Missing, delayed, and old: The status of ESA recovery plans

Jacob W. Malcom[1] and Ya-Wei Li[1,2]

[1] Center for Conservation Innovation, Defenders of Wildlife, 1130 17th Street NW, Washington, DC 20036

[2] Present address: Environmental Policy Innovation Center, 1015 15th Street NW, Washington, DC 20005

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

Key words: Endangered Species Act, recovery planning, Fish and Wildlife Service, National Marine Fisheries Service
words (abstract): 153
words: 3,082
references: 29
figures: 6
tables: 3

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. Using data from all U.S. domestic and transboundary ESA-listed species, we quantify the completeness, timeliness, age, and other variation among ESA recovery plans over the past 40 years. Among eligible listed taxa (n = 1,548), nearly 1/4 lack final recovery plans; half of plans have taken >5 years to finalize after listing; half of recovery plans are more than 20 years old; and there is significant variation in planning between agencies, and among regions and taxonomic groups. These results are not unexpected given dwindling budgets and an increasing number of species requiring protection, but underscore the need for systematic improvements to recovery planning. We discuss solutions—some already underway—that may address some of the shortcomings and help improve recovery action implementation for threatened and endangered species.

Introduction

The U.S. Endangered Species Act (ESA) is widely considered the strongest wildlife conservation law in the world. Recovery plans are a key part of the strength of the ESA, and detail the biology of ESA-listed species, the threats they face, and the actions needed to achieve the goals of preventing the extinction of and recovering the species (U.S. Congress 1978, 1988, Schwartz 1999). For example, species with recovery plans are more likely to have improving status than species without plans (Taylor *et al.* 2005). 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 they find doing so would not promote the conservation of the species (e.g., for foreign-listed species).

Recovery plans have evolved significantly over the years. Perusing available plans (http://ecos.fws.gov), one observes that those from the 1980s are rarely more than several dozen pages in length while recent plans are more substantial. A significant part of the evolution of recovery plans was driven by detailed studies of recovery planning organized by the Society for Conservation Biology (SCB) in the late 1990s (see overview in Clark *et al.* 2002). Informed by the SCB review, the Services developed their joint recovery planning handbook (NMFS & FWS 2003, 2010), which has improved recovery plans by, for example, shifting the focus of recovery to threats (Troyer & Gerber, 2015). Because available data indicate the status of most ESA-listed species declined between 1990 and 2010 (Evans *et al.* 2016), species need plans with timely information to guide recovery efforts.

Although many aspects of ESA recovery plans have improved, practitioners recognize that significant challenges remain with the recovery planning process. For example, in NMFS' 2016 public review of its recovery program, panelists and participants noted that too many

species lack recovery plans; plans take too long to develop; plans remain unchanged for too many years despite new knowledge; and there may be too much variation in how recovery planning is implemented (NMFS 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 that plant recovery plans took on average 4.1 years to complete while plans for animals took 11.3 years. Schwartz (2008) found that 15% of species lacked recovery plans in his broad review of the ESA. Since then, >350 species have been listed as threatened or endangered, 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 (FWS 2017), there is a need to understand and, as necessary, improve the status of ESA recovery planning.

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

1. *How many species have final recovery plans, and how has that changed since 1978?* Finalized recovery plans are the official position about what is needed for recovery. They can inform regulatory actions, such as section 7 consultations, e.g., through "recovery units" (FWS & NMFS 1998) and in mitigation (U.S. Fish and Wildlife Service, 2008). Recovery outlines or draft recovery plans are useful, but are not official positions on recovery.
2. *What is the average 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" (FWS & NMFS 1994). This goal is relevant because the longer a species goes without a recovery plan, the more likely

it is to be neglected and recovery actions to remain uncoordinated. However, the Services and their conservation partners recognize that recovery planning often takes far longer than 2.5 years (e.g., >6 years for Cook Inlet beluga whale [*Delphinapterus leucas*]; NMFS 2016, Appendix C), in part because addressing these complex problems requires coordination among multiple parties (Crouse *et al*. 2002).

3. *How old are recovery plans as of 2018?* A significant challenge of current recovery planning is the difficulty of updating plans: revisions often require extensive and expensive work. But our knowledge of species and threats—consider the emergence of our understanding of climate change in the past decades—can change rapidly. A previous analysis found that revisions did not improve recovery criteria (Harvey *et al*. 2002), but we anticipate that recovery will be more successful if plans contain up-to-date information beyond original recovery criteria.
4. *How has recovery planning varied among FWS regions, between the Services, and among taxonomic groups?* Systematic differences may be present in recovery planning given differences between the Services in funding, culture, and workload (e.g., Lowell & Kelly 2012), the high degree of independence of FWS regions, and taxonomic biases in conservation (e.g., Stein *et al*. 2002). Identifying patterns of differences can help focus attention 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 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 set by the Services (FWS & NMFS 1994). We discuss several solutions that can improve recovery planning for threatened and endangered species.

Methods

We collected all available recovery plan metadata by web-scraping FWS's ECOS website (http://ecos.fws.gov), recording all data in every table on each species' page, and downloading all documents. Because listings occur on a species-by-location basis, we manually linked recovery plans to the listed entity when there were multiple locations (e.g., Distinct Population Segments) that each require their own recovery plan. We refer to every listed entity as "species" for simplicity. NMFS does not provide tabular metadata for its recovery plans, so we manually curated data from its recovery plan website (http://www.nmfs.noaa.gov/pr/recovery/plans.htm). Many species have multiple documents listed in recovery plan tables even though those documents are often just related addenda; we used only the document that is the core plan rather than associated documents. We collected data for all domestic U.S. and transboundary listed species because foreign listed species rarely warrant recovery plans.

To quantify completeness of plans (Q1), we simply tallied species listed in each year and recovery plans in each year. For the *time-to-plan* analyses (i.e., the time from listing to final plan; Q2), we included only final recovery plans and not subsequent revisions so as not to inflate the time period. Importantly, time-to-plan is right-censored data: we don't know the plan date for species lacking plans. While there are ways to estimate expected values, those methods require assuming stationarity (Qin & Shen 2010), which is invalid for our data. Instead, we simply acknowledge that the time-to-plan estimates are likely biased low because of species that still lack plans. In contrast to the time-to-plan estimates, we included all species with official plans for estimating *plan age* (Q3) as of 2018-01-08 because the most recent plan revision date is

known and the age is unbiased. We used Pearson's correlation and general linear models (McCullagh & Nelder 1999) for variance partitioning to understand variation among places and groups (Q4).

We used R for scraping, data management, and analyses (R Core Team 2016). The code for data preparation, model specifications, other analyses, and graphs can be found in the public GitHub repository at https://github.com/jacob-ogre/recovery.plan.overview, including an R vignette of all analyses. Data and code are archived at the Open Science Foundation under project 'zwhv3' (https://doi.org/10.17605/OSF.IO/ZWHV3).

Results

Species with and without plans

The number of domestic and transboundary listed species has increased to 1,660 taxa (Figure 1a) since 1973. Of these, seven species were exempted from recovery planning and 105 taxa were listed less than 2.5 years ago, i.e., are newer than the Services' target for plan development. We exclude these 112 species from subsequent calculations unless noted. Of the 1,548 species eligible for final recovery plans, we found 1,038 species had a final plan as of January 2018 and 131 had a revised plan (n = 604 official plans), leaving 379 species (24.5% of eligible species) without official recovery plans. Of the species lacking an official plan, 98 (6.3%) had a draft recovery plan or a recovery outline, leaving 280 species (18.1%) without any publicly available recovery guidance. Starting around 1980, the number of species with final recovery plans began increasing at a rate comparable to the listing increases (Figure 1a). A steep increase in the number of species with plans in the 1990s was associated with an increased emphasis by FWS on recovery planning and an increase in the number of multi-species recovery plans (Figure 1b, Supporting Information Figure S1). The rate of listing has outstripped recovery planning since

153 that peak of recovery plan production, and the proportion of species listed each year that have a
154 recovery plan has declined since 2000 (Figure 2).

155 ***Time-to-plan***

156 Using only data for species with final, non-revised recovery plans, we found a median time-to-
157 plan of 5 years, which was skewed toward longer times ($\bar{x}$ = 6.7 years; Table 1; Figure 3a). Only
158 18.6% of species received a plan within 2.5 years of listing and 18.4% required ≥10 years
159 (Figure 3b). The data include 53 species for which the time-to-plan was negative. These are not
160 mistakes: species were included in existing multi-species plans that had already identified the
161 species of concern before they were listed. Excluding these species from the calculations only
162 slightly increased the average time-to-plan ($\bar{x}$ = 7.06y). Recognizing that species without final
163 plans constitute right-censored data, the time-to-plan for species with plans has generally
164 declined over the past four decades (year parameter = -0.12, $p = 4.56e^{-6}$; Figure 4). Last, species
165 in multispecies plans had a time-to-plan approximately 1.4 years shorter than those in single-
166 species plans (median 4.7 vs. 6.1 years).

167 ***Plan ages***

168 The age distribution of current recovery plans is highly variable, with a median recovery plan
169 age of 22.8 years (n = 604 plans; Figure 5a). It is useful to examine both ages of plans (Figure
170 5b) and ages of plans on a per-species basis (Figure 5c): multi-species plans mean that the ages
171 cluster on a per-species basis. As a result of this clustering, the median age of plans per-species
172 is 20.5 years. As of January 2018, 10% of species have plans that are <10 years old, and 10% of
173 species have plans that are >31.7 years old.

Plans by region, agency, and taxon

NMFS has a lower proportion of 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 across regions and between the Services ($F_{8,1029} = 21.74$, $p < 2.2e^{-16}$, multiple $R^2 = 0.145$), with time-to-plan substantially longer for NMFS species than for FWS species (Figure 6a). Similarly, plan age varied across regions and between the Services ($F_{8,1029} = 32.8$, $p < 2.2e^{-16}$, multiple $R^2 = 0.197$), but plans are substantially newer for NMFS species than for FWS species (Figure 6b). Time-to-plan and plan age were negatively correlated ($r = -0.361$; $t = -12.464$, $df = 1036$, $p = 2.2e^{-16}$).

We found substantial variation in plan completion among taxonomic groups (Table 3). None of the diverse taxonomic groups are complete, but some (e.g., reptiles and birds) have particularly high completion rates at 94 and 89% (respectively), while amphibians, insects, and snails (63, 60, and 65%, respectively) have noticeably low rates. Species in a few small groups—conifers and cycads (three species), lichens (two species), and arachnids (12 species)—all have official recovery plans. Time-to-plan is structured by taxonomic group ($F_{14,1023} = 17.03$, $P < 2.2e^{-16}$), but is driven by high time-to-plan for birds and mammals (SI Figure S2). Plan age also covaries by group ($F_{14,1023} = 5.62$, $P = 1.43e^{-10}$), but is highly variable within groups (SI Figure S3).

Discussion

Recovery plans are one of the few requirements of the ESA that encourages forward planning (Schwartz 2008) and play a critical role in 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 number of ESA-listed species is increasing and funding is widely recognized as insufficient and static or declining (Gerber 2016, Lowell & Kelly 2016, Negrón-Ortiz 2014), leaving the Services unable to develop recovery plans or keep them up-to-date. Here we have shown that many ESA-listed species' plans are missing, out-of-date, slow to develop relative to Services expectations (FWS & NMFS 1994), or taxonomically biased, which informs how future recovery planning can be improved.

The first challenge we identified is the number of species without recovery plans. We found a quarter of eligible ESA-listed species currently lack an official recovery plan. This rate is less than half the 53% in 1991 (Tear *et al.* 1995), but substantially higher than the ~15% (n = 211) of species that lacked recovery plans in 2007 (Schwartz 2008). The increased rate of listings since 2009 has outstripped the relatively constant rate of recovery plan completion during that period, creating the current gap. Time-to-plan is a complement of completeness: the longer the gap without plans, the lower the rate of completeness at any point in time. The NMFS recovery review panel recognized the problem of delays (NMFS 2016), and our finding that recovery plans require twice the target set by the Services (5.1y versus 2.5y) underscores that issue.

The second and substantially different challenge of recovery planning is plan age. At a median age of >20 years and with 10% of plans ≥31.7 years old, hundreds of recovery plans are showing their age. Not only has our knowledge about these species likely advanced over these extended timeframes, but the biological status and threats have likely changed significantly. For example, the indigo snake (*Drymarchon corais couperi*) recovery plan was finalized in 1982, when poaching was identified as a significant threat. Today, habitat destruction in the Southeastern U.S. is clearly the leading threat (Breininger *et al.* 2012). Similarly, very few

219 recovery plans consider climate change but almost all should (e.g., Ruhl, 2008, Povilitis &
220 Suckling 2010).

221 Addressing the challenges of recovery planning we have detailed here will require a
222 combination of approaches. First, more funding is needed: a recent analysis found <25% of
223 required recovery funding had been allocated annually from 1980-2014 (Gerber 2016). The U.S.
224 Congress and states need to significantly increase funding, and perhaps develop a dedicated
225 revenue stream for ESA recovery (AFWA 2016), akin to the Pittman-Robertson Act, which
226 provides funding from firearm sales to state wildlife agencies. The Services should also look at
227 recruiting resources beyond traditional funding. For example, professional societies and
228 organizations such as Xerces Society and Partners for Reptile and Amphibian Conservation may
229 be able to mobilize resources to help the Services complete missing insect and amphibian
230 recovery plans. The Services may even be able to solicit funding for recovery planning, e.g.,
231 from entities who benefit from the regulatory certainties arising from final recovery plans (SI
232 Article S1). Regardless the sources, this funding will need to be coupled with priority-setting—
233 which plans need to be written or revised first—and expectation management, for example,
234 through policy revision, as discussed further below, and public engagement.

235 Second, fundamental administrative changes underway at the Services will help address
236 some issues in recovery planning. For example, FWS has developed their Recovery Planning and
237 Implementation framework (RPI; SI Articles S2 and S3), which holds promise for making plans
238 both faster to create and easier to update. (NMFS expressed its interest in RPI in its response to
239 the recent recovery program review [Consensus Building Institute 2016].) Under RPI, the
240 traditional monolithic recovery plan is split into three parts: a Species Status Assessment (SSA)
241 that is maintained as a "living document"; a short (10-20 pages) core recovery plan that contains

mostly static content such as recovery criteria; and one or more Recovery Implementation Strategies that contain implementation details. With the adoption of RPI, SSAs are developed before listing decisions or as part of status reviews. This means a significant amount of recovery planning happens before the "formal" recovery planning period, and suggests that the formal planning timeline can be shortened. Last, the adoption of SSAs means FWS can keep key status information up-to-date.

Third, the Services should update their 1994 policy to build on the past >20 years of experience and take advantage of RPI, including points to address several of our findings:

- To provide early guidance, the required recovery outline should be publicized soon after the final listing rule. This should include preliminary recovery objectives and a list of needs for developing the full recovery plan.
- To help manage public engagement, which is part of planning but is likely part of the high time-to-plan (Crouse et al. 2002) we observed, the policy could state that an initial public meeting on the recovery plan will be scheduled, if warranted, within six months of listing.
- To allow early and continuous public engagement, even before the traditional 30- or 60-day formal comment period, interim recovery plan content should be posted online as soon as possible, and before the *Federal Register* notice of the draft plan.
- To encourage shorter time-to-plan, the policy can state the draft recovery plan should be available within 1.5 years of listing, revised as necessary, and approved as final within two years of listing.
- Exemptions from the preceding deadlines should be allowed in cases of:
    - Scientific uncertainty, which, if ignored, could result in harm to the species;

- Recovery actions already underway that would significantly change the content of the recovery plan;
- Other reasons for which a species' conservation would be harmed by adhering to the timeline.

This is not an exhaustive list of possible policy updates, but we believe it is a useful starting point for the Services to consider.

Species recovery is the ultimate goal of the ESA and planning is a central component of achieving that goal. Our analyses quantify some of the challenges of recovery planning to date. Some of our recommendations are being addressed while others need prompt attention. Closing the recovery planning and implementation gaps will require not only closing the funding gap (Gerber 2016, Lowell & Kelly 2016, Negrón-Ortiz 2014), but also administrative and technological reforms.

Acknowledgements

We thank R. Dreher, J. Rappaport Clark, J. Miller, and an early anonymous reviewer for their constructive feedback that improved the manuscript. We also thank the associate editor, M. Schwartz, for the encouragement to offer bolder recommendations.

Literature Cited

Association of Fish and Wildlife Agencies (AFWA) (2016). The Future of America's Fish and Wildlife Blue Ribbon Panel on Sustaining America's Diverse Fish and Wildlife Resources: Final Report and Recommendations. Available at https://www.fishwildlife.org/application/files/8215/1382/2408/Blue_Ribbon_Panel_Report2.pdf. Accessed 08 March 2018.

Breininger D. R., Mazerolle M. J., Bolt M. R., Legare M. L., Drese J. H., Hines J. E. (2012). Habitat fragmentation effects on annual survival of the federally protected eastern indigo

288 snake. *Anim. Cons.* 15:361–368.

289 Boersma P. D., Kareiva P., Fagan W. F., Clark J. A., Hoekstra J. M. 2001. How Good Are
290 Endangered Species Recovery Plans? *BioScience* 51:643–649. DOI: 10.1641/0006-
291 3568(2001)051[0643:HGAESR]2.0.CO;2.

292 Clark J. A., Hoekstra J. M., Boersma P. D., Kareiva P. (2002). Improving US Endangered
293 Species Act recovery plans: key findings and recommendations of the SCB recovery plan
294 project. *Conserv. Bio.* 16:1510–1519.

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

298 Crouse D. T., Mehrhoff L. A., Parkin M. J, Elam D. R., Chen L. Y. (2002). Endangered species
299 recovery and the SCB study: A US Fish and Wildlife Service perspective. *Eco. App.*
300 12:719–723.

301 Evans D. M., Che-Castaldo J. P., Crouse D., Davis F. W., Epanchin-Niell R., Flather C. H., Kipp
302 Frohlich R., Goble D. D., Li Y-W., Male T. D., Master L. L., Moskwik M. P., Neel M. C.,
303 Noon B. R., Parmesan C., Schwartz M. W., Scott J. M., Williams B. K. (2016). Species
304 Recovery in the United States: Increasing the Effectiveness of the Endangered Species Act.
305 *Iss. Ecol.* 20:1–29.

306 Gerber L. R. (2016). Conservation triage or injurious neglect in endangered species recovery.
307 *Proc. Nat. Acad. Sci. USA* 113:3563–3566.

308 Harvey E., Hoekstra J. M, O'Connor R. J, Fagan W. F. (2002). Recovery plan revisions: progress
309 or due process? *Eco. App.* 12:682–689.

310 Lowell N, Kelly R. P. (2016). Evaluating agency use of "best available science" under the

United States Endangered Species Act. *Biol. Conserv.* 196:53–59.

McCullagh P, Nelder J. A. (1999). *Generalized linear models.* Chapman & Hall, CRC, Boca Raton, Florida.

National Marine Fisheries Service [NMFS]. (2016). Endangered Species Act; Public Meeting: A review of our recovery program under the Endangered Species Act of 1973, as amended (ESA). *Fed. Reg.* 81:11518.

National Marine Fisheries Service and U.S. Fish and Wildlife Service [NMFS & FWS]. (2010). *Interim Endangered and Threatened Species Recovery Planning Guidance.* Departments of Commerce and Interior, Washington, D.C.

Negrón-Ortiz V. (2014). Pattern of expenditures for plant conservation under the Endangered Species Act. *Bio. Conserv. 171:36–43*.

Povilitis A., Suckling K. (2010). Addressing climate change threats to endangered species in US recovery plans. *Conserv. Biol.* 24(2):372-376.

Qin J., Shen Y. (2010). Statistical methods for analyzing right-censored length-biased data under Cox model. *Biometrics* 66:382–392.

R Core Team. (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Ruhl J. B. 2008. Climate change and the Endangered Species Act: building bridges to the no-analog future. *BUL Rev.* 88(1):1-63.

Schwartz, M.W. (1999). Choosing the Appropriate Scale of Reserves for Conservation. *Annu. Rev. Ecol. Syst.*, 30, 83–108.

Schwartz M. W. 2008. The Performance of the Endangered Species Act. *AREES* 39:279–299.

Taylor M. F. J., Suckling K. F., Rachlinski J. J. 2005. The Effectiveness of the Endangered

334 Species Act: A Quantitative Analysis. *Bioscience* 55:360–367.
335 Troyer C. M., Gerber L. R. 2015. Assessing the impact of the U.S. Endangered Species Act
336 recovery planning guidelines on managing threats for listed species. *Conserv. Biol.*
337 29:1423–1433.
338 U.S. Congress. 1973. *Public Law Public Law 93-205; The Endangered Species Act of 1973.*
339 U.S. Congress. 1978. *Public Law 95-632; An Act to amend the Endangered Species Act of 1973.*
340 U.S. Congress. 1988. *Public Law 100-478; Endangered Species Act amendments of 1988*.
341 U.S. Fish and Wildlife Service [FWS]. 2008. Endangered and Threatened Wildlife and Plants;
342 Recovery Crediting Guidance. *Fed. Reg.* 73:44761–44772.
343 U.S. Fish and Wildlife Service [FWS]. (2017). National listing workplan. Available at
344 https://www.fws.gov/endangered/what-we-do/listing-workplan.html. Accessed 10 January
345 2018.
346 U.S. Fish and Wildlife Service, National Marine Fisheries Service [FWS & NMFS]. (1994).
347 Cooperative Policy (NMFS & FWS) for Recovery Plan Participation and Implementation
348 Under the ESA. *Fed. Reg.* 59:34272.
349 U.S. Fish and Wildlife Service, National Marine Fisheries Service [FWS & NMFS]. (1998).
350 *Handbook of Procedures for Conducting Consultation and Conference Activities Under*
351 *Section of the Endangered Species Act*. Departments of the Interior and Commerce,
352 Washington, D.C.

353

354 **Tables**

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

356

guide	min	median	mean	max
*1,038 spp. with final plans**				
Listed Date	3/11/67	5/14/92	8/20/90	9/19/13
Plan Date	3/17/80	7/29/97	4/22/97	10/13/17
Years Elapsed	-13.5	5	6.7	50
119 spp. with revised plans				
Listed Date	3/11/67	10/28/75	8/07/76	5/13/10
Plan Date	6/14/83	8/22/01	3/2/01	6/1/17
35 spp. with draft plans				
Draft Date	9/30/84	9/30/97	1/11/04	6/26/17
Years Elapsed	-5.7	7.9	11.9	45

357

358 * These species include only those with a "Final" plan and does not include plan revisions (see

359 text for details).

360

361 **Table 2.** The distribution of species with and without recovery plans, between U.S. Fish and
362 Wildlife Service regions (1-8) and the National Marine Fisheries Service (NMFS).

363

Region	# with plan	# eligible	Proportion with plan
1	353	505	69.9
2	120	159	75.5
3	36	46	78.3
4	316	363	87.1
5	38	43	88.4
6	40	61	65.6
7	6	8	75
8	220	295	74.6
NMFS	40	73	54.8

364
365

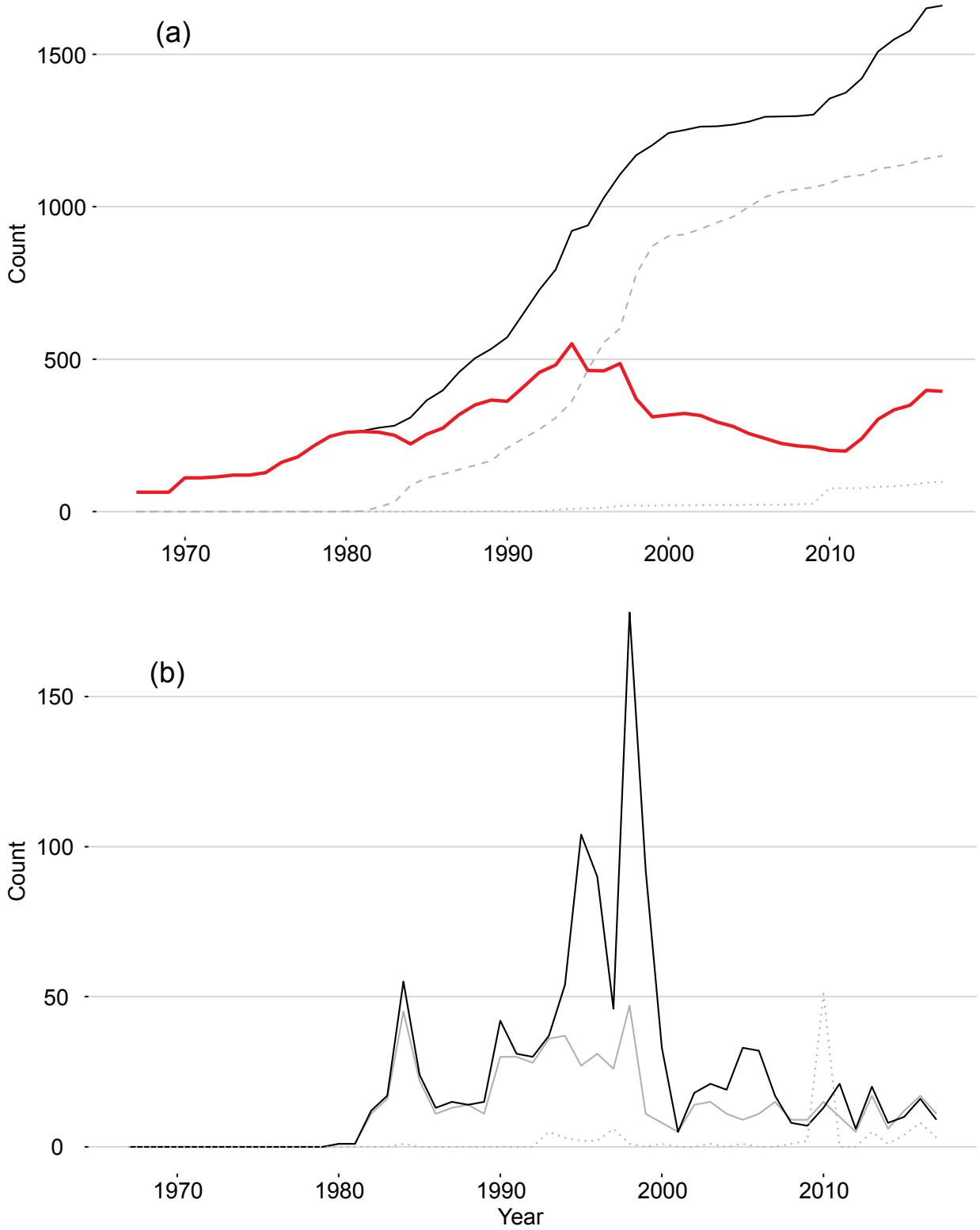
366 **Table 3.** The distribution of species with and without recovery plans by taxonomic group.

367

Taxonomic group	# with Plan	# eligible	Proportion with plan
Amphibians	22	35	62.9
Arachnids	12	12	100
Birds	85	97	87.6
Clams	71	88	80.7
Conifers and Cycads	3	3	100
Corals	2	6	33.3
Crustaceans	19	25	76
Ferns and Allies	26	30	86.7
Fishes	126	162	77.8
Flowering Plants	625	847	73.8
Insects	43	72	59.7
Lichens	2	2	100
Mammals	68	93	73.1
Reptiles	34	35	97.1
Snails	30	46	65.2

368
369

370 **Figures**



371
372

373 **Figure 1. Species listings and recovery plan completions show distinct periods of change**
374 **over the past >40 years.** (a) The cumulative number of listed species (black line), species with
375 official recovery plans (gray dashed line), species with draft recovery plans (gray dotted line),
376 and the number of species lacking recovery plans (red line) show distinct tempos. The number of
377 species with plans correlates well with the number of listed species ($r = 0.864$, $p = 7.08e^{-5}$). A
378 concerted effort to increase the number of species with recovery plans in the mid-1990s and the
379 low listing rate from 2001 to 2009 led to a decline in the number of species without recovery
380 plans. That trend began reversing as the rate of listings increased again starting in 2009. (b)
381 Recovery plans by year show a pulse of planning in the mid- and late-1990s. The greater the
382 difference between the black line (number of species with plans) and gray line (number of plans),
383 the greater the proportion of species covered by multispecies plans. There was a pulse of draft
384 plan (dotted line) in 2010.
385
386

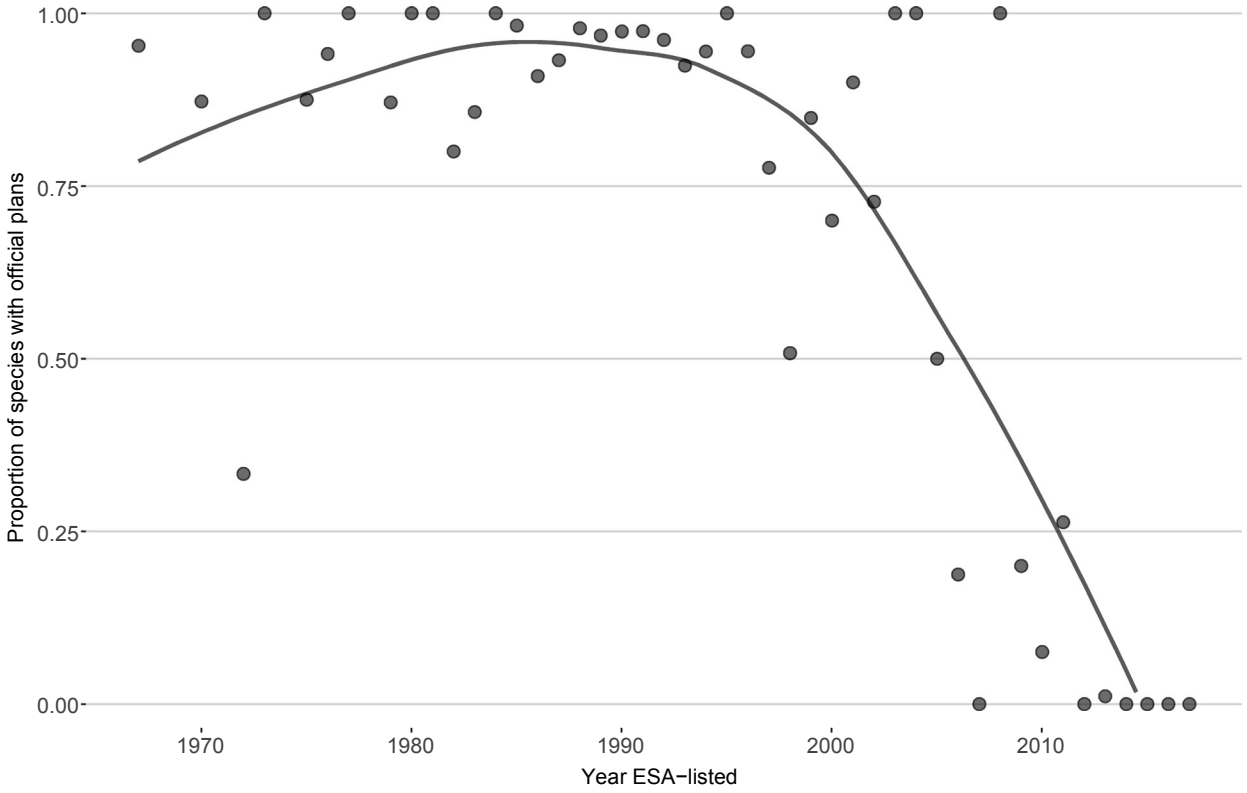


Figure 2. The proportion of species with recovery plans by year begins to drop significantly starting with species listed around 2000. Points represent the proportion of ESA-listed species with recovery plans each year; line represents the spline-fit curve. Despite the decline, a high proportion of species listed between 2001 and 2009 had recovery plans (see Fig. 1) because very few species were listed during this time.

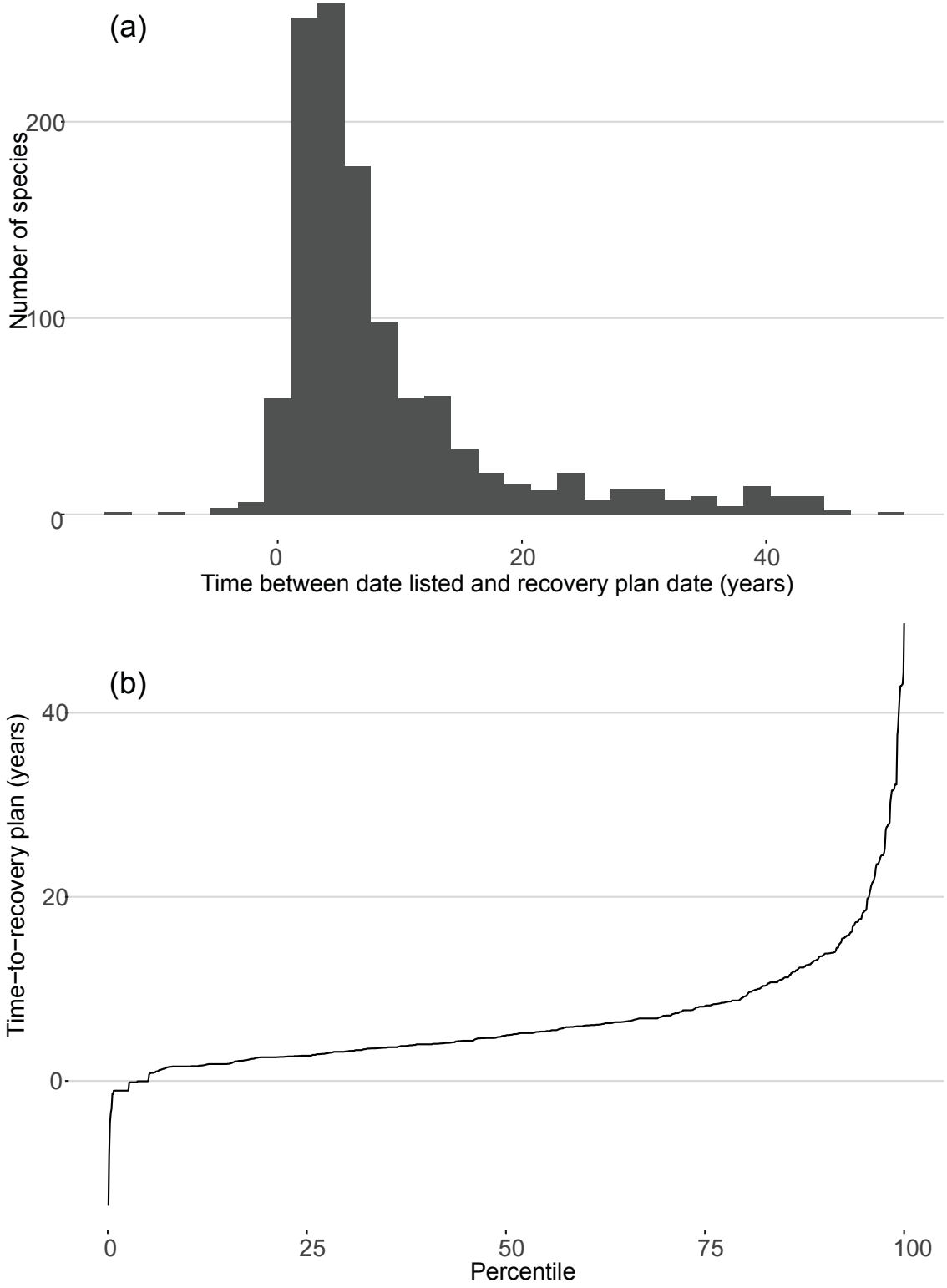


Figure 3. The median time-to-plan was 5.1 years, but skewed towards higher values (mean = 7 years). In (a), negative values indicate species with plans written before the species was

listed under the ESA, typically in multispecies / ecosystem recovery plans. In (b), the line represents the percent of plans with time-to-plan less than X and 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.

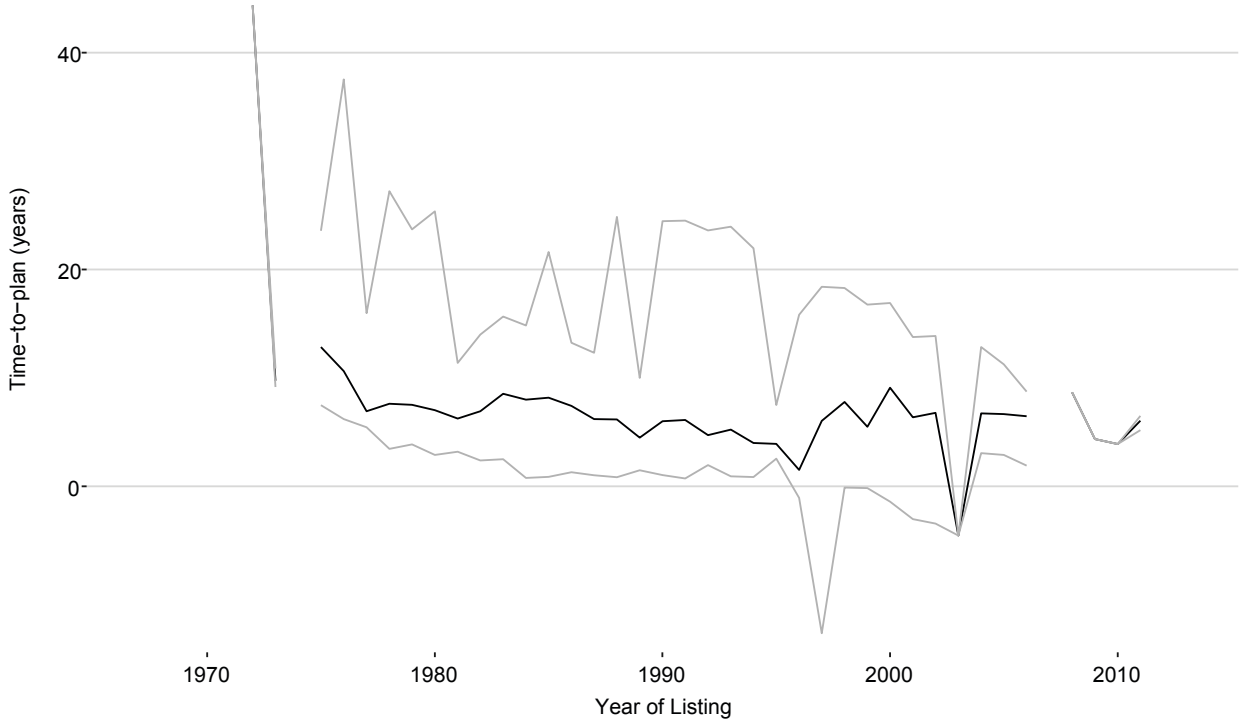
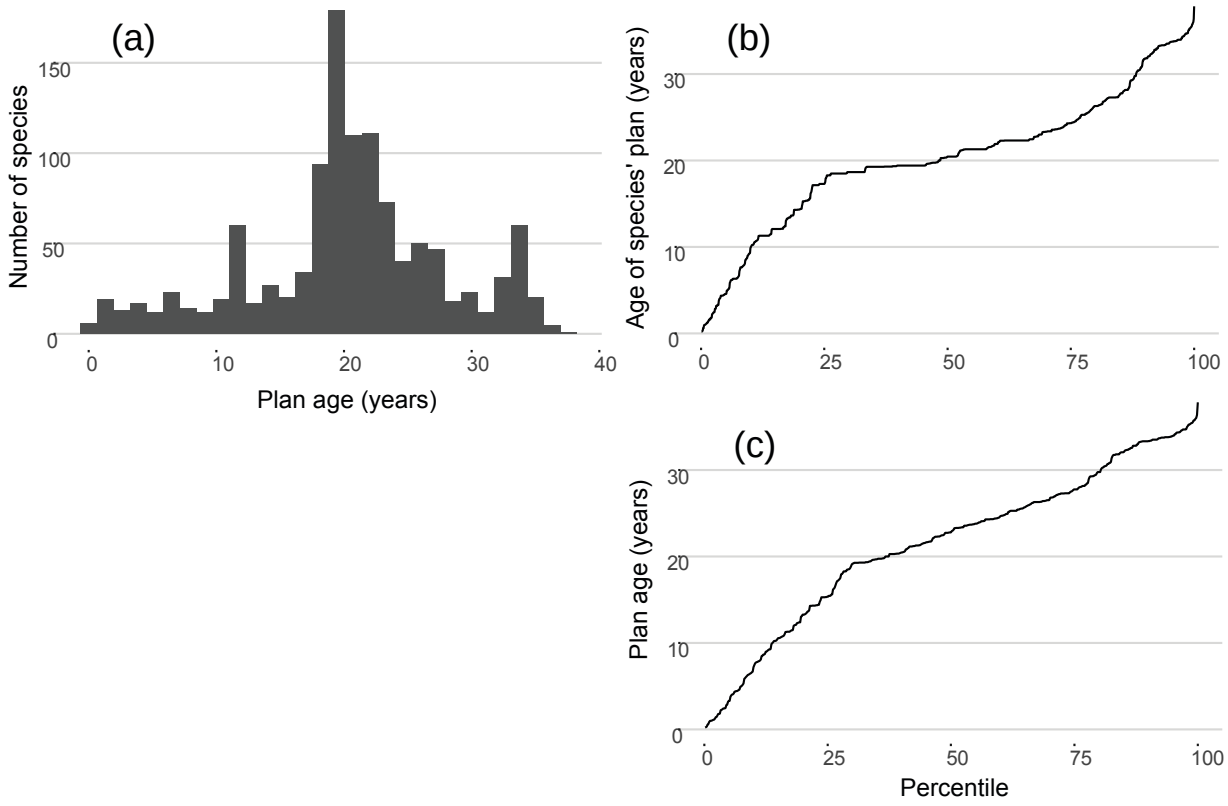


Figure 4. The mean time-to-plan (black line) has declined slightly through time. The maximum and minimum times-to-plan for each year are shown in light gray. Note that this trend does not account for the right-censored species that do not yet have recovery plans.



408

409 **Figure 5. The distribution of the ages of current recovery plans is complex and the range is**

410 **wide (<1 year to >36 years old).** Variation in the tempo of recovery planning is clear in the

411 histogram of plan ages, e.g., the pulse of recovery plans from the mid-to-late 1990s is very

412 evident (a). Half of all recovery plans are >19.5 years old, and 10% are 32.5 or more years old as

413 of 2016. The shape of percentile curves (i.e., the line represents the percent of plans with time-to-

414 plan less than X) varies slightly between the age of plans on a per-species basis (b) and the age

415 of plans (c) because of the use of multi-species plans, especially in the 1990s.

416

417

418

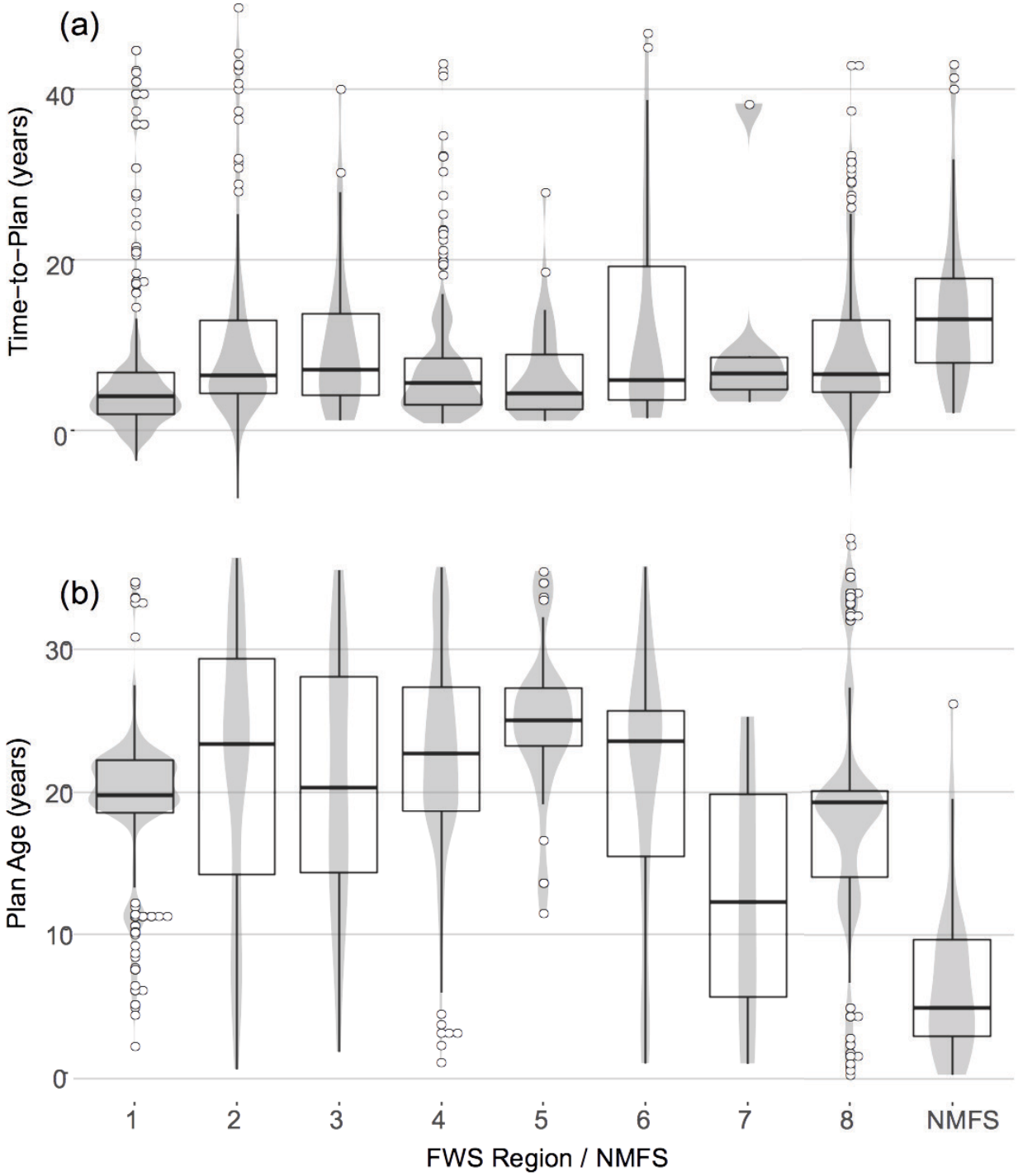


Figure 6. Variation in the time-to-plan (a) and plan age (b) is high between U.S. Fish and Wildlife Service (FWS) regions and between FWS and National Marine Fisheries Service (NMFS). Box plots show the median and interquartile range along with outliers, and violin plot

423 overlays show the data density along the y-axis. Time-to-plan is strongly negatively correlated
424 with plan age at the regional / Service level (r = -0.84, p = 0.001).
425