SALIENCE, SPECIAL INTEREST, AND SCIENCE: AN EMPIRICAL ASSESSMENT OF ESA LISTING DECISIONS

A Dissertation

by

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ABSTRACT

It is collectively understood that the best quality science is needed to inform policy decisions; however, what constitutes quality science or how much scientific evidence is needed to make an informed decision is usually unclear. The Endangered Species Act (ESA) seeks to protect plants and animals in their native habitats and the use of "best available science" is required to make decisions regarding the listing of species as endangered or threatened. To date, no comprehensive study has evaluated the interaction of "best available science" and public and private interests in the bureaucratic decision-making process within a limited period. In 2011, U.S. Fish and Wildlife Service (FWS) reached agreements to create a multi-year work plan to review 251 candidate species to determine if they should be protected by the ESA which provides a unique opportunity to evaluate listing decisions in a narrow period.

For most species evaluated under the ESA, the population and range extent were consistently unknown, and the strong influence of non-biological variables on listing decision indicate that scientific and commercial data are not the sole source of influence on likelihood of species protection. Additionally, species decisions that provided estimates on population metrics varied markedly by what population sizes constitute protection. My results indicate that species included in multi-species Rules were more likely to be protected than those evaluated on their own and likelihood of protection was much higher for species that had been on the candidate list for >10 yrs and the public directly influences bureaucratic behavior and decision quality. Other factors influencing decision quality interacted with workload, suggesting that under greater resource restrictions, bureaucrats will focus their resources on decisions that have higher potential negative feedback in order to avoid criticism. Additionally, the dynamics of listing decisions affecting public lands were different from those affecting private lands. My recommendations for improvement of ESA implementation include increased overall transparency in the listing process including what constitutes an endangered or threatened species, clarity in who is making the final decisions, and specifying which literature were the primary sources in each decision. Additionally, more funding should be allocated for candidate species research before listing decisions are made and resources should be increased for overextended regions and offices.

DEDICATION

For my husband and daughter, Brian and Juniper.

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NOMENCLATURE

BAS	Best Available Science
BLM	Bureau of Land Management
DOI	Department of the Interior
ESA	Endangered Species Act
FR	Federal Register
FWS	United States Fish and Wildlife Service
IUCN	International Union for Conservation of Nature
LCV	League of Conservation Voters
LPN	Listing Priority Number
NMFS	National Marine Fisheries Service
NPS	National Park Service
PRJ	Peer-reviewed Journal
USFS	United States Forest Service

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CHAPTER I

INTRODUCTION

Policy initiation, development, and implementation is often informed by scientific understanding. The extent of the science-policy interaction needed for reliable decision-making is unclear and often disputed (Doremus 1997, Pedersen 2014). This is because policies are social constructs that reflect the values of the societies they govern and, thus, science can only provide the information, not the answers (Wilhere 2008). It is collectively understood that the best quality science is needed to inform policy decisions, demonstrated by the special issues published by scientific journals as well as numerous national and international meetings and symposiums which focus on the topic (Francis et al. 2005). However, what constitutes quality science or how much scientific evidence is needed to make an informed decision is usually unclear. This is exacerbated because a major principle of scientific research is that results of study can only support a theory, not confirm it (Popper 1959, Lakatos 1970). Therefore, decision makers are usually required to make decisions with varying degrees of risk. Because the scientific evidence will never be certain and comprehensive, it may be more appropriate to explore which policy conditions and procedures encourage the best use of robust science.

United States policy mandates are often ambiguous, allowing for more pluralistic bargaining (Lowi 1979, Chun and Rainey 2005) and maximization of support from a variety of constituencies with varying views and values (Page 1976). Vague mandates, however, leave more room for interpretation by bureaucrats during implementation of these policies. When the subject of the policy is highly complex then interpretation and implementation becomes even more cumbersome and difficult (Ingram and Schneider 1990, Matland 1995, Chun and Rainey 2005). Along with significant discretionary status for bureaucracies ("abdication principle") (Lee 2012), Congress attempted to incorporate more strict scientific mandates in the federal conservation statutes of the 1960s and 1970s to ensure the appearance of objectivity in complex environmental decisions but did not foresee the obstacles of implementing unbiased scientific methods in the context of imperfect science and value-laden decisions (Doremus 1997).

Multiple policy stakeholders have the potential to influence bureaucratic behavior from both top down and bottom up. Legislators can exert their influence on agencies through budgeting, political appointments, administrative resources, congressional hearings, and the news media (Wood and Waterman 1993, Innes and Mitra 2015). Bureaucracies can also have their own political power and discretion by blocking information leakage or controlling what information gets released (Lee 2012). These situations allow the agencies to maintain a high brokerage capacity and increases their ability to establish environments of negotiation with interest groups (Lee 2012). Administrative agencies must also react to the public in situations that maintain prominent attention (i.e., salient) and adjust their behavior and outputs to avoid negative reactions (Leaver 2009).

The Endangered Species Act of 1973 (ESA; the Act) is perhaps one of the most comprehensive and controversial environmental laws in U.S. history despite being signed with bipartisan support. Meant to prevent species extinction by managing threats and mediating recovery, the ESA seeks to protect plants and animals in their native habitats. A rising number of species are declining because of anthropogenic changes to their habitat across the United States (Andren 1994, Gratwicke et al. 2012, Merritt and Bateman 2012). Despite implementation of many recommendations from scientists and policy makers over the years, the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (USFWS and NMFS) are frequently ridiculed and litigated against for their decisions surrounding listing decisions and enforcement of the ESA (Rohlf 1991, Wilcove et al. 1993, Benson 2012).

The ESA Listing Process

The process of listing a species under the ESA is extensive (Fig. 1) and requires many steps that may take a couple of years or decades. A species listing can be initiated either by internal assessment by FWS or NMFS or by petition from private citizens or organizations. An initial assessment of the petition must conclude there is sufficient information about species' vulnerability and exposure to threats. The FWS then publishes a 90-day finding rule in the Federal Register (Fig. 1) either declaring the petition not sufficient for further review or prompting the FWS to collect and evaluate additional information. The FWS then evaluates all the information available and makes a determination on whether the species is warranted for listing (i.e., endangered or threatened), not warranted, or warranted but precluded (Fig. 1). An amendment to the ESA in 1982 provisioned that a species remains a candidate for listing if it is warranted but precluded by other higher priority listing activities (48 FR 43098) and the species is then required to be re-evaluated each year. When a species is declared warranted but precluded, a species becomes a “candidate” and FWS or NMFS assigns a listing priority number (LPN). LPNs range from 1 to 12 with lower numbers indicating higher listing urgency which is determined by magnitude and immediacy of threats, relative distinctiveness or isolation of genetic material of the species, number of remaining species in the species’ genus, and if it is a subspecies. Section 4 of the ESA lists the five criteria, only one needing apply, for determining if a species is endangered or threatened. The criteria are: 1) the present or threatened destruction, modification, or curtailment of its habitat or range; 2) overutilization for commercial, recreational, scientific, or educational purposes; 3) disease or predation; 4) the inadequacy of existing regulatory mechanisms; or 5) other natural or manmade factors affecting its continued existence.

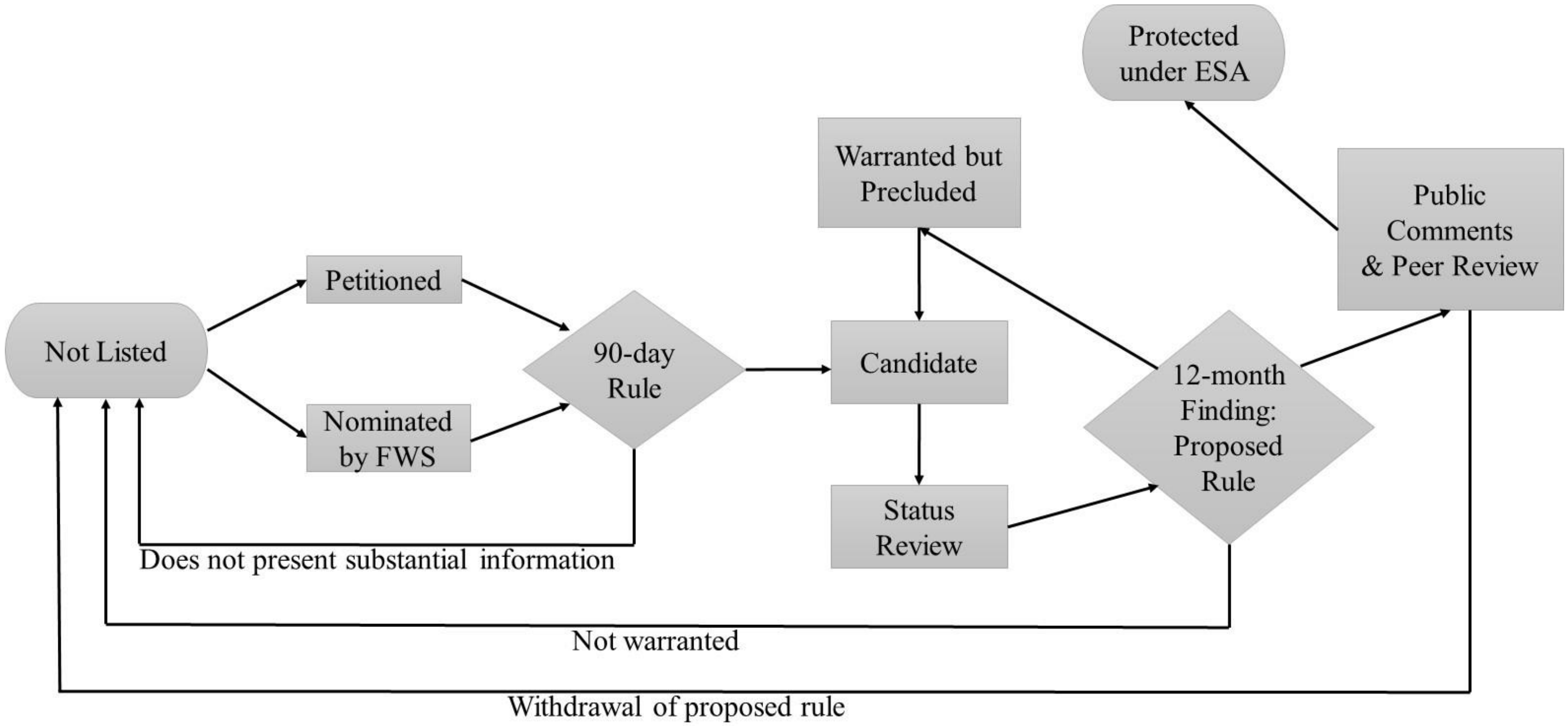

Figure 1. Flow chart representing the process used by U.S. Fish and Wildlife Service (FWS) to evaluate species for listing under the Endangered Species Act (ESA).

If the species is determined to be warranted for listing, a 12-month period ensues during which time public comments are accepted, public hearings are held, and additional information is requested by FWS, including peer review by selected individuals. Unless sufficient evidence is presented that the species should not be listed (e.g., elimination of threats, larger population than previously known) then FWS publishes a Final Rule in the Federal Register and the species assumes endangered or threatened status under the ESA. An alternative to the normal listing process is the issuance of an emergency rule by FWS or NMFS. Emergency rules bypass a large part of the process described above and immediately declare species as endangered if the agency identifies impending threats that create significant risk to the immediate survival of the species. Once emergency listed, the FWS or NMFS conducts a formal full review process.

A common criticism of the ESA is that it is chronically underfunded and this impedes recovery efforts (Mann and Plummer 1995, Abbitt and Scott 2001, Stokstad 2005b, Langpap and Kerkvliet 2010). Funding for endangered species is currently mandated to be allocated based on priority rank (61 FR 64475) based on measures of the degree of threat, potential for recovery, genetic distinctiveness, and conflict with development or other economic activity (Simon et al. 1995). Some reports regarding species-specific spending indicate that funding is based largely on other considerations including funding stability and opportunities for partnership such as states or non-government organizations (Dawson and Shogren 2001, Restani and Marzluff 2001). There is also evidence that certain factors including taxonomic class and, subsequently, lack of data regarding population status and trends affect the amount of protection and funding for many species (Gratwicke et al. 2012). However, Langpap and Kerkvliet (2010) found that documented inconsistencies in FWS recovery spending do not impede the number of species recovering or predicted extinction rates, a claim that is difficult to prove due to the lack of up-to-date recovery plans and scarce data (Neel et al. 2012) for many species already protected as well as a lack of clarity regarding the definition of "recovery" under the ESA (Scott et al. 2005).

Litigation prior to 1995 primarily focused on the effects of various listings on economic and other human interests, not the listing process itself (Baur and Irvin 2010, p. 17). Increasing controversy in the 1990s led to modifications to several facets of the ESA including modifications to the listing process (59 FR 34270, 61 FR 36075, 61 FR 64475) and protection of endangered and threatened species on private lands with policies like "No Surprises" (59 FR 65782) and "safe harbor agreements" (64 FR 32717). A unique conservation tool that eased a large amount of controversy surrounding the ESA in the 1990s was the addition of Habitat Conservation Plans (HCPs) and Incidental Take Permits which allows the lawful "take" of endangered species (ESA Section 10, 61 FR 63854). HCPs allow for continued economic development while setting aside permanent protection for species in the path of the development, which eased tensions between FWS, environmental groups, and private landowners for a period.

By the early 2000s, both an increase in the number of species petitioned by various environmental groups and lack of listing decisions by the FWS had led to a record number of species on the ESA candidate list. In 2011, FWS reached agreements with WildEarth Guardians and The Center for Biological Diversity to create a multi-year work plan to review 251 candidate species to determine if they should be added to the Federal Lists of Endangered and Threatened Wildlife and Plants by 2016 (WildEarth Guardians v. Salazar 2011). This provides a unique opportunity to evaluate listing decisions in a narrow period, eliminating variation that would occur across many decades and administrations. In this study, I use data from current species listings decisions (i.e., Federal Register; 2011 - 2014) to evaluate listing decisions for a wide variety of species made by the FWS under various levels of available reliable scientific literature, public salience, and interest group participation.

The use of "best available science" is required to make decisions regarding the listing of species as endangered or threatened under the Endangered Species Act (Woods and Morey 2008). However, "best available science" remains undefined in the Act. Several court decisions have refined the subject and provided practical guidelines (Table 1). The Department of the Interior released an interagency policy for information standards in 1994 "to require biologists to evaluate all scientific and other information that will be used to…support listing actions… to ensure that any information used by the Services to implement the Act is reliable, credible, and represents the best scientific and commercial data available" (USFWS and NMFS 1994). Rohlf (1991), Doremus (1997), and others have discussed the dilemma of defining what it means to be endangered or threatened, in that these definitions are guided by what society deems to be an acceptable level of extinction risk. However, they also point out that society's choice should be guided by science. Based on these conclusions, the policy guidelines listed in Table 1 may be encumbering accurate policy decisions.

Table 1. Summary of guidelines for U.S. Fish and Wildlife Service and National Marine Fisheries Service imposed by the courts in the context of "best scientific data available" under the Endangered Species Act (ESA; Baur and Irvin 2010).

Agencies may not manipulate their decisions by unreasonably relying on certain sources to the exclusion of others
Agencies may not disregard scientifically superior evidence
Relatively minor flaws in scientific data do not render the information unreliable
Agencies must use the best data available, not the best data possible
Agencies may not insist on conclusive data in order to make a decision
Agencies are not required to conduct independent research to improve the pool of available data
Agencies must rely on even inconclusive or uncertain information if that is the best available at the time of the decision
Agencies must manage and consider the data in a transparent administrative process

To date, no comprehensive study has evaluated the interaction of "best available science" and public and private interests in the bureaucratic decision-making process within a limited period. In this dissertation, it is my goal to summarize the listing process and the important factors that influence listing decisions under the ESA as well as the circumstances which encourage the most appropriate use of reliable science. I begin by summarizing characteristics, both biological and in general, of recent listing decisions both nationally and by FWS region. I then determine if biological metrics or other non-biological listing characteristics correlate with FWS listing decisions, hypothesizing that population and range size will influence ESA listing decision, at least in part. I then assess the role of bureaucratic behavior under various levels or public and interest group pressure on influencing the reliability of science used, predicting that avoidance of negative feedback and bureaucratic workload will alter FWS behavior due to limited time and resources. The overall goal of this dissertation is to better understand the factors that influence bureaucratic behavior through analyses of ESA listing decisions in order to elucidate changes that could enhance decision-making conditions and, hence, improve overall decision quality.

CHAPTER II

WHAT IS (UN)KNOWN: THE ENDANGERED SPECIES ACT

Listing a species under the Endangered Species Act (ESA) is a costly and time-consuming process (Woods and Morey 2008). As of 2005, 39% of listed species had an uncertain population status (Stokstad 2005a). The lack of empirical data regarding population status and trends for candidate species, the critical information that should be informing listing decisions, may be leading to misallocation of funding and other resources to species that do not need the support and away from species that are rare and declining. As of 2005, 15 species had been subsequently delisted after more research revealed that their populations were larger than previously determined (Stokstad 2005a). Additionally, delisting a species can be exceedingly difficult because of the paradigm established (i.e., the species is in danger of extinction and subsequent studies rely on this idea as the basis for their questions) once the species is deemed worthy of protection under the ESA, regardless of its actual population status (Morrison et al. 2012).

A more recent example of a listed species' population exceeding what was previously known after appropriate surveys methods were implemented is the Lake Erie watersnake (*Nerodia sipedon insularum*). Federally listed as a threatened species in 1999, the Lake Erie watersnake was removed from the ESA in 2011, citing "recovery" based primarily on population estimates from a long-term survey (USFWS and King 2011). Starting in 2001, standardized surveys consistently indicated population estimates exceeded those set forth in the Lake Erie watersnake Recovery Plan for 4 of the 5 targeted populations and 5 out of 5 beginning in 2002 (USFWS 2003, USFWS and King 2011). It is clear the snake's population was not in peril, as was believed during the ESA listing process, and the resources and funding its protection has occupied could have been allocated towards species that are in more immediate conservation need. Indeed, in addition to the direct and indirect cost of listing the species and protecting it for 12 years (~$1 million; https://www.fws.gov/Endangered/esa-library/index.html), the post-delisting monitoring plan was projected to cost ~$289,000 over 5 years and the plan admits acquiring these funds would require tradeoffs with other competing endangered species (USFWS and King 2011).

According to previous data and research, the availability of relatively complete and accurate science is lacking in many ways, both before and after the listing of a species as endangered or threatened (Schultz 2008, Gibbs and Currie 2012). Very often, little is known about species distribution, abundance, and threats, simply because there has been very little scientific investigation. Historically, U.S. Fish and Wildlife Service (FWS) was guided by Congress to be cautious and provide ESA protection for a species when the information is inconclusive (Schultz 2008). Many species have been candidates for listing under the ESA for 10+ years, and some of those species may have slipped beyond recovery while waiting to be listed. For example, Wilcove et al. (1993) found that, according to the best available information at the time of the listing, the median population size of plant species listed from 1985 to 1991 was 119.5 known individuals, placing these populations at high risk of extinction and low probability of recovery because of the long delay while being listed as endangered. The decision process needs to be prompt, with or without thorough scientific data, to help ensure that species do not go extinct while waiting to be listed (Ando 1999).

Previous empirical studies of bureaucratic behavior use either inter-agency (Chun and Rainey 2005, Yackee 2006, Eckerd 2014, Lowell and Kelly 2016) or intra-agency comparisons (Stazyk and Goerdel 2011, Gerlach et al. 2013, Lee 2013) to analyze how agency structure influences performance and relative consequences of their decisions. Focusing on one agency, however, can permit the control of several variables, essentially treating them as constants, while allowing other variables to be more easily measured (Meier and O'Toole 2006). In regards to listing decisions under the ESA, FWS employees likely face similar conditions such as issue complexity (Ringquist et al. 2003), goal ambiguity (Chun and Rainey 2005) and, subsequently, political influence across regions. Therefore, I will examine the influence of variables that can contrast by FWS region including workload, ownership of habitat, public attention, interest group involvement, or political opinions. My objectives for this chapter are to descriptively summarize the information surrounding recent ESA listing decision and assess the differences by FWS region in order to evaluate if FWS decision-makers face similar challenges across the U.S. concerning what data is available for decisions and if there are regional differences in the variables mentioned above. Then I will use these results in Chapters 3 and 4 to help explain potential variations seen in factors influencing ESA decisions and decision quality across FWS regions.

Methods

I collected ESA listing decisions conducted on species that occur in the U.S., Proposed Rules for *not warranted* and *warranted but precluded* species and Final Rules for *endangered* and *threatened* species (hereafter "Rules"), published in the Federal Register (http://www.regulations.gov/). The majority of these species were evaluated because of a 2011 settlement between the FWS and two environmental groups, WildEarth Guardians and The Center for Biological Diversity, to create a multi-year work plan to review 251 candidate species to determine if they should be added to the Federal Lists of Endangered and Threatened Wildlife and Plants by 2016 (WildEarth Guardians v. Salazar 2011). In order to avoid potential bias of a large number of species in one decision, I randomly sampled one species from decisions >6 species and did not include species evaluated in multi-species decisions >14 because they were all Hawaiian species that were evaluated as a group based on threats to their ecosystem, not individual species.

For each species, I collected general information such as listing decision, taxonomic group, category of potential threats, time as candidate species, FWS region and office, and number of other species in the listing decision. I also recorded the states where the species are currently known to occur, if it utilizes island or mainland, and if it is known to occur outside the U.S. during any part of its life history requirements (i.e., Canada or Mexico). I also determined if the species occurs primarily (> 50% of current range) on public (e.g., managed by U.S. Forest Service (USFS), Bureau of Land

Management (BLM), National Park Service (NPS)) or private lands by examining range maps and descriptions of their current range in the Rules published by the FWS.

I accessed NatureServe (http://explorer.natureserve.org) for additional potential threats in case FWS did not list a threat in the Rule because of non-biological reasons. NatureServe, an independent organization which works closely with the International Union for Conservation of Nature to expertly assess threats and levels of endangerment of species, is not legally recognized but has been used previously as an indicator of potential for formal listings under the ESA (Metrick and Weitzman 1996, Gratwicke et al. 2012). I determined time as candidate by calculating the time since the FWS initially deemed the species warranted for full review in a 90-day Rule and the date of the Proposed Rule.

I recorded population estimates, population range size estimates, and descriptive location information from both the published Rules and NatureServe and I noted when population and range size estimates were not available in the Rule. For each species, I recorded the maximum and minimum population estimates and maximum and minimum range size estimates as well as if FWS estimated the population or range size in the Rule. I evaluated public attention for each species decision by recording the number of total news articles published by an established media organization, a metric considered to be an accurate metric for comparisons of issue salience (Epstein and Segal 2000), published online between 6 months prior and post the date of the publishing of the Proposed Rule. Because I did not have previous information regarding the effects of various levels of public attention on FWS behavior, I divided public attention into 3 categories based on the natural breaks in the number of news articles for each species. Based on these natural breaks, I considered public attention "high" if >4 news articles were published during this 1 yr period, medium if 1-4 articles were published, and "low" if 0 articles were published. I used U.S. Congress League of Conservation Voter score (LCV) for each species to assess political influence differences between FWS regions. League of Conservation Voters scorecards rate members of Congress based on environmental, public health, and energy issues. Specifically, I averaged Senator LCV scores in states where the species occur to proximate level of "pro-land-use" (0) to "pro-environment" (100) Congressional representation, similar to Ando (1999).

Results

I collected data on 143 ESA listing decisions from 101 Rules published by the FWS in the Federal Register between 10 February 2011 and 3 October 2014. Fifty-one (35.7%) of the 143 species were designated as *endangered*, 22 (15.4%) were designated as *threatened*, 17 (11.9%) were deemed *warranted but precluded*, and 53 (37.1%) were declared *not warranted* for protection under the ESA (see Appendix A for a complete breakdown of taxonomic class by decision). Of the species evaluated, 78 (~55%) have habitat that occurs primarily on private property while the remaining 65 (~45%) species occur primarily on public land. One-hundred and twenty (84%) of the species evaluated occur exclusively in the U.S. while 14 (10%) and eight (6%) have ranges that also overlaps Canada and Mexico, respectively. Of the total listing decisions, 82 (57%) came from multiple species rules (i.e., ≥2 species per rule) and 61 (43%) were single species decisions. Eighty-three (58%) of the evaluated species were exclusively terrestrial, 52 (36%) were exclusively aquatic, and 8 (~6%) utilized both terrestrial and aquatic habitats at some point in their life cycle. Only 11 species exclusively inhabit islands while eight of the evaluated species utilize both islands and mainland.

FWS presented a current population range size estimate for 44 (~31%) species decisions and a population size estimate for 47 (~33%) decisions (Table 2). Rules for plant species contained the largest percentage of population and range estimates and aquatic invertebrate rules presented the fewest (Table 2). When NatureServe estimates are included, terrestrial invertebrates had much smaller minimum population size estimates than other taxa and birds had the smallest maximum population estimates (Table 3). The smallest ranges belonged to terrestrial invertebrates and the largest ranges belonged to herpetofauna, which also had the largest amount of variation in range sizes (Table 3). Of the species deemed warranted for protection by the FWS (i.e., endangered or threatened), I found clear peer review documents for the proposed rule 75% of the time. Of the remaining decisions, I could not clearly distinguish which documents in the docket folder were peer review as opposed to public comments for 7 (~10%) species and the remaining 11 (15%) decisions did not provide peer review. The most common threats to species overall was land conversion, population isolation, and exotic or invasive species (Table 4). The most common threats to aquatic species also included water diversion while climate change appears to threaten species that utilize both aquatic and terrestrial habitats (Table 4).

Table 2. Total count and percentage of species by taxonomic group and count and percentage of Rules published by U.S Fish and Wildlife Service (FWS) containing population and range estimates for Endangered Species Act (ESA) listing decisions evaluated from 2011 –2014.

		Estimated by FWS	
Taxonomic group	# of species	Population	Range
Plant	40 (28.0%)	26 (65%)	20 (50.0%)
Terrestrial invertebrates	30 (21.0%)	5 (16.7%)	12 (40.0%)
Aquatic invertebrates	23 (16.1%)	5 (21.7%)	0 (0.0%)
Herpetofauna	18 (12.6%)	1 (5.6%)	4 (22.2%)
Fish	14 (9.8%)	2 (14.3%)	4 (28.6%)
Mammals	9 (6.3%)	1 (11.1%)	3 (33.3%)
Birds	9 (6.3%)	7 (77.8%)	1 (11.1%)
Total	143	47 (32.9%)	44 (30.8%)

Table 3. Population size (# of individuals) and range sizes (ha) estimated by U.S. Fish and Wildlife Service in listing decisions or by NatureServe by taxonomic group for species being evaluated for listing under the Endangered Species Act from 2011 – 2014.

Taxonomic group	Min. population	Max. population	Min. range (ha)	Max. range (ha)
Plant	141,774 ± 682,367 (*n* = 34)	172,007 ± 824,944 (*n* = 34)	196,923 ± 1,000,821 (*n* = 34)	232,706 ± 1,008,624 (*n* = 34)
Terrestrial invertebrates	1,228 ± 2738 (*n* = 12)	155,924± 374,628 (*n* = 12)	12,453 ± 28,271 (*n* = 23)	960,823 ± 4,159,373 (*n* = 23)
Aquatic invertebrates	85,466 ± 245,331 (*n* = 18)	334,458 ± 437,205 (*n* = 18)	198,169 ± 436,629 (*n* = 22)	1,499,546 ± 4,200,236 (*n* = 22)
Herpetofauna	12,758 ± 29,207 (*n* = 11)	220,508 ± 387,988 (*n* = 11)	19,138,259 ± 60,910,365 (*n* = 17)	70,208,259 ± 169,673,781 (*n* = 17)
Fish	10,112 ± 21,268 (*n* = 10)	205,634 ± 394,831 (*n* = 10)	330,558 ± 618,853 (*n* = 9)	2,436,363 ± 6,224,356 (*n* = 9)
Mammals	43,792 ± 47,117 (*n* = 6)	600,417 ± 468,403 (*n* = 6)	3,692,106 ± 4,193,006 (*n* = 5)	4,192,106 ± 3,894,377 (*n* = 5)
Birds	14,524 ± 22,595 (*n* = 9)	20,999 ± 21,427 (*n* = 9)	6,154,167 ± 7,615,353 (*n* = 6)	127,926,667 ± 133,742,066 (*n* = 6)
Total	69,682 ± 409,790 (*n* = 100)	218,899 ± 575,934 (*n* = 100)	3,379,342 ± 23,662,709 (*n* = 97)	17,687,397 ± 77,507,541 (*n* = 97)

Table 4. Count and percentage of species by threat type and utilized general habitat type according to U.S. Fish and Wildlife Service or NatureServe in Endangered Species Act listing decisions from 2011 – 2014.

Threat	Description	Aquatic	Terrestrial	Both	Total
Agriculture	Crop or livestock production	25 (48%)	30 (36%)	0 (0%)	55 (38%)
Land conversion	Urban or suburban development; road construction	23 (44%)	51 (61%)	3 (38%)	77 (54%)
Resource use	Mining, oil and gas extraction, timber harvest	20 (38%)	25 (30%)	2 (25%)	47 (33%)
Water diversion	Dams, dredging, or extraction	41 (79%)	11 (13%)	0 (0%)	52 (36%)
Commercial fishing	Indirect effects of overfishing or equipment use	0 (0%)	0 (0%)	3 (38%)	3 (2%)
Competing uses (other)	Recreational, military, etc.	6 (12%)	31 (37%)	1 (13%)	38 (27%)
Exploitation	Collection or killing by humans	4 (8%)	10 (12%)	4 (50%)	18 (13%)
Climate change	Harm due a change in the mean or variability of one or more measures of climate that persists for an extended period	20 (38%)	31 (37%)	5 (63%)	56 (39%)
Modified disturbance regimes	Altered historical fire and grazing patterns	7 (13%)	42 (51%)	0 (0%)	49 (34%)
Pesticides/Herbicides	Direct or indirect effects of pesticides or herbicides	9 (17%)	13 (16%)	0 (0%)	22 (15%)
Pollution (other)	Contamination of habitat by toxic substances	23 (44%)	2 (2%)	5 (63%)	30 (21%)
Exotic/invasive spp.	Exotic or invasive species displacing species or species' habitat	34 (65%)	38 (46%)	4 (50%)	76 (53%)
Species interactions	Depredation, parasitism, disease	8 (15%)	20 (24%)	3 (38%)	31 (22%)
Small, isolated populations	Population(s) small and relatively isolated	38 (73%)	58 (70%)	1 (13%)	97 (68%)
Unknown/Other	Other threats that do not apply to categories above or species decline is caused by an unknown factor	2 (4%)	6 (7%)	0 (0%)	8 (6%)

Regional differences

Most of the decisions (~33%) came from FWS Region 2, specifically Arizona and Texas Offices, while the fewest decisions came from the FWS Region 5 (<1%) which encompasses the states in the Northeastern U.S. (Table 5). Texas contained the highest number of species evaluated, followed by California and Arizona (see Appendix B for complete list of decision by state). FWS regions 1, 2, 3, 4, and 5 evaluated species that primarily occurred on private property while regions 6, 7, and 8 evaluated species that occurred primarily on public land. All Rules published in FWS region 7 (n = 3; Alaska) contained a population estimate; however, the other regions supplied this estimate for <40% of the species (Fig. 2). Region 8 (n = 29; Pacific SW) provided the largest number of decisions with range size estimates and regions 3 (n = 9; Great Lakes) and 7 (n = 3) supplied the fewest (Fig. 2). Regions 1, 6, and 7 had the largest number of species with high public attention and regions 2, 3, and 8 had the fewest (Table 6). Highest LCV scores (i.e., pro-environment) occurred in regions 1 and 8 while the lowest (i.e., pro-land use) occurred in regions 2 and 4 (Fig. 3). LCV scores in regions 3, 6, and 7 were moderate (Fig. 3).

Threats varied across FWS region, but FWS and NatureServe cited the threat of invasive species and population isolation consistently for species across most regions (see Appendix C for complete proof of threats by region). Land conversion appears to be a major threat to species in region 4 (87% of species; Southeast) as well as influencing declines of many species in regions 1 (64%; Pacific) and 3 (67%; Great Lakes). FWS and NatureServe cited agriculture as a threat to a majority of the species evaluated in regions 2 (51%; Southwest) and 3 (67%) while commercial fishing and exploitation only appears to be major threats to species in region 7 (67%; Alaska). Climate change was listed as threat for the majority of species evaluated in the more mountainous region 6 (58%; Mountain Prairie) and the high latitude region which ecompasses Alaska (100%), but FWS did not consider it a threatening factor for any decisions in region 3 (Midwest). Resource use, specifically oil and gas extraction, was considered a major threat for species evaluated in region 3 (78%) either directly or indirectly and affects ~1/3 of the species in all other regions except region 1 (9%; Pacific).

Table 5. Count of species evaluated under the Endangered Species Act by U.S. Fish and Wildlife Service (FWS) region and office from 2011 – 2014.

FWS Region	Office	State	Species
Pacific (1)	Oregon Fish and Wildlife Office	Oregon	1
	Pacific Islands Fish and Wildlife Office	Hawaii	2
	Washington Fish and Wildlife Office	Washington	8
Southwest (2)	Arizona ESFO	Arizona	16
	Arlington Field Office	Texas	2
	Austin Field Office	Texas	18
	Corpus Christi ESFO	Texas	2
	New Mexico ESFO	New Mexico	6
	Oklahoma ESFO	Oklahoma	1
	Texas Coastal ESFO	Texas	2
Great Lakes, Big Rivers (3)	Chicago ESFO	Illinois	1
	Columbia ESFO	Missouri	2
	Columbus ESFO	Ohio	2
	Green Bay ESFO	Wisconsin	1
	Illinois Field Office	Illinois	2
	Rock Island Field Office	Illinois	1
Southeast (4)	Arkansas ESFO	Arkansas	3
	Asheville ESFO	North Carolina	1
	Caribbean ESFO	Puerto Rico	6
	Florida ESFO	Florida	1
	Georgia ESFO	Georgia	2
	Kentucky ESFO	Kentucky	1
	Mississippi Field Office	Mississippi	2
	Panama City Field Office	Florida	1
	South Florida ESFO	Florida	8
	Tennessee ESFO	Tennessee	6
Northeast (5)	West Virginia Field Office	West Virginia	1
Mountain Prairie (6)	Colorado Field Office	Colorado	2
	Montana ESFO	Montana	3
	Nebraska ESFO	Nebraska	1
	Utah ESFO	Utah	5
	Wyoming ESFO	Wyoming	1
Alaska (7)	Alaska Regional Office	Alaska	1
	Fairbanks Fish and Wildlife Office	Alaska	1
	Juneau Fish and Wildlife Office	Alaska	1
Pacific Southwest (8)	Arcata Fish and Wildlife Office	California	2
	Bay Delta Fish and Wildlife Office	California	2
	Carlsbad Fish and Wildlife Office	California	4
	Nevada Fish and Wildlife Office	Nevada	11
	Sacramento Fish and Wildlife Office	California	7
	Ventura Fish and Wildlife Office	California	3

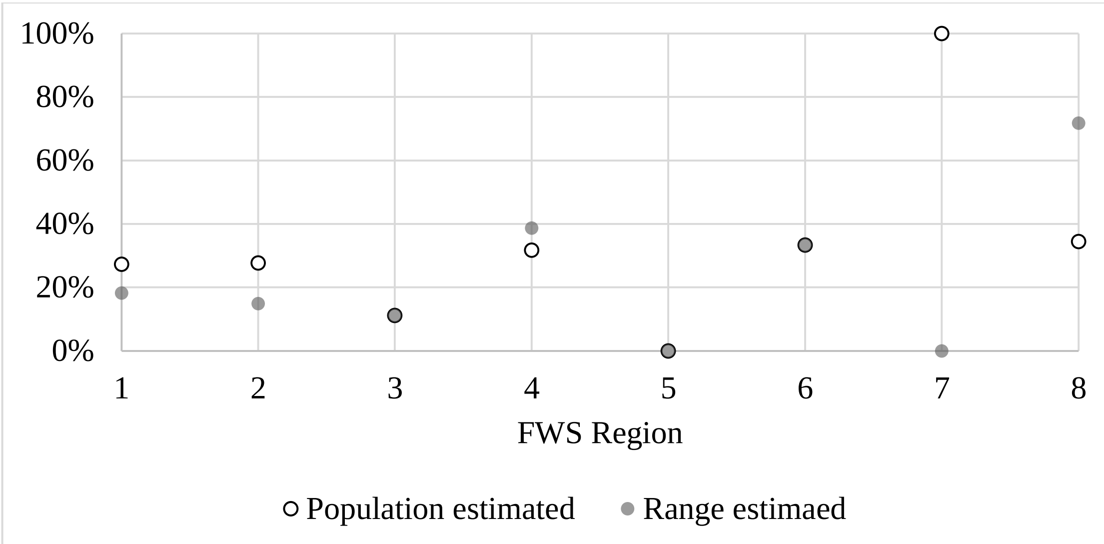

Figure 2. Percentage of Rules containing population and range estimates by U.S. Fish and Wildlife Service (FWS) region for Endangered Species Act listing decisions made from 2011 – 2014.

Table 6. Count and percentage of public attention calculated by number of news articles published during a 1-year period (i.e., 6 months before and after proposed rule published in Federal Register), classified as low (0 articles), medium (1-4 articles), and high (>4 articles) for species evaluated under the Endangered Species Act from 2011 – 2014 in each U.S. Fish and Wildlife Service Region.

	Public Attention		
Region	Low	Medium	High
1	2 (18%)	2 (18%)	7 (63%)
2	22 (47%)	15 (32%)	10 (21%)
3	5 (56 %)	2 (22%)	2 (22%)
4	11 (35%)	15 (48%)	5 (16%)
5	0 (0%)	0 (0%)	1 (100%)
6	2 (17%)	3 (25%)	7 (58%)
7	0 (0%)	1 (33%)	2 (67%)
8	13 (45%)	8 (28%)	8 (28%)

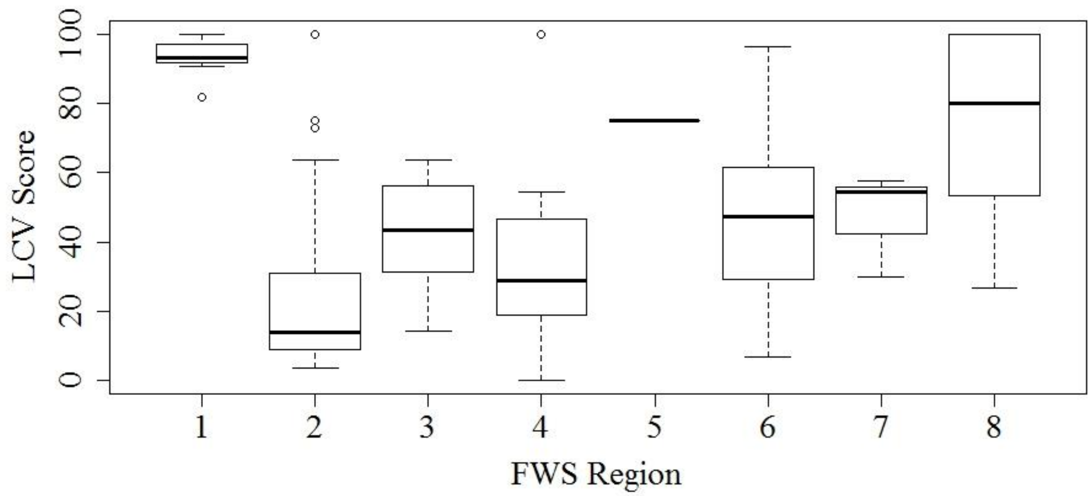

Figure 3. League of Conservation Voter (LCV) scores for species evaluated under the ESA from 2011 – 2014 by U.S. Fish and Wildlife Service (FWS) region.

Discussion

It is clear that for most species evaluated under the ESA, the population and range extent is consistently unknown across all FWS regions. Additionally, species decisions that provide estimates on these metrics vary markedly by what population sizes constitute protection even within taxonomic groups. For most candidate species, FWS is probing for decisions without the possibility of knowing many of the essential facts and this can lead to increased agency discretion and less transparency (Schultz 2008). Previous research shows similar results and conclusions regarding uncertainty surrounding wildlife policy decisions (Easter-Pilcher 1996, Prato 2005, Schultz 2008), but there has been little done to address these issues in regards to the ESA. Further, the lack of clarity induced by the lack of objectively defined terms regarding what it means to be an endangered or threatened species further complicates the decision process (Rohlf 1991, Woods and Morey 2008). Ruhl (2005) argued that “sound science could produce a mountain of relevant data of the highest quality and still provide no clues as to what to do for the purposes of the environmental law decision.” Therefore, in order for sound science to be applied accurately and effectively, there should be clear guidelines for not only its use in the listing process but also what it means to be an endangered species, a definition that is not clearly defined (Wilcove et al. 1993, Fallon 2007).

Wilcove et al. (1998) pointed out that the largest threats to species on the brink of extinction around the world include direct habitat loss and invasive species. Similarly, my data indicates direct conflicts with competing human land use and invasion by exotic species threaten more than half of all species evaluated under the ESA during my study. Indeed, known threats to species in peril are the common denominator between them, and policies that confront conservation needs from the point of view of mitigating common threats rather than single species focuses, like that of the ESA, may be the key to addressing cascading losses in biodiversity. Further, current recovery ESA tools may not effectively address species needs to adequately lead to recovery and delisting (Gibbs and Currie 2012) and, therefore, a more broad ecosystem-based approach which focuses on threats to systems may be more effective. Recently, FWS has attempted to implement more ecosystem-based approaches to listing decisions (i.e., multiple species decisions) and multi-species management plans under the ESA have become more common, potentially a step in the right direction (94 FR 16025). However, the current structure of the ESA as well as the configuration and content of listing rules are not conducive to making decisions based on threats to ecosystems. The consequence of this misalignment of ESA structure and current ESA multiple species (i.e., by geography, taxonomy, or ecosystem) focus could potentially inflate problems regarding landowner perceptions, public opinion, and legitimacy of decisions if FWS gives protections to species under the ESA because of ecosystem-level threats without proper justification of actual population level effects.

Despite similarities, FWS regions and the challenges they face vary by threats posed to species, political influences, public opinion, public attention, personnel, and workload. A major threat in one region may be non-existent in others. Additionally, some FWS regions comprise primarily private land ownership while others are largely publicly owned. These differences affect the level and makeup of stakeholder interactions with bureaucrats in those regions, which could influence institutional behavior in regards to defining “best available science” in each region differently. Further, institutional behaviors that vary by region may be exacerbated by the level of uncertainty surrounding listing decisions due to lack of sufficient data. For example, Gerlach et al. (2013) found that collaborators (e.g., local natural resource community, other agencies with previous positive experiences with the source) with FWS field offices often influence data-selection decisions through recommendations of data sources and these recommendations are perceived as the safe option for agency decision-makers to use as the “best available science”, particularly when there is a high degree of uncertainty. Additionally, resources, both human and financial, likely vary greatly by region (information regarding these details by region are exceedingly difficult to locate). This scenario leads to variation across FWS regions and offices in terms of agency staff that comprise the appropriate expertise, training to differentiate and evaluate sources of varying scientific rigor, and adequate time to make the most appropriate decisions regarding the science that is relied upon for the ESA listing decisions (Murphy and Weiland 2016).

Policy Recommendations

Addressing the issue of uncertainty in ESA decisions is not entirely clear, mostly because there will always be a lack of complete data on population size and trends for most species. However, more funding allocated for research conducted prior to proposed ESA listing rules would likely decrease waste associated with listing species that do not need protections (e.g., Lake Eerie watersnake) and increase funding available to species that would benefit significantly from it. This issue is becoming more important as FWS and NMFS are pressured by environmental groups to list more species and the financial burden of recovering the large number of ESA protected species continues to grow.

Shifting focus from single species protections to more broad geographic or ecosystem-based approaches and the major threats to these areas may be the most cost-effective way to deal with the ever-growing pressure human impacts have on species. For example, if we know that exotic or invasive species affect a majority of species of conservation concern, then it makes sense to allocate resources that would address the issue directly (e.g., broad-scale exotic species removal programs). The impacts would benefit not only current species of concern but also species and populations that may become threatened in the future, potentially preventing the need for protection under the ESA.

It is unclear if the ESA, as written, is equipped to handle this shift in focus. Congress would likely need to amend a new comprehensively written section to the ESA, aimed to ensure transparency and goals of ecosystem-level conservation in order to avoid the complications of cajoling the ESA to do something it was not originally written to do. The most important impacts could potentially come from modifying or improving other, non-ESA, policies that are currently in place (e.g., Clean Water Act of 1972, local zoning laws) or incentivizing new policies (e.g., best management practices, landowner incentive programs). These policies would need to vary by the characteristics and demands of each region with some focusing on the needs of private landowner and others focused on issues common to public land use (e.g., grazing rights, recreation). The immense demands of broad-scale problems affecting species across the U.S. and around the world requires broad-scale solutions that encourage conservation on several levels.

CHAPTER III

UNCERTAINTY AND ESA DECISIONS

Due to the current alteration of the Earth's ecosystems through human over-population and exploitation of Earth's resources, many paleontologists and biologists believe we are on the verge of a great extinction event with some ecosystems experiencing extinction rates >1000 times the background rate (Pimm et al. 2014). Conservation efforts have managed to slow the decline of many species and, in the U.S., the Endangered Species Act (ESA) of 1973 is considered one of the most powerful laws meant to slow species decline and extinction. Some characteristics may cause a species to be more vulnerable to extinction than others. Extinction probability increases with the inability of a species to disperse efficiently (McKinney 1997, Pimm et al. 2014), lower reproductive and survival rates (Purvis et al. 2000), increasing size of home ranges (i.e., individual's territory size) (Benscoter et al. 2013), and life history complexity (Koh et al. 2004). Studies have shown that taxonomic group is not a good predictor of extinction risk (Ando 1999, Jenkins et al. 2013); however, some characteristics of species within certain taxonomic groups can predict likelihood of extinction. For example, McKinney (Doremus) found that large body size is a good predictor of extinction risk except in fish, because, he theorized, it is difficult for small fish species to disperse safely. He also found that poorly dispersing mammals and plants go extinct more quickly than their widely dispersing relatives (McKinney 1997). Additionally, birds and mammals that occur at low densities are more susceptible to extinction than those with small individual territories (Benscoter et al. 2013).

Specific threats and threat accumulation can also contribute to likelihood of species extinction. Examples of preeminent threats that can be the singular cause of a species' decline include the effect of DDT on Bald Eagles (*Haliaeetus leucocephalus*) or over-hunting of the extinct Passenger Pigeon (*Ectopistes migratorius*). The majority of declining species, however, are experiencing the synergistic effects of multiple threats, which influence their habitat, reproductive success, and survival. Even when a threat is severe, such as an expansive disease, it is rarely the single contributing factor that leads to decline or extinction (Heard et al. 2013). For example, Gonzalez-Suarez and Revilla (2014) found that increasing extinction risk correlated with increasing number of threats to mammals listed on the International Union for Conservation of Nature (IUCN) Red List.

Population and range size are also potential contributing factors to level of extinction risk for a species. Extinction risk increases greatly with decreasing species range size (Manne et al. 1999, Purvis et al. 2000) and abundance (McKinney 1997) and increasing fragmentation (Henle et al. 2004). Low population density and high temporal variation in population size also correspond with increased likelihood of extinction except for species adapted to persisting at low population densities (McKinney 1997). The influence of habitat fragmentation and population size on extinction risk varies by life history traits, which are determined by the evolutionary history of the species. For example, Henle et al. (2004) reviewed the empirical data and hypotheses of various theories predicting the sensitivity of species to fragmentation and recent population decline and concluded that the level of species specialization influences the way an otherwise stable population reacts to changes in habitat.

Ecological specialization and isolation of populations appears to be a formidable indicator of extinction risk. Stefanaki et al. (2015) concluded that range restrictedness and endemism was not related to vulnerability of plants in the Mediterranean. Instead, they found that vulnerability of extinction, the main external threat being human induced land-use changes, was positively correlated increasing distance between a taxon's most distant population as well as floral complexity (i.e., only pollinated by specialized pollinators). There is increasing evidence that specialized species in all taxa are being displaced by habitat generalists that are rapidly adapting to human-induced changes in their environment (McKinney 1997, Henle et al. 2004, Eskildsen et al. 2015).

The opinions of the success of the Endangered Species Act (ESA) in its 40 years of implementation vary. Very few species listed have recovered to the point of delisting (Abbitt and Scott 2001, Beissinger and Perrine 2001); however, supporters of the ESA point out the prevention of extinction and population-level improvement for many species protected under the Act (Schwartz 2008, Greewald et al. 2013). Much of the contention surrounding the ESA relates to listing decisions and ambiguity of terminology within the Act (Bean 2009, Waples et al. 2013). Determinations of species status under the ESA (i.e., endangered, threatened, not warranted), made by U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (USFWS and NMFS), are required to be made solely based on the best scientific and commercial data available and without the consideration of possible economic or other effects (ESA, Section 4). Comprehensive data on population and range extent are more likely for species that are common within large geographical ranges; however, ample population data is exceedingly rare for the majority of species in existence (Pimm et al. 2014). Additionally, science can only make predictions regarding risk of extinction and cannot provide guidance for how much risk is acceptable. Doremus (1997) stated that "the ESA's 'strictly science' mandate rests on the assumption that conservation policy decisions can be made objectively on the basis of existing or reasonably attainable scientific knowledge", an assumption she declared as wrong and "impossible to implement". Because there is no declaration in the ESA regarding the degree of risk of extinction qualifies a species to be protected, decisions on listing a species under the ESA are value judgements, legally mandated to be informed primarily by science, that are disposed to effects from various other influences.

The cost, both ecological and social, of protecting species that do not need protection (Type I error) and not protecting species that need protection (Type II error) are significant; therefore, it is important to recognize which factors are influencing ESA listing decisions in situations of meager scientific data and equivocal legislative mandates. Previous studies support the theory that non-biological factors can influence the likelihood of protection by the ESA including those mentioned above (i.e., species body size and taxonomic group as well as procedural influences such as regulatory delay (Bechtold 1999). Regulatory delay (e.g., increasing time as a candidate species) is believed to be a way bureaucratic entities avoid decision-making, likely in response to pressure from outside interest groups (Ando 1999). For example, Bechtold (1999) determined that FWS delayed listing the Bull Trout (*Salvelinus confluentus*) by making the determination that it was warranted but precluded in an attempt to avoid listing it altogether.

My goal for this study was to evaluate the role, if any, of species characteristics, population metrics, and threat level serve in the listing decisions under the ESA. Based on this previous research on the effects of characteristics that influence extinction risk and ESA listing decision, I evaluated several predictions (Table 7). I also evaluated potential listing bias by assessing discrepancies in endangerment status between ESA listing decision and NatureServe classification (discussed below), a non-legal rank also used by previous research on ESA listing decisions (Wilcove and Master 2005, Laband and Nieswiadomy 2006, Gratwicke et al. 2012) as a proxy for potential of species for formal listing.

Table 7. Predicted influence of explanatory variables on likelihood of protection under the Endangered Species Act.

Explanatory variable	Prediction	Citation
Body size	Increasing body size increases likelihood of protection.	Metrick and Weitzman (1996)
Taxonomic group	Reptiles and fish less likely to be listed than other taxa.	Gratwicke et al. (2012)
	Plants less likely to be listed than animal species.	Harllee et al. (2009)
Threats	Increasing number of threats increase likelihood of protection.	Gonzalez-Suarez and Revilla (2014)
Time as candidate	Increasing time as candidate increases likelihood of protection.	Ando (1999); Bechtold (1999)
Range size	Decreasing range size increases likelihood of protection.	McKinney (1997)
Population size	Decreasing population size increases likelihood of protection.	McKinney (1997)

Methods

Data collection

From 10 February 2011 to 3 October 2014, I collected ESA listing decisions conducted on species that occur in the U.S., Proposed Rules for *not warranted* and *warranted but precluded* species and Final Rules for *endangered* and *threatened* species (hereafter "Rules"), published in the Federal Register (http://www.regulations.gov/). In order to avoid bias, I randomly sampled one species from multi-species decisions >6 species and did not include species evaluated in multi-species decisions of >14 species because they were all Hawaiian species that were evaluated as a group based on threats to their ecosystem, not individual species. For each species, I collected general information such as listing decision, taxonomic class (hereafter taxa), number of potential threats, time as candidate (see above), FWS region and office, and number of other species in the listing decision. In order to maintain sufficient sample size, I combined reptiles and amphibians into "herpetofauna" and categorized all invertebrates as "aquatic" or "terrestrial" (for 7 total taxonomic categories). I accessed NatureServe (http://explorer.natureserve.org) for additional potential threats and conservation status ranks (G1 – G5). NatureServe, an independent organization which works closely with the International Union for Conservation of Nature to expertly assess threats and levels of endangerment of species, is not legally recognized but has been used previously as an indicator of potential for formal listings under the ESA (Metrick and Weitzman 1996, Gratwicke et al. 2012). I calculated number of threats by totaling the number of threats cited by the Rule or NatureServe. This sum could include multiple threats under one criteria category discussed Section 4 of the ESA. I determined time as candidate by calculating the time since the FWS initially deemed the species warranted for full review in a 90-day Rule and the date of the Proposed Rule (Fig. 1).

I recorded population estimates, population range size estimates, and descriptive location information from both the published Rules and NatureServe. For each species, I recorded the maximum and minimum population estimates and maximum and minimum range size estimates as well as if FWS estimated the population or range size in the Rule. Additionally, I recorded the states where the species are currently known to occur, if it utilizes island or mainland habitat, and if it is known to occur outside the U.S. during any part of its life history requirements (i.e., Canada or Mexico). I also determined if the species occurs primarily (>50% of current range) on public (e.g., managed by U.S. Forest Service (USFS), Bureau of Land Management (BLM), National Park Service

(NPS)) or private lands by examining range maps and descriptions of their current range in the Rules published by the FWS.

Statistical analyses

All statistical analyses were conducting using R software for statistical computing and graphics (R Core Development Team 2013). I initially conducted preliminary analysis to determine if ESA listing decisions (i.e., endangered, threatened, warranted but precluded, or not warranted) was independent of descriptive explanatory variables associated with each species by conducting a chi-square analysis for categorical variables (i.e., taxa, FWS region, habitat ownership, island vs mainland, overlap with Canada or Mexico) and analysis of variance (ANOVA) for continuous variables (i.e., time as candidate, number of threats, maximum and minimum population estimates, maximum and minimum range size estimates; Agresti (2007)). I also conducted a chi-square test to evaluate if listing potential (i.e., NatureServe conservation rank) corresponded with ESA listing decision.

To account for the influence of explanatory variables on each other as they related to their effect on likelihood of protection under the ESA, I fit a logistic regression model with generalized linear models (Bates and Maechler 2009). Response variable was coded by combining species that were designated *endangered* and *threatened* ("protected") and *not warranted* species ("not protected"). I excluded species with warranted but precluded decisions because they are still undecided for protection under the ESA. To select variables associated with likelihood of protection under the ESA, I used forward selection with backward elimination and Akaike information criterion for small samples sizes (AIC_c) as selection criterion (Burnham and Anderson 2003). I stopped adding variables when they no longer reduced AIC_c by > 2 because values within that window are considered equivalent. When no new variables could be added, I added 2-way interaction terms for taxa and population size and taxa and range size. I was able to identify a single best model for likelihood of protection and did not perform model averaging for evaluation of explanatory variables. I then conducted a Fisher's multi-comparison test to specify which taxa and FWS regions differed by likelihood of protection (Agresti 2007).

Results

I collected data on 143 ESA listing decisions from 101 Rules published by the FWS in the Federal Register between 10 February 2011 and 3 October 2014. Of the total listing decisions, 82 (57%) came from multiple species rules (i.e., ≥2 species per rule) and 61 (43%) were single species decisions. Of the species evaluated, 78 (~55%) have habitat that occurs primarily on private property while the remaining 65 (~45%) species occur primarily on public land. Fifty-one (35.7%) of the 143 species were designated as *endangered*, 22 (15.4%) were designated as *threatened*, 17 (11.9%) were deemed *warranted but precluded*, and 53 (37.1%) were declared *not warranted* for protection under the ESA.

The majority (28%) of the species evaluated were plants and the least represented were birds (6.3%) and mammals (6.3%) (Table 8). Mean (± SD) time each species was a candidate (i.e., time since the species was initially deemed warranted for full review) was 189.2 ± 151.6 months. Median time as candidate for *endangered*, *threatened*, *warranted but precluded*, and *not warranted* species was 271, 153, 20, and 103 months, respectively. Plants spent more time on the candidate list than other taxa and birds spent the least (Table 8). Mean (± SD) number of threats listed for a species given by Rule or NatureServe was 4.6 ± 1.9 with herpetofauna having the most number of threats (6 ± 2), on average (Table 8). Of all species evaluated, most had the highest NatureServe conservation rank of G1 and G2 and species FWS listed as *threatened* and *warranted but precluded* had the most evenly distributed ranks (Fig. 4).

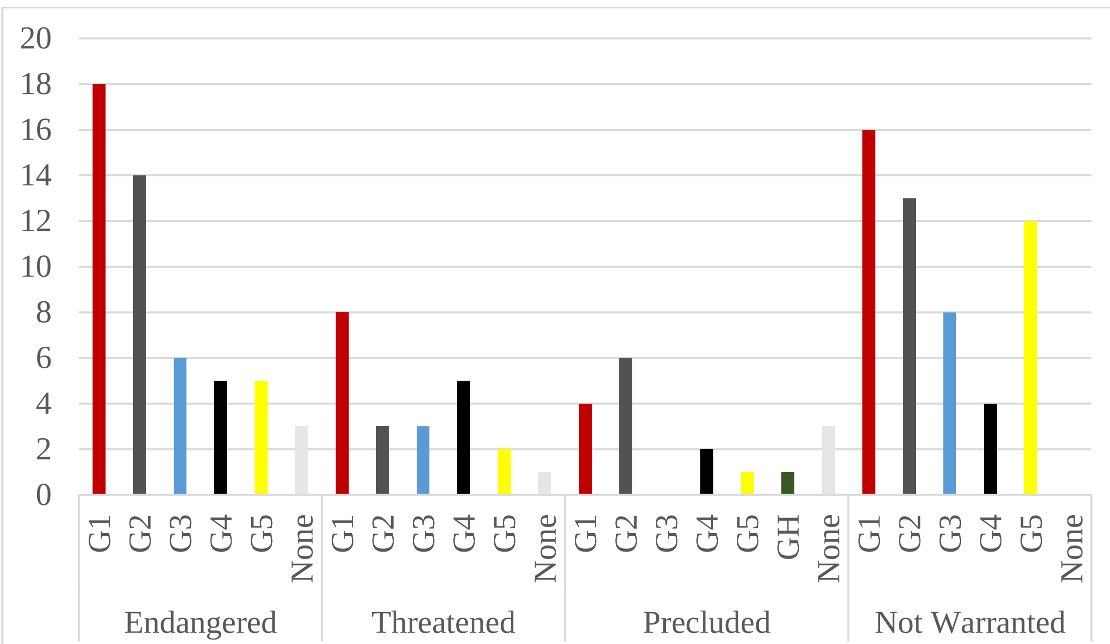

Figure 4. Count of species evaluated under the Endangered Species Act (ESA) from 2011 – 2014 by rank given by NatureServe for level of endangerment of extinction and ESA listing decision.

Table 8. Count and percentage of species evaluated under the Endangered Species Act (ESA) by U.S. Fish and Wildlife Service (FWS) from 2011 – 2014 by taxonomic group and ESA listing decision (endangered = EN, threatened = TH, warranted but precluded = PR, not warranted = NW), mean (± SD) months as candidate species, mean (± SD) months proposed for protection, and mean number of threats (± SD) cited in both the Federal Register Rules and on NatureServe.

Taxonomic group	Count	EN	TH	PR	NW	Months candidate[a]	Months proposed[b]	# threats
Plants	40 (28.0%)	16	7	2	15	261.0 ± 162.2	12.3 ± 2.2	4 ± 1
Terrestrial invertebrates	30 (21.0%)	8	0	6	16	146.2 ± 145.7	12.9 ± 5.1	4 ± 1
Aquatic invertebrates	23 (16.1%)	14	3	5	1	181.5 ± 145.7	12.1 ± 1.5	5 ± 2
Herpetofauna	18 (12.6%)	6	7	1	4	155.4 ± 118.8	13.3 ± 2.4	6 ± 2
Fish	14 (9.8%)	5	1	1	7	156.8 ± 118.8	13.0 ± 2.4	5 ± 2
Mammals	9 (6.3%)	2	1	2	4	123.0 ± 114.7	13.3 ± 2.3	5 ± 2
Birds	9 (6.3%)	0	3	0	6	111.7 ± 58.3	14.7 ± 4.6	5 ± 2
Total	143	51	22	17	53	189.2 ± 151.6	12.7 ± 2.7	5 ± 2

[a]Calculated as number of months from the time a species was considered a candidate species by FWS to the time a Proposed Rule was published in the Federal Register
[b]Calculated as number of months between the published Proposed and Final Rules in the Federal Register

Factors influencing ESA listing decisions

Taxa influenced ESA decision ($\chi^2_{18} = 43.203$, $p < 0.001$) and FWS region appears to influence the likelihood of protection ($\chi^2_{21} = 51.949$, $p < 0.001$). ESA decision is influenced by both primary ownership of the species habitat (i.e., public vs. private; $\chi^2_3 = 23.658$, $p < 0.001$) and if the species utilizes aquatic or terrestrial habitats ($\chi^2_6 = 20.735$, $p = 0.002$). Island and mainland species did not differ by ESA decision ($\chi^2_6 = 6.124$, $p =$

0.41) and it did not matter if the species range overlapped Canada or Mexico (χ^2_9 = 11.340, p = 0.253). There was no association between ESA decision (i.e., *endangered*, *threatened*, *warranted but precluded*, *not warranted*) and NatureServe rank (χ^2_{12} = 12.995, p = 0.369).

Time as candidate species influenced listing decision (F_{141} = 12.8, p = 0.0005; Fig. 5). There was no difference in candidate length for species designated as *endangered* and *threatened* or *threatened* and *not warranted* (Fig. 5). However, there was a significant difference in candidate time for *endangered* and *warranted but precluded*; *endangered* and *not warranted*; *threatened* and *warranted but precluded*; and *warranted but precluded* and *not warranted* (Fig. 5). Number of threats also had a significant effect on listing decisions (F_{141} = 22.4, p < 0.001; Fig. 6). Species designated as not warranted had significantly fewer threats than species designated as *endangered*, *threatened*, or *warranted but precluded* while all other designations were equivalent in number of threats cited (Fig. 6). Estimated maximum current range size influenced ESA decision but no population estimates (maximum or minimum) influenced ESA listing decision (Table 9). However, once I removed the four outliers (one *not warranted* and three *threatened* species) maximum range sizes were equivalent for all ESA decisions (F_{107} = 0.392, p = 0.759).

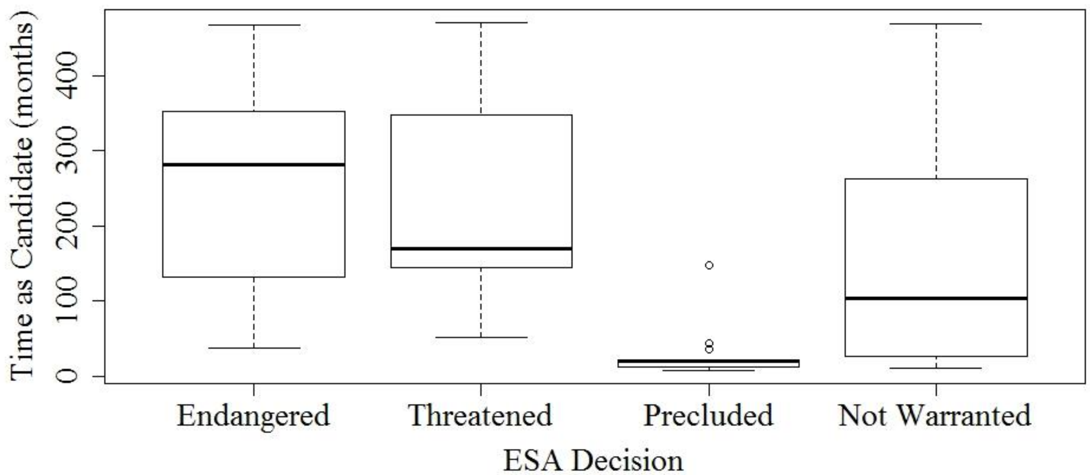

Figure 5. Boxplot representing time spent as a candidate (i.e., number of months from the time a species was considered a candidate species by U.S. Fish and Wildlife Service (FWS) to the time the Proposed Rule was published in the Federal Register) for Endangered Species Act (ESA) decisions made from 2011 – 2014.

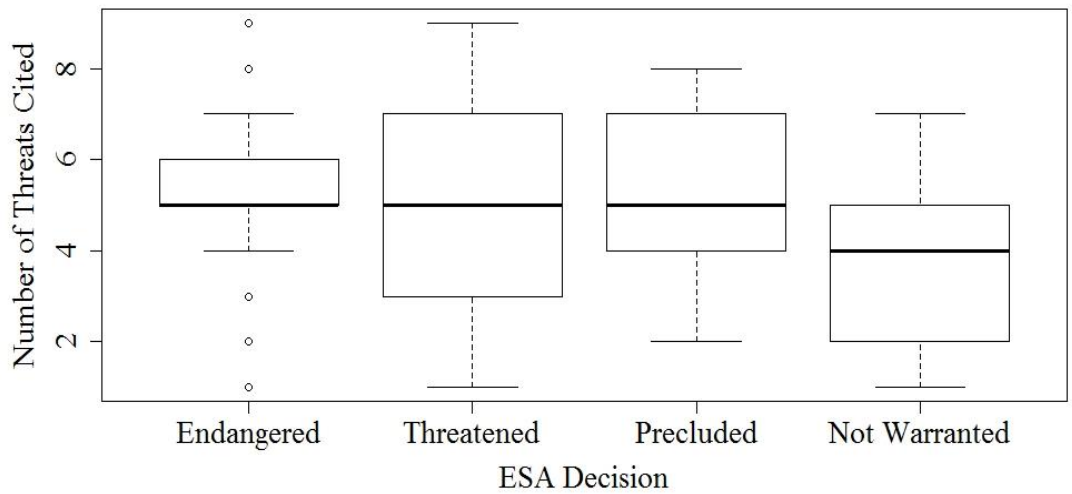

Figure 6. Boxplot representing the number of threats to a species listed in the Rule by the U.S. Fish and Wildlife Service and NatureServe by Endangered Species Act listing decision for species evaluated under the ESA from 2011 – 2014.

Table 9. ANOVA results for the influence of population and range size estimates, maximum and minimum, given in the Rule published in the Federal Register by the U.S. Fish and Wildlife Service and by NatureServe on Endangered Species Act listing decision.

Independent variable	*n*	*F*	*df*	*p*
Maximum population	103	1.788	99	0.154
Minimum population	104	1.833	100	0.146
Maximum range	117	2.822	113	0.042
Minimum range	117	0.694	113	0.558

Model of best predictors of protection under ESA

I included six parameters in the final logistic regression model (Table 10). The best fit model differed significantly from the intercept only model (likelihood ratio test: χ^2 =

87.633; *df* = 6; *p* <0.001), and there was no evidence of lack of fit (Pearson's χ^2 goodness-of-fit test: χ^2 = 77.470; *df* = 119, *p* = 0.984). I found that when a species was evaluated alone, it was 7.6% less likely to be protected under the ESA than a species that was included with other species in the listing decision. Species evaluated in the Southeastern FWS region (4) were over ~23 times more likely to be given ESA protection than species evaluated in other regions; however, there is no difference in likelihood of protection in the Mountain Prairie region (6) when all other listing characteristics were considered so it was omitted from the model. Aquatic invertebrates and herpetofauna were ~23 and ~5 times more likely, respectively, to receive protection than other taxa. Species that primarily occupy public lands were 23.6% less likely to be protected by the ESA than species occurring primarily on private land. Finally, the odds of a species being protected increased ~2.5 times as the number of threats increased by one.

Table 10. Significant parameters in the final logistic regression model representing the probability of protection under the Endangered Species Act for species evaluated from 2011 – 2014 by the U.S. Fish and Wildlife Service (FWS).

	β	*SE*	*p*	*odds ratio*
Intercept	-2.862	0.934	0.002	
Dichotomous variables				
Single species rule[a]	-2.583	0.724	<0.001	0.076
FWS Region 4[b]	3.123	0.915	0.001	22.724
Taxa[c]				
Aquatic inv.	3.124	1.254	0.013	22.744
Herpetofauna	1.614	0.872	0.064	5.024
Private ownership[d]	-1.445	0.569	0.011	0.236
Continuous variable				
Threats	0.909	0.212	<0.001	2.482

[a]Compared to multiple species (>2) decisions.
[b]Compared to other FWS Regions.
[c]Compared to other taxonomic groups
[d]Species occurring primarily on private lands as opposed to those occurring on public land.

Discussion

The strong influence of non-biological variables, specifically FWS region and ownership of habitat, on listing decision indicate that scientific and commercial data are not the sole source of influence on which species are protected under the ESA. Population estimates had no influence on likelihood of protection in my model despite the expectation that abundance would be a primary indictor of level of imperilment. Additionally, I did not find a correlation between NatureServe conservation rank and ESA listing decision, a result that supports previous research indicating that species of high conservation concern are not more likely to be protected under the ESA than species of less concern (Wilcove and Master 2005, Laband and Nieswiadomy 2006, Gratwicke et al. 2012).

My results indicate that species included in multi-species Rules are more likely to be protected under the ESA than those that are evaluated on their own; therefore, it is critical to determine if multi-species evaluations are of less quality (i.e., less rigorous, poorer use of science) than single species decisions. In the Interagency Policy for the Ecosystem Approach to the ESA, released by the Department of Interior and Department of Commerce (59 FR 34274, 1 July 1994), the stated purpose was to “provide a means whereby the ecosystem upon which endangered and threatened species depend may be conserved” (ESA, Section 2(b)). This was to be done partially by “grouping listing decisions based on a geographic, taxonomic, or ecosystem basis where possible”. FWS rarely applied this policy until the recent court decisions mandating the large number of listing decisions by 2016 (WildEarth Guardians v. Salazar 2011) and, therefore, the impact of its application has not been evaluated until now.

There are potential benefits to listing several species in one listing decisions, both for conservation purposes and bureaucratic efficiency. Species that occur within the same ecosystem or geographic area likely face similar threats that FWS can identify and evaluate concurrently, decreasing their workload. Additionally, if multiple species that occur in the same geographic area are protected at the same time, then recovery and management actions can be implemented simultaneously which would potentially decrease overall cost. Because much of the ESA costs are indirect, they are difficult to quantify and, therefore, no explicit data exists to assess cost savings for integrative approaches to conservation (Ando 2001). Ando (2001) concluded that FWS benefits from listing several species in one rule because it decreases the overall interest group opposition. She found that, above a certain count, more species that are already protected under the ESA by county increases the likelihood of opposition to new listings. Additionally, the amount of opposition did not increase as the number of species in the decision increased.

Likelihood of protection increased as number of threats increased which supports my prediction and potentially indicates species protected under the ESA are in more need of protection than those designated as not warranted for protection. It is possible this correlation is also the result of FWS listing more threats in the Final Rules in order to justify protection of species under the ESA (i.e., more support for their decision). Another cause of this correlation may be “discovery bias,” which Heard et al. (2013) described as the accumulation of increasing knowledge as an artifact of amassed resources for species whose extinction risk continues to increase. My data shows that the likelihood of protection by the ESA was much higher for species that had been on the candidate list for >10 yrs. The longer a species is warranted but precluded from protection, the more likely research dollars and time may be channeled its direction, which would subsequently increase awareness of threats. There is also the possibility that species that spend a long time waiting to be protected under the ESA accumulate more threats (e.g., more population fragmentation, loss of genetic diversity) and, thus, delaying the benefits of protection under the ESA and decreasing chances of recovery (Ando 1999).

My results indicate that larger body size (e.g., mammals and birds) is not a significant predictor of protection under the ESA despite the previous research that suggested large body size and "likeability" by humans increases likelihood of support for conservation (Metrick and Weitzman 1996, Gunnthorsdottir 2001). This may be because many of the larger mammals in the U.S. are already protected under the act (e.g., Gray Wolf (*Canis lupus*), Grizzly Bear (*Ursus arctos horribilis*), Florida Panther (*Puma concolor coryi*)). Gratwicke et al. (2012) found that > 80% of U.S. amphibians listed by NatureServe as at risk in 2011 remained unprotected by the ESA. My data indicates that herpetofauna, which includes amphibians, are more likely to be protected by the ESA than most other taxa. It should be noted, however, that my study only includes species that FWS judged as having substantial merit in the initial 90-day Rules to deserve a full evaluation. Further research is needed to determine if certain taxonomic classes are more or less likely to be petitioned or considered warranted for further review during the early evaluation phases under the ESA.

It is clear that for the majority of species I evaluated there is a high level of uncertainty surrounding their population sizes and range extents, primarily evident because FWS enumerated these estimates in only one third of listing decisions (see Chapter 2). Previous research suggests that uncertainty allows for increased agency discretion (Schultz 2008) and uncertainty, along with the ESA "science only" mandate, appears to encourage the FWS to conceal the true basis for their decisions, make their decisions appear objective and certain, and ultimately undermine political support by declaring that science is the ultimate foundation for their decisions (Doremus 1997). For example, FWS was substantially more likely to list aquatic invertebrates than any other taxa but gave no range extent estimation in the Rules on any aquatic invertebrate species.

Ando (2001) concluded that vertebrate species, with larger range sizes and greater potential for conflict, are more likely to incur more opposition than invertebrates. The increased likelihood of protection for invertebrates may be due to lack of opposition and general public interest in invertebrate listing decision.

ESA listing decisions appear to be influenced, at least in part, by criteria other than level of endangerment. Previous research indicates that political factors may play a role in ESA listing decisions including environmental attitudes of legislators (Harllee et al. 2009), participation of legislators in relevant Congressional subcommittees (Rawls and Laband 2004), and cultural attributes within the state such as hunting and fishing participation and percentage of farmland (Laband and Nieswiadomy 2006). My research shows that land ownership (i.e., public vs. private) of habitat and FWS region have a large influence on likelihood of protection. These results may be an artifact of higher threat levels (e.g., human population size, development, invasive species) for species in specific locations that correspond with these variables. It is also possible that these differences are influenced by political or cultural variation within the states or regions where the species occur or that listing decisions are influenced by bounded rationale and institutionalized agency norms within the FWS (Gerlach et al. 2013). I will evaluate the role, if any, of threat from organized business interests to species and address potential political and cultural influences on the quality of ESA decisions in Chapter 4.

CHAPTER IV

INSTITUTIONAL BEHAVIOR AND DECISION QUALITY

Bureaucracies in the U.S. exert a large amount of power not only through implementation of policy but also by creating it when policy mandates are incomplete. Indeed, bureaucrats make the majority of policy decisions compared to legislators (Meier 1993). Bureaucratic behavior is a dynamic process made up of both top-down and bottom-up motivating factors from legislators and the public, respectively (Wood and Waterman 1993, Bennedsen and Feldmann 2006). Additionally, information included in legislation that is implemented by bureaucrats is almost always ambiguous (Zahariadis 1999) which leaves decisions open to interpretation by agencies as well as outside influences. Scholars have produced a large body of research exploring *who* influences bureaucratic decision-making and *how* they go about doing so. Entities believed to influence bureaucratic behavior once legislation has passed include politicians (i.e., Congress and the President) (Ando 1999, Innes and Mitra 2015), interest groups (Yackee 2006), the public (Eckerd 2014), and the dynamics within the agency itself (Francis et al. 2005, Meier and O'Toole 2006).

Bounded rationality theory asserts that decision-makers are confined by what they can comprehend as well as the time and resources available to them (Simon 1972). March (1978) stated that rational choice involves two guesses, one about uncertain future consequences and the other about uncertain future preferences. Bureaucrats deduce future consequences based on previous experiences (Gerlach et al. 2013) and bureaucratic institutions seek to enhance legitimacy, increase resources, and augment the likelihood of existence into the future (Meyer and Rowan 1991, Townley 1997). Additionally, many bureaucratic institutions operate under the logic of avoidance of negative feedback, a concept that is fundamental to bureaucratic behavior when assessing mechanisms during limited time frames (Baumgartner and Jones 2002).

When bounded rationality, institutionalism, and negative feedback are incorporated, predictions can be made regarding bureaucratic behavior. Additionally, factors influencing behavior may differ depending on incentives or potential consequences imposed on bureaucrats at the regional versus local level. In this chapter, I compare the influence of opposing interest groups, public attention, and political pressure on bureaucratic decision-making quality (i.e., decisions that are nearest to the intention of the legislation) under high and low workloads at both the regional and office level. I will begin by outlining the theories and previous research regarding the influence of interest groups, public attention, and political pressure on bureaucratic behavior. I will then assess which factors, if any, influence decision quality of Endangered Species Act (ESA) listing decisions made by the U.S. Fish and Wildlife Service (FWS) and if any of these factors interact with political influences at either the regional or office level under low or high workload conditions.

Interest Groups and Bureaucratic Decisions

The theory of *pluralism* postulates that in an open democratic environment, the policies that win out are those supported by the greatest number of interests while the theory of *elitism* suggests that a small minority of actors hold the majority of the power to influence policy. Garson (1978) suggested that neither of these ideas represent a holistic view of interest group influence. Many scholars believe resources (e.g., money, time) increase the ability of interest groups to organize and exert their influence (Lowi 1969, Schlozman 1984). Indeed, Yackee and Yackee (2006) found that agencies alter decisions to be amenable to business interests, consistently well-organized and funded, but not for other interest groups. McKay (2012), in contrast, found that any interest groups that participated in negative lobbying (i.e., lobbying against a proposal) were more likely to defeat proponents, regardless of resources, and with less effort. Even so, other research indicates that the loudest groups (i.e., those that are the most organized, consistent, and united) receive the most agency attention and are more likely to influence policy than other groups (McKay and Yackee 2007), likely because agencies wish to avoid the high public attention conditions organized interest groups can trigger (Epstein and O'Halloran 1995). Recently pro-environmental interest group influence has grown through increased membership, lobbying, and litigation practices (Dalton 2005) which may indicate an increase in their ability to substantially influence agency decision-making as well.

Due to fears over too much agency discretion, the Administrative Procedures Act (APA) of 1946 requires agencies to publish a notice of all proposed rules in the Federal Register and request comments from the public. However, public comments are relegated to the later stages of the policy development process, typically once the critical issues and decisions have been made (Nixon et al. 2002, West 2009). Some agencies are encouraged to invite participation by selected stakeholders in proposal development. For example, the Department of the Interior (DOI) guidelines encourage avoidance of communications with outside stakeholders once an agency publishes a public notice but provide no restrictions before publishing. Due to its informality and idiosyncratic nature, influence of participation by external stakeholders in early policy development is less understood than the later, more public, stages of the agency decision-making process and can vary greatly across and within agencies (West 2009). However, agencies likely maximize their own interests (i.e., avoid criticism and increased oversight) by including interest groups affected by their decisions and utilizing the resources they provide (Crone and Tschirhart 1998) and there is case study evidence that pre-proposal participation by interest groups can influence content of proposed rule (Rinfret 2011). Early access of interest groups can increase decision bias because those that provide the information will likely provide information that primarily supports their cause. This bias in proposal development is exacerbated when the bureaucrats who staff the agency are politically inclined in the same direction as the interest group (Patty 2009).

Public Attention and Political Pressure

In order to justify inserting oneself into a bureaucratic decision process, an organization or individual is concluding that the benefits outweigh the consequences of not acting. However, benefits are not always explicit or directly observable. The goals and needs of legislators, interest groups, and the public interact, despite often being evaluated as separate influences on agency behavior. There is evidence that lobbying by interest groups has a substantial effect on legislative oversight or agencies (Hall and Miler

2008). Additionally, Boehmke et al. (2013) found that interest groups engage in extensive agency lobbying of bureaucrats and the amount of lobbying by specific interest groups is strongly related to the amount of activity of the same groups in the legislature. Some scholars theorize that the political power has shifted towards the agencies. For example, Lee (2012) suggests that some agencies are political organizations that have the power to influence interest groups through their “brokerage capacity”, which allows them to create favorable environments for negotiating directly with interest groups in order to increase agency discretion and decrease negative feedback.

Issue salience, defined as an issue being very important or visible to the public, can influence Congressional behavior towards bureaucracies by increasing oversight (Epstein and O'Halloran 1995) and decreasing agency discretion (McCubbins 1985), especially when there are clear public preferences. However, Ringquist et al. (2003) concluded that the effects of salience on legislative activity decreases as policy complexity increases. Therefore, the amount of discretion given to agencies may be lower when the policy arena involves complex issues, no matter how much the public is paying attention. Congress often relies on the public to act as “fire alarms”, alerting them to independent bureaucratic drift away from legislative preferences (McCubbins and Schwartz 1984, Bennedsen and Feldmann 2006). Additionally, salience influences interest group behavior because groups can use conflict to increase public awareness in order to exert pressure on decision makers and Congress (Kollman 1998).

Use of Science in Policy Decisions: The Endangered Species Act

Currently, some of the most contentious aspects of the ESA surround the role of "best scientific and commercial data available" as the sole indicator of whether or not a species should be listed as endangered or threatened. There are several practical issues surrounding the idea that good science alone can provide unbiased guidance in listing decisions under the ESA. First, the "best" science for a species is sometimes observational records or professional intuitions that lack scientific rigor and accountability; the FWS gives them equal sanction as peer-reviewed journal articles in the absence more reliable research. Second, what constitutes good science is an axiological question that changes over time in the scientific community. For example, a widely accepted method for approximating population metrics can fall in and out of favor in the scientific community because of new evidence or methodologies. Finally, even when comprehensive scientific information is available and agreed upon, it cannot inform an acceptable level of risk to a species or ecosystem; therefore, FWS staff must inevitably make a value judgement (Doremus 1997, Wilhere 2008). Congress has intensified this burden because of the absence of clear definitions of "endangered" and "threatened" designations for species under the Act (Doremus 1997, Bean 2009, Regan et al. 2013). Bureaucracies, including FWS, are part of a political system and are not neutral bodies (Lee 2012). When a bureaucratic entity such as the FWS responds to external pressures from politicians (Wood and Waterman 1993), special interests (Leaver 2009), the public (Eckerd 2014), or the predisposition of its employees (Meier and O'Toole 2006) it is not relying —and perhaps cannot rely—solely on the "best scientific and commercial information available".

Despite the requirement that the listing of species under the ESA should be based on best available science only, interest group action and Congressional characteristics have been shown to have a prominent role in listing decisions (Ando 1999;2001, Brosi and Biber 2012). However, factors that affect ESA decisions differ between the pre-proposal and post-proposed rule periods. For example, once a proposed rule (i.e., agency decision that is proposed to the public for review before it is finalized) has been drafted and published, an increasing number of support comments and higher salience hasten time to final rule while a single opposing comment in the absence of support slows down publication of final rules (Ando 1999). Ando (1999) also found that Congressional environmental voting record on ESA subcommittees effects the rate at which species are protected pre-proposal but not post. It also appears the amount of historical interaction that stakeholders have with the ESA (i.e., number of previously protected species within the county) can affect their propensity to participate in the process of new listing decisions, leading to delays in protection or no protection of new species (Ando 2001). Additionally, Ando (2001) found that interest group participation, both pro- and anti-species listing, increases as the perception that the species is threatened by economic activity increases, regardless of whether or not the species occurs primarily on public or private land.

Recently, environmentalist groups have used litigation and the threat of litigation to pressure FWS to make decisions on over 700 candidate species, which were waiting to be fully evaluated under the ESA, citing the scientific information that best supports their agendas while accusing FWS of purposely delaying the listing of species. A recent and controversial approach by environmental groups is to petition a large number of species at one time (74 FR 419, 78 FR 10601), causing FWS and NMFS to miss procedural deadlines and leading to litigation and settlements. There is evidence that litigation has significantly decreased delays in listing decisions (Goble 2005) likely to benefit of species in need of protection (Ando 1999). Additionally, Biber and Brosi (2010) found no evidence to support that petitions or litigation significantly lead to uninformed decision-making, interfered with FWS agenda setting, or over-enforced the ESA by listing species that are not in need of protection. Nevertheless, the overall long-term effect of litigation on the limited resources of FWS and NMFS and, subsequently, the reliability of science used in ESA decisions remains unclear. In 2011, FWS reached agreements with WildEarth Guardians and The Center for Biological Diversity to create a multi-year work plan to review 251 candidate species to determine if they should be added to the Federal Lists of Endangered and Threatened Wildlife and Plants by 2016 (WildEarth Guardians v. Salazar 2011). Due to this decision, numerous ESA listing decisions made during a narrow period with little administrative and personnel variation can be used to evaluate bureaucratic decisions and the factors that influence decision quality.

Based on previous research on bureaucratic behavior and the use of science in agency decisions, I predict that decision quality will vary according to various perceived pressures (i.e., public and political opposition, public attention) on FWS and the degree to which the negative feedback influences decision quality depends on the workload experienced by the bureaucrats involved in the decision-making. Specifically, I predict higher workload regions and offices will have lower overall decision quality because they will need to prioritize effort toward some species over others due to resource constraints. In high workload regions and offices, I predict decision quality will be higher under circumstances of high public attention, when business is listed as a direct threat to the species, and under circumstances of high opposition to the decision through public comments. Finally, I predict decision quality will be the highest for species that occur in in pro-land use states (i.e., more conservative) compared to pro-environmental states (i.e., more liberal), particularly when there is high public attention, business is listed as a direct, and when there is high public opposition to the decision.

Methods

Species information

From 2011 to 2014, I collected ESA listing decisions conducted on species that occur in the U.S.; Proposed Rules for *not warranted* and *warranted but precluded* species and Final Rules for *endangered* and *threatened* species (hereafter "Rules") published in the Federal Register (http://www.regulations.gov/). *Not warranted* species are those that FWS deems not eligible for protection under the ESA because there is not sufficient evidence regarding their biological status and threats to conclude they are at risk of extinction in the near future. Species that FWS deems *warranted but precluded* become candidate species that qualify for protection under the ESA but are precluded by higher priority species of greater immediate need of protection.

Species in Rules with >2 species, which were given the same determination (i.e., endangered, threatened, not warranted, warranted but precluded), were more likely to have similar interest group participation, political interest, and public attention. In order to avoid this bias, I randomly sampled one species from multi-species decisions ≥3 species. Additionally, I did not include species evaluated in multi-species decisions of >14 species because they were all Hawaiian species that FWS evaluated as a group based on threats to their ecosystem, not individual species. For each species, I recorded threat category (e.g., resource extraction, agriculture, climate change, invasive species) in each Rule as well as those listed on NatureServe (http://explorer.natureserve.org), an independent organization which works closely with the International Union for Conservation of Nature (IUCN) to assess threats and levels of endangerment of species through expert opinion. I did not want to rely solely on Rules published by the FWS for threats to each species in case political factors influenced inclusion of threats. In order to evaluate work load and if different variables effect decision quality at different bureaucratic levels, I recorded FWS region and office where each species was evaluated. Because there is evidence that ownership of habitat may influence ESA decision (see Chapter 3), I also recorded public versus private ownership of the occupied habitat described in each Rule. I determined ownership by description of the location of the occupied habitat in the Rule. Species occurring on >50% public land was considered as occurring on publically owned land.

Opposition, public attention, and political influence

In order to assess the level of opposition to each decision I recorded sentiment of comments submitted to the FWS, available on regulations.gov for each species, including if the commenter was “for” or “against” the protection of the species under the ESA. I classified business as a threat to the species, and therefore potentially opposing the decision to protect the species under the ESA, if threats to the species included agriculture or resources extraction (e.g., coal, oil, gas) primarily because these industries have organized lobbies that maintain contact with the FWS (Yackee and Yackee 2006, Braun 2013) as well as Congress and the executive branch (Hall and Miler 2008). I evaluated public attention for each species decision by recording the number of total news articles published by an established media organization, a metric considered to be an accurate metric for comparisons of issue salience (Epstein and Segal 2000), published online between 6 months prior and post the date of the publishing of the Proposed Rule.

I used U.S. Congress League of Conservation Voter score (LCV) for each species to assess political influence and potential interaction with public attention on decision quality. League of Conservation Voters scorecards rate members of Congress based on environmental, public health, and energy issues. Specifically, I averaged Senator LCV scores in states where the species occur to proximate level of “pro-environment” (i.e., 100) or “pro-land-use” (i.e., 0) Congressional representation, similar to Ando (1999). I used Senators opposed to members of the House of Representatives because Representatives' districts are geographically distinct within a state and are difficult to match up with the species' ranges for that state, particularly because ranges are only available approximately a third of the time (see Chapter II). Additionally, Senators were more likely to speak up and become involved in ESA listing decisions during the public comment process (K. Smith-Hicks, unpublished data). Therefore, Senator LCV score was the most accurate representation of the political influence given the likelihood for a politician to become involved in a listing decision.

Quality of decision

The evaluation of decision quality needs to assess not only what literature is used but also the relative availability of scientific literature as well as its quality. Therefore, I included these variables in the metric to evaluate decision quality of each species evaluated by the FWS. In order to do this, I first gauged the proportion of use of the most reliable literature (Corn et al. 2002), peer-reviewed journal articles (hereafter PRJ). In order to gauge the relative importance of each individual source in the overall decision, I calculated the number of times FWS referenced a literature source for information regarding population status, population trends, and threats for each species in a Rule. Using the list of literature cited for the Rule, typically available on regulations.gov but occasionally upon request from the appropriate FWS office, I classified each piece of literature into a category (e.g., PRJ, federal report, state report, personal communication). I then calculated the available PRJ and total citations by counting these items in the list of literature cited for each Rule. I did not use the total number of PRJ available for the species because many PRJ articles focus on information irrelevant to a listing decision (i.e., not population or threats). Additionally, I assumed the list of literature cited from the FWS contained the literature FWS was aware of at the time of the Rule which was consistent with what I wanted my metric to capture. I then calculated quality for each ESA decisions according to the equation below.

$$\text{Quality} = \frac{PRJ\ citations}{total\ citations} \div \frac{total\ of\ times\ PRJ\ used}{total\ of\ times\ citations\ used}$$

Lowell and Kelly (2016) used a similar metric, among many others, to compare FWS and National Marine Fisheries Services science use under the ESA. However, they did not have information to gauge relative importance of each source to overall decision, an issue I overcame by recording the proportion of each source used to the overall number of citations used in the decision. I calculated "PRJ citations" as the number of PRJ articles used in the rule and "total citations" as the number of individual citations included in the rule. I then calculated "total of times PRJ used" as the total number of times FWS cited all PRJ as a source and "total of times citations used" as the total times FWS used a citation in the rule. Decision quality could range from 0 (poor) to > 1 (high).

Statistical analyses

I modeled decision quality at both the regional and office levels using multiple linear regression analyses using R 3.1.0 (R Core Development Team 2013) by evaluating both linear and mixed models with R packages *lme4* (Bates et al. 2014) and *AICcmodavg*

(Mazerolle 2016) following model construction and selection procedures outlined in Zuur et al. (2009). I first constructed the most complex models for both region and office level, incorporating fixed effects of ownership of habitat, opposition, business threat, public attention ($\log_e$ transformed), and LCV score as well as public attention-workload interactions (i.e., public attention x region workload, public attention x office workload), ownership-LCV score interaction (owner x LCV), and public attention-business interaction (public attention x business). I used likelihood ratio tests to determine support for the random effects of region and office (i.e., models with random effects vs. without). I then selected the best models based on the Akaike's Information Criterion corrected for small sample sizes (AIC_c) (Hurvich and Tsai 1989) and considered models to be equivalent if their AIC_c were <2. I used package *AICcmodavg (Mazerolle 2016)* to calculate model-averaged coefficients for the predictive variables included in the top models ($\Delta AIC_c < 2$) to determine overall level and direction of influence on decision quality (Burnham and Anderson 2003).

Results

I evaluated literature cited, public comments, public attention, League of Conservation Voter (LCV) scores, and literature used for 59 species evaluated between 10 February 2011 and 3 October 2014. USFWS Regions 2, 4, and 8 conducted >30 ESA listing decisions; therefore, I classified decisions conducted in these regions as "high" workload. Regions 1, 3, 5, 6, and 7 had considerably fewer ESA listing decisions (<20) so I classified these as "low" workload (Appendix D). Table 11 presents summary statistics for decisions per office, number of public comments, and news articles as well as overall LCV scores. Overall, mean ± SD quality of decisions made by all FWS offices was 0.79 ± 0.23 (Table 11). Mean ± SD LCV scores for low and high workload regions were 66 ± 29 and 50 ± 34, respectively. Decision quality differed significantly by regional workload (t_{56} = -2.95, p = 0.005) but did not differ by ownership of habitat (t_{54} = -1.60, p = 0.12), potential business interest intervention (t_{38} = -0.36, p = 0.005), or opposition through comments against the decision (t_{53} = -1.09, p = 0.28; Table 12). Public attention and opposition were slightly correlated (r_{52} = 0.49, p < 0.001) so I excluded opposition from all subsequent analyses.

Table 11. Summary statistics for Endangered Species Act listing decisions made by U.S. Fish and Wildlife from 2011 – 2014.

	Range	Mean	Median
Independent variables			
Decisions per FWS office	1 to 18	5.6	5
Decisions per FWS region	1 to 47	17.9	12
News Articles[a]	0 to 730	33.2	4
Public comments[b]	1 to 1161	58.8	8
LCV score[c]	7 to 100	56.2	52
Dependent variable			
Decision quality	0.3 to 1.3	0.79	0.8

[a]Total number of news articles published online 6 months before and after Proposed Rule was published in the Federal Register.
[b]Number of public comments submitted to the FWS for each species.
[c]League of Conservation Voter Score calculated for each species based on U.S. Senator voting record in each state where the species occurs.

Table 12. Mean (SD) decision quality for Endangered Species Act listing decisions made by U.S. Fish and Wildlife Service for categorical variables evaluated from 2011 – 2014.

	Decision Quality
Predictive variables	*Mean (SD)*
Owner of habitat	
Public (*n* = 25)	0.84 (0.21)
Private (*n* = 34)	0.75 (0.23)
Business listed as threat[a]	
Yes (*n* = 36)	0.80 (0.20)
No (*n* = 23)	0.77 (0.27)
Comments against decision[b]	
Yes (*n* = 22)	0.83 (0.19)
No (*n* = 37)	0.77 (0.25)
Regional workload[c]	
Low (n = 21)	0.89 (0.16)
High (n = 38)	0.73 (0.24)
Overall (*n* = 59)	0.79 (0.23)

[a]Organized business, resource extraction or agriculture) threatened by ESA listing.
[b]Number of public comments submitted to the FWS for each species.
[c]Categorized based up on the number of decisions per region, ≤20 = Low; >20 = High.

Factors influencing quality of decision

When evaluated by regional workload, the model with the owner-LCV and public attention-region workload interactions explained the most variation in decision quality and received the most support (Table 13). Additionally, Owner-LCV score interaction was also in 3 of the top 5 region models (Table 13, Fig. 7). Similarly, owner-LCV score interaction was also an important factor explaining decision quality when evaluating influential factors by office workload, occurring in 2 of the top 5 models (Table 14). Specifically, decision quality increases for species occurring on private lands as the states they are in become more pro-environment (i.e., less pro land-use) and decision quality decreases for species occurring on public land (Fig. 7). Decision quality is not affected by workload under varying public attention when workloads are low at both the region and office levels; however, decision quality increases dramatically as public attention increases in high workload regions and offices (Fig. 8). Public attention, owner of habitat, and workload also occur in the top models explaining variation in decision quality at both the region and office levels (Table 13, Table 14). However, public attention was the only factor that explained decision quality and was significant at both the region and office level (Table 15, Fig. 9).

Table 13. Top models fitted for factors influencing U.S. Fish and Wildlife Service decision quality for Endangered Species Act listing decisions by FWS region workload from 2011 – 2014.[a]

Model	*k*	R^2	ΔAIC_c	ω_i
(Owner x LCV) + (public attention x workload)	8	0.23	0.00	0.22
Public attention + region workload	4	0.14	0.19	0.20
Public attention + owner + workload	5	0.15	0.92	0.14
Public attention + (owner x LCV)	6	0.16	1.71	0.09
Public attention + workload + (owner x LCV)	7	0.18	1.99	0.08
Owner + workload	4	0.11	2.38	0.07
Public attention	3	0.08	2.46	0.06
Business + (owner x LCV) + (public attention x workload)	9	0.21	2.82	0.05
Workload	3	0.07	2.95	0.05
Public attention + owner	4	0.10	2.98	0.05

[a]Abbreviations: *k*, number of model parameters; R^2, adjusted coefficient of determination; ΔAIC_c, difference in the AIC_c between a particular model and the top-ranked model; ω_i, probability that the model is the best for the given set of models and data.

Table 14. Top models fitted for factors influencing U.S. Fish and Wildlife Service decision quality for Endangered Species Act listing decisions by FWS office workload from 2011 – 2014.[a]

Model	*k*	R^2	ΔAIC_c	ω_i
Public attention + (owner x LCV)	6	0.16	0.00	0.25
Owner + (public attention x workload)	6	0.15	0.50	0.19
(Owner x LCV) + (public attention x workload)	8	0.19	0.96	0.15
Public attention + owner	4	0.10	1.27	0.13
Public attention + owner + workload	5	0.11	2.00	0.09
Owner + LCV + (public attention x workload)	7	0.13	3.10	0.05
(Owner x LCV)	5	0.08	3.46	0.04
(Owner x LCV) + (public attention x workload) + (public attention x business)	10	0.20	3.73	0.04
Public attention + (owner x workload)	6	0.09	4.19	0.03
intercept only	2		4.38	0.03

[a]Abbreviations: *k*, number of model parameters; R^2, adjusted coefficient of determination; ΔAIC_c, difference in the AIC_c between a particular model and the top-ranked model; ω_i, probability that the model is the best for the given set of models and data.

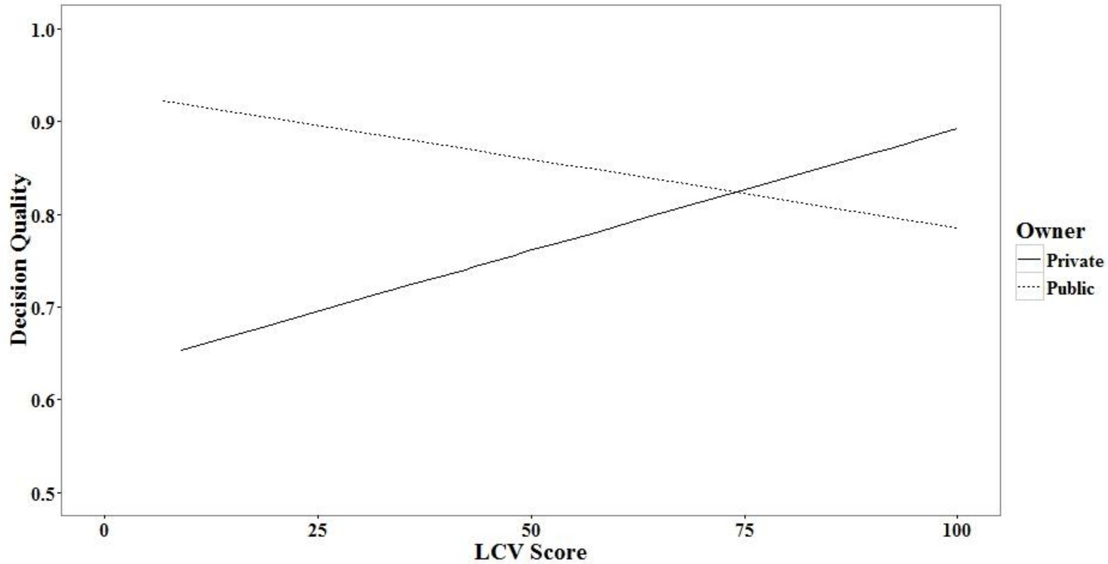

Figure 7. Predicted interaction of League of Conservation Voter (LCV) score and owner of habitat on U.S. Fish and Wildlife Service decision quality for species evaluated under the Endangered Species Act from 2011 – 2014.

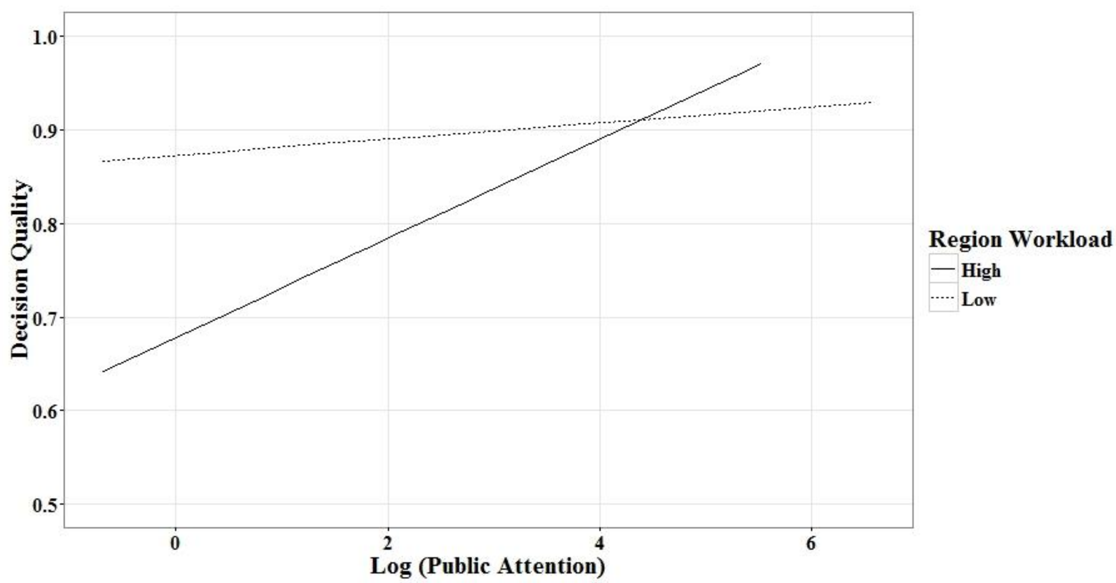

Figure 8. Predicted interaction of public attention and region workload U.S. Fish and Wildlife Service listing decision quality for species evaluated under the Endangered Species Act from 2011 – 2014.

Table 15. Model averaged coefficients for top models ($\Delta AIC_c \leq 2$) evaluating U.S. Fish and Wildlife Service listing decision quality for species evaluated under the Endangered Species Act from 2011 – 2014 at the region and office level.

			90% Confidence Limits	
Parameter	b	*SE*	Lower	Upper
Region				
Public attention*	0.03	0.02	0.01	0.06
Owner*	0.03	0.02	0.01	0.06
Region workload*	0.12	0.06	0.02	0.22
Office				
Public attention*	0.04	0.02	0.01	0.06
Owner	0.08	0.06	-0.02	0.17
Office workload	-0.01	0.01	-.02	0.00

*Indicates significant estimated predictor variables with 90% confidence intervals that do not cross zero.

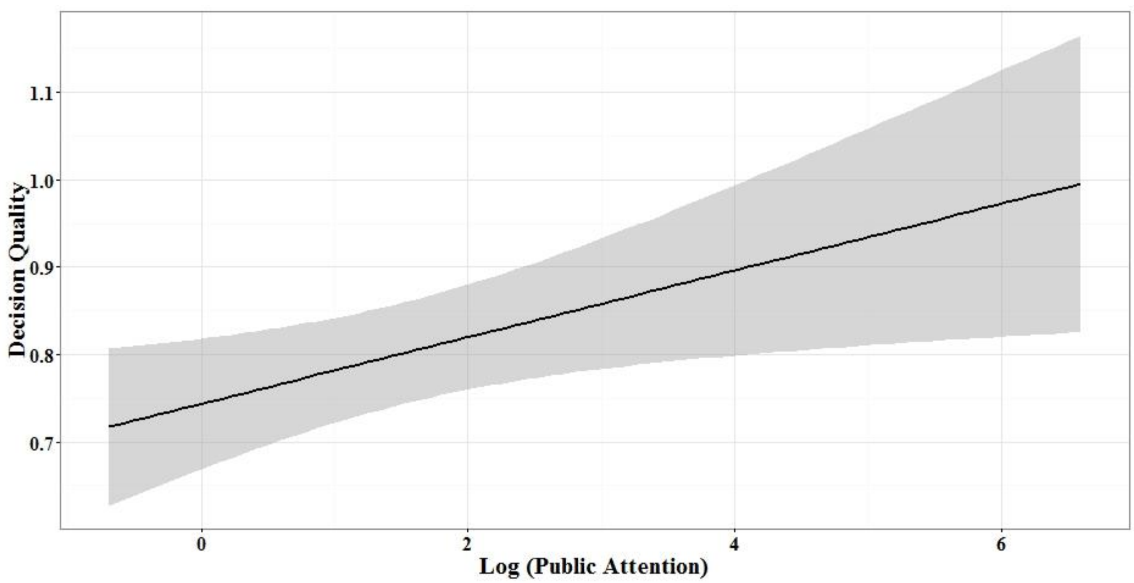

Figure 9. Predicted mean effects (95% CI) of public attention on U.S. Fish and Wildlife Service decision quality for Endangered Species Act listing decisions made from 2011 – 2014.

Discussion

My results show that the public itself is directly influencing bureaucratic behavior and workload condition greatly enhances this trend with higher public attention and high workloads interacting to increase decision quality, likely in an attempt by bureaucrats to avoid negative feedback. These results support research that public attention is acting as a “fire alarm” to legislators (McCubbins and Schwartz 1984, Bennedsen and Feldmann 2006) or other entities in which bureaucrats seek to avoid criticism, including their superiors within the agency itself (Francis et al. 2005, Meier and O'Toole 2006). Other explanations for the influence of public attention on decision quality may be less direct and more difficult to evaluate. For example, the FWS may be intentionally increasing public attention for particular listing decisions in an attempt either to draw attention to decisions in which they have applied a greater effort or to distract from the decisions they would prefer ignored. It is difficult to conclude if public attention is driving the decision quality or if the FWS is driving decision quality and public attention without more transparency in how ESA listing decisions are made and by whom.

Factors influencing decision quality interacted with workload, suggesting that under greater resource restrictions (i.e., less time and money) bureaucrats will focus their resources on decisions that have higher potential negative feedback in order to avoid criticism (Leaver 2009, Eckerd 2014). In high workload situations, FWS biologists may be relying more on what has been successful for them to use in the past or what their peers have used rather than applying the time needed to vet the literature properly. FWS biologists have been shown to rely more heavily on literature that has been historically successful for them to use for decision making, also known as *path dependency* (Pierson 2000, Gerlach et al. 2013), in order to decrease time and effort under stretched resources. Gerlach et al. (2013) found that FWS biologists perceived “best available science” as the literature that was socially sanctioned as superlative (i.e., *normative isomorphism*) due to high numbers of collaborations between natural resource agencies, particularly other federal agencies. Specifically, it is easier for field offices to rely on familiar data resources and institutionalized processes rather than seek out new resources (Gerlach et al. 2013). Additionally, jurisdiction size, which could be equivalent to region size or volume of responsibilities, has been shown to influence sourcing of scientific literature used in decision-making (Francis et al. 2005), which may correlate with workload, reliance on outside resources, or quality of decision makers and their ability to discern between good and bad scientific data.

Overall, decision quality was ~18% higher and varied less than high workload regions. However, other factors may be influencing differences in decision quality. For example, Gerlach et al. (2013) suggested that literature use behavior patterns by FWS biologists may diffuse on the regional scale; that is, there are similar patterns in what is considered “best” science within regions. Factors influencing decision quality across regions or offices may also be the result of variation regarding the influence of previous experiences on biologists or managers (Gerlach et al. 2013), institutional norms and practices (Wood and Waterman 1993, Egeberg 1999, Lee 2013), or values held by the bureaucrats themselves that may be unique to the area of the country (Meier and O'Toole 2006). It is likely that bureaucrats at the regional level are more exposed to direct political pressure than those functioning at local FWS offices simply due to the structural hierarchy with the FWS. It is also possible that local office bureaucrats are influenced by local political factors (Innes and Mitra 2015), a factor which I did not measure for my analyses. Local FWS offices also face varying habitats, species needs, local cultures, and environmental group pressures, all of which may influence decision quality more locally than at a regional scale but were not considered in my analyses.

The interaction between potential political influence (i.e., LCV score) and ownership of habitat are difficult to explain; however, the dynamics of listing decisions affecting public lands are profoundly different from those affecting private lands. On public land, political influence and perspective may shape the public opinion of the purposes and uses of public lands. For example, in “pro-land” use states the majority opinion may be that public land is best suited for public grazing and, therefore, there is an increased likelihood of public scrutiny of ESA listing decisions. In contrast, ESA listing decisions that take place on public lands in “pro-environment” states may suffer less public scrutiny because the people that live there welcome the environmental protections. I did not find strong evidence of potential opposing business interest on decision quality; however, interest groups may be playing a more complex role that is more difficult to discern given that they often rely on public attention to determine their participation or trigger it themselves (Holyoke 2003) while also considering their political advantages (Kollman 1998).

My results are not intended to suggest that decisions with better quality literature sources are always more accurate (i.e., protection is or is not necessary). Indeed, bureaucrats may be using more literature that is accepted as the “best” (e.g., peer-reviewed journal articles) simply to justify their decisions under circumstances of higher scrutiny even when sufficient data is not available. Uncertainty due to lack of sufficient information on species’ populations and threats is prevalent throughout listing decisions (see Chapter 2) which may indicate that even when the “best available science” is used, poor decisions can still potentially be made. However, unless an effort is made to increase the knowledge for candidate species (e.g., funding of targeted research), even decisions of the highest quality will risk protecting species that do not need protection or not protecting those that do. Additionally, not acknowledging the uncertainty and touting the use of “best available science” is likely doing a disservice to the ESA itself by undermining its legitimacy and masking hidden discretionary bureaucratic choices (Doremus 1997, Woods and Morey 2008).

There have been previous attempts to make the process of ESA listing decisions more scientific. For example, in an attempt to simulate the journal peer review process used to evaluate original research, FWS and NMFS announced in 1994 that they were changing their policy to include independent peer reviews with the intention of the reviewers to comment on the pertinent scientific and commercial data and assumptions included in the proposed listing (USFWS and NMFS 1994). However, the a priori premise that ESA listing decisions can be made using the scientific process (i.e., deductive rather than inductive reasoning) when there are outside forces influencing the outcome of the decision may to be false (Murphy and Weiland 2016), at least under the current guidelines for ESA listing decisions. The variation in decision quality found in this study reveals that decisions are often likely biased because of (1) predisposition of decisions-makers towards a pre-determined outcome, (2) reliance of decision-makers on biased sources of information which are pre-disposed to be selected over others for reasons discussed above or (3) both.

Policy Recommendations

The majority of the literature addressing the use of science in environmental policy, particularly for the ESA, encourages more regulation and guidelines for those making the decisions so that the "best science available" is more consistent across time and space (Meffe et al. 1998, Francis et al. 2005, Sullivan et al. 2006). My data suggests the FWS, in general, is aware of what constitutes the best science and is capable of writing rules that use it. However, quality of the science used in ESA listing Rules declines with decreasing oversight and potential negative feedback to the agency, particularly when resources are stretched. Carroll et al. (2012) suggested a decrease in oversight is preferable in order to maintain continuity of "acceptable" risk of endangerment to species over time and strict guidelines that define acceptable risk of extinction would negate the need for oversight. My data suggests a decrease in oversight, which appears to be prompted partially by the public as a "fire alarm", would decrease the quality of the decisions made under the ESA. However, this does not negate the need for consistency in the definition acceptable risk to species and the potential benefits of it being clearly defined under the ESA (Wilhere 2008, Woods and Morey 2008), as this nebulousness allows agencies to manipulate their use of the literature to support the decision and not the other way around, a tactic used historically in the name of science (Oreskes and Conway 2011).

My results show that workload and, potentially, limited resources appear to have a direct influence on decision quality. It is unlikely that the general trends in species decline due to human population growth and resource consumption will decrease in the future. Therefore, it is unlikely FWS will see a decrease in petitioned species in need of evaluation under the ESA. If more resources, including more qualified decision-makers, can improve decisions quality then those resources should be allocated to overstretched regions and offices. Another option could be for overburdened offices to share workload with other, lower workload, offices. I believe that higher transparency in the decision making process, specifically providing information on which FWS employees are writing and making decisions, would provide more accountability, increase incentives to hire capable biologists, and improve overall quality in ESA listing decisions.

Finally, the presentation and layout of ESA Proposed and Final Rules need to be adjusted to increase transparency of what information is available for each species and, more importantly, what information is most heavily relied upon to make the final decision and why. The current layout allows decision-makers to muffle decisions by presenting all data, no matter how obscure, in a way that does not distinguish quality or reliability. This allows for the misrepresentation or incomplete presentation of science and potentially places an inappropriate emphasis and reliance on information that is not felicitous, all impediments to quality decisions when using the “best available science” (Murphy and Weiland 2016).

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Previous research shows similar results and conclusions to the results found in my study regarding uncertainty surrounding wildlife policy decisions (Easter-Pilcher 1996, Prato 2005, Schultz 2008), but there has been little done to address these issues in regards to the Endangered Species Act (ESA). Further, the lack of clarity prompted by the lack of objectively defined terms regarding what it means to be an endangered or threatened species further confounds the decision process (Rohlf 1991, Woods and Morey 2008). Previous research suggests that uncertainty allows for increased agency discretion (Schultz 2008) and uncertainty, along with the ESA "science only" mandate, appears to encourage the U.S. Fish and Wildlife Service (FWS) to conceal the true basis for their decisions, make their decisions appear objective and certain, and ultimately undermine political support by declaring that science is the ultimate foundation for their decisions (Doremus 1997). More transparency in listing decisions (i.e., which data is relied upon most to make decisions) as well as clarification of what is known or not known in regards to data variability and estimation error would minimize potential bias produced by writing rules that essentially "defend" positions a priori decisions.

Because of the uncertainty in the data and the lack of the requirement for transparency regarding which data sources FWS uses to make final listing decisions, there appears to be a strong influence of non-biological variables, specifically FWS region and ownership of habitat, on listing decisions. My research also shows that land ownership (i.e., public vs. private) of habitat and FWS region have a large influence on likelihood of protection. These results may be an artifact of higher threat levels (e.g., human population size, development, invasive species) for species in regions that correspond with these variables. It is also possible that these differences are influenced by political or cultural variation within the states or regions where the species occur or that listing decisions are influenced by institutionalized agency norms within the FWS (Gerlach et al. 2013). Additionally, workload affects decision quality and, under high workload situations, public attention and political pressure dictate the level of rigor used in ESA listing decisions, likely in an attempt by bureaucrats to avoid negative feedback and consequences. Issues affecting decision quality undoubtedly vary by FWS region and so policies that address the shortcomings of the ESA would need to vary by the characteristics and demands of each region, including which threats are prevalent, how and from whom decision-makers decide which data constitutes the "best available", and the resources available in the context of ESA workload.

Specific Recommendations for Improvement in Use of "Best Available Science"

1. Increase transparency in decisions. Modify how Proposed and Final Rules are written and presented by clearly reporting the shortcomings of the data available, clearly identifying which literature provided the largest contribution to the final decision and why, and identify which literature was not considered valid or appropriate and why. Provide a clear definition of what it means to be endangered or threatened. There will always be room for varying opinions on acceptable level of endangerment as long as

acceptable risk of extinction is not clearly defined in the ESA, which allows the FWS to be less transparent and less accountable for their decisions. Potential negative feedback may be more impactful to decision quality when accountability is higher. Be more transparent about who writes the Rules and makes the final decision. Accountability will go a long way to makes sure qualified individuals are tasked with evaluating the literature and determining its quality and usefulness to the decision process.

2. Fund research before unneeded protections are put in place. When data regarding species population status, trends, and threats are largely unavailable, provide resources to researchers to fill in the gaps so listing decisions are more accurate and resources are not squandered on species that do not need protection. Funding for research on candidate species, before the financial burden of ESA protections are implemented, will increase decision quality and decrease Type I and Type II errors.

3. Be more pro-active than reactive. Direct resources into programs and policies that address the most common threats in each region and nationally (i.e., invasive species, direct habitat loss and fragmentation). Addressing common threats directly instead of on a species-by-species basis will not only prevent further deterioration in populations of already protected species but also to slow the need for protections for potential future species of concern.

4. Increase agency resources. Insufficient financial resources and stretched agency staff are leading to lower quality decisions, which likely include protecting species that do not need protection and not protecting those that do. If more resources, including

more qualified decision-makers, can improve decisions quality then those resources should be allocated to overstretched regions and offices.

Limitations of Study

The results from this dataset may have generalizability problems regarding FWS behavior or overall bureaucratic behavior under average circumstances. FWS does not typically conduct the large number of listing reviews in a short time, which was required by the Center for Biological Diversity vs Salazar 2011 settlement, and, therefore, regions and offices may not typically suffer from the lack of resources brought on by the extremely high workloads observed during my study. While the data offers the advantages of observing large numbers of bureaucratic decisions over a short period, thus eliminating many variables that may otherwise influence outcomes (i.e., changes in personnel, change of administration, shifts in public opinion), it is also possible that the large number of decisions over a short period may also influenced outcomes and behavior. For example, the perception by FWS employees of environmental group pressure may have been exacerbated due to the recent legal settlements thus modifying the way FWS operated with each species (i.e., listing species using low decisions quality when public attention is low in order to appease environmental groups). More research is needed regarding environmental group behavior and its impact on FWS behavior in order to understand the dynamics of their interactions under these varying conditions.

Additionally, public attention may have been diluted for many species within my dataset simply because of the large number of listing decisions. It is possible that species in more direct conflict with human interests gained substantial enough attention to have an effect on decisions quality while others did not receive the public attention they would normally receive. Therefore, it is possible that decision quality is normally higher overall under ordinary circumstances of FWS listing decisions because the average public attention per decisions is, on average, higher. This does not negate my finding of the strong influence of public attention on decision quality. However, more research is needed on the amount of public attention necessary to trigger a bureaucratic reaction under typical workloads as well as how much it varies under normal conditions to better understand how bureaucratic behavior and decision quality fluctuates overall.

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APPENDIX A

SUMMARY OF ESA LISTING DECISION BY TAXONOMIC GROUP

						mean ± SD		
Taxonomic group	Count	EN	TH	PR	NW	Months candidate	Months proposed	# threats
Plant	40 (28.0%)	16	7	2	15	261.0 ± 162.2	12.3 ± 2.2	4 ± 1
Terrestrial invertebrates	30 (21.0%)	8	0	6	16	146.2 ± 145.7	12.9 ± 5.1	4 ± 1
Aquatic invertebrates	23 (16.1%)	14	3	5	1	181.5 ± 145.7	12.1 ± 1.5	5 ± 2
Herps	18 (12.6%)	6	7	1	4	155.4 ± 118.8	13.3 ± 2.4	6 ± 2
Fish	14 (9.8%)	5	1	1	7	156.8 ± 118.8	13.0 ± 2.4	5 ± 2
Mammals	9 (6.3%)	2	1	2	4	123.0 ± 114.7	13.3 ± 2.3	5 ± 2
Birds	9 (6.3%)	0	3	0	6	111.7 ± 58.3	14.7 ± 4.6	5 ± 2
Total	143	51	22	17	53	189.2 ± 151.6	12.7 ± 2.7	5 ± 2

APPENDIX B

NUMBER OF ESA LISTING DECISIONS BY STATE

State	# of species
Texas	31
California	26
Arizona	21
Nevada	16
Alabama	14
New Mexico	14
Washington	13
Kentucky	11
Florida	10
Tennessee	10
Utah	10
Arkansas	9
Colorado	9
Missouri	9
Oregon	9
Oklahoma	8
Virginia	8
Indiana	7
Ohio	7
West Virginia	7
Illinois	6
Pennsylvania	6
Georgia	5
Idaho	5
Kansas	5
Michigan	5
Mississippi	5
Montana	5
Alaska	4
Minnesota	4
North Carolina	4
Wisconsin	4
Wyoming	4
Puerto Rico	4

Iowa	3
Louisiana	3
New York	3
Connecticut	2
Delaware	2
Hawaii	2
Maine	2
Maryland	2
Massachusetts	2
Nebraska	2
New Hampshire	2
New Jersey	2
South Carolina	2
Vermont	2
North Dakota	1
Rhode Island	1
South Dakota	1
U.S. Virgin Islands	1

APPENDIX C

THREATS CITED IN ESA RULE AND NATURESERVE BY FWS REGION

	Region								
	1	2	3	4	5	6	7	8	All
Agriculture	5	24	6	5	0	5	0	10	55
	45%	51%	67%	16%	0%	42%	0%	34%	38%
Land conversion	7	20	6	27	1	2	0	14	77
	64%	43%	67%	87%	100%	17%	0%	48%	54%
Resource use	1	14	7	8	1	5	1	10	47
	9%	30%	78%	26%	100%	42%	33%	34%	33%
Water diversion	2	24	4	10	1	3	0	8	52
	18%	51%	44%	32%	100%	25%	0%	28%	36%
Commercial fishing	1	0	0	0	0	0	2	0	3
	9%	0%	0%	0%	0%	0%	67%	0%	2%
Competing uses (other)	6	8	0	4	0	3	0	17	38
	55%	17%	0%	13%	0%	25%	0%	59%	27%
Exploitation	0	2	2	6	0	2	2	4	18
	0%	4%	22%	19%	0%	17%	67%	14%	13%
Climate change	4	18	0	9	1	7	3	14	56
	36%	38%	0%	29%	100%	58%	100%	48%	39%
Modified disturbance regimes	9	10	2	13	0	2	0	13	49
	82%	21%	22%	42%	0%	17%	0%	45%	34%
Pesticides/herbicides	1	10	1	7	0	0	0	3	22
	9%	21%	11%	23%	0%	0%	0%	10%	15%
Pollution (other)	1	12	5	8	1	0	2	1	30
	9%	26%	56%	26%	100%	0%	67%	3%	21%

Exotic/invasive species	9	21	7	18	1	6	0	14	76
	82%	45%	78%	58%	100%	50%	0%	48%	53%
Species interactions	5	7	3	8	0	2	1	5	31
	45%	15%	33%	26%	0%	17%	33%	17%	22%
Isolated populations	9	29	7	26	1	5	0	20	97
	82%	62%	78%	84%	100%	42%	0%	69%	68%
Other	1	3	1	1	0	0	0	2	8
	9%	6%	11%	3%	0%	0%	0%	7%	6%
Total decisions	11	47	9	31	1	12	3	29	143

APPENDIX D

DECISION QUALITY BY REGION AND OFFICE

	FWS Region	Mean ± SD Decision Quality by Region (*n*)	Office	State	Mean ± SD Decision Quality by Office (*n*)
1	Pacific (*n* = 11)	0.93 ± 0.12 (*n* = 7)	Pacific Islands FWO (*n* = 2)	Hawaii	0.85 (*n* = 1)
			Oregon FWO (*n* = 1)	Oregon	1.02 (*n* = 1)
			Washington FWO (*n* = 8)*	Washington	0.93 ± 0.13 (*n* = 5)
2*	Southwest (*n* = 47)	0.70 ± 0.18 (*n* = 12)	Arizona ESFO (n = 16)*	Arizona	0.75 ± 0.18 (*n* = 2)
			New Mexico ESFO (n = 6)*	New Mexico	0.75 ± 0.23 (*n* = 3)
			Oklahoma ESFO (n = 1)	Oklahoma	0.94 (*n* = 1)
			Texas Coastal ESFO (n = 2)	Texas	0.72 ± 0.09 (*n* = 2)
			Arlington Field Office (n = 2)	Texas	NA
			Corpus Christi ESFO (n = 2)	Texas	NA
			Austin Field Office (n = 18)*	Texas	0.56 ± 0.16 (*n* = 4)
3	Great Lakes, Big Rivers (*n* = 9)	0.90 ± 0.14 (*n* = 4)	Rock Island Field Office (n = 1)	Illinois	0.76 (*n* = 1)
			Illinois Field Office (n = 2)	Illinois	0.90 ± 0.12 (*n* = 2)
			Chicago ESFO (n = 1)	Illinois	
			Columbia ESFO (n = 2)	Missouri	1.06 (*n* = 1)
			Columbus ESFO (n = 2)	Ohio	NA
			Green Bay ESFO (n = 1)	Wisconsin	NA
4*	Southeast (*n* = 31)	0.71 ± 0.30 (*n* = 15)	Arkansas ESFO (n = 3)	Arkansas	1.19 (*n* = 1)
			Panama City Field Office (n = 1)	Florida	NA

			Florida ESFO (n = 1)	Florida	0.59 (*n* = 1)
			South Florida ESFO (n = 8)*	Florida	0.86 ± 0.44 (*n* = 3)
			Georgia ESFO (n = 2)	Georgia	0.38 (*n* = 1)
			Kentucky ESFO (n = 1)	Kentucky	NA
			Mississippi Field Office (n = 2)	Mississippi	0.77 ± 0.15 (*n* = 2)
			Asheville ESFO (n = 1)	North Carolina	0.50 (*n* = 1)
			Caribbean ESFO (n = 6)*	Puerto Rico	0.50 ± 0.19 (*n* = 4)
			Tennessee ESFO (n = 6)*	Tennessee	1.01 (*n* = 1)
5	Northeast (*n* = 1)	0.58 (*n* = 1)	West Virginia Field Office (n = 1)	West Virginia	0.58 (n = 1)
6	Mountain Prairie (*n* = 12)	0.88 ± 0.19 (*n* = 7)	Colorado Field Office (*n* = 2)	Colorado	NA
			Montana ESFO (n = 3)	Montana	0.91 (*n* = 1)
			Nebraska ESFO (n = 1)	Nebraska	0.82 (*n* = 1)
			Utah ESFO (n = 5)*	Utah	0.86 ± 0.11 (*n* = 2)
			Wyoming ESFO (n = 1)	Wyoming	1.27 (*n* = 1)
7	Alaska (*n* = 3)	0.89 ± 0.12 (*n* = 2)	Juneau FWO (n = 1)	Alaska	NA
			Fairbanks FWO (n = 1)	Alaska	0.98 (*n* = 1)
			Alaska Regional Office (n = 1)	Alaska	0.81 (*n* = 1)
8*	Pacific Southwest (*n* =29)	0.81 ± 0.22 (*n* = 11)	Sacramento FWO (n = 7)*	California	0.84 ± 0.16 (*n* = 6)
			Arcata FWO (n = 2)	California	NA
			Bay Delta FWO (n = 2)	California	0.80 (*n* = 1)
			Ventura FWO (n = 3)	California	0.85 (n = 1)
			Carlsbad FWO (n = 4)	California	0.85 ± 0.49 (*n* = 2)
			Nevada FWO (n = 11)*	Nevada	0.50 (*n* = 1)

*indicates regions and offices designated as high workload.