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Delay on the Path to the Endangered Species List: Do Costs and Benefits Matter?

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Abstract

This paper uses duration analysis to evaluate the ability of interest groups to influence the timing of decisions to add species to the endangered species list by exerting pressure on the Fish and Wildlife Service. Using data from 1990 to 1994, it finds that public opposition and support can substantially slow and hasten (respectively) the progress of candidate species through the parts of the listing process most directly under the agency's control. Since the Service is not an atypical agency, similar patterns of public influence on delay may exist in other areas of bureaucratic decision making as well.

Key Words: duration analysis, endangered species, political economy, interest groups

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Delay on the Path to the Endangered Species List: Do Costs and Benefits Matter?

Amy Whritenour Ando¹

1. INTRODUCTION

Many empirical political economy studies have tried to quantify the determinants of administrative agency behavior, exploring the influence of Congress, interest groups, and other factors. Most work in this vein has focused on the outcomes of regulatory processes.² But as Yaffee points out, "two general outcomes are possible in response to political pressure: decisions may be sped up or slowed down or their content may be changed."³ Delays in regulatory action can have important repercussions; this fact has prompted empirical studies of regulatory decision-making finally to begin looking at the timing of decisions.⁴ This paper moves that research agenda forward, using duration-analysis econometrics to evaluate the ability of interest groups to influence the timing of regulatory decisions by exerting pressure on the agency, either directly or through legislators.

As a case study, this paper examines part of the administration of the Endangered Species Act by the Fish and Wildlife Service: the timing of listings (additions to the endangered species list). The Act contains a written mandate against economic balance in listing decisions; critics of the law often implicitly assume that the mandate is preserved in the transformation of law into working policy.

¹ Fellow, Quality of the Environment Division, Resources for the Future. Thanks go to Winston Harrington, Paul Joskow, Sam Peltzman, Dick Schmalensee, V. Kerry Smith, Jim Snyder, Steve Stern, and an anonymous referee for helpful comments, advice, and suggestions. The people at the Fish and Wildlife Service were a great help to me in providing data and information. All errors, of course, remain my own.

² For example: Barry Weingast and Mark Moran, *Bureaucratic Discretion or Congressional Control? Regulatory Policymaking by the Federal Trade Commission*, 91 *Journal of Political Economy* 765 (1983); Wesley Magat, Alan Krupnick, and Winston Harrington, *Rules in the Making: A Statistical Analysis of Regulatory Agency Behavior* (1986); L. Glenn Thomas, *Revealed Bureaucratic Preference: Priorities of the Consumer Product Safety Commission*, 19 *Rand Journal of Economics* 102 (1988); and Maureen Cropper, et. al., *The Determinants of Pesticide Regulation: A Statistical Analysis of EPA Decision Making*, 100 *Journal of Political Economy* 175 (1992).

³ Stephen Yaffee, *Prohibitive Policy: Implementing the Federal Endangered Species Act* (1982).

⁴ John Hird, *Superfund: The Political Economy of Environmental Risk* (1994); Hilary Sigman, *The Pace of Progress at Superfund National Priorities List Sites*, UCLA mimeo (1997); and David Dranove and David Meltzer, *Do Important Drugs Reach the Market Sooner?* 25 *Rand Journal* 402 (1994).

Souder complains that "most of the costs of endangered species protection result from the initial listing of the species, where no economic balancing is applied."⁵ A growing number of policymakers and citizens believe that the agencies that administer the Act do so without regard to the economic effects of their actions, and that the public needs to have "a seat at the negotiating table"⁶ where decisions are made about which species to protect.

Such critics effectively ignore the unmistakable fact that the Act is not administered in a political vacuum. Interest groups have a variety of tools at their disposal with which to affect the administrative process; they can act directly with petitions or comments, or work indirectly through the influence of important members of Congress. That pressure may influence the timing more than the content of listing decisions, but delay has real effects on the costs and benefits of a listing. Environmental groups, for example, have cared enough about the timing of some listings to sue the Fish and Wildlife Service for dragging its heels (the Northern spotted owl was one such case).

The results of this paper indicate that, although the Fish and Wildlife Service does not answer directly to the public, the timing of at least some of its decisions does respond to pressure originating from those who bear the costs and benefits associated with its actions. Public opposition and support can substantially slow and hasten (respectively) the progress of candidate species through the parts of the listing process most directly under the agency's control. The Act may not be written to have a "sense of tradeoff" between the costs and benefits of listings, but our political and regulatory systems impose some balance through at least some parts of the administrative process.

2. BACKGROUND ON THE ENDANGERED SPECIES ACT

The Endangered Species Act of 1973 (ESA, "the Act") states that endangered plants and animals "are of esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people."⁷ By the 1960s, enough species were on the brink of extinction (including such "charismatic mega-fauna" as the bald eagle and the grizzly bear) that the federal government passed

⁵ Jon Souder, *Chasing Armadillos Down Yellow Lines: Economics and the Endangered Species Act*, 33 *Natural Resources Journal* 1095 (1993).

⁶ Sen. Slade Gorton's (R-WA) words in describing the purpose of his ESA re-authorization bill. *Congressional Quarterly Weekly Report* (May 13, 1995): 1324.

⁷ Endangered Species Act of 1973, Serial No. 100-C, 12/15/88: Section 2(a)(3).

a series of wildlife protection laws, culminating in the ESA.⁸ The ESA is administered primarily by the Fish and Wildlife Service (FWS, “the Service”) and provides for listing of species in danger of extinction, legal protection from harm and habitat disruption for listed species (reactive), and authority for government expenditures on attempts to improve the status of listed species (pro-active). The National Marine Fisheries Service administers protection for marine species. In order to keep this study manageable, we will explore neither the administration of marine species protection nor the pro-active side of the law (land acquisition and recovery plans).

The Act forbids “take” (defined in the Act to mean “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect”) of a member of an endangered species, and gives the administrators the right to promulgate regulations designed to protect listed species. The ESA also requires the agency to determine critical habitat for listed animal species; other federal agencies must ensure that “any action authorized, funded, or carried out”⁹ by that agency (including private projects requiring federal permits) will not damage the critical habitat of any listed species. All species are not given equal protection by the law. The taking of plants on private property is not prohibited by the Act, and critical habitat is rarely determined for plant species. Protection is also limited for species outside of the United States, though such species are reviewed and listed.¹⁰ These features of the law and its enforcement lower the potential costs of listing foreign species and plants. However, cost issues are not supposed to affect listing decisions.

Figure 1 is a simplified, schematic representation of the administrative process through which additions were made to the endangered species list during the time period studied in this paper. Species can enter the process via in-house nomination, but interested parties outside the FWS may also petition the agency to consider a species for listing. These petitions represent an opportunity to provide information about the species that may hasten its progress towards protection; the petitioner may also sue the agency if it fails to act quickly enough on the petition. If the preliminary nomination or petition is determined to be substantive, the species enters the pool of Category 2 (C2) species.

⁸ Charles Mann and Mark Plummer, *The Butterfly Problem*, *Atlantic Monthly* 47 (January 1992).

⁹ Endangered Species Act of 1973, Serial No. 100-C, 12/15/88: Section 7(a)(2).

¹⁰ Andrew Smith, Margaret Moote, and Cecil Schwalbe, *The Endangered Species Act at Twenty: An Analytical Survey of Federal Endangered Species Protection*, 33 *Natural Resources Journal* 1027 (1993).

This pool contains species the agency believes it may eventually add to the list, but for which the agency does not have conclusive evidence in support of listing.¹¹ Once the Service decides it has enough information to support listing the species, the candidate is elevated to Category 1 (C1) in the next Notice of Review.¹² This status officially implies that the agency plans to publish a proposal for that listing in the near future. Indeed, most C1 species leave that category by being proposed for listing; this will be referred to as exit via “promotion.” However, species are occasionally returned to C2 or Category 3 (C3) from C1 at the time of a Notice of Review if the Service feels that its evidence for listing the species is no longer adequate; this is denoted exit via “demotion.” C3 is just a brief stopping place; the agency's reason¹³ for not listing the species is announced, and then the species is returned to the pool of species not under any consideration for listing. Note that exit from C1 is the first process that will be studied in the empirical analysis.

Species can be proposed for listing either individually or in groups.¹⁴ Each proposal is published in the *Federal Register*, after which there is a period of public comment (and hearings, if the public requests them); this comment period provides interest groups with further opportunity to attempt to influence the agency directly. At the end of the comment period, the FWS places a final rule in the *Federal Register* in which it announces whether the species is listed as proposed, listed in a different category than proposed (the two options are "endangered" or "threatened"), or withdrawn from listing consideration altogether. The final rule incorporates any new data that were submitted to the Service during the comment period, and responds to the questions and complaints embodied in the comments. The time between the proposal and the final rule is limited to one year unless the Service files notice extending the deadline for six months. Such comment period extensions are supposed to result in a comment period no longer than two years. Proposal-period length is the second subject of empirical analysis in this paper.

¹¹ Category 2 ceased to be publicly enumerated after 1994 but still exists informally.

¹² Notices of Review were published only about once a year during the time relevant to this study, and they tended to alternate between plant and animal candidates.

¹³ Official reasons are: the species is thought to be extinct; it does not meet the definition of a “species” under the Act; it is not thought to be threatened.

¹⁴ The listing outcome need not be the same for all species within a group.

There has been a chronic backlog of species in the administrative process. Most queued species have been in C2, though many C1 species have been waiting at each point in time to be listed.¹⁵ This situation prompted Congress to force the FWS to develop priority-index systems for various stages of the process. The Service developed a system in 1981 that favored species according to (among other things) life-form. Roughly, that system preferred vertebrates to plants, and plants to invertebrates. The 1982 Amendments to the Act, however, forbade such life-form distinctions. The current priority system for listing, established in 1983,¹⁶ assigns to each species an index value ranging from 1 to 12 (in decreasing order of priority) based solely on degree of threat and taxonomic distinctness. C1 species with low index values are supposed to be moved towards listing relatively more rapidly; the system applies only to the stages of the process that precede listing proposal.

3. TIMING VS. OUTCOME

Empirical work by Metrick and Weitzman has explored the composition of the endangered species list. In their analysis of which North American vertebrate species had been added to the list by March 1993, they find that a vertebrate species is more likely to have been listed if it is large, of favorable animal type,¹⁷ of monotypic genus, and highly endangered. Their empirical approach, however, does not separate the contribution of the regulatory process from that of the scientific community to the observed patterns in listings; a species may not be on the list either because the agency is dragging its heels over its addition, or because scientists have not gathered enough information about the species to support a case for its listing.

In order to focus on patterns in agency decision-making, this paper analyzes actions taken regarding a sample of species that made it to C1 or were proposed for listing, and thus are more homogenous in terms of how much knowledge the agency and the scientific community have of their

¹⁵ For example, in the 1990 Notice of Review there were 1572 plants in C2 and 527 animals in C1; in the 1991 Notice of Review there were 1675 animals in C2 and 80 animals in C1.

¹⁶ John Fay and W. L. Thomas, *Endangered Species Listing and Recovery Priority Guidelines*, 48(76,184) Federal Register (1983).

¹⁷ Andrew Metrick and Martin Weitzman, *Patterns of Behavior in Endangered Species Preservation*, 72 Land Economics 1 (1996). They find listing likelihoods in the following ranking (high to low): mammal, bird, reptile, fish, amphibian.

endangerment. Note that because these species are not a random sub-sample of all (or even of all truly endangered) species, the results of the analyses in this paper can not be taken to apply to a broader range of species.

We see from Table 1 that there is relatively little variation in what route species take to exit C1 and the proposal period. Of the C1 species in the whole sample, 7% exited via demotion. However, only 1% of the species proposed for listing end with their proposals completely withdrawn; even the fraction of species proposed endangered but listed threatened (a minor downgrading) is a mere 3%. Though we might analyze variation in outcome for C1 species, there is too little variation to do the same for proposal spells.

We can, however, analyze factors that influence how long species take to move through these stages of the listing process. As Table 2 illustrates, there is substantial variation in the lengths of both C1 and proposal periods. The timing of these actions can have important implications for the welfare of species and of interest groups. Long delay in the addition of a species to the endangered-species list can reduce the likelihood that the species will escape extinction; species have even been thought to have become extinct while waiting for final action from the agency.¹⁸ Thus, delay diminishes the benefits of a listing. It also reduces the costs. If nothing else, delay will let the costs be borne further in the future, subjecting them to discounting. But delay can enable private citizens and firms to take preemptive irreversible actions (harvesting trees, developing land) on the land that will be protected once the listing is made. In addition, if a species does become extinct while waiting for protection, then its habitat does not get protected, and the costs associated with that protection are not incurred.

Timing may also influence outcome. In the case of additions to the endangered-species list, delay in the early stages of the process probably makes it more likely that a candidate species is sent back in the process rather than being moved forward toward listing. Demotion from C1 is only possible when the infrequent Notices of Review are published, so the longer a species waits in C1 to be proposed for listing, the more often it experiences an opportunity to be demoted. More substantively, population surveys and other information needed to support the case for listing a species can get outdated. Delay may increase the likelihood that the case is weakened by such

¹⁸ For example, the listing of the Alabama sturgeon was delayed so long that the fish could no longer be found in its native rivers; the listing proposal was dropped on the grounds that the fish was presumed extinct.

“information decay,” causing the species to be demoted from C1 to C2 rather than being proposed for addition to the list.

There are other more mechanical reasons to study the timing of decisions. First, this approach circumvents an endogeneity problem that is common in the political-science literature. Scholars sometimes look for links between the presence of a legislator on an important committee and the actions taken in that legislator’s district by the agency overseen by that committee. For example, the number of listed species in a district may be correlated with whether the district has a representative on an ESA-oversight sub-committee. However, the causal relationship is not obvious, since the representative may be on the committee precisely because there are many listed endangered species in his region. Duration analysis of listing times evades that endogeneity. Second, it is easy to quantify the choices available to the agency in this facet of its decisions (sooner or later?). In contrast, it may be difficult to observe the choices open to the agency in determining (to pick an example) the appropriate recovery plan for a species when only one plan is chosen, the alternatives may never have been elucidated, and such plans are highly idiosyncratic.

4. FRAMEWORK

The listing of a species will impose benefits and costs on members of the public. The level of benefits associated with listing and protecting a given species depends on many factors, such as popular appeal, contribution to some metric of biodiversity, and level of endangerment. The benefits include some that are diffuse across the population (e.g. preservation of biodiversity that may contribute to current and future research in pharmacology and horticulture) and some that are concentrated in local hands (e.g. the value of seeing a rare and unusual creature). In general, the benefits of a listing are greater if the listing happens quickly. Therefore, members of the public who perceive themselves as beneficiaries of a potential listing will want the listing to happen as soon as possible. The costs of protecting a listed species, on the other hand, will be concentrated among individuals who live near enough to the habitat of the species to be subject to the restrictions of the ESA. They may be prohibited from developing (or otherwise altering) their own private land, or their jobs may be threatened by similar prohibitions on government- and industry-owned lands. These agents will usually be better off if the listing is delayed.

The interest groups that coalesce around each candidate species thus have good reasons to exert influence on the agency in order to shift the outcome and the timing of the agency's decisions in their favor. Becker's theory of interest-group competition¹⁹ describes Cournot competition between interest groups on opposing sides of a public-policy decision from which one group stands to gain and the other to lose. His theory postulates an “influence function” through which pressure from the groups is translated into influence over the decision (through the black box that is the maker of policy decisions). Given that function, the groups choose levels of pressure in a simultaneous game, and those equilibrium levels of pressure generate the equilibrium public-policy outcome. One goal of this paper is to estimate something that is the intellectual cousin of that influence function; to that end, we identify two channels available to interest groups in their quest for influence.

First, they can pressure the agency directly using the set of mechanisms, established by Congress in the Administrative Procedures Act and the ESA itself, that permit direct public participation in the regulatory process. Individuals can submit petitions to the FWS, providing substantive information supporting the case for listing a species and carrying the implicit threat of a lawsuit should the Service act too slowly on the case. They can submit comments during the public comment period. Comments can contain information that strengthens or muddies the agency's case for the listing, and act as a signal of willingness to bring political pressure to bear on the agency in the case. Finally, they can request hearings during the proposal period which are time-consuming, and can stir up uncertainty over the merits of the listing. Individuals and business interests in U.S. territories and foreign countries can exploit some of these mechanisms, but they are likely to be less effective because such agents can less easily back up their pressure with support from the U.S. Congress.

Second, U.S. residents can exert pressure on the agency indirectly by requesting that their legislators intercede with the agency on their behalf. The desire to be re-elected gives the legislator an incentive to respond to such requests.²⁰ However, since endangered-species listings may help one

¹⁹ Gary Becker, *A Theory of Competition among Pressure Groups for Political Influence*, 98 *Quarterly Journal of Economics* 371 (1983).

²⁰ D. Mayhew, *Congress: The Electoral Connection* (1974) and Morris Fiorina, *Representatives, Roll Calls, and Constituencies* (1974). Voting studies imply that legislators do strike a balance between ideology and constituent interests: see Joseph Kalt and Mark Zupan, *Capture and Ideology in the Economic Theory of Politics*, 74 *American*

group of constituents at the expense of the other, legislators must choose which side to help. Political economy theory pioneered by Stigler and Peltzman²¹ implies that legislators may favor those that bear the costs of the listings, since costs are more concentrated than benefits. On the other hand, a representative may have a strong personal preference for pro-conservation policy, or may have a true constituency that lies largely in the pro-environment sector of the region he represents. Under these circumstances, he may want to address the concerns of the listing's beneficiaries, despite the diffuse nature of any benefits he can provide for them. Such legislators are likely to have pro-environment voting records.

Not all members of Congress are equally able to influence the FWS on behalf of the group they wish to help. Scholars like Fenno²² have discussed the ability of appropriation sub-committees to control agencies through the “power of the purse,” but re-authorization concerns seem really to have dominated budgetary issues for the Endangered Species Act during the time period of this study.²³ Thus, it is largely the legislators with seats on one of the ESA's re-authorizing sub-committees that have substantial power over the agency.²⁴ In addition to having more power over the FWS than other members of Congress, a member of these sub-committees is more likely to take an active interest in the Service's listing activities, either because of personal interest or because he has constituents who strongly support or oppose new listings under the ESA.

We can observe whether a candidate species is located in an area represented by one or more members of the re-authorization subcommittees (such legislators will be referred to as “SCM”s). We

Economic Review 279 (1984); John Jackson and John Kingdon, *Ideology, Interest Group Scores, and Legislative Votes*, 36 American Journal of Political Science 805 (1992); and Steven Levitt, *How Do Senators Vote? Disentangling the Role of Voter Preferences, Party Affiliation, and Senator Ideology*, 86 American Economic Review 425 (1996).

²¹ George Stigler, *The Theory of Economic Regulation*, 2 Bell Journal 3 (1971) and Sam Peltzman, *Toward a More General Theory of Regulation*, 19 Journal of Law and Economics 211 (1976).

²² R. Fenno, *The Power of the Purse* (1966).

²³ The Act has historically been authorized for five year periods, with heated and extended re-authorization battles occurring in between each of them. Only in the 104th Congress did the appropriations process act to substantially curb the FWS in administering the Act.

²⁴ They can threaten to gut the version of the Act that hits the floor for re-authorization. They can also engage in oversight; see Barry Weingast and Mark Moran (1983), cited in note 18; Mathew McCubbins and Thomas Schwartz, *Congressional Oversight Overlooked: Police Patrols versus Fire Alarms*, 28 American Journal of Political Science 165 (1984); and Mathew McCubbins, Roger Noll, and Barry Weingast, *Administrative Procedures as Instruments of Political Control*, 3 Journal of Law, Economics, and Organization 243 (1987), and *Slack, Public Interest, and Structure-Induced Policy*, 6 Journal of Law, Economics, and Organization 203 (1990).

do not, however, observe actual levels of pressure from those SCMs. This limits our ability to interpret the empirical results in two ways. First, the presence of a sub-committee member may signal that the agency is influenced directly by the legislator. However, constituents in such areas may also be relatively likely to exert direct pressure on the agency, since sub-committee membership reflects, among other things, strong constituent interest in the affairs over which the sub-committee has control.²⁵ Thus, when direct public pressure is not controlled for in the analysis, variables indicating the presence of SCMs may pick up the effect of that direct pressure as well as any pressure from the legislators. Second, the agency may respond to pressure from multiple sub-committee members (or constituencies) with the same agenda differently than it does to pressure from just one, but there may also be free riding among like-minded SCMs and/or the interests they represent. Either phenomenon will affect whether the pressure felt by the agency from N like SCMs (and/or their constituents) is N times the effect of just one.

Pressure from outside the agency may work through substantive means. Petitions with real information can reduce the amount of work the FWS has to do to propose a species for listings, while opposing comments may include taxonomic studies that challenge the candidate's standing as a "species" under the Act. The agency may also respond to non-substantive pressure strategically, trying to adhere as closely as possible to the "Noah's ark" mandate of the ESA while maintaining good political support for the Act itself. This latter mechanism may involve simple foot-dragging on controversial species, or differential caution in preparing the scientific cases for various listings. We cannot observe the precise mechanism, but the empirical analysis can quantify the net impact of pressure on delay, treating the agency itself as a black box.

The notion that government agencies act to maximize social welfare with respect to the policy decisions under their control is old-fashioned, and largely absent from a literature that now swims with models of principal-agent problems and bureaucratic incentives. Nonetheless, many real-life bureaucrats have ideas about what is best for society; their actions may be affected by those ideas. Therefore, the analysis will accommodate the possibility that the agency has preferences over three factors which may also affect the support that a listing has in the general public. First, many

²⁵ See Michael Munger, *Allocation of Desirable Committee Assignments: Extended Queues Versus Committee Expansion*, 32 American Journal of Political Science 314 (1988).

opponents of the ESA object to the listing of “species” that are of low taxonomic distinctness; such “species” may also contribute relatively little to some metric of biodiversity. Second, “endangered” species may attract more support than their less imperiled “threatened” cousins both within and outside of the agency, but the protective regulations regarding highly endangered species may be more restrictive (and impose higher opportunity costs on land-owners). Third, the agency's old priority system preferred vertebrates to plants to invertebrates; those preferences may still exist in unofficial form. The costs imposed on land-owners, however, are likely to be smaller if the listed species is a plant than if it is a vertebrate.

Finally, there may be economies of scale in ESA administration. The use of multi-species listing-proposal packages is the beginning of the FWS's attempt to consider species as ecosystem components. Many packages (especially those of domestic species) consist of similar species that share habitat, face similar threats, and affect similar interest groups, so the administrative economies could be large.

5. ECONOMETRICS AND DATA

We are interested in the effects of independent variables on how long it takes the agency to make a given decision. One could, for example, simply regress the length of time species spend waiting to achieve final listing (once they have been proposed for listing) on the relevant explanatory variables. However, duration analysis is superior to that approach for a large number of reasons. Among other things, it allows for explanatory variables to change values during the time periods being analyzed, and handles observations for which we do not know the length of the time period (because the final outcomes came after the end of data collection) without having to drop them from the sample.

Using this technique to analyze the length of proposal periods, we estimate a “baseline” hazard function that is common to all species. The hazard function for proposal periods is defined to give the probability that a species achieves final listing status t days after its listing was proposed (where t ranges from 1 to ∞), given that the species has waited at least that long. We also estimate coefficients that indicate how each of a set of covariates shift that function up and down. If an

independent variable has a positive estimated coefficient, that variable shifts the hazard function up; this reduces the amount of time a species can expect, at the outset, its proposal period to last.

The analysis of the time spent by species in C1 is similar in spirit, but complicated slightly by the fact that exit from C1 can occur via promotion (being proposed for listing) or via demotion (back to C2 or C3). This is handled by what is known in the literature as a “competing risk” model. Two hazard functions are estimated, one for each mode of exit; a C1 period ends according to whichever of the two competing outcomes happens to the species first. The specification used here accommodates the fact that administrative procedure only allows demotion to happen on a small number of dates; at all other times, the hazard rate for demotion is constrained to be zero. In theory, one could estimate the impacts of independent variables on the hazard functions for both promotion and demotion. However, since relatively few species exit C1 via demotion, no covariates are included in the equation for demotion, though the basic demotion process is still estimated.²⁶ If an independent variable in the promotion equation has a positive estimated coefficient, an increase in that variable shifts the promotion hazard function up. This reduces the expected length of the C1 period. It also increases the probability that the species ends up being promoted rather than demoted. See Appendix I for econometric details.

The data-collection effort was aimed at a sampling period which is reasonably recent, and which is likely to be relatively free from structural change. Thus, the data cover a time period after administrative changes triggered by the 1988 amendments to the ESA had time to take place, and before the “Republican revolution” (and its listing moratorium) in 1995. It should be noted that by this point in time, most “charismatic” endangered species had already been added to the list. This highlights the fact that the results of the current analyses can not be applied to a time period, past or future, when the pool of candidate endangered species looks very different.

The C1 sample includes species that entered C1 in the 1990, 1991, 1993 and 1994 Notices of Review, while the proposal sample includes all species that were proposed for listing within the period 1/1/90 to 12/31/94. The ends of C1 and proposal periods are not observed if they occur after 12/31/94. The sampling period overlaps with three Congresses. To check for robustness, the analysis

²⁶ Preliminary analyses included such covariates; estimates of their coefficients proved not to be robust, and their exclusion does not change any other results.

of the length of proposal periods is conducted with the unit of observation defined first as an individual species, and then as a package of species. Thus, data are maintained for both kinds of observations. Details of the data sources, construction methods, and summary statistics for the independent variables are found in Appendix II.

Data from this sampling period indicate that C1 periods tend to last much longer than proposal periods. Even after about 6 years, the longest observed C1 period in the sample, the probability that a C1 species has not been promoted or demoted is about .25, while proposal periods have almost no probability of surviving longer than the longest proposal period observed in the sample, about 3.25 years. This is likely to be the result of the provisions in the Act that place limits on the amount of time the FWS can wait to issue a final rule on a listing proposal once the proposal has been made.

Table 3 gives the definitions of all the independent variables used to analyze the length of C1 and/or proposal spells. One group of variables relates to Congressional representation. Species can be foreign, from a part of the U.S. with representation by sub-committee members with “pro-environment” or “pro-land-use” voting records, or from domestic districts with moderate SCMs or non-SCM legislators only (this is the excluded category). Additionally, the presence of some kind of “free-rider” or “diminishing-impact” effect can be tested for in the C1 analysis by comparing the impact of one “pro-environment” sub-committee member and his constituents to the effect of the presence of additional like-voting SCMs and voting groups (“# Extra “Pro-Environment” SCMs”).²⁷

The priority index is included, normalized to be increasing with higher priority and to have a mean of zero. Note that priority index values are assigned to species when they are in C1; thus, we do not observe index values for species that are proposed for listing without having spent time in C1. Therefore, the proposal-period analyses use two variables to capture the effect of a candidate’s priority index, conditional on it having one.

A set of variables is also used to capture the influence of supporting and opposing public comments on the length of proposal periods. The specification allows the impact of the first comment

²⁷ The measure of habitat-range is more refined for the proposal spells; so few observations at that level have SCM “groups” with more than one member that is “pro-environment” that this variable must be dropped from that level of analysis. In neither analysis are there significant numbers of observations with more than one “pro-land-use” SCM.

of a given type (supporting or opposing) to have a disproportionate impact on the hazard rate relative to the comments of that type that follow it. Note that comment tallies are not observed for incomplete proposal periods. Thus, the effects of comments on the length of a proposal period are estimated conditional on the proposal being made early in the sample - before the earliest date on which a proposal period began that was not observed to end. This treatment prevents inclusion of comments for one species and non-inclusion of comments for another that was proposed on the same date just because one was listed earlier than the other.

Another group of variables captures the effects of other forms of public involvement in the listing process: hearings and supportive petitions. The Smithsonian Institution published several reports on endangered and threatened plants in the 1970s which became, officially, “petitions” in support of listing the plants they enumerated. These bulk petitions, however, are counted separately from all the others. In the proposal-spell analysis, dummy variables for petitions of both types are allowed to interact with the dummy for hearings.²⁸

Most of the last set of variables measures factors related to the costs and benefits of a listing that may affect the support that listing has in the general public or within the agency. They are: taxonomic distinctness (those which are “less unusual” are not full species, or are only populations of species that are not endangered in other parts of their ranges), life-form type (vertebrate animal, plant, or invertebrates), and official level of endangerment (“endangered” or the less-endangered “threatened”). If the variables designed to capture public pressure are adequate to that task, these variables should pick up whether the agency’s own implicit preferences influence the decision-making process. Finally, the proposal-spell analysis accounts for the number of species in each proposal package. The importance of this variable will indicate how large the economies of scale are in the process of making listing decisions.

6. RESULTS

We begin by considering the results of the analysis of the C1 periods - the time species spend waiting in Category 1 to be either proposed for listing or dropped back to an earlier stage of the

²⁸ No observations in this sample have both a regular petition and a Smithsonian endorsement.

process. The promotion hazard (shown in Appendix I) seems to rise to a peak around 2.5 years, and taper off after that; after about 6 years there is almost no probability of being promoted. Conversely, the demotion hazard rate is higher each successive time that demotion occurs (all of which come after the peak in the promotion hazard). These results strengthen the connection between delay and outcome; as a species waits to leave C1, the likelihood that it is demoted in the next review rises and its chances of being proposed for listing fall.

The estimated parameters for the independent variables in the promotion-hazard equation are given in Table 4. The results indicate that regular petitions reduce the time a species spends waiting to be proposed for addition to the list (by increasing the promotion hazard), but Smithsonian endorsements do not. Though those endorsements are technically petitions, they contain old information and embody unfocused support relative to the other, apparently effective, petitions. Thus, it seems that petitions work through the information they contain and the pressure implicit in the presence of a concerned petitioner, rather than through administrative procedure.

The coefficients on “Has ‘Pro-Environment’ SCM?” and “Has ‘Pro-Land-Use’ SCM?” are significant and (respectively) positive and negative, and the coefficient on “# Extra ‘Pro-Environment’ SCMs” is positive and significant, though relatively small. This could mean that when a species overlaps with the jurisdiction of a member of a subcommittee in charge of ESA reauthorization who has a voting record strongly for (or against) typical “environmental” issues, that legislator is successful in influencing the agency to move faster (or slower) in proposing the species for listing. (Under this interpretation, it seems also that the presence of additional “pro-environment” legislators further increases the promotion-hazard rate, though with diminished marginal effect.) However, such legislators are likely to be backed by constituents who have similar strongly-held opinions about whether or not they want new species to be listed in their regions. Thus, this set of findings could really be picking up effective (but unobserved) direct pressure from interest groups on the Fish and Wildlife Service.

Finally, Congress seems to have influenced the administrative process through the listing-priority system it imposed on the agency. Species with high-priority index values have bigger promotion-hazard rates; to the extent that the priority index system captures the true social benefits of a listing, high-benefit species move faster towards protection. Furthermore, there is no evidence

that taxonomic distinctness has any impact on the process beyond its role in the index, and life-form type seems to have no impact on promotion-hazard rates (in keeping with the mandate from Congress).

Just how effective is the pressure brought to bear on the agency by petitioners and by subcommittee members and their constituents? Table 5 indicates that a supporting petition moves a species out of Category 1 over a year sooner, and petitioned species are 37% less likely to make that move by being demoted to C2 or C3. Similarly, species from regions represented by a “green” oversight-subcommittee member exit C1 over 2.5 years earlier than those from areas with only moderate SCMs, and are fully 73% less likely to be demoted rather than proposed for listing. On the other hand, species that inhabit areas with “pro-land-use” SCMs (and the interests that back them up) tend to languish in the process. These candidates spend more than an extra year in C1, and are 10% more likely than species from neutral areas to end up being demoted to earlier stages in the process. Public pressure, whether direct or indirect, can have big effects on bureaucratic delay, and those effects can translate into non-trivial changes in the likelihood that a species is thwarted completely from being proposed for listing.

Next we investigate whether similar patterns of agency behavior exist once a species has been proposed for addition to the endangered species list. One difference is that the hazard rate for being formally listed tends to rise and fall, but then rise again (as shown in Appendix I). It seems that delay during this part of the administrative process (unlike in C1) does not doom species to languish in the pipeline with an increasingly lower conditional probability of being listed.

However, as shown by the parameter results in Table 6 and the calculations in Table 7, public interest groups still influence how long a species takes to move toward being listed and protected under the Act. The slowing effect of the submission of a single opposing comment is large and significant.²⁹ In the absence of support, one opposing comment can increase the expected length of

²⁹ Additional opposition yields additional impact that only appears significant when species are used as the level of observation.

a proposal period by almost 14 weeks (about a 26% increase). Conversely, while a single supporting comment has no statistically significant effect,³⁰ additional such comments act to speed the package along. Uncontested supporting comments can reduce the wait for final listing by amounts ranging to over 6 months.

In fact, it is unusual to observe opposing comments without supporting ones, or to observe massive uncontested pressure from either side. This raises the question, what happens to the delay before final listing when both sides exert pressure on the FWS with regard to a proposed package of species? Delay is increased at low levels of pressure (when the importance of initial opposition dominates that of support). That increase is whittled away as pressure rises, since large numbers of supporting comments swamp the combination of important early opposition and insignificant additional opposition. Eventually, support overwhelms opposition; the net result of very large amounts of pressure is to shorten the proposal period.

Public opposition can also take the form of requests for hearings. Such requests significantly reduce the rate at which a proposed species moves to be officially added to the endangered species list. The results indicate that packages that attract hearings can expect to wait more than 6 weeks longer than those with no hearings (an increase of about 12%). At this stage in the process, the mere existence of an interested petitioner does nothing to mitigate that delay (and plants that were on the Smithsonian lists move even slower than other species, perhaps out of accustomed neglect).

The variables designed to capture the influence of oversight subcommittee members on the length of proposal periods are generally insignificant. It seems that once a species has been proposed for listing, its wait for final listing is influenced more by direct public participation than by intervention from legislators. This finding may support the theory that the significant findings on the SCM variables in the C1 analysis were picking up effective pressure from the constituents of the non-moderate sub-committee members; once better measures of direct pressure from interest groups are included, the SCM results disappear.

³⁰ Ninety percent of all packages with comments included have at least one “supporting” comment; many of these are simply routine, rubber-stamp approval from other government agencies. On the other hand, fully half of all proposal packages receive no opposing comments at all.

Estimates of the impacts of species characteristics on the length of proposal periods are not robust to changing the unit of observation. This may be because these characteristics are the most difficult to define for a package. Many proposal packages contain species proposed both endangered and threatened, or species of varying taxonomic distinctness; a few have mixtures of life-form types.³¹ Nonetheless, the fact remains that endangerment level, life-form type, and taxonomic distinctness are not found, in this study, to have any robust effect in either the Category 1 or the proposal stage of the listing process. While vertebrate species may well have been over-represented in the listing activities of the early years of the ESA, that bias either no longer exists, or exists only in the stages of the process preceding C1. However, the Service does not seem to have completely internalized the priorities set forth by Congress. While high priority species move faster through C1, priority-index values cease to affect decision making once species have been proposed and the index system ceases to bind.

Finally, the number of species in a given proposal package does not have a robust statistically significant impact on how long it takes the agency to issue a final listing rule for that package. It seems there are large economies of scale in the process, perhaps in controversy avoidance as well as in paperwork. When several proposed species share a habitat, the affected landowners may not object much more to listing all of them than they would to listing one of them.³²

7. CONCLUSION

This paper has studied the timing of Fish and Wildlife Service decisions to move species through the final parts of the process by which additions are made to the endangered species list. Some of the results are of interest to those concerned with the Endangered Species Act itself. For one thing, if the agency has preferences over taxonomic distinctness, endangerment, of life-form type (vertebrate, invertebrate, or plant), there is no evidence that it allows them to influence its decisions about these parts of the listing process during the time period studied here. Also, the listing priority

³¹ There are too few of these to allow them their own hazard rates; they are put together with invertebrates in the analysis.

³² See Amy Ando, *Interest-Group Behavior and the Endangered Species Act*, Resources for the Future Discussion Paper 97-44 (1997) for statistical evidence supporting this claim.

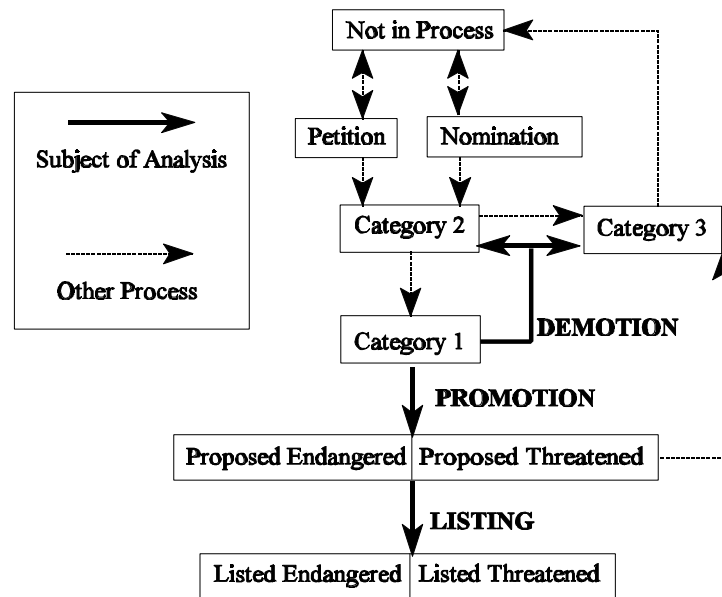
system mandated by Congress works to hasten the proposal of high priority species over low (though the agency does not seem to have internalized those priorities).

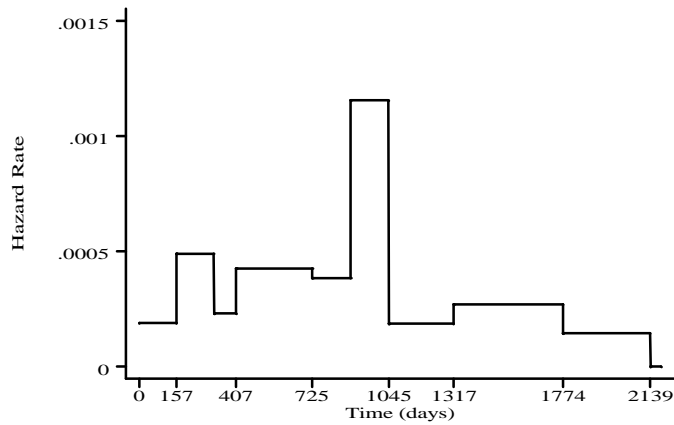
Of more general interest, however, is that interest groups influence the rates at which the Service moves species through these parts of the listing process. A number of measures of and proxies for public and political pressure regarding species were included as explanatory variables: petition and comment submissions, hearing requests, and the presence of local legislators with non-moderate environmental voting records on ESA-reauthorization subcommittees. All of them have statistically and qualitatively significant effects on the time species spend waiting in one stage of the process or the other, even though the Service does not answer directly to the public, and the Act specifies that the listing process studied here ought to be immune to all but scientific considerations.

Such differential delay in regulatory decision making can be very important. It certainly postpones costs and benefits associated with the decisions at hand. It may also cause the impacts of the decisions to change as a result of events and actions that occur during the wait. Depending on the decision-making process, delay may even influence the probability of a given regulatory action being taken. For example, in the particular case of endangered species protection, if a species has not yet been proposed for addition to the endangered species list, delay can affect whether the species moves on to be proposed, or stalls out and gets demoted to an earlier part of the process.

Differential delay is a plausible response of regulators to public pressure, especially when legislation circumscribes an agency's ability to let the content of decisions be influenced by the interest groups who stand to bear the costs and benefits of those decisions. This paper has found precisely that mechanism at work in parts of the process through which species are granted basic protection under the Endangered Species Act. The Fish and Wildlife Service is not an atypical agency. Thus, future studies may well find similar patterns of public influence on delay in other areas of bureaucratic decision making as well.

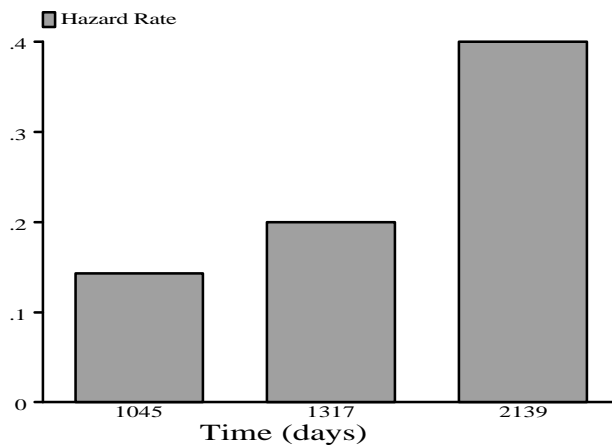
Figure 1: Administrative Process for Adding to Endangered Species List





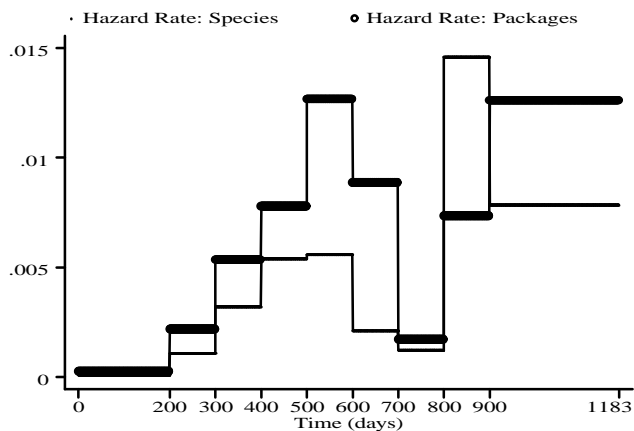
Note: Promotion hazard rates are constrained to equal zero at 1045, 1317, and 2139 days.

Figure A1-1: Promotion Hazard Function



Note: Demotion hazard rates are constrained to equal zero at all times except 1045, 1317, and 2139 days.

Figure A1-2: Demotion Hazard Rates



Note: These listing hazard functions are estimated in separate analyses. One uses species as the unit of observation, the other uses packages of species as the unit of observation.

Figure A1-3: Listing Hazard Functions

**Table 1: Variation in Action Taken (as of 12/31/94)
on Category 1 and Proposed Species**

	Exit Route from C1		Exit Route from Proposal Period			No Exit Yet	Total in Sample
	Proposed for Listing	“Demoted” to C2 or C3	Listed Endangered	Listed Threatened	Proposal Withdrawn		
Category 1	148 (39.89)	26 (7.01)				197 (53.10)	371 (100.00)
Proposed Endangered			338 (72.53)	15 (3.21)	5 (1.07)	108 (23.18)	466 (100.00)
Proposed Threatened			2 (2.06)	51 (52.58)	1 (1.03)	43 (44.33)	97 (100.00)

Note: Figures in parentheses are percentages that add to 100% across each row.

Table 2: Variation in Length of Completed Category 1 and Proposal Periods (Days)

	N	Mean	Stand. Dev.	Minimum	Maximum
Completed Category 1 Periods	174	849	502	1	2139
Completed Proposal Periods	412	461	200	154	1183

Table 3: Variable Definitions**NOTES:**

- 1) An “SCM” is a legislator on a sub-committee that has oversight jurisdiction for the ESA.
- 2) “LCV” means League of Conservation Voters rating, rising with “pro-environment” voting from 0 to 100.
- 3) The variables in the first block vary over time as Congressional composition changes
- 4) See Appendix II for summary statistics and for discussion of definition modifications made for analysis of packages (rather than species) as observations.

Variable	Description
Foreign?	Dummy: Species exists only outside the United States
Has “Pro-Environment” SCM?	Dummy: At least one local SCM has LCV>74
# Extra “Pro-Environment” SCMs?	Maximum of: {0, (Number "Pro-Environment" SCMs - 1) }
Has “Pro-Land-Use” SCM?	Dummy: At least one local SCM has LCV ≤25
Priority Index Value	Priority index, normalized to increase with priority and have mean 0
Has Priority Index?	Dummy: Went through C1 process, so index value exists
HasPriorityIndex? * Priority Index Value	HasPriorityIndex? * Priority Index Value
Comment-Data Subsample?	Dummy: Proposal was on or before 11/21/91 (abbreviated "CS")
Got Support?	Dummy: CS * (Some supporting comments were received)
Amount of Support	Got Support ?* (Number of supporting comments - 1)
Got Opposition?	Dummy: CS* (Some opposing comments were received)
Amount of Opposition	Got Opposition? * (Number of opposing comments - 1)
Number of Petitions	Number of petitions sent supporting domestic listing
Petition?	Dummy: At least one petition was sent supporting domestic listing
Smithsonian?	Dummy: Was listed on the Smithsonian “petitions”
Hearing?	Dummy: At least one hearing was requested for this package
Hearing? * Petition?	Dummy: Hearing? * Petition?
Hearing? * Smithsonian?	Dummy: Hearing? * Smithsonian?
Less Unusual?	Dummy: “Species” is a sub-species, variety, or population
Vertebrate?	Dummy: Vertebrate animal
Plant?	Dummy: Plant
Endangered?	Dummy: Proposed endangered (rather than threatened)
Size of Package	Number of species in package - 1

Table 4: Coefficient Results For Category 1 Duration Analysis

NOTES:

- 1) Estimates are of covariate coefficients in the promotion-hazard equation.
2) † indicates significant at the 5% level; * indicates significant at the 10% level.

	Coef.	S.E.	
LogL: -1316.45			
Number of Petitions	.403	.228	*
Smithsonian?	-.255	.201	
Foreign?	.330	.319	
Has “Pro-Environment” SCM?	.860	.199	†
# Extra “Pro-Environment” SCMs	.154	.093	*
Has “Pro-Land-Use” SCM?	-.353	.194	†
Priority Index Value	.117	.032	†
Less Unusual?	-.247	.213	
Vertebrate?	-.282	.354	
Plant?	-.050	.319	

**Table 5: Average Impacts of Changing Selected Independent Variables
on Category 1 Period**

NOTES:

- 1) Expected length of Category 1 period in **years** is denoted E
- 2) Probability that exit from Category 1 will be by demotion (rather than promotion) is denoted P.
- 3) An “SCM” is a member of the re-authorization subcommittee in charge of the ESA in either the House or Senate.

	ΔE	% ΔE	ΔP	% ΔP
Petition: 1 petition instead of no petitions (among domestic species)	-1.18	-27%	-.07	-37%
Pro-Environment SCM: 1 pro-environment SCM instead of no pro-environment or -land-use SCMs (given domestic species)	-2.58	-58%	-.14	-73%
Pro-Land-Use SCM: 1 pro-land-use SCM instead of no pro- environment or -land-use SCMs (given domestic species)	+1.10	+18%	+.03	+10%
Priority Index: : change from average priority index to best priority index	-1.35	-32%	-.08	-48%

Table 6: Coefficient Results For Proposal-Period Duration Analyses

NOTES:

1) † indicates significant at the 5% level; * indicates significant at the 10% level.

2) One analysis uses species as the unit of observation; the other uses packages of species as the unit of observation.

Number of Observations Log Likelihood Value	Species: 563 -2707.20			Package: 211 -1064.59		
	Coef.	S.E.		Coef.	S.E.	
Comment-Data Subsample?	1.235	.204	†	.999	.389	†
Got Support?	-.232	.203		.200	.349	
Amount of Support	.003	.001	†	.002	.001	*
Got Opposition?	-.608	.176	†	-.998	.250	†
Amount of Opposition	-.001	.000	†	-.0004	.0003	
Hearing?	-.373	.225	*	-.550	.330	*
Petition?	.104	.309		.047	.355	
Hearing? * Petition?	-.444	.407		.163	.467	
Smithsonian?	-.278	.148	*	-1.239	.295	†
Hearing? * Smithsonian?	-.273	.281		.175	.449	
Foreign?	-.028	.199		.111	.260	
Has “Pro-Environment” SCM?	.267	.150	*	.207	.207	
Has “Pro-Land-Use” SCM?	.037	.235		-.064	.273	
Has Priority Index?	-.381	.152	†	-.138	.239	
Has Priority Index? * Priority Index Value	.021	.022		-.047	.044	
Less Unusual?	-.309	.147	†	.001	.003	
Vertebrate?	-.062	.230		-.597	.287	†
Plant?	-.008	.228		.357	.269	
Endangered?	.305	.170	*	.001	.002	
Size of Package	-.013	.007	*	-.031	.027	

**Table 7: Average Impacts of Changing Public-Pressure Variables on
Expected Length of Proposal Periods**

NOTES:

- 1) Expected length of proposal period in **weeks** is denoted E.
- 2) Calculations use packages as unit of observation.
- 3) Calculations for comment variables are performed only for the 104 observations with comments included.

	ΔE	% ΔE
Hearing: one hearing instead of no hearings	+6.44	+12%
Opposition: one opposing comment instead of no comments	+13.71	+26%
Support: 1000 supporting comments instead of no comments	-24.98	-77%
Moderate Opposition and Support: 200 opposing and 200 supporting comments instead of no comments	+6.68	+14%
High Opposition and Support: 1000 opposing and 1000 supporting comments instead of no comments	-15.16	-40%

Table A2-1: Summary Statistics of Independent Variables for C1-Period Analysis

(N=371)	Mean	Min	Max
Foreign?	.10	0	1
Has “Pro-Environment” SCM?	.25	0	1
# Extra “Pro-Environment” SCMs	.18	0	8
Has “Pro-Land-Use” SCM?	.46	0	1
Priority Index Value	.00	-7.06	3.94
Number of Petitions	.13	0	3
Smithsonian?	.40	0	1
Less Unusual?	.28	0	1
Vertebrate?	.17	0	1
Plant?	.69	0	1

NOTE: Time-varying variables are summarized using values observed at the start of the periods.

Table A2-2: Summary Statistics of Independent Variables for Proposal-Period Analysis

	Species (N=563)			Package (N=211)		
	Mean	Min	Max	Mean	Min	Max
Foreign?	.17	0	1	.15	0	1
Has “Pro-Environment” SCM?	.15	0	1	.19	0	1
Has “Pro-Land-Use” SCM?	.07	0	1	.16	0	1
Has Priority Index?	.73	0	1	.72	0	1
Has Priority Index? * Priority Index Value	0	-7.44	3.56	0	-7.94	3.06
Comment-Data Subsample?	.44	0	1	.49	0	1
Got Support?	.35	0	1	.45	0	1
Amount of Support	13.11	0	3673	31.43	0	3673
Got Opposition?	.20	0	1	.27	0	1
Amount of Opposition	38.94	0	18717	102.91	0	18717
Hearing?	.27	0	1	.30	0	1
Petition?	.18	0	1	.25	0	1
Hearing? * Petition?	.06	0	1	.13	0	1
Smithsonian?	.47	0	1	.46	0	1
Hearing? * Smithsonian?	.11	0	1	.08	0	1
Less Unusual?	.20	0	1	25.32	0	100
Vertebrate?	.18	0	1	.24	0	1
Plant?	.68	0	1	.57	0	1
Endangered?	.83	0	1	63.14	0	100
Size of Package	7.80	0	29	1.67	0	29

NOTE: Time-varying variables are summarized using values observed at the start of the periods.

APPENDIX I: ECONOMETRIC DETAILS¹

In practice, a hazard function for observation j is often specified to have three components: $\lambda_j(t) = \theta_j \exp\{\beta'X_j\} \lambda_0(t)$ where λ_0 is the baseline hazard for all observations, the coefficients on X capture the effect of observed characteristics on the hazard function, and θ is a term designed to mitigate any bias in the estimated baseline hazard that might be caused by the presence of unobserved heterogeneity in the sample. This specification incorporates the Cox proportional hazard assumption that the multiplicative effect of X on the hazard rate does not depend on t . The analyses in this paper use this proportional hazards model, and specify the baseline hazards to be step-wise linear. Heckman-Singer non-parametric unobserved heterogeneity² was used, but since the results revealed insignificant variation in θ , further discussion of the unobserved heterogeneity will be bypassed in the interests of space.

The survival function, $S(t)$, is the unconditional probability that a spell lasts at least as long as t . It is related to the hazard function according to $S(t) = \exp\left(-\int_0^t \lambda(t) dt\right)$. If there are no data sampling problems, the likelihood function (with a single hazard rate) is constructed as

$$L = \prod_{j=1}^J \lambda_j(t)^{\delta_j} \cdot S_j(t) \quad \text{where } \delta_j = 1 \text{ if observation } j \text{ ended with observed failure, and } 0 \text{ otherwise.}$$

Since proposal spells are modeled as ending only in promotion to final listing status, the exact likelihood function for that analysis is laid out first. Following Lancaster,³ we divide the time line into M segments using a set of dividing times $\{c_m\}$, $m=1, \dots, M-1$. Let t_j^* denote the time at which species j 's spell is observed to end, and define $\delta_j^l = 1$ if the observation ends in listing, and 0 if it ends due to right censoring (the end of the data-collection period). Covariates are divided into those which are time invariant, X_j , and those which vary between time segments (but not within a given segment), Z_j .

¹ Those interested in more basic reading about duration analysis should consult Nicholas Kiefer, *Economic Duration Data and Hazard Functions*, 26 Journal of Economic Literature 646 (1988).

² James Heckman and Burton Singer, *A Method for Minimizing the Impact of Distributional Assumptions in Econometric Models for Duration Data*, 52 Econometrica 271 (1984), and *Econometric Duration Analysis*, 24 Journal of Econometrics 63 (1984).

³ Tony Lancaster, *The Econometric Analysis of Transition Data* (1990).

We use a set of M time-segment specific constants in the baseline hazard, $\{\lambda_m\}$, and define the following sets of variables as:

$$\begin{aligned}\Delta_{jm} &= \begin{cases} 1 & \text{if } c_{m-1} \leq t_j^* < c_m \\ 0 & \text{otherwise} \end{cases} \quad \text{for } m=1,2,\dots,M. \\ D_{jm} &= \prod_{n=1}^m (1 - \Delta_{jn}) \quad \text{for } m = 1,2,\dots,M-1 ; \quad D_{j0} = 1 ; D_{jM} = 0. \\ T_{jm} &= (t_j - c_{m-1})\Delta_{jm} + (c_m - c_{m-1})D_{jm} \quad \text{for } m=1,\dots,M.\end{aligned}\tag{1}$$

Intuitively, Δ_{jm} is an indicator variable for whether spell j ended in time period m . T_{jm} gives the amount of time spell j was active in time period m ; as such, it is equal to the full length of m if m comes before the period in which the spell ended, and zero if m comes after that period. With this notation in hand, we can write out the likelihood function for listing times, L_l as:

$$L_l = \prod_{j=1}^J \left[\left(\exp\{\beta'_x X_j\} \exp\left\{ \sum_{m=1}^M \Delta_{jm} (\beta'_z Z_{jm} + \lambda_m) \right\} \right)^{\delta_j^l} \cdot \exp\left\{ -\exp\{\beta'_x X_j\} \sum_{m=1}^M \exp\{\beta'_z Z_{jm} + \lambda_m\} T_{jm} \right\} \right] \tag{2}$$

The likelihood function for C1-spell analysis is similar. However, we need to account for the presence of an additional failure type, and accommodate the fact that administrative procedure constrains the hazard of failure by demotion to be zero at all but a small number of dates. Thus, additional notation must be introduced. The index k indicates failure type, where $k=p$ denotes promotion via proposal and $k=d$ denotes demotion to C2 or C3. We also define the variable E_{mj}^k equal to 1 if species j is eligible for failure-type k during time-period m , and 0 otherwise. The two dummy variables δ_j^k are equal to 1 if species j fails due to failure-type k , and 0 otherwise. The observed failure time for species j is still given by t_j^* , and $\{\Delta_{jm}\}$, $\{D_{jm}\}$, and $\{T_{jm}\}$ are defined just as they were in Equation 1. Using this notation, the hazard for each failure type k (λ^k) and the overall survivor function (S^{pd}) are written:

$$\lambda^k \equiv \lambda^k_{(t_j|X_j, Z_j)} = \left(\exp\{\beta_x^k X_j\} \exp\left\{ \sum_{m=1}^M \Delta_{jm} (\beta_z^k Z_{jm} + \lambda_m^k) \right\} \right) \cdot E_{mj}^k$$

$$S^{pd} \equiv S^{pd}_{(t_j|X_j, Z_j)} = \exp\{-\zeta^p + z^d\} , \quad (3)$$

$$\text{where } z^k \equiv z^k_{(t_j|X_j, Z_j)} = \exp\{\beta_x^k X_j\} \sum_{m=1}^M (\exp\{\beta_z^k Z_{jm} + \lambda_m^k\} T_{jm} E_{jm}^k)$$

and the likelihood function, L_{pd} , is:

$$L_{pd} = \prod_{j=1}^J (\lambda^p_j)^{\delta_j^p} \cdot (\lambda^d_j)^{\delta_j^d} \cdot S^{pd}_j \quad . \quad (4)$$

In order to estimate the baseline-hazards, the time axes are divided into segments. Three of the segments in the C1-spell data last only one day; they occur at 1045, 1317, and 2139 days. Demotion only occurs at these times, while promotion occurs during the other segments of time. The results do not seem sensitive to changes in the dividing points for these segments. Figures A1-1 and A1-2 show the estimated baseline hazard functions for promotion and demotion from C1, respectively. Figure A1-3 shows the estimated baseline listing hazards from the analysis of proposal periods performed with both species and packages as the unit of observation.

With an estimated hazard function (and hence survival function) in hand, the expected spell length for a given observation is calculated according to $E(T) = \int_0^\infty S(t)dt$. The C1 data only enable us to estimate the C1 survival function out to about .25; in order to calculate expected C1 spell lengths, the baseline hazard processes need to be extrapolated over the entire period of time where $S_0(t) > 0$. To that end, the calculations in Table 5 assume that demotion occurs every two years, and that the demotion and promotion hazards estimated in the second-to-last two time periods obtain for the remaining time. The calculations in Tables 5 and 7 use point estimates of coefficients even when statistically insignificant.

APPENDIX II: DATA

Much of the data are culled from various notices and rules published by the FWS in the *Federal Register*. Listing-proposal notices provide proposal dates, the current location of species (by county), the number of other species in the package, whether the species was proposed “endangered” or “threatened”, and the number of petitions promoting listing of the species. Final listing rules give the number of public hearings held to discuss proposals, and the numbers of neutral, opposing, and supporting comments. Notices of Review (through 1994) provide information for all domestic candidate species on their administrative status (current category), whether the species is a plant or animal (and, if animal, what kind), and the states that comprise their historic ranges.

Additional measures are taken to fill out the data for proposal or C1 periods that did not finish by the end of 1994, and for C1 spells that ended in demotion. Information on the number of public hearings comes from *Federal Register* hearing announcements. Petition information is obtained by looking back through 1979 at petition decisions published in the *Register*, and data on whether plant species were ever part of a Smithsonian report/petition come from those reports. Missing data on the number of comments received during incomplete proposal periods is dealt with as follows. A dummy variable ("Comment-Data Subsample?") marks whether observations begin before 11/5/91, that being the earliest date on which a spell began that was not observed to end. Comment variables are then included for (and only for) observations that began before that date.

The FWS generously provided data for this study on the index values for the 1990, 1991, 1993 and 1994 Notices of Review. We do not observe an index value for species that are proposed without going through a formal period as a C1 species; such species are coded in the proposal data set as having no index.

Data on whether a species lives in an area that is represented by an SCM (a member of a reauthorization sub-committee) are created as follows. Maps of voting districts (both before and after the re-districting induced by the 1990 census) are used to identify what voting districts comprised the ranges of species. Various editions of *Congressional Quarterly Almanac* provide information on the membership of the House and Senate subcommittees with control over ESA re-authorization. Measures of the SCMs' attitudes towards the environment come from measures that were constructed using the League of Conservation Voters' *National Environmental Scorecard* for the years 1987-

1994. Every legislator listed in those *Scorecards* is given a raw voting index value based on the average of their annual scores (weighted by the number of votes for which they were present in each year). Each SCM is then categorized as “pro-environment” if his raw index is greater than 74 and “pro-land-use” if it is less than or equal to 25.⁴

Since packages often contain more than one species, a number of variables listed in Table 3 must be re-defined for analysis of proposal-period lengths with proposal packages as the observations. The variable “Has Priority Index?” is a dummy that indicates that at least one member of the package has an index value, and “Priority Index Value” is the average priority index value for the package (normalized to be increasing with priority and have mean zero.) “Petition?” and “Smithsonian?” indicate that at least one species in the package received a petition or was on a Smithsonian list (respectively). “Less Unusual?” and “Endangered?” give the percent of package members that are taxonomically less distinct or proposed endangered, respectively. “Vertebrate?” and “Plant?” indicate that all species in the package are vertebrates or plants, respectively.

Summary statistics for the independent variables are found in Tables A2-1 and A2-2.

⁴ The results are robust to changing the cutoff values or using non-discrete indicators of ideology.

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