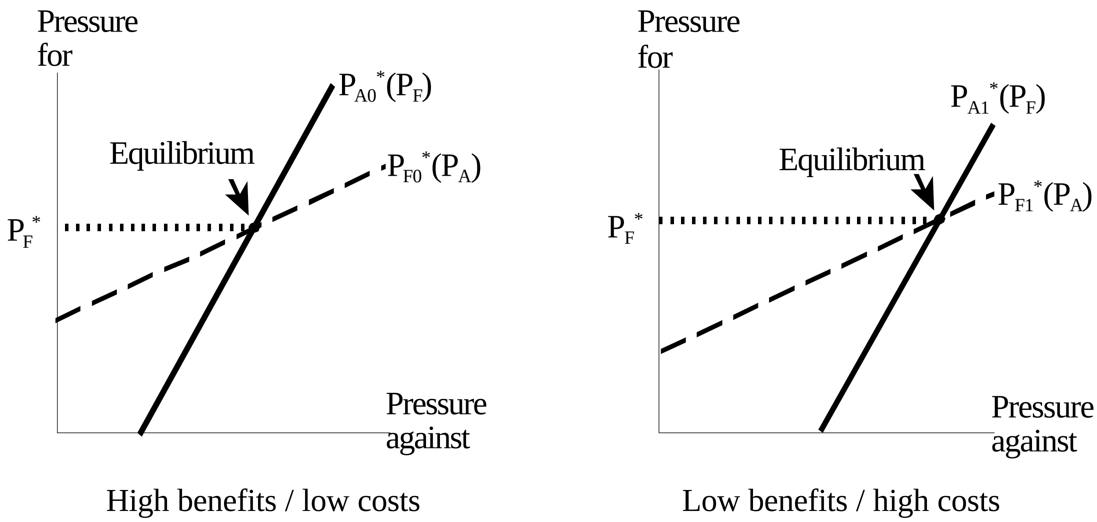

Figure 2: Numbers of Comments

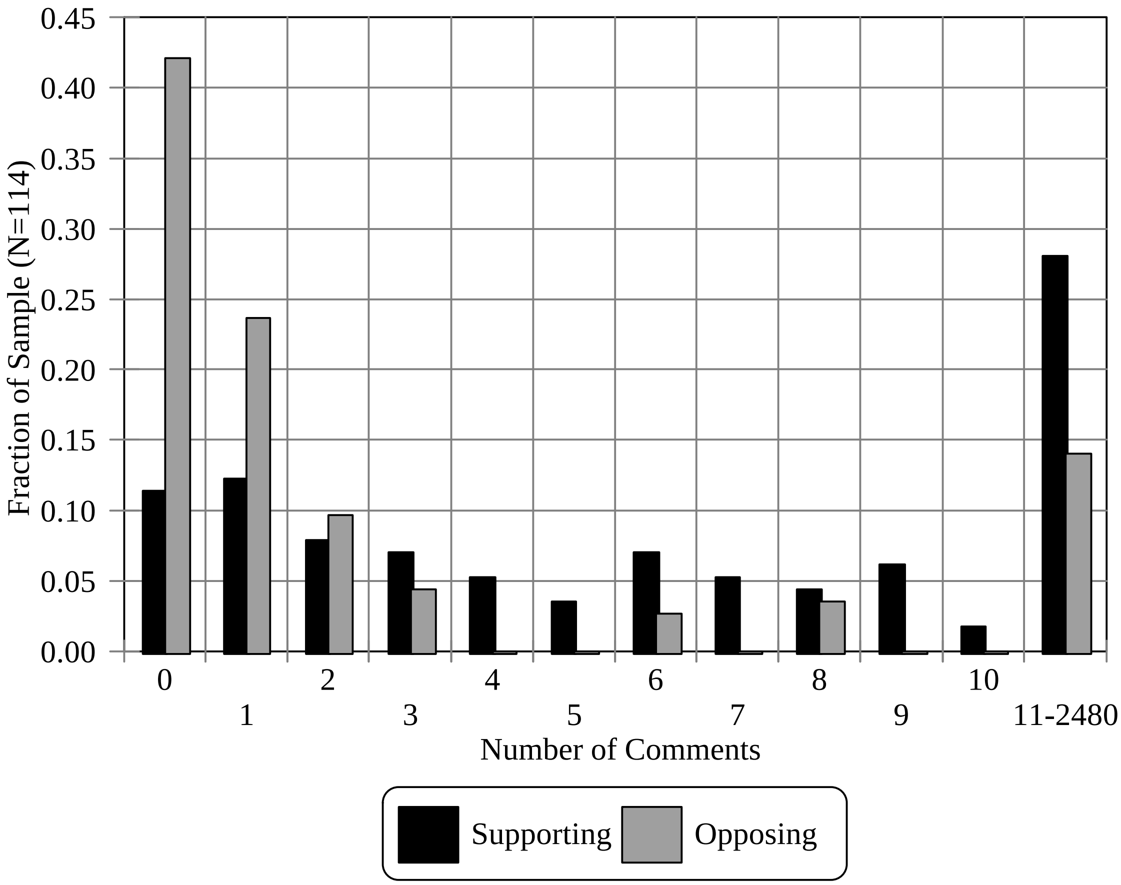

Table I: Cross-Tabulation of Intensity of Comment Submissions

	Intensity of Opposition				
	Low[a]	Med-Low[b]	Med-High[c]	High[d]	Total
Intensity of Support:					
Low[a]	10	3	0	0	13
Med-Low[b]	14	9	0	0	23
Med-High[c]	19	17	5	5	46
High[d]	5	9	7	11	32
Total	48	38	12	16	114

[a] "Low" implies 0 comments.
[b] "Med-Low" implies 1 or 2 comments.
[c] "Med-High" implies 3-10 comments.
[d] "High" implies 11 or more comments.

Table II: Summary Statistics[a]

Variable	Mean	Min.	Max.
Density of Previously Listed Species (100 * species/km^2)	4.79	.00	32.81
# Species in Package	2.81	1	26
All in Package Endangered?	.64	0	1
All in Package Vertebrate?	.15	0	1
All in Package Plant?	.72	0	1
Fraction Land Owned by Federal Govt. in States	.08	.00	.6
Don't Know Whether in Conflict?	.11	0	1
In Conflict with Development?	.25	0	1
All in Package of Low Taxonomic Distinctness?	.24	0	1
Average Value of Land (1000$ in 1992)	4.60	.10	115.37
Environmentalism (fraction population members of groups)	.04	.00	.13
Median Income ($1000s)	28.36	10.18	41.73

[a] There are 114 proposal packages in the sample.

Table III: Results of Bivariate Ordered Probit Analyses with Heteroskedasticity [a, b, c]

	Full Model						Restricted Model					
	Pressure For			Pressure Against			Pressure For			Pressure Against		
Variables of Interest:												
Density Listed Species	-.054	(.024)	**	-.022	(.030)		-.102	(.025)	***	-.053	(.018)	***
# Species	-.018	(.023)		-.014	(.056)		-.009	(.027)		.000	(.026)	
All Endangered?	-.442	(.265)	*	.016	(.246)							
All Vertebrate?	.697	(.527)		1.883	(.541)	***						
All Plant?	-.043	(.410)		.521	(.357)							
All Low Distinctness?	.121	(.221)		.314	(.304)							
Don't Know if in Conflict?	.458	(.373)		.717	(.301)	***						
In Conflict?	.773	(.356)	**	.914	(.354)	***						
Fraction Govt. Land	-.226	(.454)		1.060	(1.835)							
Land Value	.008	(.011)		.005	(.007)							
Environmentalism	-3.316	(2.904)		-.657	(5.591)							
Income	-.005	(.016)		-.021	(.022)							
Variables in Heteroskedasticity:												

# Species	-.007	(.021)		.017	(.026)		.004	(.018)		-.004	(.022)	
Fraction Govt. Land	-4.131	(2.303)	*	.433	(1.118)		-.857	(.815)		-2.040	(.801)	***
Don't Know if in Conflict?	.384	(.386)		-.974	(.495)	*	.333	(.326)		-.214	(.342)	
In Conflict?	.606	(.354)	*	.120	(.275)		.663	(.292)	**	.325	(.278)	
Ancillary Parameters:												
c1	-2.020	(.660)		.121	(.561)		-2.065	(.377)		-.441	(.148)	
c2	-1.068	(.551)		1.238	(.565)		-.974	(.236)		.401	(.159)	
c3	.100	(.527)		1.864	(.628)		.373	(.181)		.818	(.216)	
ρ	.491	(.108)	***				.491	(.096)	***			
Log-likelihood value	-223.413						-250.360					
Likelihood-ratio test for heteroskedasticity	$\chi^2_8 = 20.18$		***				$\chi^2_8 = 14.48$		*			

[a] Figures in parentheses are standard errors.
[b] ***: significant at 1% level; **: significant at 5% level,*: significant at 10% level
[c] There are 14 proposal packages in the sample.

Table IV: Marginal Effects[a] of Selected Significant Variables from Full Model

Variable	Change in Probability of Level of Pressure For: Low	Med-Lo	Med-Hi	Hi	Change in Probability of Level of Pressure Against: Low	Med-Lo	Med-Hi	Hi
Density Listed Species	.008	.007	.000	-.015				
In Conflict?[b]	-.095	-.114	-.031	.241	-.285	.040	.082	.163
All Vertebrate?[c]					-.516	-.029	.137	.407

[a]The marginal effects sum to zero across the four categories of each dependent variable; any deviation from that here is due to rounding.
[b]The alternative to "In Conflict?" is assumed to be the excluded category "Not in Conflict."
[c]The alternative to "All Vertebrate?" is assumed to be the excluded category "All Invertebrate or Mixed."

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