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

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Recovery planning is an essential part of implementing the U.S. Endangered Species Act (ESA), but conservationists and government agencies recognize many problems with the 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 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.

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Abstract

Recovery planning is an essential part of implementing the U.S. Endangered Species Act (ESA), but conservationists and government agencies recognize many problems with the 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 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.

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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. Plans 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. Despite this evolution, conservationists recognized that recovery plans could be improved to better guide species recovery. A set of detailed studies of recovery planning that concluded in 2002 resulted in many suggestions of how recovery plans should be improved (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).

Although many aspects of ESA recovery plans have improved, practitioners generally recognize that significant problems remain with the recovery planning process. These include too many species lacking recovery plans, plans that take too long to develop, plans that remain

unchanged for too many years despite new knowledge, and spatial and agency variation in how recovery planning is implemented. While these problems are known to exist, their extent has not been quantified. Using data scraped and curated from the Services' websites, we answered four general questions about the history and current status of ESA recovery planning:

- *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. But 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. 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 changes rapidly, from basic biological

research to the types of management that can help or hinder recovery, especially when threats change over time. 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 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). 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). 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* 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 because the most recent plan revision date is known and the age estimate is unbiased. We used Pearson's correlation for simple correlations and generalized 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). Base `stats` packages were used for analysis. Figures were created using ggplot. 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 to designate five distinct population segments in 2016 even though its recovery plan was written in 1999; we removed these five 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-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-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 static or declining funding (Lowell & Kelly; 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 understand how recovery planning has been implemented in the past and present.

We found that 22.2% (n = 334) of domestic and transboundary ESA-listed species currently lack a final recovery plan. For comparison, Schwartz (2008) found 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 final 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.

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). 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 shown, and are working to find solutions. For example, FWS has been developing their Recovery Enhancement Vision (REV) or Recovery Planning and Implementation (RPI) for a number of years (see overviews in Articles S2 and S3). 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 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 will be an important step forward, but the Services also need a strategy 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 REVs 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—would 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.

Species recovery is the ultimate goal of the ESA and planning is a central component of achieving that goal. Our analyses provide quantitative evidence of many 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. 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.

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Tables

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

	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

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

346

347 **Table 2.** The distribution of species with and without recovery plans, between U.S. Fish and
348 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

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Figures

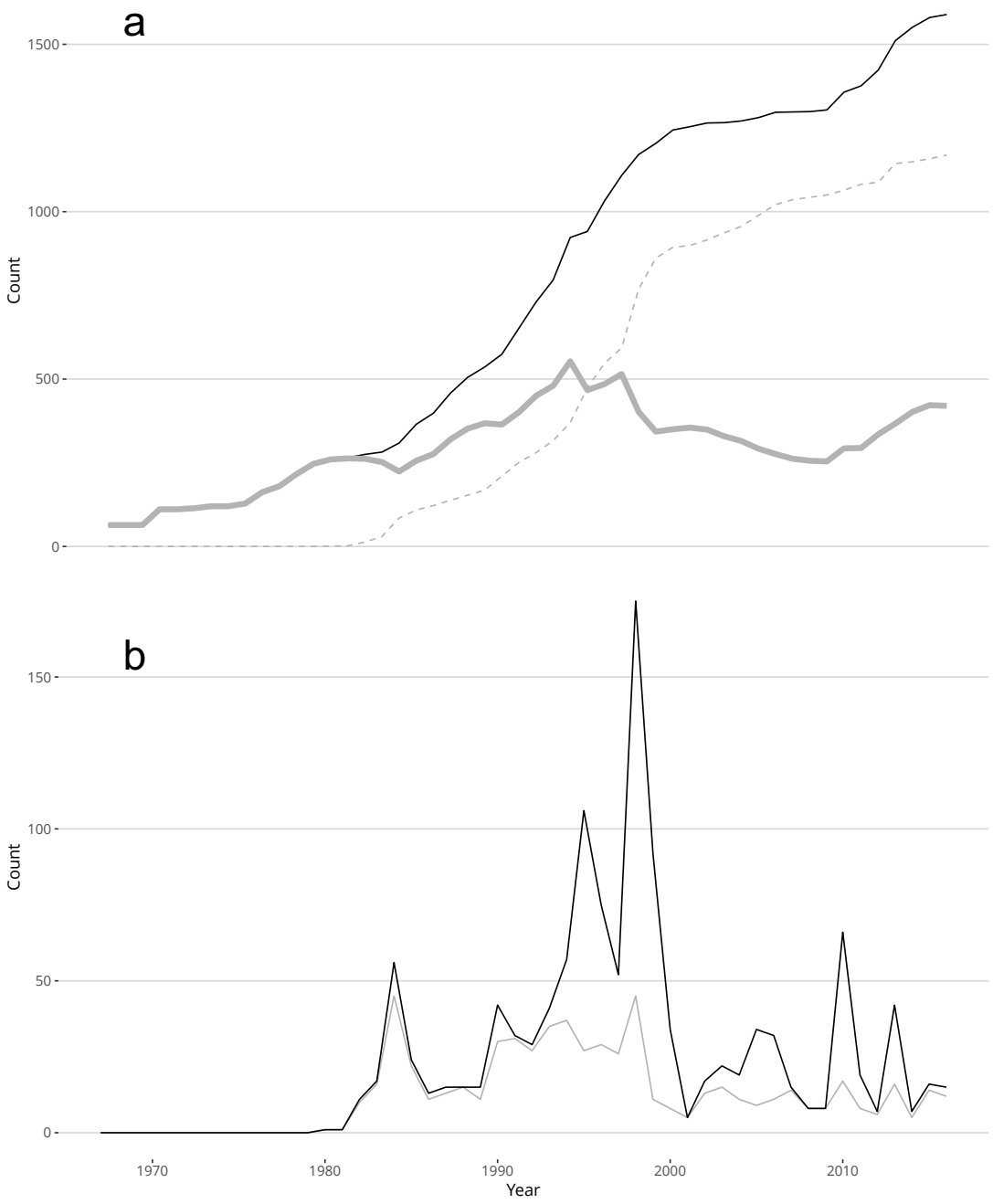

Figure 1. Species listings and recovery plan completions show distinct periods of change over the past >40 years. (a) The cumulative number of listed species (black line), species with recovery plans (gray dashed line), and the number lacking recovery plans (heavy gray line) show distinct tempos. The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

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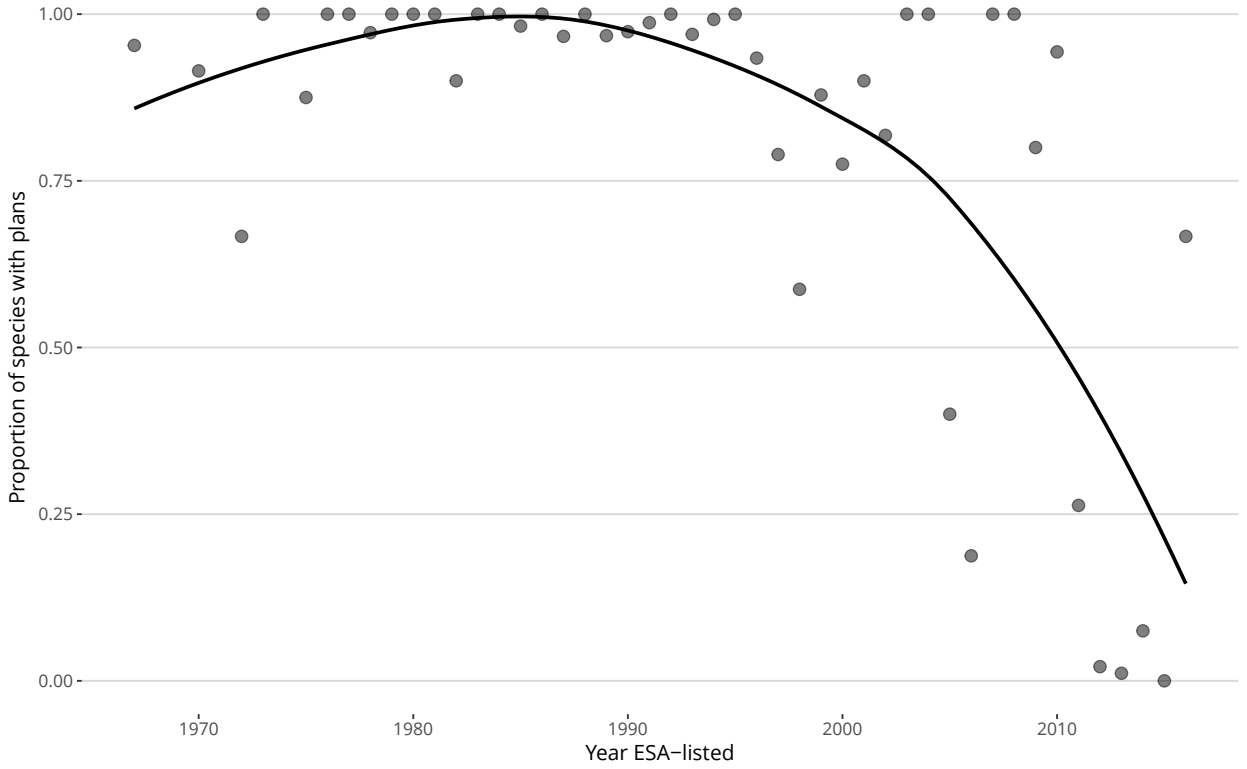


Figure 2. The proportion of species with recovery plans by year begins to drop significantly starting with species listed just before 2000. Despite this drop, a relatively large proportion of species listed between 2001 and 2009 had recovery plans simply because very few species were listed during this time.

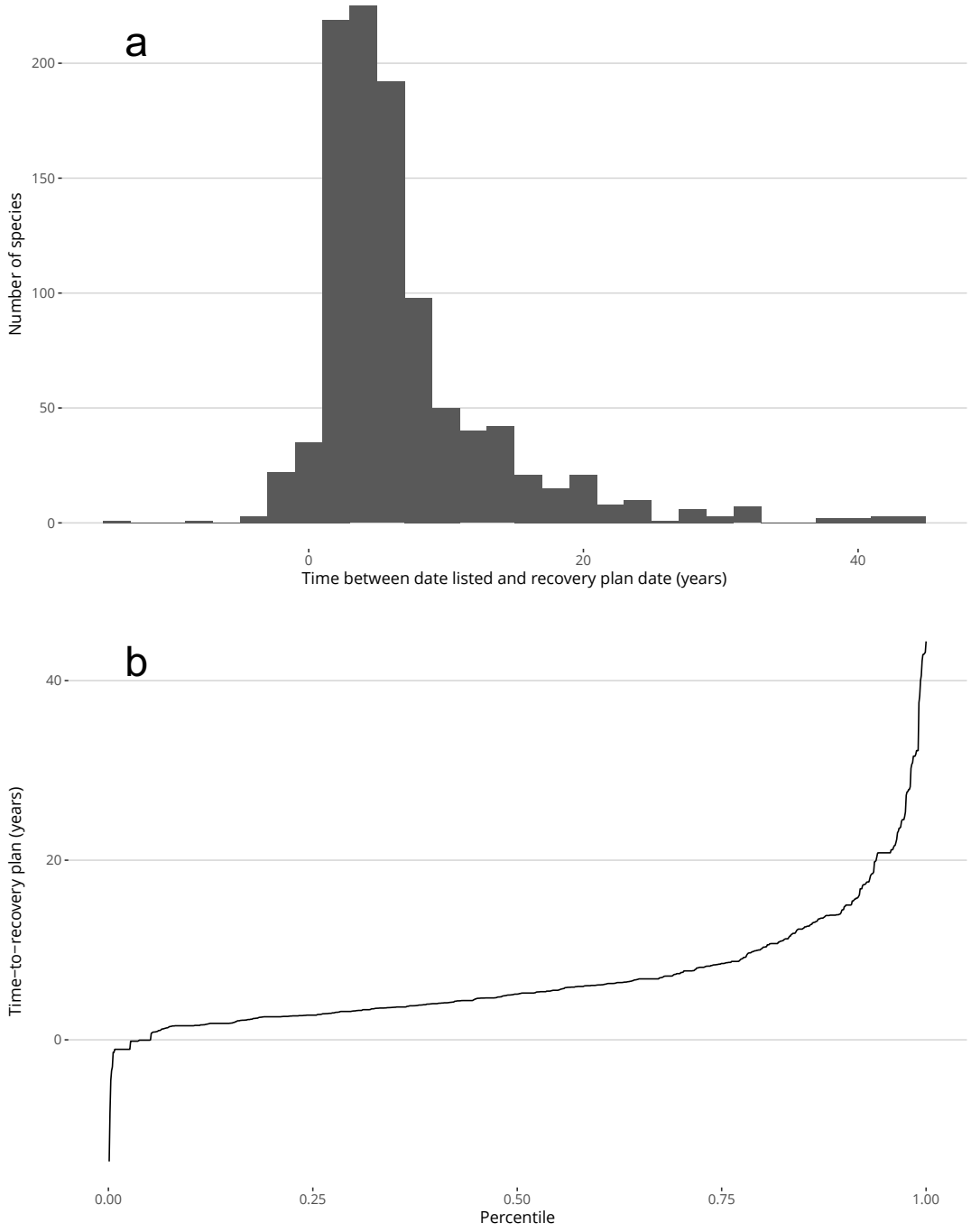
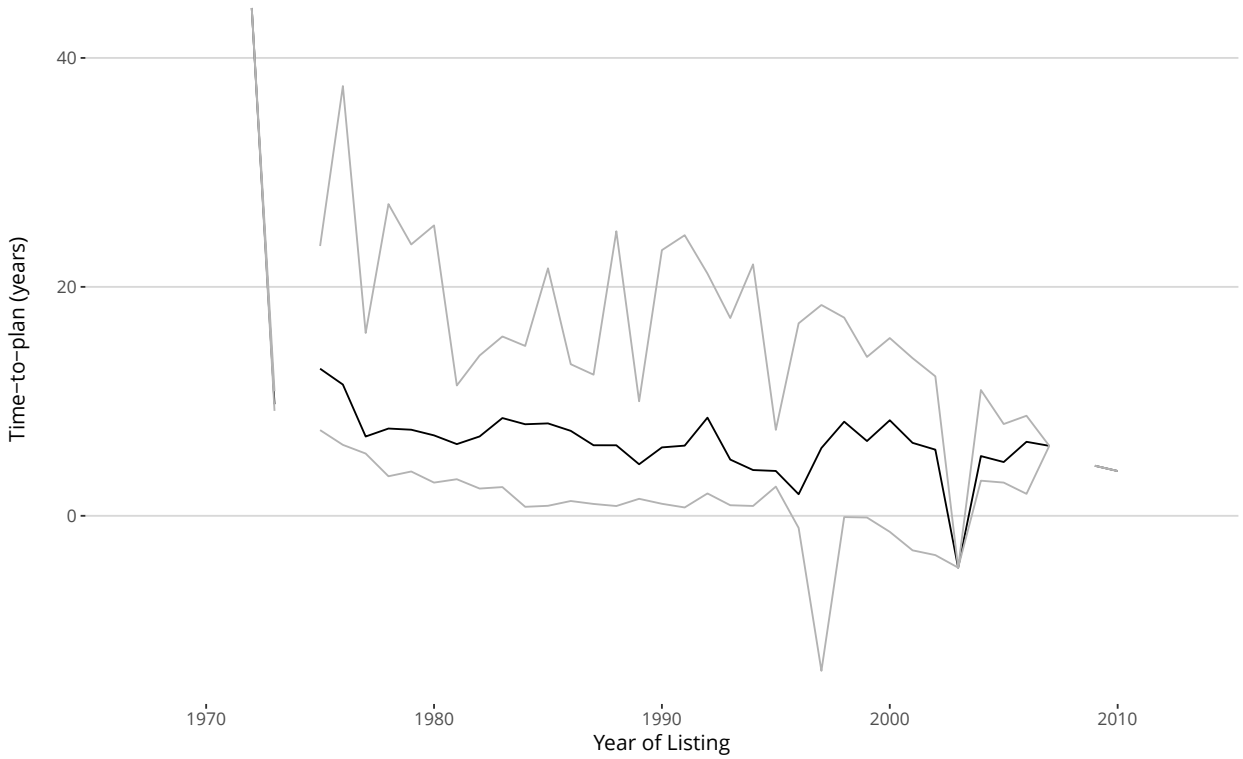


Figure 3. The median time-to-plan was 5.1 years, but skewed towards higher values (mean = 7 years). (a) The histogram of times-to-plan includes negative values for species included in multispecies / ecosystem recovery plans written before the species was listed under the ESA. (b) The percentile plot 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.



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380 **Figure 4. The time-to-plan has declined slightly through time.** Note that this trend does not
381 account for the right-censored species that do not yet have recovery plans.

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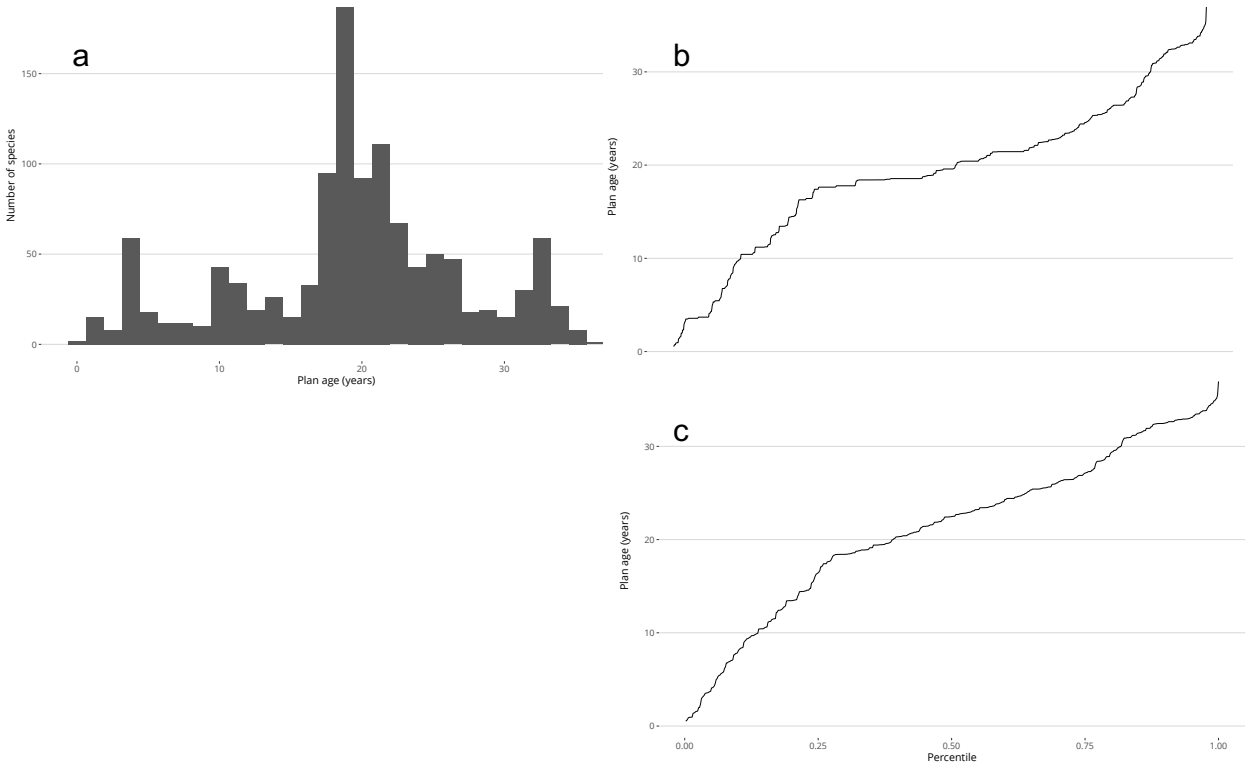

Figure 5. The distribution of the ages of current recovery plans is complex and the range is wide (<1 year to >36 years old). Variation in the tempo of recovery planning is clear in the histogram of plan ages, e.g., the pulse of recovery plans from the mid-to-late 1990s is very evident (a). Half of all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

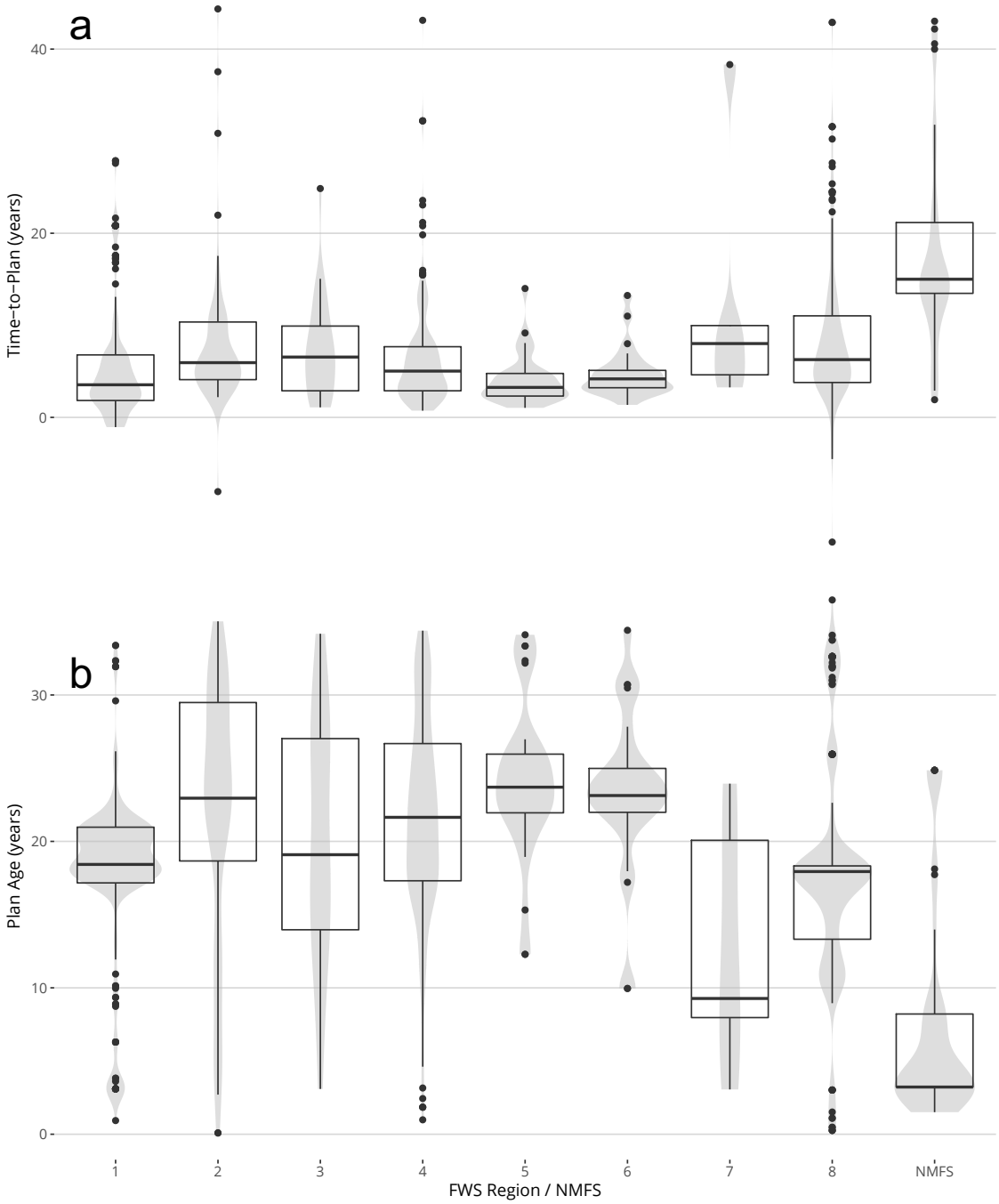

Figure 6. Variation in the time-to-plan (a) and plan age (b) is high between U.S. Fish and Wildlife Service (FWS) regions and between FWS and National Marine Fisheries Service (NMFS). Time-to-plan is weakly negatively correlated with the number of species per region, but strongly negatively correlated with plan age ($r = -0.89$, $p = 0.001$).