Missing, delayed, and old: A status review of ESA recovery plans

Recovery planning is an essential part of implementing the U.S. Endangered Species Act (ESA), but conservationists and government agencies recognize challenges with the current planning process. Common criticisms are that too many species lack recovery plans, plans take too long to write, and they are rarely updated to include new information. Using data from all U.S. domestic and transboundary ESA-listed species—most of which are required to have recovery plans—we quantify these basic characteristics of ESA recovery planning over the past 40 years. We show that nearly 1/4 of eligible listed species (n = 1,503) lack recovery plans; the average recovery plan has taken >5 years to finalize after listing; half of recovery plans are 19 or more years old; and there is significant variation among regions and between agencies in plan completion rates and time-to-completion. These results are not unexpected given dwindling budgets and an increasing number of species to protect, but underscore the need for systematic improvements to recovery planning. We discuss solutions that may address some of the shortcomings we identify here, including a transition to dynamic, web-based recovery plans.

PeerJ Preprints | https://doi.org/10.7287/peerj.preprints.2882v2 | CC BY 4.0 Open Access | rec: 19 Jul 2017, publ: 19 Jul 2017

Missing, delayed, and old: A status review of ESA recovery plans

Jacob W. Malcom[1] and Ya-Wei Li[1]

[1] Defenders of Wildlife, 1130 17th Street NW, Washington, DC 20036

Corresponding author:

Jacob Malcom
Defenders of Wildlife
1130 17th Street NW
Washington, DC 20036
jmalcom@defenders.org

PeerJ Preprints | https://doi.org/10.7287/peerj.preprints.2882v2 | CC BY 4.0 Open Access | rec: 19 Jul 2017, publ: 19 Jul 2017

Abstract

Recovery planning is an essential part of implementing the U.S. Endangered Species Act (ESA), but conservationists and government agencies recognize challenges with the current planning process. Common criticisms are that too many species lack recovery plans, plans take too long to write, and they are rarely updated to include new information. Using data from all U.S. domestic and transboundary ESA-listed species—most of which are required to have recovery plans—we quantify these basic characteristics of ESA recovery planning over the past 40 years. We show that nearly 1/4 of eligible listed species (n = 1,503) lack recovery plans; the average recovery plan has taken >5 years to finalize after listing; half of recovery plans are 19 or more years old; and there is significant variation among regions and between agencies in plan completion rates and time-to-completion. These results are not unexpected given dwindling budgets and an increasing number of species to protect, but underscore the need for systematic improvements to recovery planning. We discuss solutions that may address some of the shortcomings we identify here, including a transition to dynamic, web-based recovery plans.

Introduction

The U.S. Endangered Species Act (ESA) is widely considered the strongest wildlife conservation law in the world. It was enacted in 1973 in recognition of an impending extinction crisis, with the purpose to provide a legal framework to conserve threatened and endangered species to the point that the law's protections are no longer needed (U.S. Congress, 1973). Recovery plans, which detail the biology of ESA-listed species, the threats to the species, and the actions needed to meet criteria for recovery, are a key part of the strength of the ESA. Recovery plans became a required part of ESA implementation with the 1978 amendments to the law (U.S. Congress, 1978), and the three modern requirements for recovery plans—objective recovery criteria, site-specific recovery actions, and cost and time estimates for recovery—were established with the 1988 amendments (U.S. Congress, 1988). The federal agencies responsible for implementing the ESA, the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS; collectively, the Services), are required to develop recovery plans unless doing so is not warranted (e.g., for foreign-listed species).

Recovery plans have evolved significantly over the years. Perusing available plans (see FWS's Environmental Conservation Online System [ECOS], http://ecos.fws.gov, for plan access), one observes that those from the early 1980s are rarely more than several dozen pages in length. By the mid-1990s, the background information in recovery plans became slightly more extensive and the recovery criteria became substantially more focused. As plans continued to evolve, conservationists recognized that they could be improved to better guide species recovery. A set of detailed studies of recovery planning organized by the Society for Conservation Biology and concluded in 2002 resulted in many suggestions of how recovery plans should be improved (overview in Clark et al., 2002). Informed by these recommendations, the Services developed their joint recovery planning handbook (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2010), which has been revised several times since the first version published in 2003. Modern recovery plans are much longer and more detailed than earlier plans, addressing many of the quality issues identified by the 2002 review (Troyer & Gerber, 2015). Recovery plan development is considered an effective use of resources: species with recovery plans were more likely to have improving status than species without plans (Taylor, Suckling & Rachlinski, 2005). Boersma and colleagues (2001) also found that species with revised recovery plans had performed better than those without revisions, but suggested that performance may be related to

plan age. Because available data indicate the status of the majority of ESA-listed species declined between 1990 and 2010 (Evans et al. 2016), there is a substantial need to ensure recovery plans are realizing their full potential.

Although many aspects of ESA recovery plans have improved, practitioners generally recognize that significant problems remain with the recovery planning process. For example, in May, 2016, NMFS performed a public review of the effectiveness of its recovery program (National Marine Fisheries Service, 2016a). The panelists and participants—most of whom were practitioners with the Services—noted too many species lack recovery plans; plans take too long to develop; plans remain unchanged for too many years despite new knowledge; and that there is spatial and agency variation in how recovery planning is implemented. These shortcomings likely stem in part from inadequate funding (see e.g., Gerber 2016). While these problems are known to exist, their extent has not been comprehensively quantified or estimates are dated. For example, Tear and colleagues (1995) reviewed recovery plans for 344 species (53% of 652 species listed as of 1991) and found, among other results, that plant recovery plans took an average of 4.1 years to complete while plans for animals took an average of 11.3 years. Schwartz (2008) found that 15% of species lacked recovery plans in his broad review of the ESA. Since then, ~300 additional species have been listed as threatened or endangered, some new plans have been published, and other plans have been updated. Now, nearly a decade later and with a new batch of species likely to be listed in the coming decade, there is a need to understand the status of recovery planning for ESA-listed species.

Using data scraped and curated from the Services' websites, we answered four general questions about the history and current status of ESA recovery plans:

- *How many species have final recovery plans, and how has that changed since 1978?* Finalized recovery plans set forth the official position of the Services about what is needed for recovery. Species that lack final recovery plans are more susceptible to be overlooked for recovery funding and action. Further, final recovery plans can inform regulatory actions, such as section 7 consultations and section 10 permitting. For example, "recovery units," which are smaller components of a species' range that are essential for the species' conservation, are delineated in recovery plans. Recovery units in turn may be used in consultation and permitting decisions (U.S. Fish and Wildlife Service & National Marine Fisheries Service, 1998) and in mitigation (U.S. Fish and Wildlife

Service, 2008). Note that we do not suggest that recovery outlines or draft recovery plans are not useful; they usually are. But final plans indicate the government's formal position on recovery.

- *What is the average (median) time from listing to an original final recovery plan?* The Services' 1994 recovery planning guidance stated that, "the Services will...develop recovery plans within 2-1/2 years after final listing" (U.S. Fish and Wildlife Service & National Marine Fisheries Service, 1994). But the Services and their conservation partners know a persistent problem is that recovery planning often takes far longer than that. Recovery planning is a team effort (Crouse et al., 2002) addressing a complex problem and often takes considerable time. For example, the recovery plan for the Cook Inlet beluga whale took over six years to complete, in part because the recovery planning team included two large "sub-teams," one composed of scientists and one of stakeholders (National Marine Fisheries Service 2016b, Appendix C). But we anticipate that the longer a species goes without a recovery plan, the more likely it is to be neglected and the more likely that recovery actions remain uncoordinated because the knowledge synthesis of recovery planning has not occurred. Related questions include, What proportion of species have plans completed within the 2.5-year time-frame? How has the time required for a recovery plan changed over the past ~40 years?
- *How old are recovery plans as of 2016?* A significant challenge of recovery planning as currently practiced is the difficulty of updating plans: revisions require extensive work by planning teams, *Federal Register* notices, and revisions to a draft before finalization. But what we collectively know about a species can change rapidly, from basic biological research to the types of management that can help or hinder recovery, especially when threats change over time. For example, the current recovery plan for the eastern indigo snake (*Drymarchon couperi*) focuses on addressing overutilization (e.g., snake collecting) as a primary threat (FWS 1982). But the species' most recent five-year review states, "Over-utilization for commercial, recreational, scientific, or educational purposes is not considered to be a threat to the species at this time" (FWS 2008). Another clear example is the threat posed by climate change, which is addressed in very few recovery plans (Ruhl, 2008; Povilitis and Suckling, 2010). Although we have not calculated the frequency of obsolete threats addressed in recovery plans, which is beyond the scope of

the current contribution, our impression is that cases such as the indigo snake and the broad challenge of climate change are relatively common. A previous analysis found that vertebrates with designated critical habitat were more likely to receive recovery plan revisions, but also found that revisions did not improve recovery criteria (Harvey et al., 2002). We anticipate that recovery will be more successful if plans contain up-to-date information.

- *How has recovery planning varied among FWS regions and between the Services?* Differences between the Services in funding, culture, and workload (Lowell & Kelly, 2012), and the high degree of independence among FWS regions, suggest systematic differences in recovery planning. Identifying spatial or agency differences in recovery planning may help the Services identify strong recovery planning approaches or areas of the country that need an infusion of resources to initiate, complete, or revise recovery plans.

We do not attempt to answer other important and interesting questions, such as whether the recovery criteria of newer or revised plans are scientifically better supported than those of older or original recovery plans. Our results show that both the extent of recovery plan coverage and the time required for recovery plan development, finalization, and revision are falling short of expectations, and the shortfall varies between the Services and among FWS regions. These results highlight the need for the Services to reform how they plan for species' recovery.

Methods

We collected all available recovery plan metadata by web-scraping FWS's ECOS website (http://ecos.fws.gov) using an R package that we wrote to simplify data collection (https://github.com/jacob-ogre/ecosscraper). The functions in `ecosscraper` record all data in every table on each species' page, download all documents, and follow all non-mundane links (e.g., do not follow http://www.fws.gov) to gather additional content. Because NMFS does not have tabular metadata suitable for scraping for its recovery plans, we manually curated data from its recovery plan website (http://www.nmfs.noaa.gov/pr/recovery/plans.htm). Manual curation included downloading the plans and recording the species and plan dates for recovery plans. We collected data for all domestic U.S. and transboundary species only because foreign listed species will rarely, if ever, have recovery plans. Data collection for this analysis was done on 03 September 2016.

For the *time-to-plan* (i.e., the time from listing to final plan) analyses, we only included species with original final recovery plans: including species with revised plans (which may come many years later) would artificially inflate the time-to-plan. We are not aware of any public data that provide the original plans or their dates, so we do not know the time-to-plan for species that have revisions. Importantly, this is right-censored data. While there are ways to estimate expected values for right-censored data, those methods require assuming stationarity, i.e., that the same underlying process generates the data (Qin & Shen, 2010). We expect that variation in presidential administrations, congresses, and career staff at national, regional, and local levels have significant effects on the process that generates final recovery plans. Rather than assume stationarity, which is almost certainly invalid for our data, we simply acknowledge that the time-to-plan estimates are likely biased low because of the species that still lack plans. In contrast to the time-to-plan estimates, we included all species with either final or revised plans for estimating *plan age* as of 2016 (i.e., time from final plan approval to September, 2016) because the most recent plan revision date is known and the age estimate is unbiased. We used Pearson's correlation for simple correlations and general linear models (McCullagh & Nelder, 1999) for variance partitioning.

The raw data scraped from ECOS cannot be used directly, so we undertook several data cleaning and management steps to prepare it for analysis. R (versions 3.1 and 3.2) was used for scraping, data management, and analyses (R Core Team, 2016). The base stats package was used for analyses; the exact model specifications can be found in the archived analysis code (see below). The data and all code used in data preparation, analysis, and graphing can be found in a public GitHub repository at https://github.com/jacob-ogre/recovery.plan.overview, including an R vignette of all analyses. In addition, the data and code have been archived at the Open Science Foundation under project 'zwhv3' (https://doi.org/10.17605/OSF.IO/ZWHV3).

Results

Species with and without plans

Since the ESA was passed in 1973, the number of domestic listed species has increased to 1,593 species (Figure 1a, solid black line). Of these, seven species were exempted from recovery planning, and 72 species were listed less than 2.5 years ago (i.e., less than the Services' deadline); these 79 species are excluded from further analysis. In addition, one species (green

turtle, *Chelonia mydas*) underwent a listing change from a single listed species to five distinct population segments in 2016. This gives a time-to-plan of approximately -17 years because the species' recovery plan was written in 1999. We removed these five green turtle listings from further analysis. As of September 2016, 334 species (22.2% of 1,503 eligible species) lacked a final recovery plan, but 100 of these species had a draft recovery plan or a recovery outline. Starting after about 1980, the number of species with final recovery plans has increased at rates similar to listing rates (Figure 1a, gray dashed line). The steep increase in the number of species with plans in the 1990s was associated with an increased emphasis on recovery planning and an increase in the number of multi-species recovery plans (Figure 1b). But the number of listings has generally outstripped recovery planning since that peak of recovery plan production: the proportion of species listed each year that have a recovery plan has declined dramatically since 2000 (Figure 2).

Time-to-plan

Using only data for species with recovery plans, we found a median time-to-plan of 5.1 years, which was skewed toward longer times (mean = 7.0 years; Table 1; Figure 3a). Calculating percentiles (Figure 3b) we found only 18% of species receiving a plan within 2.5 years of listing and 20% taking ≥10 years. The data include 53 species for which the time-to-plan was negative. These are not mistakes: these species were included in existing multi-species plans that had already identified the species as ones of concern before they were listed. Excluding these "sub-zero" time-to-plan species from the calculations only slightly increased the average time-to-plan (mean = 7.4y). Acknowledging that species without final plans constitute right-censored data, the time-to-plan for species with plans has generally declined over the past four decades (year parameter = -0.13, p = 5.37e-6; Figure 4).

Plan ages

The distribution of ages of current recovery plans is highly variable, with a median recovery plan age of 19.45 years (Figure 5a). It is useful to examine both *ages of plans* (Figure 5b) and *ages of species' plans* (Figure 5c): the past use of multi-species plans means that the ages cluster on a per-species basis. As a result of this clustering, the median age of plans per-species is 22.47 years. As of September 2016, 14% of species have plans that are <10 years old, and 10% of species have plans that are >32.5 years old.

Plans by region and agency

NMFS has a lower proportion of domestic / transboundary species with recovery plans than FWS, and FWS regions with fewer listed species tend to have a higher proportion of species with plans (Table 2). Time-to-plan varied significantly across regions and between the Services ($F_{8,1021} = 20.12$, $p < 2.2e\text{-}16$, multiple $R^2 = 0.14$); time-to-plan for NMFS species was substantially longer than for FWS species (Figure 6a). Similarly, plan age varied significantly across regions and between the Services ($F_{8,1025} = 28.39$, $p < 2.2e\text{-}16$, multiple $R^2 = 0.18$), but plans for NMFS species are substantially newer than for FWS species (Figure 6b). Time-to-plan and plan age were negatively correlated ($r = -0.896$; $t = -5.3268$, $df = 7$, $p = 0.001$).

Discussion

Recovery plans are an essential component of the ESA. They are one of the few requirements of the ESA that encourages forward planning (Schwartz, 2008) and play a critical role guiding the actions of agencies, conservation partners, and the regulated community (Clark et al., 2002; Crouse et al., 2002). Significant progress has been made improving the quality of recovery plans: contemporary plans are far more detailed and science-based than many older plans (Troyer & Gerber, 2015). But the growing number of ESA-listed species combined with insufficient and static or declining funding (Gerber, 2016; Lowell & Kelly, 2016; Negrón-Ortiz, 2014) has outstripped the ability of the Services—and the conservation community more broadly—to develop recovery plans or keep them up-to-date. Conservationists and the Services recognize a variety of challenges with contemporary recovery planning, but there are few recent evaluations of the extent of those challenges. We used data on all ESA-listed species that are legally required to have recovery plans—U.S. domestic and transboundary species—to quantify the extent to which recovery planning is complete and the timeliness of plans.

We found that 22.2% ($n = 334$) of domestic and transboundary ESA-listed species currently lack a final recovery plan. This is a lower proportion lacking plans than in 1991 (Tear et al. 1995) but substantially higher Schwartz's (2008) finding that 211, or 15% of the 1351 species listed in late 2007, lacked recovery plans. Our Figure 1a illustrates how the increase in listings since 2009 has outstripped recovery planning and created the current 334-species gap. The relatively recent high rates of plan completion in the 2000-2010 window (Figure 2) coincide with a period during which very few species (n = 60, or six per year) were listed. In addition to

the lack of guidance for recovery, the missing plans mean that implementation of the ESA may be falling short of its potential in other ways. For example, the recovery units that may be delineated in recovery plans allow the jeopardy analysis of section 7 consultations to be conducted at a scale smaller than a species' entire range (U.S. Fish and Wildlife Service & National Marine Fisheries Service, 1998). Recovery units cannot be used in this critical analysis if there is no recovery plan.

The gap between listed species and those with recovery plans begs the question: how can this gap be filled? Although not as useful as final recovery plans, draft recovery plans are often informative (e.g., using recovery units in section 7 consultation; Article S1) and can be developed more quickly because they are not the final, official position on recovery that has gone through public review. But the data indicate only 34 species currently have draft plans, which average 10 years old. Recovery outlines can be considered lightweight versions of recovery plans and can help fill the gap until detailed planning occurs (and can help guide the planning process). But the data indicate only 64 species have a recovery outline. Because of the far-reaching implications of recovery plans, filling the gap with at least some well-informed guidance—draft recovery plans and recovery outlines—for the 234 species lacking any type of plan should be a high priority. The same emphasis is needed for the 71 species listed between March 2014 and September 2016, as well as the hundreds of species that will likely be listed in the coming decade. Services personnel can draft recovery outlines to spur plan development, and the outlines may be useful for recruiting robust recovery planning teams from different stakeholder groups.

We found the median time-to-plan was 5.1 years for all listed species. We note that the estimate is biased low because (a) 120 species were part of recovery plans that were finalized before those species were listed; and (b) the species that currently lack a recovery plan are excluded from the analysis and adding their final plans today would increase the median time-to-plan. In May 2016, NMFS reviewed the effectiveness of its recovery program (National Marine Fisheries Service, 2016), and the review panel recognized the extensive delay between listing and approval of final recovery plans. The NMFS review panel report provides a substantial number of recommendations that can likely reduce the time to draft recovery plans and to finalize them (Consensus Building Institute, 2016). As we discuss below, there are likely technological tools that can help reduce time-to-plan, but planning will still take time because of

public engagement. As noted above, there are likely many opportunities to jump-start recovery planning with recovery outlines and draft recovery plans.

At a median age of >19 years and with 10% of plans ≥32.5 years old, hundreds of recovery plans are showing their age and require updating. Not only has our knowledge about these species advanced, but the biological status and threats to species have likely changed significantly over these extended timeframes. For example, the indigo snake recovery plan was finalized in 1982. Poaching was identified as a significant threat at that time, but habitat destruction in the Southeastern U.S. is clearly the leading threat today (Breininger et al., 2012). Similarly, very few recovery plans consider climate change but almost certainly should (e.g., Ruhl, 2008; Povilitis and Suckling 2010). Recognizing that formal recovery plan updates are time-consuming and expensive as traditionally practiced (e.g., most or all updates trigger *Federal Register* notices), the Services should transition to a new and improved recovery planning framework.

The Services understand through experience some of the challenges that our analysis has quantified, and are working to find solutions. For example, FWS has been developing their Recovery Enhancement Vision (REV; Article S2) or Recovery Planning and Implementation (RPI; Article S3) for a number of years. The central idea of REV/RPI is to separate recovery plans into three components: a core that addresses the three statutory requirements of recovery plans, a Species Status Assessment (SSA) that is regularly updated, and a recovery implementation plan that provides more detail about recovery actions. FWS also anticipates recovery planning will occur much more quickly in part because the most extensive component of REVs, the SSAs, will be prepared during the listing analysis (G. Schultz, FWS, *pers. comm.*). (NMFS expressed its interest in the REV model in its response to the recent recovery program review.) Full adoption of the REV/RPI will be an important step forward, but the Services also need a strategy and toolkit to update recovery plans quickly and easily.

Recognizing the challenges of recovery planning highlighted here, the authors have been developing prototypes of dynamic, web-based recovery plans (see https://cci-dev.org/dynamic-recovery/). We think these can be particularly useful in implementing REV/RPI by taking advantage of online collaboration tools that facilitate both recovery plan development and updates. Adopting web-based recovery plans may help close the gap for the >400 species lacking plans—and hundreds of species that will be listed in the coming years—because the plans can

start as recovery outlines in the web-based framework. The Services can update the outlines regularly, notify the public when outlines are converted into draft recovery plans for public review, and then finalize those drafts. The species status and recovery actions sections of online plans would be continually updated rather than remain fixed. As a result, a recovery plan might be updated every 19 days instead of 19 years. However, the statutory requirements for recovery plans—recovery criteria, site-specific actions required, and estimated time and cost (U.S. Congress, 1988)—will still require public review and comment before changing. Web-based recovery plans also offer the benefit of directly incorporating real-time data on other components of the ESA, such as section 7 consultations and section 10 voluntary conservation agreements. This is important because permitting under both sections 7 and 10 can allow habitat destruction and incidental take that undermine recovery. Placing permitting data directly in the context of recovery can enable better permitting decisions that increase the chances of recovery. To help ensure new and up-to-date plans change how conservation practitioners implement recovery actions—which Boersma et al. (2001) suggest may not happen—the Services may need to update its training and standard operating procedures for staff.

Species recovery is the ultimate goal of the ESA and planning is a central component of achieving that goal. Our analyses quantifies some of the challenges of recovery planning to date. Many of our recommendations are not new—the Services are beginning to move in these directions—but our results underscore the importance of adopting these changes. Closing the recovery planning and implementation gap will still require closing the funding gap that has emerged (Gerber, 2016; Lowell & Kelly, 2016; Negrón-Ortiz, 2014), regardless the technologies that can help close the planning gap. We close by recognizing that planning is one important step in recovering ESA-listed species, but those plans must be implemented properly (Brown & Beckett, 2016) for recovery to succeed.

Acknowledgements

We thank R. Dreher and J. Rappaport Clark for their constructive feedback that improved the manuscript.

Literature Cited

Breininger DR., Mazerolle MJ., Bolt MR., Legare ML., Drese JH., Hines JE. 2012. Habitat fragmentation effects on annual survival of the federally protected eastern indigo snake. *Animal Conservation* 15:361–368.

Boersma PD., Kareiva P., Fagan WF., Alan Clark J., Hoekstra JM. 2001. How Good Are Endangered Species Recovery Plans? *BioScience* 51:643–649. DOI: 10.1641/0006-3568(2001)051[0643:HGAESR]2.0.CO;2.

Brown S., Beckett J. 2016. A Case Study for the Implementation of Recovery Plans to Conserve Listed Species. *Natural Resources & Environment* 30(3):1:4.

Clark JA., Hoekstra JM., Boersma PD., Kareiva P. 2002. Improving US Endangered Species Act recovery plans: key findings and recommendations of the SCB recovery plan project. *Conservation Biology* 16:1510–1519.

Consensus Building Institute. 2016. *National Marine Fisheries Service National Recovery Program Review: Final Synthesis Report*. National Marine Fisheries Service, Washington, D.C.

Crouse DT, Mehrhoff LA, Parkin MJ, Elam DR, Chen LY. 2002. Endangered species recovery and the SCB study: A US Fish and Wildlife Service perspective. *Ecological Applications* 12:719–723.

Evans DM., Che-Castaldo JP., Crouse D., Davis FW., Epanchin-Niell R., Flather CH., Kipp Frohlich R., Goble DD., Li Y-W., Male TD., Master LL., Moskwik MP., Neel MC., Noon BR., Parmesan C., Schwartz MW., Michael Scott J., Williams BK. 2016. Species Recovery in the United States: Increasing the Effectiveness of the Endangered Species Act. *Issues in Ecology* 20:1–29.

356 Gerber LR. 2016. Conservation triage or injurious neglect in endangered species recovery.
357 *Proceedings of the National Academy of Sciences of the United States of America*
358 113:3563–3566.
359 Harvey E., Hoekstra JM, O'Connor RJ, Fagan WF. 2002. Recovery plan revisions: progress or
360 due process? *Ecological Applications* 12:682–689.
361 Lowell N, Kelly RP. Evaluating agency use of "best available science" under the United States
362 Endangered Species Act. *Biological Conservation* 196:53–59.
363 McCullagh P, Nelder JA. 1999. *Generalized linear models.* Chapman & Hall, CRC, Boca Raton,
364 Florida.
365 National Marine Fisheries Service. 2016. Endangered Species Act; Public Meeting: A review of
366 our recovery program under the Endangered Species Act of 1973, as amended (ESA).
367 *Federal Register* 81:11518.
368 National Marine Fisheries Service, U.S. Fish and Wildlife Service. 2010. *Interim Endangered*
369 *and Threatened Species Recovery Planning Guidance.* Departments of Commerce and
370 Interior, Washington, D.C.
371 Negrón-Ortiz V. 2014. Pattern of expenditures for plant conservation under the Endangered
372 Species Act. *Biological Conservation 171:36–43*.
373 Povilitis A., Suckling K. 2010. Addressing climate change threats to endangered species in US
374 recovery plans. *Conservation Biology* 24(2):372-376.
375 Qin J., Shen Y. 2010. Statistical methods for analyzing right-censored length-biased data under
376 Cox model. *Biometrics* 66:382–392.
377 R Core Team. 2016. R: A language and environment for statistical computing. R Foundation for
378 Statistical Computing, Vienna, Austria. https://www.R-project.org/.

379 Ruhl JB. 2008. Climate change and the Endangered Species Act: building bridges to the no-
380 analog future. *BUL Rev.* 88(1):1-63.
381 Schwartz MW. 2008. The Performance of the Endangered Species Act. *Annual Review of*
382 *Ecology, Evolution, and Systematics* 39:279–299.
383 Taylor MFJ., Suckling KF., Rachlinski JJ. 2005. The Effectiveness of the Endangered Species
384 Act: A Quantitative Analysis. *Bioscience* 55:360–367.
385 Troyer CM., Gerber LR. 2015. Assessing the impact of the U.S. Endangered Species Act
386 recovery planning guidelines on managing threats for listed species. *Conservation Biology*
387 29:1423–1433.
388 U.S. Congress. 1973. *Public Law Public Law 93-205; The Endangered Species Act of 1973.*
389 U.S. Congress. 1978. *Public Law 95-632; An Act to amend the Endangered Species Act of 1973*.
390 U.S. Congress. 1988. *Public Law 100-478; Endangered Species Act amendments of 1988*.
391 U.S. Fish and Wildlife Service. 2008. Endangered and Threatened Wildlife and Plants; Recovery
392 Crediting Guidance. *Federal Register* 73:44761–44772.
393 U.S. Fish and Wildlife Service, National Marine Fisheries Service. 1994. Cooperative Policy
394 (NMFS & FWS) for Recovery Plan Participation and Implementation Under the ESA.
395 *Federal Register* 59:34272.
396 U.S. Fish and Wildlife Service, National Marine Fisheries Service. 1998. *Handbook of*
397 *Procedures for Conducting Consultation and Conference Activities Under Section of the*
398 *Endangered Species Act*. Departments of the Interior and Commerce, Washington, D.C.

399

400 **Tables**

401 **Table 1.** Summary statistics for time-to-plan and plan completion dates for final recovery plans.

402

	n	min	median	mean	max
Final Plans*					
Listed Date	1034	1967-03-11	1992-05-13	1990-06-28	2013-09-19
Plan Date	1034	1980-03-17	1997-07-29	1997-05-31	2016-08-05
Years Elapsed	1034	-13.5	5.1	7	44
Draft Plans					
Draft Date	34	1984-09-30	1997-09-30	2003-05-30	2016-04-11
Draft Elapsed	34	-5.7	9.2	11.2	48
Other Types					
Other Date	66	1993-08-31	2010-06-17	2010-08-05	2015-07-08
Other Elapsed	66	-0.1	0.1	2.8	40

403 * These 1,034 plans are only those with a status of "Final"; including plan revisions would bias
404 the time-to-plan estimates high.

405

406 **Table 2.** The distribution of species with and without recovery plans, between U.S. Fish and
407 Wildlife Service regions and the National Marine Fisheries Service (NMFS).

Region/Agency	# spp. with plans	# spp. w/o plans	Prop. with plans
1	404	95	0.810
2	124	27	0.821
3	36	6	0.857
4	319	30	0.914
5	40	1	0.976
6	58	2	0.967
7	6	2	0.750
8	230	58	0.799
NMFS	39	26	0.600

408

409

Figures

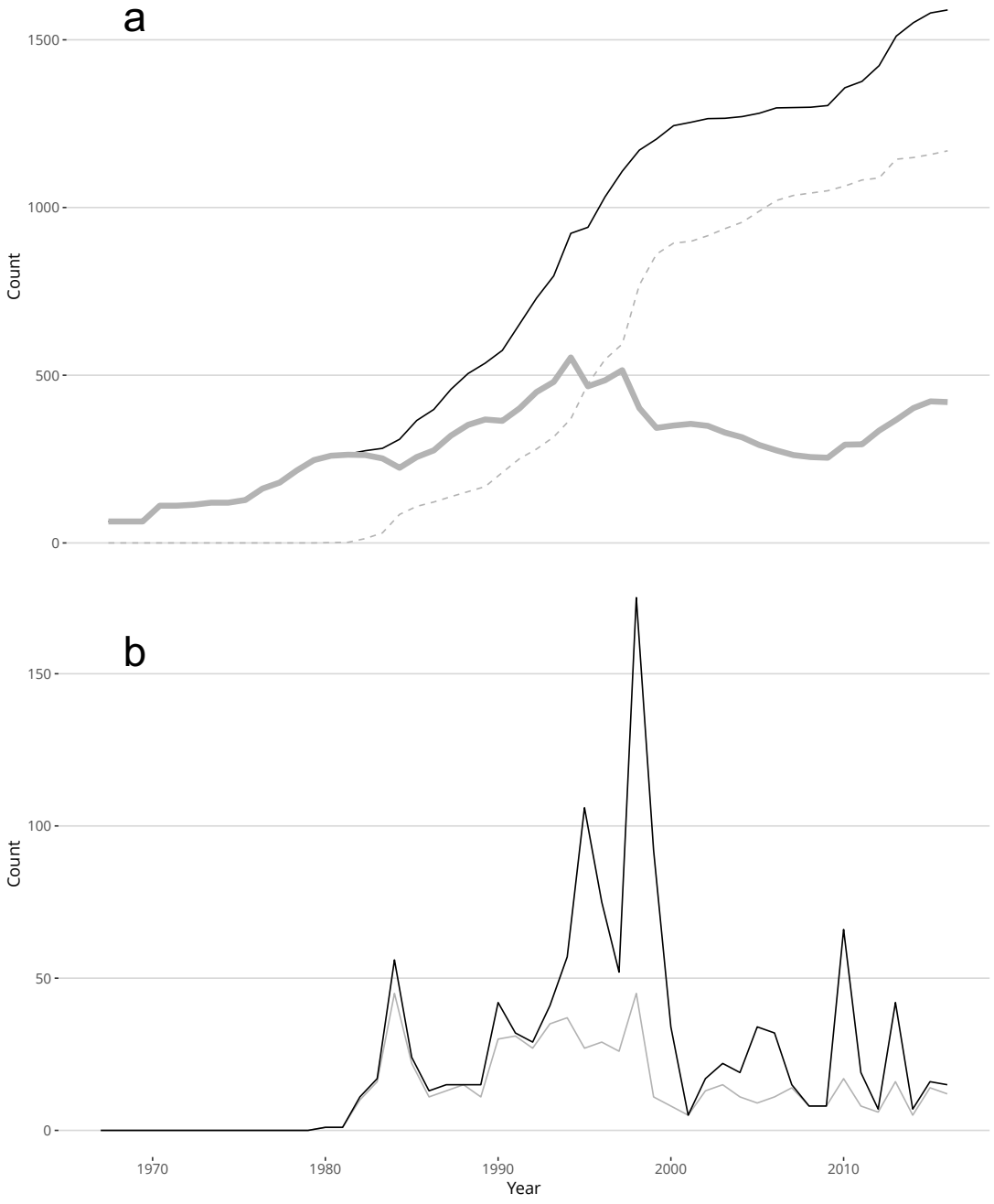
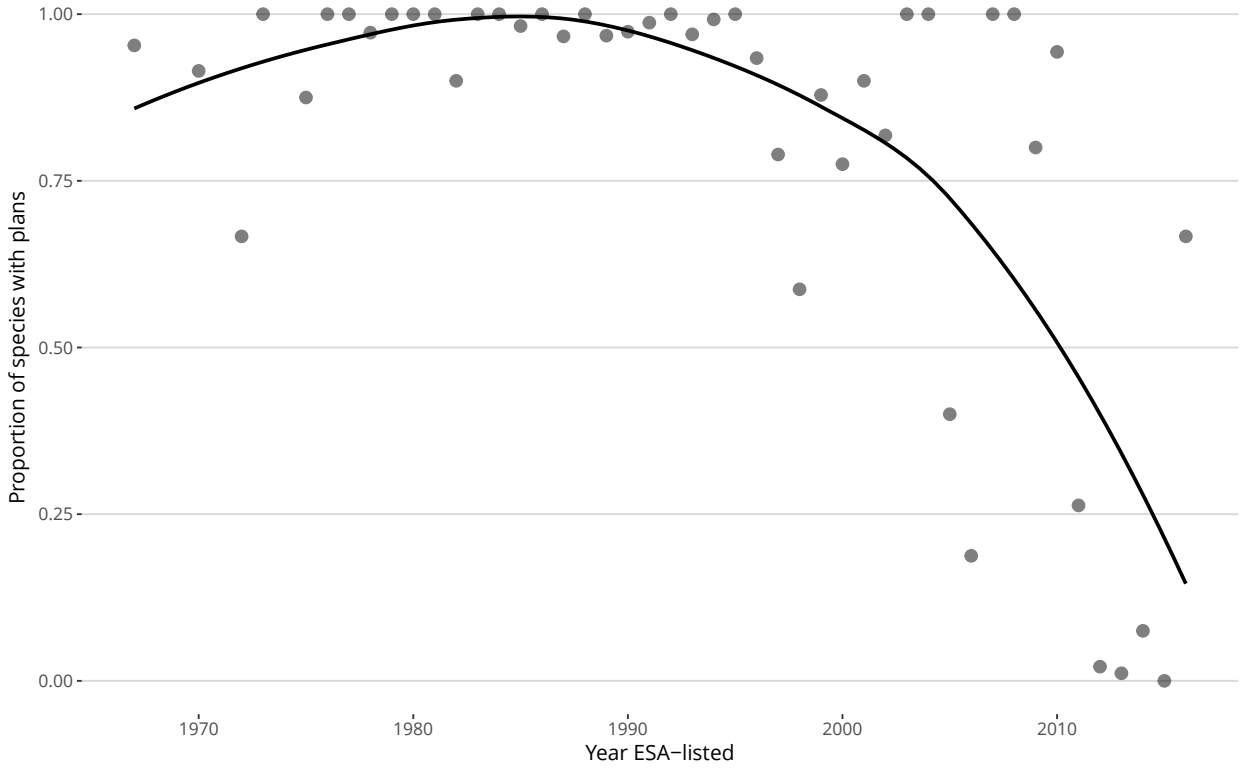


Figure 1. Species listings and recovery plan completions show distinct periods of change over the past >40 years. (a) The cumulative number of listed species (black line), species with recovery plans (gray dashed line), and the number lacking recovery plans (heavy gray line) show distinct tempos. The number of species with plans correlates well with the number of listed species (r = 0.864, p = 7.08e-5). A concerted effort to increase the number of species with

418 recovery plans in the mid-1990s and the low listing rate from 2001 to 2009 led to a decline in the
419 number of species without recovery plans, but that trend began reversing as the number of listed
420 species increased again in 2009. (b) Recovery plans by year show a pulse of planning in the mid-
421 and late-1990s. The greater the difference between the black (number of species with plans) and
422 gray lines (number of plans), the greater the proportion of species covered by multispecies plans.
423

424



425

426 **Figure 2. The proportion of species with recovery plans by year begins to drop significantly**
427 **starting with species listed just before 2000.** Each point is the proportion of ESA-listed species
428 with recovery plans in one year, and the line is spline-fit curve. Despite the drop, a relatively
429 large proportion of species listed between 2001 and 2009 had recovery plans simply because
430 very few species were listed during this time.

431

432

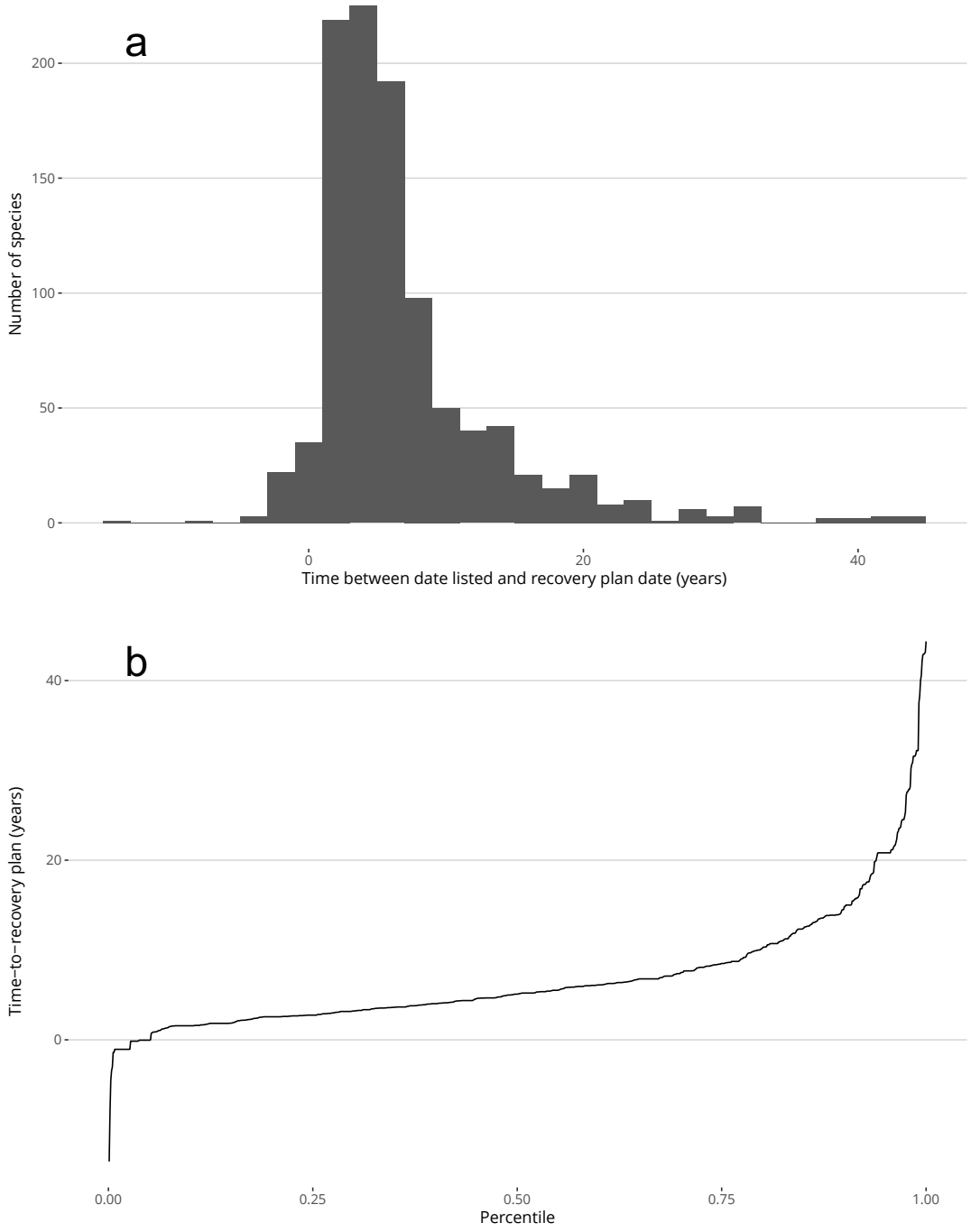


Figure 3. The median time-to-plan was 5.1 years, but skewed towards higher values (mean = 7 years). (a) The histogram of times-to-plan includes negative values for species included in multispecies / ecosystem recovery plans written before the species was listed under the ESA. (b) The percentile plot—the line is the percent of plans with time-to-plan less than X—shows only 19% of recovery plans have been completed within the Services' stated goal of 2.5 years; 20% have taken ten or more years.

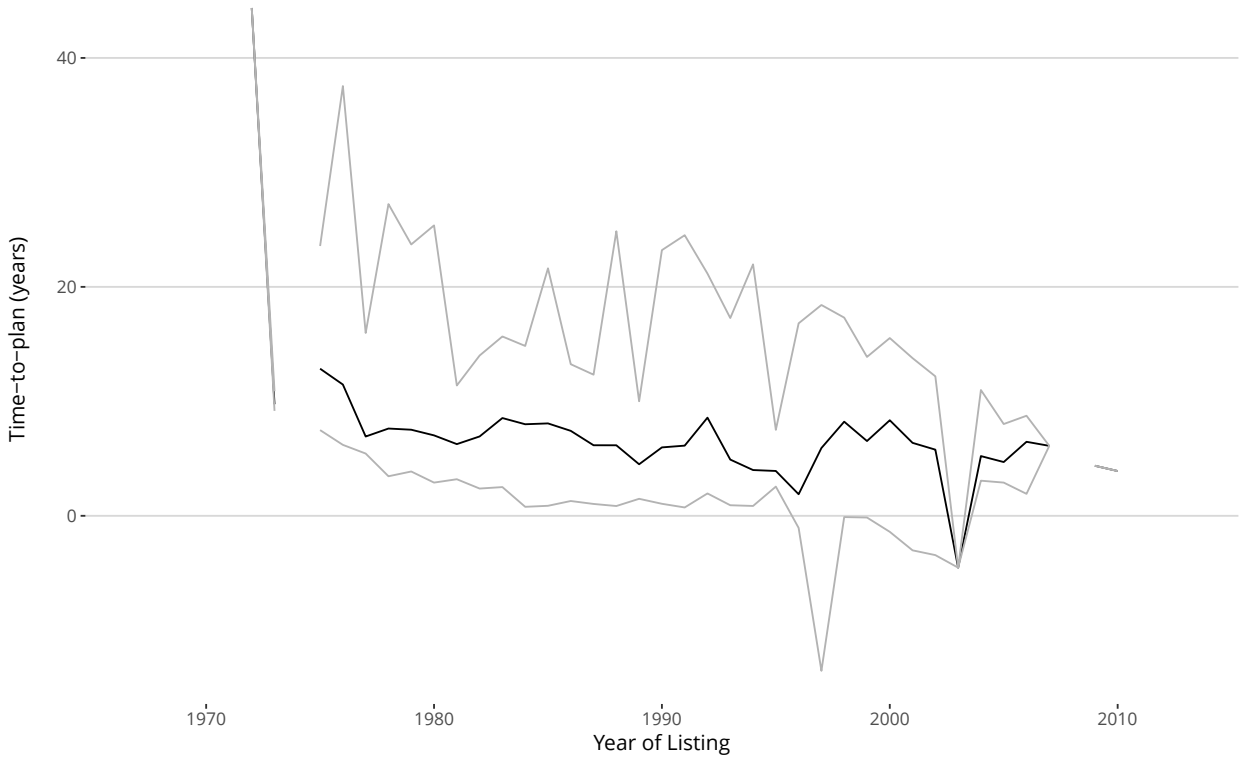
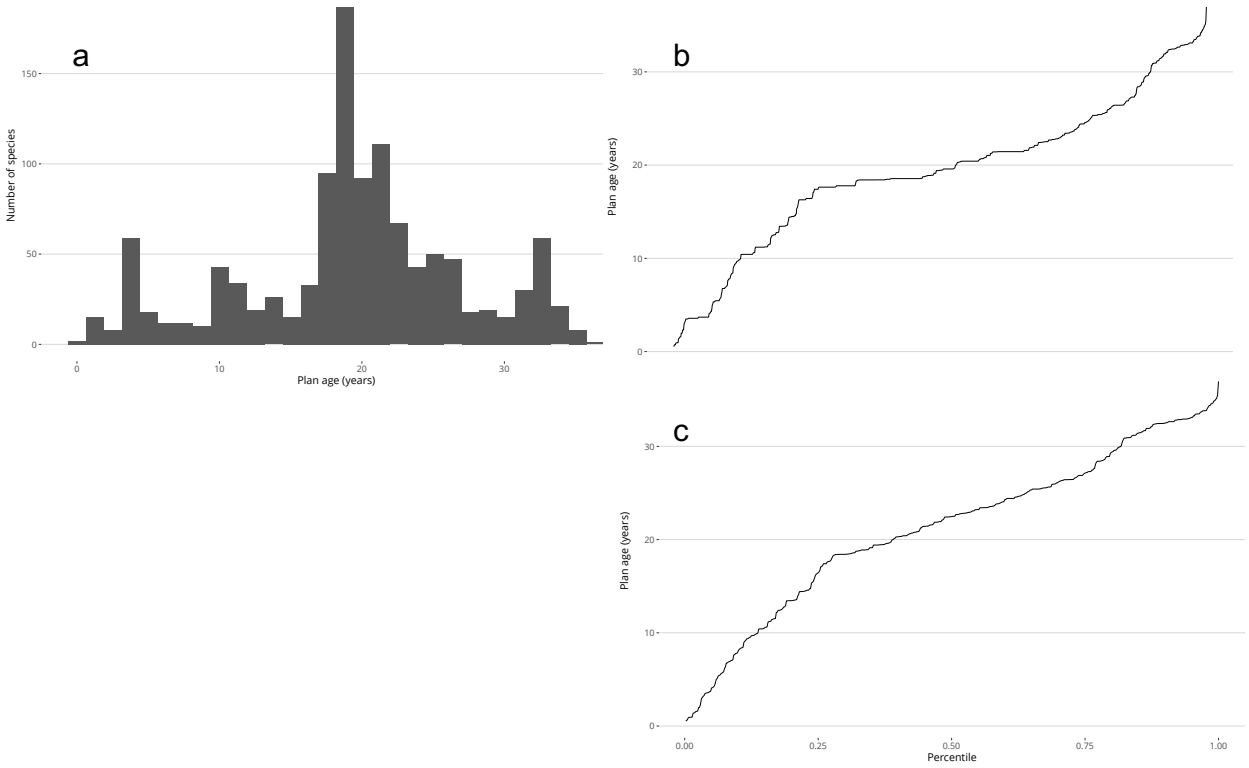


Figure 4. The mean time-to-plan (black line) has declined slightly through time. The maximum and minimum times-to-plan for each year are shown in light gray. Note that this trend does not account for the right-censored species that do not yet have recovery plans.



446

447 **Figure 5. The distribution of the ages of current recovery plans is complex and the range is**
448 **wide (<1 year to >36 years old).** Variation in the tempo of recovery planning is clear in the
449 histogram of plan ages, e.g., the pulse of recovery plans from the mid-to-late 1990s is very
450 evident (a). Half of all recovery plans are >19.5 years old, and 10% are 32.5 or more years old as
451 of 2016. The shape of percentile curves varies slightly between the age of plans on a per-species
452 basis (b) and the age of plans (c) because of the use of multi-species plans, especially in the
453 1990s.

454

455

456

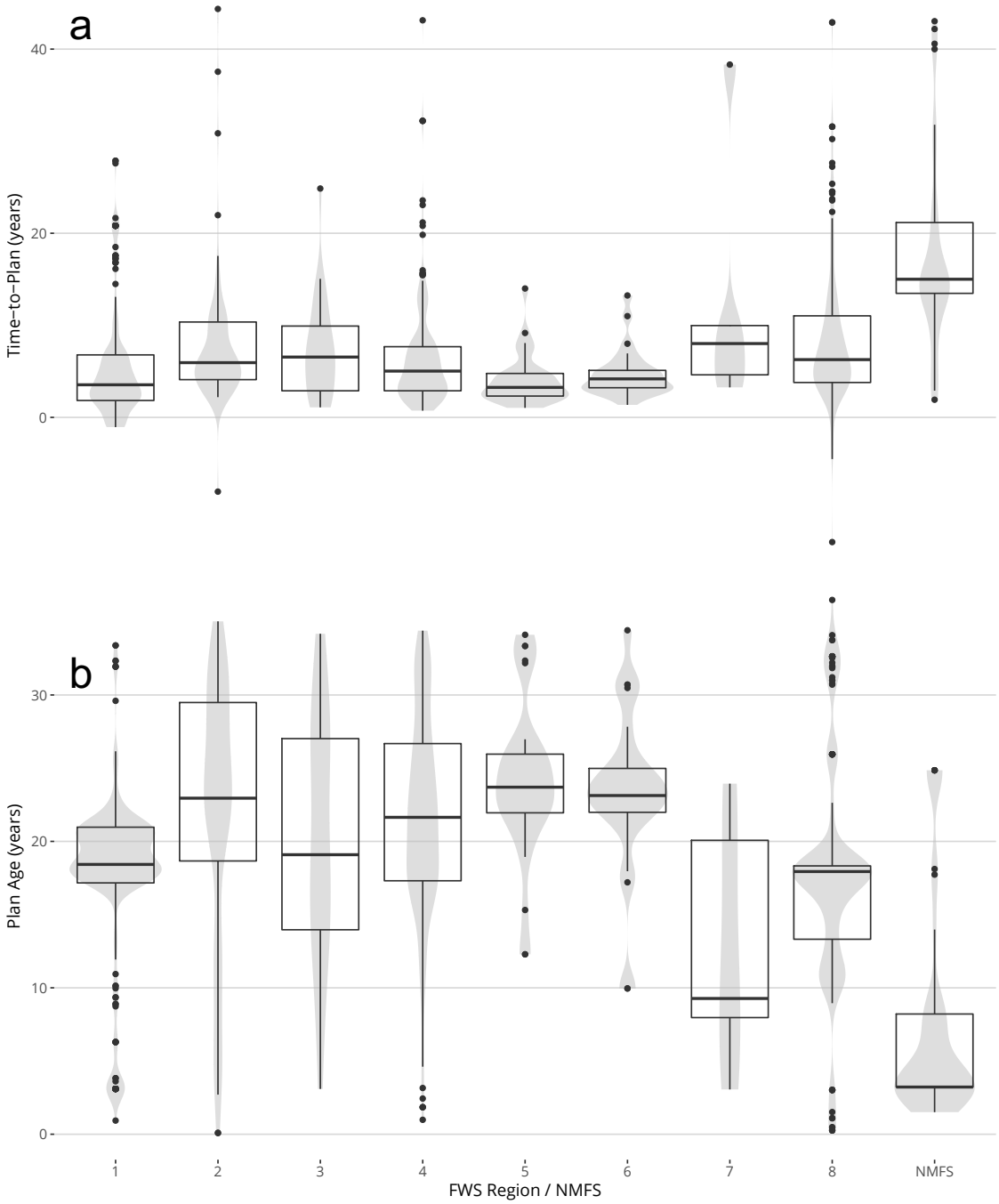


Figure 6. Variation in the time-to-plan (a) and plan age (b) is high between U.S. Fish and Wildlife Service (FWS) regions and between FWS and National Marine Fisheries Service (NMFS). Box plots show the median and interquartile range along with outliers, and violin plot overlays show the data density along the y-axis. Time-to-plan is weakly negatively correlated with the number of species per region, but strongly negatively correlated with plan age (r = -0.89, p = 0.001).