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Taxa, petitioning agency, and lawsuits affect time spent awaiting listing under the US Endangered Species Act

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ABSTRACT

The United States' Endangered Species Act (ESA) is the world's foremost law for protecting species at risk of extinction; however, species must first be listed as threatened or endangered before receiving protection under the Act. We used an information theoretic approach to assess whether listing budget, policy phase (which was correlated with presidential administration), or both factors were associated with the number of species listed annually between 1983 and 2014. Annual listing rates were positively affected by larger listing budgets; policy phase also had a significant impact on annual listing rates after accounting for the effects of budget. However, the listing process for any one species spans multiple years, thus we also evaluated how taxonomic affiliation, the initiating organization, and lawsuits affected the amount of time 1338 listed species spent in review between 1973 and 2014. Species waited a median of 12.1 years to receive protection, with plants and invertebrates experiencing longer wait times than vertebrates. These process times exceed ESA deadlines, which are two years when initiated from a third party; this may perpetuate population declines and hinder recovery efforts. We observed that at the time of a lawsuit filling for either a proposed or final rule, species had waited, respectively, 4.19 and 0.70 years longer than species for which no lawsuits were filed, indicating lawsuits targeted species that experienced longer delays. We discuss how changes in ESA implementation over time interacted to produce high variability and often long wait times in the listing process. Our results indicated a positive role for both citizen petitions and budget increases to advance the listing process, thus hastening biodiversity protection.

1. Introduction

The Endangered Species Act (ESA) is the preeminent law protecting imperiled species in the United States. Although there were previous laws designed for conservation, the 1973 enactment of the ESA brought about a new conservation era by strongly empowering the US federal government to intercept extinction. Several studies have evaluated the effectiveness of the ESA for preventing the extinction of listed species, generally finding a relationship between ESA tools, including listing, designation of critical habitat and development of recovery plans, and improvement of species' status (Gibbs and Currie, 2012; Hoekstra et al., 2002; Langpap and Kerkvliet, 2010; Neel et al., 2012; Scott et al., 2006; Suckling and Taylor, 2006). These and other works have documented biases in listing of species towards particular taxonomic groups (Wilcove and Master, 2005; Wilcove et al., 1993), temporal and policy-driven differences in the listing rate (Greenwald et al., 2006), and fluctuations in the funding allocated to ESA implementation (Gibbs and Currie, 2012). However, a recent comprehensive analysis of the factors driving annual listing rates is absent.

Previous works assessing effectiveness of the ESA for protecting imperiled species analyzed data on species only after they had been added to the list as threatened or endangered. However, species frequently experienced lengthy delays during the listing process, in many cases lasting tens of years (Brosi and Biber, 2012; Greenwald et al., 2006). Since the substantial protective power of the ESA only can be brought to bear after a species has been listed, these listing delays have likely contributed to the perilously low population sizes characterizing many species at the time of listing, and the delays may have considerably lowered prospects for recovery (Neel et al., 2012; Wilcove et al., 1993). Thus, multi-year factors that have the potential to cause delays in protection from stalled petitions or biases in the species determined for listing remain a matter of serious conservation concern.

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In 1982, the Congress of the United States amended the ESA to include strict legal timelines bounding the listing process. These timelines were enacted in response to a sharp drop in listings during the first year of the Reagan administration and were designed specifically to prevent further delays in listing (US House of Representatives, 1982). Species follow one of two pathways towards listing, depending on whether the US Fish and Wildlife Service (FWS or Service hereafter) or a third party initiated the process. When a listing petition is filed by a third party, the Service must determine within 90 days, to the maximum extent practicable, whether the petition presents sufficient data to warrant further consideration. Provided this initial finding is positive, the Service has 12 months from receipt of the petition to determine whether listing is warranted, not warranted, or warranted but precluded (WBP). FWS' practice is to add species found to be WBP to a list of candidate species, which also includes species reviewed solely by the agency and without a petition. The WBP designation was meant to be a limited exception to the otherwise strict timelines of the ESA in order to allow the Service to work on listings of higher priority species (USFWS, 1983); however, WBP has been used frequently and contributes to the backlog of species awaiting listing decisions (Harris et al., 2012).

If a species is deemed warranted for listing, the Service issues a proposed rule, opens a comment period, and within 12 months, issues a final rule to list a species or withdraw it from consideration; however, if there is scientific dispute over a species the Service may extend the process for six months. Listed species receive substantial protection 30 days after final rules are published in the Federal Register. Thus, the maximum length of time needed for a species to move from petition to protection, as prescribed by law, is two years and one month. The Service can also initiate listing on its own accord by issuing a proposed rule, in which case a final rule or withdrawal is still required within 12 months. As noted above the Service can also initiate listing by adding species to the candidate list, but in this case there are no statutory deadlines for listing these species.

Importantly, the listing process also can be affected if a third party uses litigation to reinitiate a stalled petition for listing, or to demand that a determination be made on a species that has been under consideration for lengthy periods. Many species only gained protection because litigation jump-started the listing process for species neglected in long-term candidate or WBP status (Brosi and Biber, 2012; Greenwald et al., 2006). There have been few attempts (Ando, 1999; Greenwald et al., 2006) to empirically evaluate the influence of legal actions on the extension of endangered species protections to imperiled taxa.

Our objective was to use existing data on ESA listings to better understand the factors influencing annual listing rates and the rapidity of listing. We evaluated both the number of species listed each year and the factors, singularly and in combination, that have previously been associated with the rate of listings (Schwartz, 2008), including annual listing budgets, presidential administrations, and ESA policy phases first described by Greenwald et al. (2006) (see Methods for description). However, the experience of any one species transitioning through the listing process often spans multiple years and is not well characterized by the year in which it was listed (i.e. the annual budget, administration, or policy phase of a particular year). Thus, we also assessed the effects of longitudinal factors with the potential to extend or compress consideration times for each species, including taxonomic affiliation, whether the initiation of listing consideration came from the Service or from an outside party, and the presence of lawsuits brought by third parties to facilitate listings.

2. Materials and methods

2.1. Datasets

We combined two datasets to derive information for species listed between January 1974 and October 2014, including the FWS Threatened and Endangered Species System online database (TESS: http://ecos.fws.gov/tess_public/; which included species status, listing date, and taxonomic phyla and class) and a dataset annually curated by the Center for Biological Diversity that included data about the initiating agency, lawsuits, and dates of initiation and proposed rules. For each taxonomic species, the date when species were initially considered for listing was identified by the date a petition was filed by an outside party, the date the Service announced that it was considering a species as a candidate, or for a large number of plants, the date the Smithsonian Institution submitted an imperiled list as requested by Congress. We also identified the date each species was proposed for listing in the Federal Register, and when it was officially listed. Finally, we identified whether lawsuits were initiated by a third party to facilitate a listing proposal, or a final rule.

We obtained data for 1338 listed species, and used the following criteria for exclusions. First, we excluded 102 listings administered by National Marine Fisheries Service because of the agency's differential listing process and reporting standards. Second, species classified in TESS as an experimental population, similarity of appearance, proposed due to similarity of appearance, removed from candidacy, delisted, and foreign were excluded from analyses. Third, for species with multiple distinct population segments (DPS), we included the first initiation, first proposal for listing, and first listing for a taxonomic species or subspecies but not subsequent DPS listings because they tended to have a bifurcating, versus linear, candidacy process that were more representative of reevaluations than of new listings. Fourth, listings made in predecessor legislation (e.g. Endangered Species Preservation Act of 1966) of the ESA were excluded. Fifth, we excluded species listed under emergency conditions that circumvented the normal listing process which has occurred very infrequently. Additionally, a number of species initially petitioned by the Smithsonian were proposed in 1976 and subsequently re-proposed following inactivity; we analyzed the second of the two proposal dates.

We used these data to compile summary data associated with annual listing rates, including the number of species listed each year, federal budgetary allocations for listing activities (data was obtained from annual budgets posted online by FWS then standardized to account for inflation since 1983), and the standing presidential administration. We shifted the annual listings so that they extended from 20 January each year to account for the time when presidents were inaugurated. We reinterpreted the policy phases designated by Greenwald et al. (2006) and extended their analysis through 2014. The original policy phases captured changes in the number of species listed within multiyear blocks, due to amendments or administrative policy, and included 1) 1974–1982, during which the ESA was first being implemented; 2) 1983–1990, when amendments to the ESA designed to expedite listing of species resulted in a modest increase in species being protected and when many species were identified as being in need of protection; 3) 1991–1995, when a series of settlement agreements with conservation groups led to a dramatic increase in the listing rate; and 4) 1996–2004, when administrative policies were adopted to limit the numbers of species considered for protection. Our reinterpretation of the fourth phase changes the last year to 2000, in part due to the contemporary availability of listing data from the entirety of the Bush Jr. presidential administration. Due to the low annual listing rate from 2001 to 2009, we added a fifth phase during these years. A sixth policy phase from 2010 to the present was characterized by an increase in listings as part of new settlement agreements between the Service and conservation groups.

2.2. Annualized listing rates

We modeled the effects of annual factors on yearly listing rates using an information theoretic approach. The number of species listed each year was included as a response variable, which was fitted to generalized linear models (GLM) using program R (R Core Team, 2013) using a Poisson response distribution for count data. Models were composed

of additive linear combinations of explanatory variables that included listing budget, policy phase, and presidential administration. Presidential administrations and policy phases were correlated, so we considered all possible additive combinations of variables, except those simultaneously containing both presidential administration and policy phase. We ranked and evaluated models using the MuMIn package (Barton, 2014). Only years since 1983 were included in the annual listing rate analysis because budgetary data from prior years were not available. We used adjusted Akaike information criterion (AIC_c) and model weight (ω_i) to rank models (Burnham and Anderson, 2002). No models ranked within 2 AIC_c units of the best approximating (lowest AIC_c); therefore, we did not employ model-averaging or multi-model inference (Burnham and Anderson, 2002). We estimated differences in effect size between explanatory variables using the lsmeans (Lenth, 2014) and multcompView (Graves et al., 2012) packages in program R. Least squares means were provided for insight into categorical variables, and Tukey-Kramer adjustments for multiple comparisons were made for significance test. Goodness of fit for best approximating models was assessed for gamma response distributions (see below) using Pearson's goodness of fit statistics, however they were not used for the Poisson response distributions because of previously reported issues with relatively small count data (Venables and Ripley, 2002). We considered variables influential if they appeared in the best approximating model and hypothesis tests significant at $\alpha = 0.05$, and we report means and 95% confidence intervals (CI) when appropriate.

2.3. Process time

Subsequently, we modeled the effects of multi-year factors on the time required for individual species to move through the listing process. Process time was the response variable, and we identified a number of explanatory variables with potential to affect the listing process for each individual species. Taxon was a categorical variable that included amphibians (n = 22), birds (n = 43), clams (n = 89), crustaceans (n = 25), ferns and allies (n = 29), fishes (n = 86), flowering plants (n = 839), insects (n = 65), mammals (n = 50), reptiles (n = 29), and snails (n = 44). We collapsed conifers and cycads, arachnids, and lichens into an "other" category (n = 17) due to small sample sizes. We included a variable for the organization associated with initial actions, including third parties (n = 187), the Service (n = 610), or the Smithsonian (n = 541). Finally, in some cases species awaited action for extended periods and lawsuits were subsequently filed to move a species towards a proposed (n = 547) and/or final rule (n = 146; Tables S1 and S2). We evaluated the relationship between species for which litigation was filed and process times with the inclusion of binary variables representing whether a lawsuit was submitted after initial agency action ("proposal lawsuit") or whether a secondary petition and/or litigation was used to speed the listing process ("listing lawsuit"). Forty-nine lawsuits, primarily deadline suits, were identified, of which 22 contained species in need of proposed rules, and 27 were for listing rules. Two suits had a mix of species awaiting action on proposed or listing rules.

We fit three model sets addressing multi-year factors, in which response variables were either the number of days between listing initiation and a proposed rule, the days between proposed rule and listing, or total process time. Model sets included explanatory variables for the taxon, initiating agency, and the lawsuits associated with the species. We categorized lawsuits based on the next stage of the listing process, thus "proposal lawsuits" moved a petition towards a proposed rule while "listing lawsuits" moved a proposed rule towards a final rule. The model set fitted to the initiation to proposed time included a variable for presence of a proposal lawsuit; the model set fitted to time from proposed to listed included presence of a listing lawsuit; and the total time analysis included both litigation types.

Listing time data for each species that was eventually listed as threatened or endangered between 1 January 1973 and 1 October 2014 were fitted to GLMs using a process similar to that described above for annual listing rates, except that we used a gamma response distribution with a log link function to address the larger and more continuous non-negative distribution resulting from the measure of days. Records with response variables equal to 0 were excluded from each data set (e.g. species immediately proposed for listing were excluded from the initiation to listing analysis, but not other analyses). Model ranking and interpretation also followed the methods described above for annual listing rates.

We report means, medians, and range of absolute time between process stages by levels within a factor. Additionally, we hypothesized that lawsuits were sometimes filed on species that had been neglected for an extended time. Thus to better understand the effect of lawsuits on process time, we calculated the length of time (days) between a petition and a proposed rule for species where lawsuits were not filed, and the time between a petition and a proposal lawsuit for species that were litigated. Similarly, we compared time between proposed and final rules, and proposed rules and listing lawsuits. We fitted a GLM with the binary lawsuit presence explanatory variable and number of days between process steps as a response variable, and estimated contrasts as described above.

We conducted a post-hoc analysis comparing species that moved through the listing process alone versus species that moved in tandem with one or more species. We identified species that moved in tandem from our data if the initiation, proposed, and listing dates were the same, thereby identifying two or more species as a multi-species listing. We removed species associated with lawsuits from this analysis (see results). Using one representative from each multi-species listing (n = 84) and all species that moved through as single species listings (n = 366), we compared total process time using a two tailed *t*-test in program R.

3. Results

We analyzed 1338 species listed under the ESA that transitioned between 1973 and 2014. Of species under consideration but not yet listed, a mean of 85% remained in candidacy or proposed status within any given year, whereas 8% transitioned to a proposed rule and 7% transitioned from proposed to listed. These results were derived from 40-year means and there was high annual variability observed in the number of petitions initiated, proposed rules, and listing rules (Figs. 1, 2).

3.1. Annualized listing rates

Our results indicated that between 1983 and 2013 annual listing rates were associated with a top-ranked model that included listing budget ($F_{1,24} = 22.13$, $P < 0.001$) and policy phase ($F_{4,25} = 117.9$; $P < 0.001$). The best approximating model had a weight of 0.99 (Table S3), and the null (intercept-only) model ranked 480 AIC_c units below. Results indicated that, after accounting for the effects of annual listing budget, listing rates during the fifth phase (2001–2009) were lower than all other phases ($P < 0.001$ for all pairwise comparisons). Although overall annual listing numbers during the sixth phase (2010–2014) were high relative to previous phases, model results also indicated those rates were strongly associated with the elevated budgets. Once we corrected for listing budgets, parameter estimates suggested that rates during the sixth phase were only greater than those during phase five ($z = -5.03$, $P < 0.001$). After accounting for listing budgets, annual listing rates were similar in policy phases two, three, and four, although listing rates were slightly higher during phase three ($z = 2.845$, $P = 0.036$).

3.2. Process time

3.2.1. Initiated to proposed

Taxon ($F_{11,1215} = 6.7$; $P < 0.001$), initiator ($F_{2,1227} = 86.8$; $P < 0.001$), and proposal lawsuit ($F_{1,1226} = 257.5$ $P < 0.001$) were all included in the

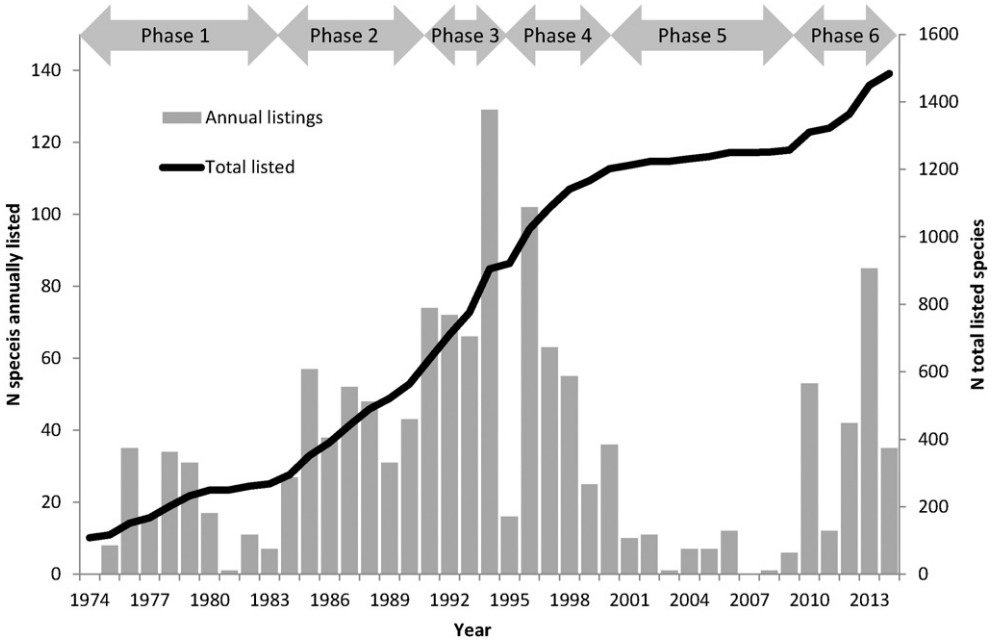

Fig. 1. Annual ESA listing activities, including the annual (gray bars) and cumulative (solid line) number of species listed as threatened or endangered in each of the six policy phases discussed. Data were obtained from USFWS TESS in February 2015. Foreign species, experimental populations, delisted and recovered species, species listed because of similarity of appearance, and multiple subsequent listings of the taxonomic species that were listed previously (e.g. DPS) are excluded.

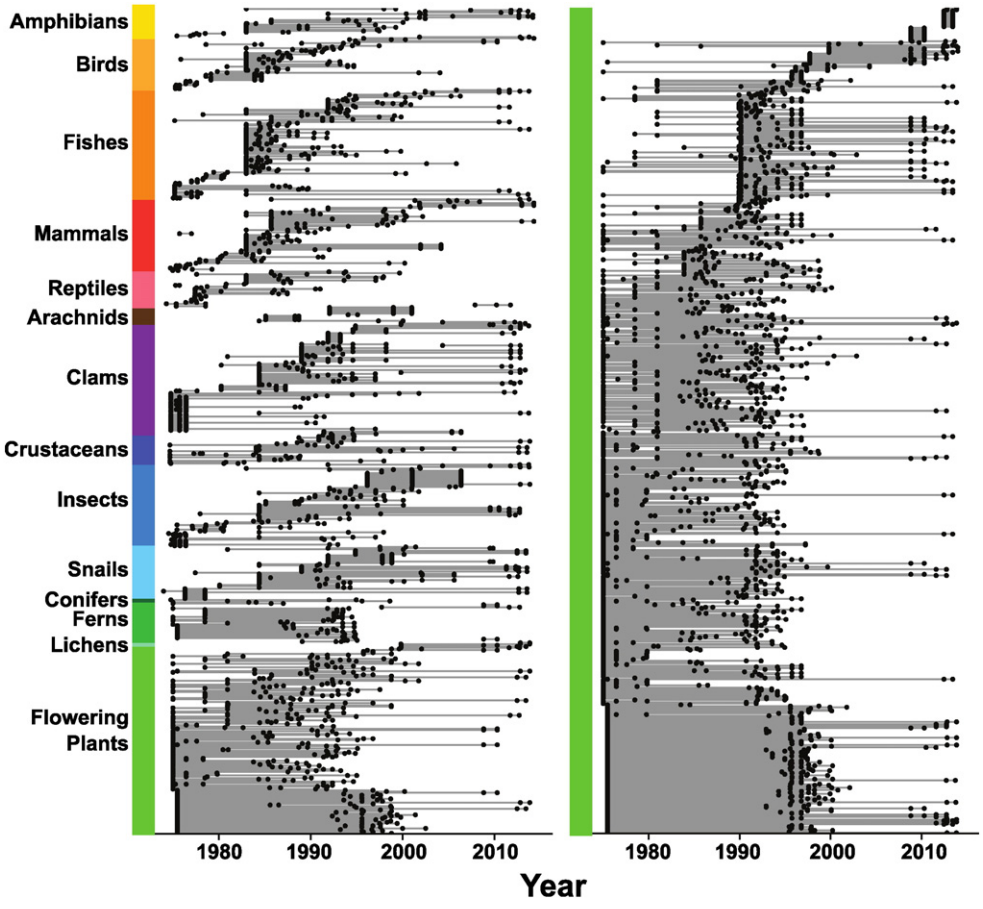

Fig. 2. Date (black circle) of initiation, proposed rule, and listing with total process time (gray line) connecting dates for individual species. Species were organized by taxon (ESA taxon categories and genus), then ordered from earliest initiated to latest. Colored blocks indicate taxon variable, ordered from top to bottom: amphibians, birds, fishes, mammals, reptiles, arachnids, clams, crustaceans, insects, snails, conifers, ferns and allies, lichens, and flowering plants. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

best approximating model of the time between initial consideration and a proposed rule. The best approximating model, also the full model, had a weight of 0.99 (Table S4), where the null (intercept-only) model ranked 372 AIC_c units below. Pearson's goodness of fit statistic indicated reasonable model fit ($X^2_{598,1213}$, $P > 0.05$).

With other variables held at mean values, and after accounting for the effects of initiating agency and listing lawsuits, the least squares means parameter estimates indicated that the mean time from initial consideration to a proposal for listing ranged from 6.51 to 14.76 years depending on taxa (Table 1). Absolute time to a proposed rule ranged from 0.08 to 37.32 years (Table S5). Time to proposal also varied by initiator, such that listings initiated by the Smithsonian were proposed for listing most slowly (11.80 years, CI 10.54–13.21), followed by those listed by the Service and third parties (Table 1). We observed that proposal lawsuits were filed after species had already experienced significantly ($P < 0.0001$) longer delays; the absolute process time between petition to proposed was 8.64 years (CI 8.62–8.65) where between petition to proposal lawsuit 12.83 years (CI 12.82–12.85) elapsed. Proposed rules were issued a median 2.34 years after the filing of the proposal lawsuit (Fig. 3A).

3.2.2. Proposed to listed

Taxon ($F_{11,1323} = 3.95$; $P < 0.001$), initiator ($F_{2,1335} = 13.85$; $P < 0.001$), and listing lawsuit ($F_{1,1334} = 274$; $P < 0.001$) were all included in the best approximating model of the time between proposed rules and final listings. The best approximating model, which was the full model, had a weight of 0.99 (Table S6). Pearson's goodness of fit statistic indicated reasonable model fit ($X^2_{388,1323}$; $P > 0.05$).

Parameter estimates indicated that the mean time from proposed to final rule for listed species ranged from 1.34 to 2.34 years (Table 1). Absolute time from a proposed to final rule ranged from 0.10 to 7.44 years (Table S7). The time between proposed and final rules also varied by initiator, such that the model indicated that after accounting for other factors, listings initiated by the Smithsonian required a mean of 2.11 years, those initiated by the Service required a mean of 1.81 years, and third party petitions were listed in a mean of 1.58 years (Table 1). As with initiation to proposed times, listing lawsuits were filed after species had already experienced significantly ($P < 0.0001$) longer delays; the absolute time between a proposed rule and listing was 1.40 years (CI 1.39–1.40) whereas the time between proposed rule and a lawsuit was 2.10 years (CI 2.08–2.11). Listings occurred a median 0.67 years following a listing lawsuit (Fig. 3B).

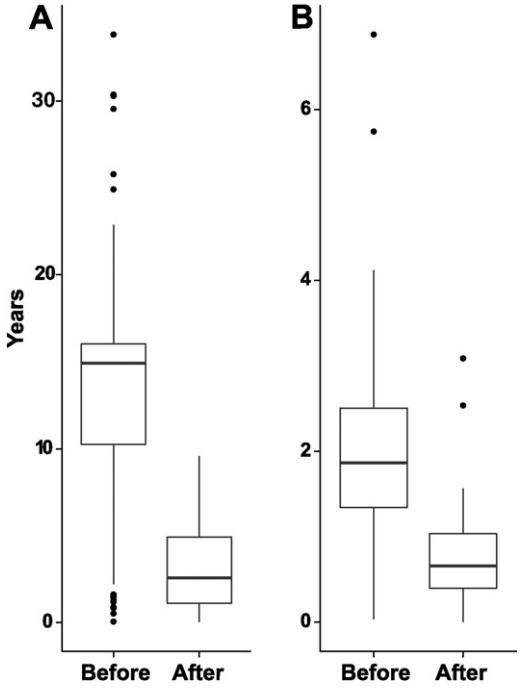

Fig. 3. Boxplots (mean, first and third quartile, 1.5 times the interquartile range, and outliers shown as dots) of the length of time (years) species were in the petition (A; n = 547) or proposed (B; n = 146) process stage both before and after filing of either a proposed or listing lawsuit, respectively.

Table 1
Least mean squares estimates (years; 95% confidence intervals in parentheses) for total process time and steps between initiation to proposed and proposed to listed for both the taxonomic class and initiating actions variables. Superscript letters within each column indicate results of Tukey-Kramer significance test where taxonomic class and initiating action (last three rows) were analyzed independently.

Variable	Total time	Initiation to proposed	Proposed to listed
Other[1]	7.33^{ab} (5.26–10.20)	6.51^{a} (4.61–9.18)	1.34^{a} (1.04–1.75)
Reptiles	8.54^{ab} (6.55–11.13)	9.50^{abc} (6.73–13.41)	2.20^{abc} (1.79–2.70)
Fish	8.77^{a} (7.42–10.37)	6.94^{a} (5.86–8.22)	1.87^{abc} (1.64–2.13)
Birds	8.79^{ab} (7.09–10.90)	7.65^{a} (6.09–9.61)	1.56^{ab} (1.32–1.85)
Amphibians	9.51^{abcd} (7.07–12.79)	7.80^{ab} (5.72–10.64)	1.53^{abc} (1.22–1.93)
Mammals	9.59^{abc} (7.85–11.72)	7.74^{a} (6.29–9.52)	1.73^{abc} (1.48–2.02)
Ferns and allies	11.62^{abcd} (8.95–15.09)	11.66^{abc} (8.90–15.27)	1.47^{a} (1.20–1.81)
Insects	12.25^{abcd} (11.30–14.55)	8.41^{a} (7.06–10.01)	2.34^{c} (2.04–2.68)
Clams	12.47^{bcd} (10.57–14.72)	10.00^{abc} (8.45–11.83)	1.75^{abc} (1.54–2.00)
Crustaceans	13.15^{abcd} (9.96–17.35)	10.93^{abc} (8.23–14.52)	2.20^{abc} (1.77–2.74)
Flowering Plants	13.46^{cd} (12.47–14.52)	12.02^{bc} (11.30–12.79)	1.92^{abc} (1.81–2.03)
Snails	16.81^{d} (13.54–20.86)	14.76^{c} (11.79–18.49)	2.28^{bc} (1.92–2.69)
The service	8.64^{A} (7.92–9.42)	8.30^{A} (7.65–9.01)	1.81^{B} (1.69–1.94)
Third party	9.91^{A} (8.82–11.14)	8.00^{A} (7.16–8.94)	1.58^{A} (1.44–1.73)
Smithsonian list	14.42^{B} (12.84–16.19)	11.80^{B} (10.54–13.21)	2.11^{C} (1.93–2.31)

[1] Other encompassed arachnids, conifers and cycads, and lichens.

3.2.3. Total ESA process time

We assessed the total time required for each listed species to move from first consideration to listed; results identified the full model as best approximating, which included taxon ($F_{11,1322} = 6.1$; $P < 0.001$), initiator ($F_{2,1335} = 125.8$; $P < 0.001$), proposed lawsuit ($F_{1,1334} = 356.3$; $P < 0.001$), and listing lawsuit ($F_{1,1333} = 2.85$; $P = 0.0914$). The best approximating model had a weight of 0.99 and the null model ranked last (Table S8). Pearson's goodness of fit statistic indicated reasonable model fit ($X^2_{631,1322}$; $P > 0.05$).

Parameter estimates indicated that, after accounting for other factors, the mean time from initial consideration to final rule for listed species ranged from 7.33 to 16.81 years depending on taxa (Table 1), whereas absolute times ranged from 0.28 to 38.36 years (Table 2). The total listing time also varied by initiator, such that the model indicated that listings initiated by the Service required a mean of 8.63 years, by third parties were listed in a mean of 9.91 years, whereas those initiated by the Smithsonian were processed for a mean of 14.42 years (Table 1). Model predictions indicated a mean of 15.68 years (CI 14.43–17.03) for total listing time for species that had litigation initiated prior to a listing proposal. However, as in previous sections, absolute times indicated that these species had been under review for a mean 12.83 years before litigation was initiated. The model indicated a mean of 7.45 years (CI 6.82–8.14) of total listing time for species not accompanied by proposal litigation. Results in previous sections showed that review had stagnated for species for which litigation was eventually initiated for final rules,

Table 2
Absolute time (years) for total process time by taxonomic class.

Class	n	Mean	Median	Min	Max
Lichens	2	2.82	2.82	1.39	4.25
Reptiles	29	6.18	3.85	0.39	28.82
Birds	43	6.43	5.50	0.43	23.16
Fish	86	6.89	3.99	0.43	30.78
Arachnids	12	7.07	8.95	1.03	15.66
Mammals	50	8.64	5.42	0.57	28.58
Clams	89	8.70	5.36	0.56	29.34
Amphibians	22	9.03	9.99	0.60	16.26
Insects	65	9.91	8.95	0.95	28.35
Crustaceans	25	10.94	7.31	0.92	29.49
Conifers and cycads	3	12.90	12.01	9.04	17.67
Snails	44	13.51	11.38	2.01	37.22
Ferns and allies	29	14.48	15.01	1.48	19.48
Flowering plants	839	15.08	16.32	0.49	38.36
Total	1338	12.83	12.11	0.39	38.36

and thus they also experienced extended total wait times. Model results predicted species for which litigation was initiated to compel a final rule were in process for a mean of 11.59 years (CI 10.27–13.07), compared to a mean of 10.08 years (CI 9.43–10.77) for those not accompanied by listing litigation.

Of the 1338 species analyzed in this dataset, 560 were listed under single species listings and 778 species were listed using 175 multi-species listings (mean = 4.0 species per listing, range 2–21; Table S9). We compared total listing time only for species not associated with lawsuits as we have already shown that lawsuits identify species not moving through the listing process efficiently. There was not a significant difference ($P = 0.331$) in total process time between single and multi-species listings.

4. Discussion

4.1. Factors affecting annual listing rates

We identified policy phase and annual budget as significant factors affecting the overall number of species listed within any particular year. The policy phases we identified encompassed changes in ESA implementation through congressional amendments, policy priorities of presidential administrations, and settlement agreements. Major changes to the listing process occurred via amendments in 1978 and 1982. Under the 1978 amendment, species were removed from candidacy if they were not listed within two years (Goble, 2006). This resulted in removal of proposals to list 1879 species in 1979 (Schwartz, 2008), many of which ended up on candidate lists, only to be listed many years later and often as a result of litigation. In response to both the 1978 amendment and a cessation of listing during the first year of the Reagan administration, the 1982 amendment established the strict deadlines for responding to petitions discussed in this paper, but also created the WBP exception for candidate species, which recognizes species that are warranted for ESA listing but precluded due to higher listing priority of other species. The WBP statutory provision has contributed greatly to extended process times.

Budgetary allocations to listing were included in our top-ranked model. The Service has indicated that staff time is the principal use of the listing budget (USGAO, 2002), and the cap on this line item, first requested by the Service itself, may impede listing progress by limiting available staff to process petitions and write rules. Thus, increased budgets are undoubtedly the simplest way to accelerate the number of species listed annually. For example the listing budget in 1991 was $4.3M and increased in 1992 to $8.1M, thereby allowing for additional petition processing (Lieben, 1997). A parallel may exist in analysis of ESA recovery funding. Kerkvliet and Langpap (2007) identified that increased ESA recovery spending, decreased the probability of a species' status declining over time, most likely due to the availability of higher budgets to fund recovery objectives (Abbitt and Scott, 2001; Male and Bean, 2005). We see parallels in that increasing listing budgets could have substantial biodiversity conservation benefits by providing imperiled species protection before further declines in both number of populations and individuals can occur.

Our models do not identify specific mechanisms for how administrative policy differences arise. Both the Clinton (see Section 4.2.3) and Bush Jr. administrations used administrative policy to retard listings. During the Bush Jr. administration, a total of 62 species were listed despite a candidate backlog of over 250 species. It is worth noting that the Secretary of Interior and FWS Director, both political appointees, can directly accelerate or decelerate listing activity in-line with the wishes of the administration. This is plausible as both the Secretary and Director must approve all ESA listings and was acutely highlighted by the finding of political interference on 20 petitions between 2002 and 2006 (DOI, 2007).

4.2. Factors affecting listings

We documented that process times from governmental acknowledgement of imperilment to final listing as a threatened or endangered species greatly exceeded the time frames contemplated in the ESA, as species waited a median 12.1 years. Listing under the ESA triggers protection from take and trade, designation of critical habitat, development of a recovery plan, and specific requirements on federal agencies to avoid jeopardizing listed species or adversely modifying their critical habitat, as well as making species eligible for recovery funding. Thus, listing delays forestall substantial protection and funding for species, during which time species may experience further declines, increasing both the cost of recovery and ultimately extinction risk (McMillan and Wilcove, 1994; Suckling et al., 2004). Our results indicate that taxon, initiator, and litigation were all factors significantly affecting the time required to list imperiled species as threatened or endangered. Below, we describe how each factor impacted listing delays over the 40 year history of the ESA.

4.2.1. Taxon

Our results indicated that taxon substantially influenced the listing process. Specifically, imperiled vertebrates were addressed more rapidly than invertebrates and plants, with the exception of the arachnids that drove the "other" category. While ferns and insects were not significantly different in process time than vertebrates, they were qualitatively slower (Tables 1, 2). The ESA does not prioritize listing or recovery of vertebrates over any other group. The Service does use a prioritization system for listing candidates based on taxonomic distinctness (as well as the magnitude and immediacy of the threats to extinction), but in accordance with the statute, it prioritizes monotypic genera and full species over subspecies without consideration of taxonomic class (USFWS, 1983). Our results thus indicate biases in the listing process that directly contradicted law and policy. Indeed, a key component of the ESA is that it explicitly allows protection of plants and invertebrates, whereas two precursor laws and other international lists have only addressed vertebrates.

The ESA included a provision that directed the Smithsonian Institution to develop a list of plants requiring protection; the Smithsonian provided such a list in 1975, including 3187 imperiled plants, which the Service treated as a petition (USFWS, 1975), and subsequently proposed 1726 of these species for listing (USFWS, 1976). The Service had yet to finalize protection for these plants by 1978, at which time Congress amended the ESA to require finalization of all proposed listings within two years. When the Service had not finalized listing of most of these plants two years later, their proposed protection was withdrawn. Instead, the Service put the bulk of these plant species on what became the first candidate list in 1980, wherein the majority waited for subsequent years, and sometimes decades, for protection. This history is insightful regarding the underpinnings of our results indicating longer

wait times experienced by plants. The Service was similarly slow to list many invertebrates that were identified as candidates in the 1980s. Many of these species would not see protection until lawsuits were filed in the late 1980s and 1990s that forced their listing.

4.2.2. Initiator

Our results indicated differences in listing processes that were initiated by the Service, by third parties, and for species initially addressed by the Smithsonian Institution, which follow two different review tracks. There are statutory time limits on process steps for the third party initiations, but no time limits for the Service until a proposed rule is written, at which time final rules must be issued within one year. Maximum process times for third party petitions are two years, which includes 12 months for both status and final reviews. However, our results document substantially more lengthy timeframes for listing – the absolute median time for the Service and third party initiated listings were respectively 6.70 years (range 0.39–38.36) and 8.95 years (range 0.72–29.49). Median time for Smithsonian petitioned plants was 18.31 years (range 2.59–38.36). Additionally a previous analysis of the petition review process, which should be completed in 90 days, estimated a median time for a decision on a petition was 2.5 years (range 0.3–15.2) (USGAO, 2008), thereby documenting additional delays. The Service has the ability to quickly provide protection for species by proposing listing absent initial candidacy or petition findings, which in part explains the difference in wait times. That the difference was not greater reflects that the Service has used this authority for only 8.2% of listed species in our dataset.

4.2.3. Lawsuits

Litigation has been used as a tool to speed or promote consideration of petitions or candidates stalled in the review process. Accordingly, our results indicated an association between species with extended process times and litigation. For species with lawsuits, significantly more time had passed at the time of lawsuit filing, when compared to species that transitioned to the next phase of the listing process without litigation. Additionally, the process appeared to accelerate substantially after lawsuits were initiated (Fig. 3). Together, these results indicated that organizations filing lawsuits effectively addressed species stalled in the listing process.

Prior to the 1990s, lawsuits were rarely filed to speed protection of species. In 1990, the inspector general for the Department of Interior audited the listing program and concluded that FWS was not making sufficient progress to address the large backlog of candidate species that had built up during the 1980s, which at the time amounted to >3000 (DOI, 1990). Following this audit, three lawsuits (California Native Plant Society v Lujan, 1991; Conservation Council for Hawaii v Lujan, 1990; Fund for Animals v Lujan, 1992) were filed and settled, and each required the Service to process listings of hundreds of candidate species, leading to the flurry of listing activity in the mid-1990s (Fig. 2). Similarly, litigation filed starting in 2006 led to two settlement agreements in 2011 (Center for Biological Diversity v Salazar, 2011; WildEarth Guardians v Salazar, 2011) that required the Service to make listing determinations for >250 candidate species. Further, the suits led to findings on petitions for hundreds of species and an associated increase in the rate of species listings (Fig. 1).

The use of litigation has been criticized for both diverting funding and removing discretion from FWS' priorities (US House of Representatives, 2011, 2013); however, no research is available to support either claim. In regards to funding, the cost of litigation does not come from the Service but instead from the Department of Justice, which in cases where plaintiffs are successful, pays attorney's fees out of a specific fund for this purpose. Brosi and Biber (2012) identified that petitions and lawsuits initiated by citizens identified species with higher imperilment levels than species initiated by the Service. Our results provide supportive evidence, as we observed that first, litigation identified species that waited within the listing process longer than species without lawsuits; and second, that species progressed through the listing process rapidly following the initiation of litigation. Both studies quantitatively identified what should be considered positive outcomes, specifically that third parties pursue protection for more imperiled species and speed process time, thereby hastening the preservation of biodiversity. One might imagine a role for conservation non-governmental organizations (NGOs) whereby they identify and write proposed and final rules to speed the listing process. The US Government Accountability Office (GAO) (2002) notes that staff time (i.e. salary) for federal employees is the predominant use of the listing budget; therefore, working with NGOs could extend limited resources to more efficiently process listings. This has been observed in recovery funding as regional offices prioritize recovery spending on species where private partnerships may enhance meeting recovery objectives (USGAO, 2005).

The three settlements reached in the early 1990s dramatically increased the number of species listed from 1991 to 1997 (Fig. 1) (Greenwald et al., 2006). This increase did not go unnoticed. In 1995, Congress passed a rider on a government spending bill that enacted a one year moratorium on species listings. Additionally, the Clinton administration undertook three actions to reduce listings. The first was elimination of the Category 2 (warranted but data deficient) candidate list in 1996 under which the majority of candidate species (approximately 3200 versus 182 Category 1 in 1996) were classified (Crystal, 1997). Second, a policy change disallowing third party petitions of candidate species and thus ensuring that candidate species would not be subject to the strict deadlines applied to petitions (Greenwald et al., 2006). Third, beginning in 1998 and every year since, the administration (via budget requests by the Service) asked Congress to cap the amount of money that could be spent on listing and critical habitat (a single line item in the budget), which prevents the Service from diverting funding from other budgets to list species. The budget cap is a secondary way in which lawsuits influenced listing rates, because in many years agency budget requests were based on the number of findings required by court order rather than on the number of imperiled species requiring action. More recently, the Obama administration proposed new regulations to impede petitioners, including prohibiting petitions for more than one species and a requirement that petitions first be submitted to states in which the species occurs (DOI and DOC, 2015). These policy changes were designed to reduce both the number of petitions and listings, likely in response to backlash from economic interests to listing of species (US House of Representatives, 2011, 2013).

4.2.4. Unaccounted for factors

We acknowledge that our analyses do not account for all circumstances that may influence process time. We did not estimate the process time for species whose petitions were withdrawn by the Service or species still in candidacy. Our interpretation of the link between budgets and process time, which is consistent with the GAO, further the idea that inadequate staffing extends process time as ever accumulating species petitions must be managed. Within this framework of finite staff time, withdrawals, current candidates, listing of foreign species, and emergency listings would use resources without receiving explicit acknowledgement of process time for final decisions within our framework. That said, the time spent on these ESA listing activities were first, outside the scope of our question regarding process time for listed species; but second, are in their own way accounted for in the analysis. If process time for a listed species extends due to work on a withdrawal or emergency listing, ultimately that is accounted for in the process time for species moving through the regular process.

Process time may also be affected by stakeholders external to the Service. Ando (1999) observed that interest groups (both for or against listings) could affect process time via submitting comments, requesting hearings, or requesting Congressional representatives to advocate their position. Additionally, analysis of congressional representation on the Department of the Interior subcommittee of the US House Appropriations Committee identified that represented states had fewer ESA

listings than states without representation (Rawls and Laband, 2004). A similar analysis relating individual members' League of Conservation Voters scores, identified greater ESA listings in states where subcommittee members had higher (pro-environment) scores (Harllee et al., 2009). These studies suggest that politicians can influence the ESA listing process, a factor unaccounted for in our analysis of process time.

4.3. Conservation implications

Delays in the listing process may increase extinction risk (Stanton, 2014). Suckling et al. (2004) documented 42 species that went extinct during a delay in the listing process between 1973 and 1995. They also estimated that 29 extinctions occurred without a petition being written (Suckling et al., 2004). Their results highlight the paramountcy of a swift listing process for decreasing extinction risk. Further, more species went extinct while in the ESA listing process than those that had already received protection, indicating the detriment of long-term candidacy on the preservation of biodiversity (Suckling and Taylor, 2006). Given that thousands of species were automatically removed from candidacy due to the 1996 administrative policy change (Crystal, 1997) and that only a fraction of plants on the Smithsonian petition were ever listed, the current candidate list does not reflect all of the presumably imperiled biota. Wilcove and Master (2005) estimated there may be more than 10 times the number of imperiled species than protected under the ESA; relatedly, the ESA recognizes approximately 36% of imperiled species recognized by IUCN (Harris et al., 2012).

The US Fish and Wildlife Service appears to have recognized the need to accelerate petition reviews, or at least increase transparency into the decision-making process, as new draft petition prioritization rules were posted to the Federal Register on January 15, 2016 (USFWS, 2016). Five new categories which account for both level of imperilment and data availability have been proposed to prioritize the initiation to proposed phase we discussed in this paper. The research community will be able to use these lists, or similarly IUCN data, to initiate studies that could aid the Service by providing information helpful to making informed determinations where there are data deficiencies.

Listing multiple species in a single action has been proposed as a mechanism to speed imperiled species listings, even appearing as a recommendation in the 1990 Inspector General's audit of the listing program (DOI, 1990) and supported by FWS in policy (USFWS, 1994) if not wholly in practice. Our results indicated no significant differences in process time between single and multi-species listings in petitions not associated with lawsuits. Thus greater utilization of multi-species listings may benefit biodiversity by decreasing overall workload for the Service. To list all of the species protected as of 2014 would have required 3.2-fold more listing findings without the use of multi-species listings, which suggests that packaging species for listings is an efficient means to address backlogs. We noticed that multi-species listings tended to address taxonomically similar species in close geographic proximity. While the Interagency Policy for the Ecosystem Approach to the Endangered Species Act (1994) allows for protection of diverse taxa within ecosystems in multi-species listings, it does not appear that this use of multi-species listings have been employed.

4.4. International context

An efficient and unbiased ESA listing process should be a goal for future biodiversity policy in the US, in part due to its potential to influence policy worldwide. The ESA serves as a model, through its structure, successes, and failures, for others developing biodiversity conservation policies (Mooers et al., 2007; Woinarski and Fisher, 1999). Analyses of the factors which influence endangered species listings and recovery plans highlight country specific values, political realities, or legislative or administrative deficiencies within the acts. Our analyses echo critiques of other endangered species listing policies specifically in the finding of biased listings. Taxonomic biases have also been observed in Australia's Environmental Protection of Biological Conservation Act (EPBCA) (Walsh et al., 2013) and the European Habitats Directive (Cardoso, 2012). Geographic biases have been reported for both Canada's Species at Risk Act (SARA) and the Habitats Directive (Cardoso, 2012; Mooers et al., 2007; Waples et al., 2013). We did not analyze geographic range as a factor due to known biodiversity hotspots in the southeast and California which could confound the data analysis. Other reported biases include under listing harvested (Findlay et al., 2009), migratory (Shumway and Seabrook, 2015), and data deficient (Favaro et al., 2014; Lukey and Crawford, 2009; Roberts et al., 2016) species.

Other countries with endangered species legislation do not have the strict statutory time frames for listing similar to the ESA. Canada's process has been estimated to take at least 3.75 years with an undefined time period for the Environmental Minister to review a recommendation (Waples et al., 2013). Alternatively, Australia does not have time frames for listings although the government estimates species remain in consideration for one to two years; statutory time frames have been proposed as a way to decrease uncertainty in Australia's process (Hawke, 2009). Conducting process time analysis on SARA, EPBCA, and similar legislation may help identify steps in country specific processes in which to improve efficiencies to achieve greater biodiversity protection. Process time analysis could alternatively show that backlogs of species have not accumulated under these younger pieces of legislation; this result could benefit the conservation community by identifying efficiencies within implementation of endangered species legislation.

One of the most challenging aspects of species conservation around the world is the potential for conflict with powerful economic interests. Our results show that empowering citizens to advocate on behalf of species may balance the scales towards conservation; as we observed that the use of litigation identified species not moving expeditiously through the listing process. Allowing citizens to take to the courts to protect species in other countries may similarly speed protection. We also note that litigation has been used to require the writing of recovery plans under SARA and thus could be effective for encouraging species conservation on other fronts (Bankes et al., 2014).

5. Conclusions

Our results highlight several factors that have biased and hindered the preservation of biodiversity through the implementation of the ESA. Whereas some species swiftly received the protections envisaged at the inception of the law, others species have lingered for many years, even decades, awaiting protection. Our results show that the process time from petition to listing would need to increase in speed 6-fold to meet statutory limits under the ESA. An increase in number of species listed annually, which currently stands at roughly 50 species per year, would be needed to provide protection to the hundreds of species not currently recognized as candidates, but that are in fact imperiled. Plant and invertebrate species experienced longer delays indicating biases in the listing process. Active public involvement through petitions and litigation accelerated species through the listing process. This result stands in contrast to unsupported assertions that litigation draws resources away from species conservation. Over time, there have been several attempts to address and improve the listing process, but the backlog of imperiled species currently awaiting attention indicates that those efforts have not been totally successful.

The US Fish and Wildlife Service has annually requested, and been granted, a cap on the listing budget despite governmental acknowledgement of backlogs, and independently published accounts indicating that additional funding was needed to list species. Given the GAO's estimate that the rate limiting step in the ESA listing process is staff to process and write proposed and final rules, an increase in processing could be met with increases in the Service's staff and budget. This increase needs to start with budget requests from the Service reflecting

the true needs of the listing program. Additionally, the Service has spoken out against citizen involvement in the listing process, even though outside petitions and litigation hasten protections. The way in which the ESA listing process is currently being implemented misses opportunities to prevent extinction by failing to provide expeditious protection to at risk species.

Author contributions

EEP and DCK designed research, structured manuscript, and analyzed data. EEP and NG collected data. All authors contributed to the preparation and editing of the manuscript.

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Appendix A. Supplementary data

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