

1 **Same law, diverging practice: comparative analysis of Endangered Species Act consultations by**  
2 **two federal agencies**

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17 **ABSTRACT**

18 Evaluating how wildlife conservation laws are implemented is critical for safeguarding biodiversity.  
19 Two agencies, the U.S. Fish and Wildlife Service and National Marine Fisheries Service (FWS and  
20 NMFS; Services collectively), are responsible for implementing the U.S. Endangered Species Act  
21 (ESA), which requires federal protection for threatened and endangered species. FWS and NMFS’  
22 comparable role for terrestrial and marine taxa, respectively, provides the opportunity to examine how  
23 implementation of the same law varies between agencies. We analyzed how the Services implement a  
24 core component of the ESA, section 7 consultations, by objectively assessing the contents of >120  
25 consultations on sea turtle species against the requirements in the Services’ consultation handbook,  
26 supplemented with in-person observations from Service biologists. Our results showed that NMFS  
27 consultations were 1.40 times as likely to have higher completeness scores than FWS consultations given  
28 the standard in the handbook. Consultations tiered from an FWS programmatic consultation inherited  
29 higher quality scores of generally more thorough programmatic consultations, indicating that  
30 programmatic consultations could increase the quality of consultations while improving efficiency. Both  
31 agencies commonly neglected to account for the effects of previous consultations and the potential for  
32 compounded effects on species. From these results, we recommend actions that can improve quality of  
33 consultation, including the use of a single database to track and integrate previously authorized harm in  
34 new analyses and the careful but more widespread use of programmatic consultations. Our study reveals  
35 several critical shortfalls in the current process of conducting ESA section 7 consultations that the  
36 Services could address to better safeguard North America’s most imperiled species.

## 37 **1. INTRODUCTION**

38 The U.S. Endangered Species Act (ESA) is considered one of the strongest wildlife laws in the world (1).  
39 Signed into law in 1973 by President Richard Nixon in response to rising concern over the number of  
40 species threatened by extinction, the ESA protects over 1,650 U.S. species by prohibiting negative  
41 impacts on species and their habitats and guiding the recovery of populations (2). Today, the ESA  
42 remains the primary piece of environmental legislation for protecting imperiled species and recovering  
43 them to the point that the law's protections are no longer needed. With such a crucial role, the ESA must  
44 be implemented correctly. Yet agencies often struggle with gaps in effective implementation as they face  
45 funding shortfalls and staff limitations alongside a rising number of listed species. Although the ESA is a  
46 strong law, effective implementation in the face of these challenges is key. Taking advantage of  
47 opportunities for improvement in efficiency and effectiveness is crucial if the ESA is to continue  
48 preventing extinction and recovering species.

49 Section 7 of the ESA directs federal agencies to use their authorities to conserve listed species  
50 and is a key aspect of the law's strength. Under section 7(a)(2), federal agencies ("action agency") are  
51 instructed to consult with the U.S. Fish and Wildlife Service (FWS) or the National Marine Fisheries  
52 Service (NMFS) if any action authorized, funded, or carried out may jeopardize listed endangered or  
53 threatened species or destroy or adversely modify species' critical habitat (for definitions see Box 1,  
54 Glossary). If an action agency initially concludes that the action is not likely to adversely affect species or  
55 their critical habitat, the agency must request Service concurrence on its finding. If the Service concurs,  
56 the consultation is complete; this assessment is classified as an "informal consultation." Conversely, if an  
57 action is deemed likely to adversely affect species or critical habitat, a "formal consultation" is initiated,  
58 and the consulted Service will issue a biological opinion with their findings of the project's impact on  
59 imperiled species. FWS and NMFS share administration of the ESA, with NMFS generally overseeing  
60 marine species and FWS managing terrestrial and freshwater species (3). However, both Services have  
61 authority over some listed species that cross jurisdictional boundaries, such as sea turtles, and consult  
62 with action agencies on these joint-jurisdiction species. If done properly, consultations ensure that federal

63 agency actions do not violate the jeopardy and adverse modification prohibitions of the ESA, thereby  
64 minimizing negative effects on listed species.

65

### 66 **Box 1: Glossary**

67 *Glossary of terms typically used to describe and discuss consultations under section 7(a)(2) of the U.S.*  
68 *Endangered Species Act. The exact legal and policy definitions can be found in the referenced Code of*  
69 *Federal Regulations (CFR) and Handbook sections.*

70

71 **Action:** All activities or programs of any kind authorized, funded, or carried out, in whole or in part, by  
72 Federal agencies in the United States or upon the high seas. [50CFR§402.02]

73 **Action agency:** The federal agency proposing the action.

74 **Biological opinion:** The document resulting from formal consultation that describes the proposed action,  
75 the Service evaluation of the effects of the action, the determination of whether the species'  
76 existence is jeopardized or its critical habitat is adversely modified, and any conservation  
77 requirements for the action agency. [50CFR§402.02, 50CFR§402.14(h)]

78 **Critical habitat:** The specific areas and habitats essential to conserving the species. Critical habitat may  
79 be designated in areas that are occupied or unoccupied at the time of listing. Occupied habitat  
80 must also have “physical or biological features” that require special management considerations  
81 or protection. [ESA§3(5)(A)]

82 **Formal consultation:** The type of detailed evaluation undertaken for federal actions that are likely to  
83 adversely affect one or more ESA-listed species. [50CFR§402.02, 50CFR§402.14]

84 **Informal consultation:** The type of detailed evaluation undertaken for federal actions that are not likely  
85 to adversely affect one or more ESA-listed species. [50CFR§402.02, 50CFR§402.13]

86 **Jeopardy (to jeopardize):** To engage in an action that reasonably would be expected, directly or  
87 indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed  
88 species in the wild by reducing the reproduction, numbers, or distribution of that species.  
89 [50CFR§402.02]

90 **Programmatic consultation:** A consultation that addresses multiple actions taken by an agency on a  
91 program, regional, or other basis. For example, programmatic consultations may cover many  
92 different energy development projects within particular Bureau of Land Management lands in a  
93 single, landscape-level evaluation. (Handbook, p. xvii)

94 **Take:** To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage  
95 in any such conduct [ESA§3(19)]

96

97 The consultation process is guided by the Section 7 Handbook (hereafter, Handbook), which was  
98 created by the Services to “promote efficiency and nationwide consistency [of consultations] within and  
99 between the Services” (4). The Handbook guides biologists to ensure consultations are serving their  
100 purpose of adequately protecting listed species to the fullest extent of the ESA and lays out a framework  
101 for what should be included in each section of a biological opinion issued by the Service. However, the  
102 Handbook is a guidance document only and does not prescribe all details of a consultation. This results in  
103 variation in consultation completeness, which could become problematic if differences introduce

104 inefficiencies or inconsistencies that ultimately reduce the protection or conservation of imperiled species.

105 Two preliminary observations suggest consultation completeness may differ between the Services in  
106 ways that reduce consultation effectiveness. First, recent analysis of data on all section 7 consultations  
107 recorded by FWS from 2008-2015 (5) revealed discrepancies in the time duration of consultations  
108 between the Services. Whereas the FWS completed 80% of formal consultations within the 135-day  
109 time limit set by the Handbook (the proportion of on-time consultations is likely higher because the data  
110 do not include information on legitimate “pauses” during consultation; JWM and Y-WL, pers. obs.),  
111 NMFS completed only 30% in this timeframe (6). This discrepancy in timing could indicate a problem  
112 in the conservation process if, for instance, FWS is compromising quality of the analyses for quantity in  
113 order to complete its required number of consultations, which is substantially greater than NMFS despite  
114 receiving similar levels of funding (7; 8). Second, based on the authors’ combined experience of reading  
115 hundreds of consultation documents, we observed high variation in the general completeness and  
116 consistency of consultation documents (authors, pers. obs.). Variation appears to be structured (e.g., by  
117 species or office) rather than random, and especially large differences occur between consultations  
118 produced by the two Services. There are numerous reasons why the FWS and NMFS could differ in  
119 their approach to or process for consultations. For example, the two agencies have overlapping but not  
120 identical legal mandates; different organizational histories and cultures; and receive different levels of  
121 funding, differences that percolate across regions and offices within each Service (9). Understanding the  
122 type and degree of variation among consultations could help identify the cause and outcome of  
123 differences. That knowledge can in turn assist in designing solutions that minimize inconsistencies and  
124 maximize quality of the consultation process to support the Services in enforcing the ESA. Yet to our  
125 knowledge, there has never been a systematic analysis of differences in consultation completeness,  
126 creating a knowledge gap with direct implications for biodiversity conservation and environmental  
127 policy.

128 Here we quantify and evaluate variation in how the Services implement section 7 by comparing the  
129 completeness of consultation documents for threatened and endangered species of sea turtles against the

130 requirements of the Handbook. Sea turtles are one of the few taxa which falls under the jurisdiction of  
131 both the FWS and NMFS, offering a unique opportunity for direct comparison of consultation  
132 completeness. As we discuss further below, we expect consultations that follow the requirements of the  
133 Handbook are more complete and more likely to result in better conservation outcomes because the  
134 Handbook provides the best available description of how to comply with section 7. Thus, we assess  
135 completeness of a consultation under the assumption that a more complete document will lead to better  
136 conservation for the species. In doing so, we take advantage of a natural experiment to analyze the  
137 differences in how the Services implement the consultation process. While the null hypothesis may be  
138 equality of consultation document completeness, based on previous observations, we expect NMFS  
139 consultations to more complete than FWS consultations. We report significant differences in the  
140 completeness of both the formal and informal consultations between the Services. Our results highlight  
141 several pathways by which the Services can systematically improve the completeness and quality of  
142 consultations to strengthen the ESA and improve the protection and recovery of North America's most  
143 imperiled species.

144

## 145 **2. METHODS**

### 146 **2.1 Sampling**

147 The Services have carried out hundreds of thousands of consultations since the ESA was established.  
148 Because consultations are often context-specific and can differ depending on specific categories such as  
149 action type and species, fully random sampling of species was not suitable for our objective. Following  
150 prior methods (10), we chose a defined subset of consultations to make comparisons between the  
151 Services more direct and insightful. We controlled for extraneous sources of variation by conducting our  
152 analysis on consultations from January 2008 through April 2015 and involving actions proposed by the  
153 Army Corps of Engineers (the Corps) that could potentially impact sea turtles in Florida. This focus  
154 enabled us to minimize confounding factors that might be introduced by the time period, type of action  
155 being evaluated, or species natural history or geographic variation, and therefore to focus on differences

156 between the Services' consultation process and output. Species of sea turtle were the most consulted on  
157 by the Corps and included green sea turtle [*Chelonia mydas*], loggerhead sea turtle [*Caretta caretta*],  
158 Kemp's ridley sea turtle [*Lepidochelys kempii*], leatherback sea turtle [*Dermochelys coriacea*], and  
159 hawksbill sea turtle [*Eretmochelys imbricata*].

160

## 161 **2.2 Consultation Selection**

162 We obtained consultation data that met our sample criteria from several publicly available databases. We  
163 accessed NMFS consultations using the Public Consultation Tracking System (PCTS;  
164 <https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts>), which allows users to directly download  
165 consultations. FWS has a similar database of consultation records, the Tracking And Integrated Logging  
166 System (TAILS). TAILS is designed to help coordinate record-keeping between field and regional  
167 offices of FWS and does not provide the consultation documents. Instead, the TAILS database provides  
168 records of FWS consultations but has no public interface, therefore we accessed TAILS records using  
169 the Section 7 Explorer web application ([https://defenders-cci.org/app/section7\\_explorer](https://defenders-cci.org/app/section7_explorer); Malcom and Li  
170 2015) that allows the public to search for consultations using TAILS data. Using PCTS and the Section 7  
171 Explorer to identify the set of consultations involving the Corps and sea turtles, from which we  
172 randomly selected 30 formal and 30 informal consultation records from each Service during the study  
173 time period. We acquired the NMFS consultations directly from PCTS, while those from FWS we  
174 acquired through FWS South Florida Field Office's online document library for biological opinions  
175 ([https://www.fws.gov/verobeach/verobeach\\_old-dontdelete/sBiologicalOpinion/index.cfm](https://www.fws.gov/verobeach/verobeach_old-dontdelete/sBiologicalOpinion/index.cfm)) or through a  
176 Freedom of Information Act (FOIA) request. While evaluating the original selection of NMFS formal  
177 consultations, we discovered some that did not assess sea turtles in the biological opinion despite search  
178 parameters constrained to sea turtles. To account for this discrepancy, we removed those not assessing  
179 sea turtles and randomly selected an additional 10 formal NMFS consultations for evaluation from the  
180 PCTS database. All of the consultations analyzed in this work are archived at Open Science Framework  
181 (OSF) under <https://dx.doi.org/10.17605/OSF.IO/KAJUQ>.

182

### 183 **2.3 Evaluation Criteria**

184 We recorded the start and end dates of the consultation, year completed, regional office filed through,  
185 species of sea turtles, page length, and other general information for each consultation. All evaluated  
186 consultations and data are provided at OSF (<https://dx.doi.org/10.17605/OSF.IO/KAJUQ>). We developed  
187 different scoring methodologies for formal and informal consultations because each type involves  
188 different content as detailed in the Handbook. Scoring rubrics are provided in SI Appendix 1 (formal  
189 consultations) and Appendix 2 (informal consultations). It was not feasible to blind scorers to the Service  
190 that wrote consultations because of the nature of the documents; any familiarity with the consultation  
191 process makes the Service immediately apparent. Therefore, reviewers were not blind to the Service when  
192 analyzing completeness. When there was any ambiguity as to the appropriate score, a second reviewer  
193 (JWM) would read the consultation in question, then decide on the appropriate score with the primary  
194 reviewer (ME).

195 For formal consultations, we selected the four core sections from the Handbook to score the  
196 completeness of each biological opinion: “Status of the Species,” “Environmental Baseline,” “Effects of  
197 the Action,” and “Cumulative Effects.” Although not an exhaustive list of biological opinion sections,  
198 these four sections contain the bulk of the information and analysis of the species and proposed action.  
199 The Status of the Species and Environmental Baseline sections received a score from 0-5 and the Effects  
200 of the Action and Cumulative Effects sections were given a score from 0-2 based on how well they met  
201 the specific requirements for that section by the Handbook. Rating the completeness of these core sections  
202 of the biological opinion was straightforward because the criteria described by the Handbook allowed for  
203 a simple present/absent scoring system. For some analyses, these present/absent scores were summed for  
204 each of the four core sections. We also calculated total completeness by summing the scores across all  
205 four sections. The overall completeness was normalized by calculating the ratio of the summed score to  
206 the total points possible for each consultation.

207 Scoring the informal consultations used a simpler rubric because informal consultation documents



208 are shorter, rarely have individual sections, and the Services generally do not prescribe the required  
209 contents. We surveyed a selection of informal consultation documents from both Services and  
210 considered what information Services personnel need in order to evaluate the effects of actions and  
211 monitor the action after consultation is complete. We identified five criteria to evaluate the completeness  
212 of informal consultations: stating the action, analysis of the action, analysis of the impacted species,  
213 stating the reason why the consultation stayed informal and including a map of the area affected by the  
214 action. Though a map is not required by the Handbook, the action area is highly important for much of  
215 the consultation analysis, and thus the inclusion or omission of a map was scored. These criteria were  
216 each assigned 1 point, for a total possible score of 5 points.

217 During preliminary work on this project we noticed the use of “sticker concurrences,” in which the  
218 FWS South Florida Office recorded only a sticker of consent applied to the request for concurrence  
219 provided to FWS (SI Figure 1). This sticker of approval for the action was in lieu of a complete informal  
220 consultation, and no additional consultation documentation was supplied. Despite their lack of analysis,  
221 sticker concurrences were scored in the same manner as all other informal consultations.

222

223

224

## 225 **2.4 Statistical Analyses**

226 Our goal was to understand patterns and associations of variation in consultation completeness. We used  
227 summary statistics (mean and standard deviation) and Pearson’s correlations to describe patterns. To  
228 examine relationships between completeness and associated factors, we used two modeling approaches:  
229 a binomial generalized linear model (GLM; 11) to identify predictors of the proportions of total possible  
230 points, and ordinal logistic regression (OLR; 12) to analyze the individual component scores. We  
231 considered six variables that were most likely to affect consultation completeness: the Service  
232 performing the consultation, whether the consultation was formal or informal, the year the consultation  
233 took place, the species of sea turtle assessed, the type of action assessed, and whether the consultation

234 was part of a programmatic consultation (see Glossary). We incorporated these variables into a global  
 235 model (Model 1) of all variables and eight additional subset candidate models for the analysis of overall  
 236 completeness using the GLM (Table 1). We also considered that the particular office within the Service  
 237 might be an important predictor of consultation completeness. However, given that our focus is on the  
 238 potential differences between the Services and that the offices are nested within the Services, the office  
 239 variable was not included in our candidate model set. Because of the fundamental differences between  
 240 formal and informal consultations and the difference in total possible score, we calculated the response  
 241 variable as the proportion of possible points for each consultation. When we analyzed data separately for  
 242 formal and informal consultations, we used reduced candidate model sets by removing the informal  
 243 consultation variable from formal analyses and the formal and programmatic variables from the informal  
 244 analyses.

245

246 **Table 1.** Candidate generalized linear and ordinal regression models for predicting overall consultation  
 247 completeness and conservation action specificity.  
 248

Model Type	Model Num.	Predictors
GLM Binom*	1	Service + Formal + Year + Action_type + Programmatic + total_duration
	2	Service + Formal + Year + Programmatic + total_duration
	3	Service + Formal + Year + Action_type + total_duration
	4	Service + Formal + Year + total_duration
	5	Service + Formal
	6	Service
	7	Formal
	8	total_duration
	9	Service + Formal + Programmatic + total_duration
Ord. regress.**	1	Service + Year + (1 consultation_ID)
	2	Service + (1 consultation_ID)
	3	Year + (1 consultation_ID)
	4	Programmatic

249 \* Binomial logistic generalized linear model

250 \*\* Ordinal logistical regression

251 \*\*\* The notation “(1|var)” indicates a random effects variable

252

253 We used a set of three candidate ordinal regression models (Table 1) with random effects for the

254 consultation document in which the components were nested. While programmatic consultation was an  
255 important predictor of completeness in the overall analysis, the Hessian was singular (presumably  
256 because of the lack of NMFS programmatic consultations) for the components and we were not able to  
257 include programmatic as a variable in these analyses. We therefore evaluated summary statistics to  
258 investigate the role of programmatic consultations in shifting completeness scores. We used the R  
259 package `ordinal` (13) to conduct ordinal regression. A univariate analysis was performed to identify  
260 predictor variables.

261 We carried out model selection (14) based on Akaike's Information Criterion adjusted for small  
262 sample sizes ( $AIC_c$ ) using the AICcmodavg package (15). We considered models with  $\Delta AIC_c > 2.0$  as  
263 having strong support (14). All analyses were done in R 3.3 (16) and are available as a package vignette  
264 in the project's OSF repository (<https://dx.doi.org/10.17605/OSF.IO/KAJUQ>).

265

## 266 **2.5 Consultation Process**

267 To supplement data gathered from the consultation documents, one of the authors (ME) discussed the  
268 consultation process with one biologist from NMFS and six biologists from FWS who consulted on sea  
269 turtles in Florida. These biologists were on the list of Service personnel who worked directly on the  
270 consultations evaluated for this study and were selected based on availability. Information collected on  
271 the consultation process was not meant to be representative of a larger sample but was instead intended  
272 to provide further insight into results. Biologists were asked about the consultation process concurrent  
273 with our scoring of the consultations (in August 2015) at the agency offices in Florida. The questions  
274 were based on our understanding of the Handbook and preliminary examination of the consultations we  
275 reviewed. We asked biologists about their opinions on the consultation process and how well  
276 consultations serve the intended purpose (SI Appendix 3). We then coded answers into categories of  
277 similar themes. All biologists were spoken to under the condition of anonymity and with full awareness  
278 of the agencies. Informed consent was obtained from all participants. Although the sample size is too  
279 small for statistical analysis, we reviewed and scored the notes on the consultation process from the

280 biologists to summarize recurring themes.

281

### 282 3. RESULTS

283 We retrieved, read, and scored 55 consultations produced by FWS (30 formal and 25 informal) and 68  
284 consultations produced by NMFS (38 formal and 30 informal) for a total of 123 consultations.

285 Consultations assessed the effects of the action on seven species on average (Table 2). Formal  
286 consultations ranged in length from 1 to 120 pages and required over a year to complete on average. Of  
287 the core completeness sections evaluated, ‘Status of the Species’ was by far the longest, with an average  
288 of 19 pages. This section often contained lengthy content that was neither relevant to the species’ life  
289 history in the geographic area of the action nor to the effects of the action. In our random sample of  
290 FWS informal consultations, only one featured the sticker concurrence that we observed in the  
291 preliminary work.

292

293 **Table 2.** Summary statistics across all 123 formal and informal consultations.

294

Consultation type	Variable	Mean	Min	Max	SD	N*
Formal	Length (pages)	34.6	1	120	21.1	284
	Duration (days)	371.5	6	1691	320.2	340
	No. of species (total)	7	4	18	3.6	324
	No. of References	164.3	1	434	121.4	330
	Species Status length (pages)	18.7	0	67	12.5	325
	Baseline length (pages)	6.7	0	23	4.7	318
	Effects length (pages)	5.4	0	15.5	3.9	303
	Cumulative Effects length (pages)	0.7	0	1.5	0.3	298
	CR**	0.9	0	1	0.3	292
	CM**	0.5	0	1	0.5	272
RPM**	0.8	0	1	0.4	287	
Informal	Duration (days)	163	0	1227	223.3	260
	No. of species	7.0	1	49	6.0	265
	Construction Conditions	0.7	0	1	0.4	264

295  
296 \* Numbers are based on individual turtle species per consultation because the jeopardy and adverse  
297 modification conclusion is made on per-species basis for an action. \*\* CR = Conservation  
298 Recommendations made by the Services; CM = Conservation Measures proposed by the action agency;  
299 RPM = Reasonable and Prudent Measures to minimize the amount of take resulting from an action.

300

301

### 302 **3.1 Overall Consultation Completeness**

303 Generalized linear modeling suggested that consultation completeness was best explained by Model 9,  
304 which showed the lowest AIC<sub>c</sub> ( $\Delta\text{AIC}_c = \sim 2$ ; Table 3). This model, which included all predictors except  
305 action type and year, indicated that a consultation done by NMFS was 1.40 times (95% CI = 1.25 - 1.57;  
306 Figure 1a) as likely to receive a higher score for completeness as a consultation done by FWS. FWS's  
307 programmatic consultations provided a significant completeness boost (OR = 1.35; 95% CI = 1.17 -  
308 1.56), but formal consultations were about as likely (OR = 1.0; 95% CI = 0.89 - 1.13; Figure 1b) to  
309 score higher as informal consultations (Table 4). The duration of consultations was positively associated  
310 with overall completeness in a univariate GLM ( $r = 0.20$ ;  $p = 1.04e^{-6}$ ) but did not rank as an important  
311 variable in the multivariate analysis. Similarly, the section length in pages was also correlated with  
312 completeness in a univariate analysis ( $r = 0.2$ ,  $p = 0.0037$ ). However, after accounting for the Service  
313 performing the consultation and for programmatic consultations in a binomial GLM, there was no  
314 relationship ( $z = 1.024$ ,  $p = 0.306$ ). Model 2, which included the same predictors as Model 9 but added in  
315 the year the consultation was completed, was also supported. This model indicated that the year was  
316 associated with a slight decrease in consultation completeness over the study period, though this  
317 association was not statistically significant (OR = 0.993; 95% CI = 0.97 - 1.02), thus we focus on model  
318 9.

319 **Table 3.** Generalized linear model selection results for overall completeness across 123 FWS and NMFS  
320 consultations.

321

Model	K*	AICc	$\Delta\text{AIC}_c^{**}$	Model	Akaike Weight	Log Likelihood	Cum. Wt.
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		Likelihood					
Mod9	5	1544.5	0.00	1.00	0.71	-767.18	0.71
Mod2	6	1546.3	1.79	0.41	0.29	-767.05	1.00
Mod1	14	1558.8	14.33	0.00	0.00	-765.03	1.00
Mod4	5	1561.4	16.90	0.00	0.00	-775.63	1.00
Mod3	13	1571.0	26.51	0.00	0.00	-772.17	1.00
Mod8	2	1574.5	30.08	0.00	0.00	-785.26	1.00
Mod5	4	1601.7	57.28	0.00	0.00	-796.84	1.00
Mod6	2	1607.4	62.94	0.00	0.00	-801.69	1.00
Mod7	2	1628.1	83.65	0.00	0.00	-812.05	1.00

322 \* Indicates the number of variables in the model

323 \*\* The Akaike Information Criterion for model selection for small sample sizes. All models with an  
324  $\Delta AIC_c < 2.0$  are considered to be supported.

325

326 **Table 4.** Odds ratios (OR), confidence intervals, and parameter statistics for model 9, the best-supported  
327 candidate set for predicting overall consultation completeness.

328

	OR	LCL (2.5%)*	UCL (97.5%)**	Model z-value	p-value
(Intercept)	5.54E <sup>-01</sup>	4.93E <sup>-01</sup>	6.23E <sup>-01</sup>	-9.883	4.94E <sup>-23</sup>
Service (NMFS)	1.40	1.25	1.57	5.689	1.28E <sup>-08</sup>
Formal (yes)	1.00	0.89	1.13	0.042	9.66E <sup>-01</sup>
Programmatic (yes)	1.36	1.18	1.57	4.202	2.64E <sup>-05</sup>
total duration	1.00	1.00	1.00	1.454	1.46E <sup>-01</sup>

329 \* LCL = Lower control limit

330 \*\* UCL = Upper control limit

331

332 **Fig 1. Completeness scores for NMFS consultations were higher on average than scores for FWS**  
333 **consultations across all consultations (A), formal consultations (B), and informal consultations (C).**

334 The overall completeness score for each consultation is the sum of points scored divided by the sum of  
335 points possible (see Methods for details). *Top panel:* Histogram and boxplots of all consultations (formal  
336 and informal, including programmatic consultations) for each Service. *Bottom panel:* Overall scores  
337 plotted by Service for formal and informal consultations separately.

338

### 339 3.2 Components of Completeness

340 We examined sources of variation in the components of overall consultation completeness. The only  
341 component of formal consultations that exhibited a strong association with any predictor variables was  
342 the Environmental Baseline, for which Service was a strong predictor of completeness and NFMS was

343 more likely to produce more complete consultations ( $z = 5.3993$ ,  $p = 6.691e^{-8}$ ;  $OR_{NMFS} = 2.6e^4$  [95% CI  
344 =  $6.5e^2 - 1.1e^6$ ]; Figure 2). For the Environmental Baseline section, NMFS consultations were more  
345 comprehensive and tended to include previous consultations in the action area and discuss critical  
346 habitat or lack thereof as per the Handbook. Neither of these characteristics were consistently present in  
347 FWS consultations. Most of the completeness components of informal consultations were similar except  
348 for two categories (Figure 3). The analysis of the action and the reason the consultation was informal  
349 were associated with the time duration of the consultation (at a nominal  $\alpha = 0.05$ ): generally, the longer  
350 the informal consultation took to complete, the more likely these components were included. Second,  
351 although not required by the Consultation Handbook, half of NMFS but only 15% of FWS informal  
352 consultations included a map of the proposed action.

353

354 **Fig 2. Individual components of consultations produced by NMFS showed higher completeness**

355 **scores than those by FWS on average.** However, the only component that statistically differed

356 between the Services was the Environmental Baseline ( $z = 5.3993$ ,  $p = 6.691e^{-8}$ ;  $OR_{NMFS} = 2.6e^4$  [95%  
357 CI =  $6.5e^2 - 1.1e^6$ ]). The scores are the raw completeness scores for formal consultation components.

358

359 **Fig 3. Informal consultations from NMFS featured more information and therefore showed higher**

360 **completeness scores than those from FWS on average.** The components of informal consultation

361 completeness scores were binary (0 indicates absence; 1 indicates presence) in the consultations.

362

### 363 **3.3 Consultation Process Feedback**

364 We spoke with six biologists from FWS and one from NMFS and coded their responses into categories

365 of similar themes (Table 5; full response notes in SI Appendix 4). When asked how the consultation

366 process could be improved, most biologists (6 of 7) mentioned they found the process frustrating and

367 many stated that they were overwhelmed with work. One biologist pointed to the fear of possible

368 litigation resulting from shorter consultations as a reason for the overly comprehensive and highly time-

369 consuming consultations that are currently the norm. Five of seven biologists also favored expanding the  
 370 use of consultation keys, which are designed to help the biologists improve the timing and consistency  
 371 of consultations when appropriate for a species or on a case-by-case basis (see, e.g.,  
 372 <http://www.fws.gov/panamacity/resources/WoodStorkConsultationKey.pdf>; SI Appendix 5). All  
 373 biologists except one mentioned that they keep a record of cumulative incidental take, which varied in  
 374 form from notes kept on a whiteboard to Excel spreadsheets. However, only three consultations (all from  
 375 NMFS) incorporated a tally of previously authorized take in the analysis of the effects of the current  
 376 action on sea turtle populations.

377

378 **Table 5.** Responses to a selected sample of consultation process questions asked of FWS/NMFS  
 379 biologists.

380

Biologist	Favor consultation keys	Often encounter scientific uncertainty	Tally cumulative take	Frequently reference section 7 Handbook	Favor publicly available consultations	Suggestions for improvement
1	In some cases	No	Yes	Yes	Yes	Inter-office consistency
2	Yes	No	Yes	No	Yes	None
3	No	No	Yes	Variable	Yes	Inter-office consistency
4	Yes	Rarely, assume species is present	Yes	No	Yes	Intra- and inter-office consistency
5	In some cases	Rarely, assume species is present	Makes an attempt	Yes	Yes	BiOp streamlining
6	In some cases	No	Yes	Yes	Yes	Inter-office consistency
7	No, too nuanced	Yes, defer to species	No - too difficult	No	Yes	Improve efficiency

381

382

#### 383 4. DISCUSSION

384 The ESA is considered one of the strongest wildlife protection laws in the world (17), and section 7 is a  
 385 foundation of this strength. The content and quality of section 7 consultations can alter conservation  
 386 outcomes, but such protections can only be realized if the scientific and regulatory analyses are robust.  
 387 Despite the importance of consistently high-quality consultations, no analyses have critically evaluated  
 388 the strengths and weaknesses of these regulatory documents. Our analysis offers an urgently needed first  
 389 step towards understanding the quality of consultations to inform and improve future consultations.



390 Across all 123 consultations evaluated, we found that completeness relative to the standards in the  
391 Handbook varied significantly between the Services: NMFS consultation documents were consistently  
392 more complete than FWS consultation documents. We interpret this difference in content as a difference  
393 in consultation quality that may be affecting the conservation of ESA-listed species. In combination with  
394 the biologist discussions, which illuminate some of the possible causes of variation, our results reveal  
395 specific areas of improvement to ensure that future consultations achieve their objective of protecting  
396 threatened and endangered species.

397

#### 398 **4.1 Consultation Quality**

399 The completion of both formal and informal consultations was higher in documents produced by  
400 NMFS than FWS. This result is consistent with prior findings that NMFS scored higher than FWS in  
401 three of seven metrics characterizing the use of “Best Available Science” in recovery plans, lawsuits,  
402 listing decisions, and literature cited in biological opinions and no difference was detected between the  
403 agencies in the other four metrics (9). Although the cause of the difference is beyond the scope of our  
404 study, our discussions with Service biologists suggested one possible explanation: that the lack of time  
405 and resources available for the agencies’ ever-increasing consultation workload may limit their quality.  
406 The FWS biologists especially stressed this point, which reflects the funding shortfall experienced by  
407 the FWS endangered species program. This program receives approximately equal funding as the Office  
408 of Protected Resources at NMFS even though Ecological Services within FWS is responsible for 15  
409 times as many ESA-listed species (9). Expenditures per consultation is therefore likely much lower for  
410 FWS. Future research should investigate how the Services allocate funding to consultations compared to  
411 other endangered species program components, such as listing and recovery.

412 Our scoring of the individual sections of biological opinions provides further insight into why FWS  
413 consultations are lower completeness than NMFS consultations and for which content both Services  
414 deviate from the expectations of the Handbook. Although documents by both Services consistently  
415 showed low completeness in the Environmental Baseline section because previously authorized

416 incidental take in the action area was rarely analyzed, FWS scored lower than NMFS because the take  
417 analysis was missing from all prior consultations. The lack of this analysis is one of the most pernicious  
418 problems with implementing the ESA (10). The omission of hundreds or thousands of minor take  
419 actions from analysis in consultations can compound to result in “death by a thousand cuts,” whereby  
420 individual actions are insignificant for the species but the cumulative effects across many actions  
421 severely damage their populations (18). A 2009 Government Accountability Office report on FWS’s  
422 implementation of the ESA highlighted this concern and recommended that the Services track  
423 authorized take across a species’ entire range to better inform consultations (19). The only three  
424 consultations that included an analysis of previously authorized take were all produced by NMFS,  
425 enhancing the difference in completeness between the Services for this core section. However, it is  
426 worth noting that FWS’s programmatic consultation for beach work across Florida (Activity Code  
427 41910-2010-F-284) listed previous formal consultations. Unfortunately, those data were not analyzed in  
428 the evaluated consultation and there was no evidence they played a role in the Environmental Baseline  
429 or the Effects Analysis. It is unclear why previously authorized take in the action area was not analyzed,  
430 especially since many biologists that we spoke with stated that they record cumulative take. Future  
431 research should investigate the disconnect between the information that Services biologists record and  
432 the information included in consultations.

433 Although the Handbook requires certain analyses for each section, sections of many FWS  
434 consultations contained little or no analysis and instead merely repeated the boilerplate language from  
435 the Handbook. This was particularly true of the Cumulative Effects section of FWS consultations, which  
436 often mentioned the obligation to “include the effects of future State, tribal, local or private actions that  
437 are reasonably certain to occur,” followed by a statement that there would be no cumulative effects. In  
438 contrast, most NMFS consultations more thoroughly analyzed the cumulative effects, which are critical  
439 to understanding the effects on species conservation status.

440 The Handbook guidance for informal consultations is less prescriptive than for formal consultations,  
441 but our analysis revealed that the completeness of consultations by FWS is similarly lower than for

442 NMFS. Three components — the analysis of the action, the species analysis, and a map of the action  
443 area — were consistently missing or insufficient in the informal FWS consultations that we reviewed.  
444 On one hand, because informal consultation is merely a prerequisite to determine whether formal  
445 consultation is warranted, we recognize that detailed informal consultation analysis is unlikely to benefit  
446 ESA-listed species. Nonetheless, omission of content means that the administrative record is inconsistent  
447 and incomplete (see ref. 20 for a relevant discussion) and, most alarming of all, differs from the  
448 Services’ expert recommendations for informal consultations. This is apparent in the use of “sticker”  
449 concurrences, observed both in our preliminary work and in one randomly sampled informal  
450 consultation. While these stickers may save time, they provide no record of why FWS approved the  
451 action or method for assessing whether FWS properly implemented that component of the ESA.  
452 Furthermore, in contrast, all informal consultations from NMFS explained why the consultation was  
453 informal. The shortcomings of FWS informal consultations can likely be explained by the resource  
454 constraints, yet we highlight this example as an invitation for the agency to critically evaluate whether  
455 such shortcuts appropriately achieve greater efficiency, or whether different improvements could make  
456 the process more effective.

457

#### 458 **4.2 Opportunities for Improving Consultation Efficiency**

459 The stark difference between the FWS and NMFS in consultation completeness highlight gap in the way  
460 section 7 is implemented. This discrepancy, coupled with the known disparity in both workload and  
461 resources (both financial and personnel) available per consultation, means that improving the efficiency  
462 with which the Services carry out consultations is essential to properly implementing the ESA. Ideally,  
463 the Services should spend enough time on each consultation so as to maximize the conservation benefit  
464 to a listed species. Awareness of this optimal threshold, and the required content to reach it, would avoid  
465 overspending precious resources (21). Here we discuss some critical inefficiencies, and potential pitfalls  
466 of efficient approaches, indicated by our results.

467 The higher completeness scores associated with consultations tiered off of the FWS programmatic

468 consultation indicate that programmatic consultations are one promising way to improve consultation  
469 efficiency. The effects analysis of programmatic consultations should provide a better description of  
470 cumulative effects because many planned or potential projects within a program are evaluated together  
471 rather than individually. We expect that when the cumulative impacts are properly acknowledged, the  
472 assessment of jeopardy or adverse modification is more likely to reflect real-world conditions. Another  
473 benefit is that because the overall program has already been evaluated, the consultations for future  
474 individual projects are faster and can contain less analysis. Malcom and Li (2015) found that project-  
475 level consultations that tiered off of a program-level consultation were completed nearly three times  
476 faster than the average standard consultation. In the set of consultations we evaluated, the single FWS  
477 program-level programmatic consultation for beach renourishment across Florida was a “tide that raised  
478 all boats,” in which the project-level programmatic consultations that tiered off of the program-level  
479 programmatic consultation “inherited” the (generally) high scores of the program-level consultation and  
480 significantly increased the completeness of FWS consultations. Whether this is an outlier or  
481 representative of programmatic consultations in general is unclear but deserves further investigation. But  
482 the converse is also possible: low-quality program-level programmatic consultations would mean that  
483 tiered consultations inherit low-quality analyses that would likely lead to poor conservation outcomes.  
484 While the results from this set of consultations are promising, the Services need to continually evaluate  
485 their programmatic consultations to ensure that the speed benefits of these consultations do not  
486 overshadow the need for high-quality analyses.

487 Our discussions with biologists from the Services provided important context for interpreting the  
488 results and indicated other possibilities for improving consultation efficiency. The lack of consistency  
489 among offices and between Services was frequently mentioned as a frustrating aspect of the consultation  
490 process. The differing approaches to consultations can be difficult for action agencies as well, who can  
491 see the approval of a project depend largely on the consulting office (Y-WL and JWM, pers. obs.). One  
492 possible solution that we did not test is the use of consultation keys, as have been developed for Army  
493 Corps of Engineers consultations for a few species, including wood storks (*Mycteria americana*) and

494 indigo snakes (*Drymarchon couperi*). The Services use these documents to promote appropriate  
495 standards for certain construction activities. Creating similar documents for other frequently-consulted  
496 species may streamline consultations and increase inter-office and inter-Service consistency. The use of  
497 consultation keys would also increase the transparency of the consultation process, making it easier for  
498 action agencies or their applicants to plan their projects.

499 We note one particular aspect of consultations that was not amenable to quantitative analysis but  
500 suggests efficiency improvements: inclusion of extensive material seemingly irrelevant to evaluating the  
501 effects of the action. For example, several consultations we reviewed included >20 pages of information  
502 on red knots (*Calidris canutus*), of which one paragraph was relevant to evaluating the action (JWM,  
503 pers. obs.). Including such inconsequential background information requires additional time not only for  
504 Services' biologists, but also for the action agency or their applicants who read the opinion. By way of  
505 explanation, one FWS biologist mentioned that such information was included to buffer against any  
506 potential legal action, ensuring all "bases are covered." However, this approach conflates "more" with  
507 "better" — the added time and cost does not always produce commensurate benefits for legal  
508 defensibility or conservation (22). We encourage the Services to critically evaluate the information in  
509 biological opinions and exclude irrelevant material. The Recovery Planning Initiative (RPI) now being  
510 adopted by FWS (SI Appendix 6) can help with this extraneous information problem. One component of  
511 RPI is a single, continually updated Species Status Assessment (SSA) for each ESA-listed species,  
512 which would be incorporated by reference in consultations, conservation permits, five-year reviews, and  
513 other aspects of ESA implementation (SI Appendix 7). Widespread adoption of SSAs would improve  
514 efficiency and, because they should include an analysis of previously authorized take, improve the  
515 effectiveness of section 7 consultations.

516 A simplifying assumption we made is that a more complete consultation that addresses each of the  
517 parameters of the Handbook will lead to better conservation outcomes for the species and is thus a  
518 higher quality document. While not every parameter set by the Handbook will help advance the goal of  
519 the consultation equally, addressing each parameter is important for understanding the rationale of the

520 Service and action agency throughout the evaluation process. For these reasons, we believe the  
521 completeness of the consultation document holds substantial importance for species conservation. A  
522 caveat to this methodology is that in reducing complex documents like biological opinions to a few  
523 indicators often means some nuances to individual situations are lost. This is inevitable in the translating  
524 of a qualitative document to a quantitative process, but in equally applying guidance from the Handbook,  
525 we avoid this to the best of our abilities.

526

### 527 **4.3 Policy Recommendations**

528 Our results provide a basis for several policy recommendations that would improve the Services  
529 implementation of section 7 of the ESA:

530 1. *Develop and require the use of a single database for recording and querying authorized take.*

531 The component most commonly missing from consultations we reviewed was an analysis of  
532 previously authorized take in the action area. This is not surprising because FWS and NMFS  
533 have not yet established a unified, systematic way for their biologists to record authorized take,  
534 much less to comprehensively quantify and track previously authorized take to use in the  
535 jeopardy and adverse modification analyses. A centralized take database was recommended by  
536 the GAO over a decade ago (19) but has not yet been implemented by the Services.

537 Implementing this recommendation would dramatically improve the completeness of the  
538 Environmental Baseline analysis of consultations. In turn, we expect better conservation  
539 outcomes for consulted-on species. In addition to consultations, an authorized take database  
540 would be invaluable for informing ESA-required five-year status reviews, such that harmful  
541 effects from consultations can be compared to beneficial effects from conservation activities.

542 2. *Establish a systematic review protocol to ensure that programmatic consultations, which can*  
543 *increase efficiency, do not reduce the effectiveness of consultation.* Programmatic consultations  
544 can increase consultation effectiveness and efficiency – in theory – but the Services must ensure  
545 that the quality of project-level consultations is not sacrificed. In our results, the programmatic

546 consultation was the “rising tide that lifted all boats.” Ensuring that other and future  
547 programmatic consultations are similarly well-crafted can result in high quality, consistently-  
548 implemented consultations. The Services have expressed an interest in increasing the use of  
549 programmatic consultations and recently promulgated new regulations to do so (50 CFR §  
550 402.14), but such an increase must formally guard against a loss of effectiveness. Regular  
551 reviews at the field office, regional, and national levels, guided by a robust “checklist” of  
552 effectiveness measures, could also benefit an expansion of the use of programmatic consultations.

553 3. *Require more widespread development and use of consultation keys.* Our results revealed  
554 variation in consultation completeness between the Services. If we had chosen a wider selection  
555 of consultations, this variation may have further increased. This highlights the need to promote  
556 standardization as a means of improving the efficiency and effectiveness of consultations. The  
557 biologists we spoke with suggested that the use of consultation keys could improve consistency.  
558 Although not every species and every type of action is amenable to consultation keys, wider use  
559 of keys could significantly improve the parts of consultations where they are relevant.

560 4. *Reduce workload by referencing prior documents.* To reduce the rote workload for consultation  
561 biologists and consulting agencies, the Services could consider transitioning to referencing SSAs,  
562 created as part of the Recovery Planning and Implementation strategy, in consultations. This  
563 would dovetail with FWS’s current revision of the recovery planning program, which places  
564 SSAs as a central piece of the process. Improving efficiency through standardization should not  
565 mean cutting corners, however. The informal concurrence stickers are a form of standardization,  
566 but, as currently used, they do not provide an adequate record of why decisions were made. They  
567 may be sufficient if modified slightly, such as by adding simple check boxes and short note fields  
568 to indicate the reason a consultation qualified as informal.

569 Implementing the above recommendations could significantly increase efficiency to better use the  
570 precious resources of the Services, and thus would improve the conservation benefit conferred by  
571 section 7 consultations. Strengthening the completeness of the consultations through these methods

572 would enable the Services to improve the overall effectiveness of the ESA, thereby reinforcing its  
573 critical role in conserving imperiled species.

574

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580 for-profit sectors.

581



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644  
645

### SI FIGURE 1: INFORMAL STICKER CONCURRENCE

646



FWS Log No. 09-I-0118

The proposed action is not likely to adversely affect resources protected by the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) This finding fulfills the requirements of the Act.

David L. Hankla 1/15/09  
David L. Hankla Date  
Field Supervisor

647

663 Complete informal consultation included in Open Science Framework archive at  
664 <https://dx.doi.org/10.17605/OSF.IO/KAJUQ>. Note that there is no accompanying analysis to clarify why  
665 this informal consultation was found not likely to adversely affect the species or any listed critical habitat.

666 **SI APPENDIX 1: SCORING RUBRIC FOR FORMAL ESA SECTION 7 CONSULTATIONS**

667

668 **Environmental Baseline Completeness (Total Points: 5)**

- 669 1. Does the Environmental Baseline address the status of the species in the action area? (1)  
670 2. Is there a mention of past/ongoing threats to the species in the action area? (1)  
671 3. Does the Environmental Baseline take past consultations in the action area into consideration? (1)  
672 4. Is there mention of critical habitat (or lack thereof) for the species? Does said critical habitat overlap  
673 with the action area? (1)  
674 5. Does the baseline include State, tribal, local and private actions already affecting the species that will  
675 occur contemporaneously with the consultation in progress, as per the handbook? (1)

676 **Effects of the Action Completeness (Total Points: 2)**

- 677 1. There is a clear and defined cause and effect analysis of the action. (1)  
678 2. The consultation gives an explanation as to if and how said action will negatively affect sea turtles. (1)

679 **Species Status Completeness (Total Points: 5)**

- 680 1. Does the consultation adequately describe the species and its habitat/critical habitat? (1)  
681 2. Is the life history of the species addressed? (1)  
682 3. Is there a detailed demographic analysis (if available for the species), including population size,  
683 variability and stability? (1)  
684 4. Is the status and distribution of the species addressed, including reasons for listing? (1)  
685 5. Is there an analysis of the species/critical habitat likely to be affected by the action? (1)

686 **Cumulative Effects Completeness (Total Points: 2)**

- 687 1. Does the consultation consider the likelihood of the species to be able to recover? (1)  
688 2. Does the consultation consider the effects of *future* State, tribal, local or private actions that are  
689 reasonably certain to occur, as per the handbook? (1)

690 **SI APPENDIX 2: SCORING RUBRIC FOR INFORMAL ESA SECTION 7 CONSULTATIONS**

691 **Informal Criteria Baseline (Total Points: 5)**

- 692 1. Mentions the action (1)
- 693 2. Some analysis of the action (1)
- 694 3. Some analysis of the impacted species (1)
- 695 4. Reason the consultation stayed informal is mentioned (1)
- 696 5. Map of the area affected by the action (1)

697 **SI APPENDIX 3: CONSULTATION PROCESS QUESTIONS FOR FISH AND WILDLIFE**  
698 **SERVICE AND NATIONAL MARINE FISHERIES SERVICE BIOLOGISTS**

- 699 1. Can you tell me a bit about how the consultation process usually begins for you?  
700 2. How frequently do you work on consultation? Has this number increased or decreased in recent  
701 years? Why might that be so?  
702 3. How common is it to ask the action agency to provide more information on the action?  
703 4. Have you seen a change over time in the way consultations are completed?  
704 5. The number of consultations for FWS in Florida has been steadily decreasing since 2008  
705 (according to the TAILS database there were 1099 in 2008 vs. 347 in 2014). Do you have an  
706 impression of how often you aren't consulted on things?  
707 6. Is there a consultation key for sea turtles, similar to the FWS Wood Stork Consultation Key? If  
708 not, is this something the Service would consider doing? Would this be an improvement to the  
709 process? Would you be in favor of a more standardized way to approach the consultation  
710 process? (Keys, a standardized ITP, etc.)  
711 7. Can you explain the process of going through the literature and files on hand to satisfy the "best  
712 possible science" condition?  
713 8. How do you exercise precaution when dealing with scientific uncertainty surrounding the effects  
714 of an action on a species/critical habitat? How much benefit of the doubt do you give to the  
715 species? Does it differ depending on the situation? Is this an issue you deal with on a regular  
716 basis?  
717 9. How much time do you spend on the average consultation? FWS TAILS database says the  
718 average days for approval for formal consultations is 89 (13 for informal) days. Does that seem  
719 right?  
720 10. Is previous take ever tallied (formally or informally) to get a sense of how much has been done to  
721 a species over time? In your view, would this be a feasible/helpful thing to implement?  
722 11. How often do you consult the section 7 Handbook?  
723 12. Do you ever get requests for re-initiation of consultations?  
724 13. NMFS is taking the lead on the revision of the handbook this year. What would you like to see in  
725 the revision? In your opinion, is there something that should be clarified?  
726 14. What is your opinion on making all of the final documents publicly available (NMFS has PCTS,  
727 Vero Beach has the formal consultations online but not the informal documents)?  
728 15. Where is there the most room for improvement in the consultation process? Does it work well as  
729 is?

730 **SI APPENDIX 4: BIOLOGIST RESPONSES**

731 Included in Open Science Framework archive at <https://dx.doi.org/10.17605/OSF.IO/KAJUQ>

732

733 **SI APPENDIX 5: WOOD STORK CONSULTATION KEY**

734 Included in Open Science Framework archive at <https://dx.doi.org/10.17605/OSF.IO/KAJUQ>

735

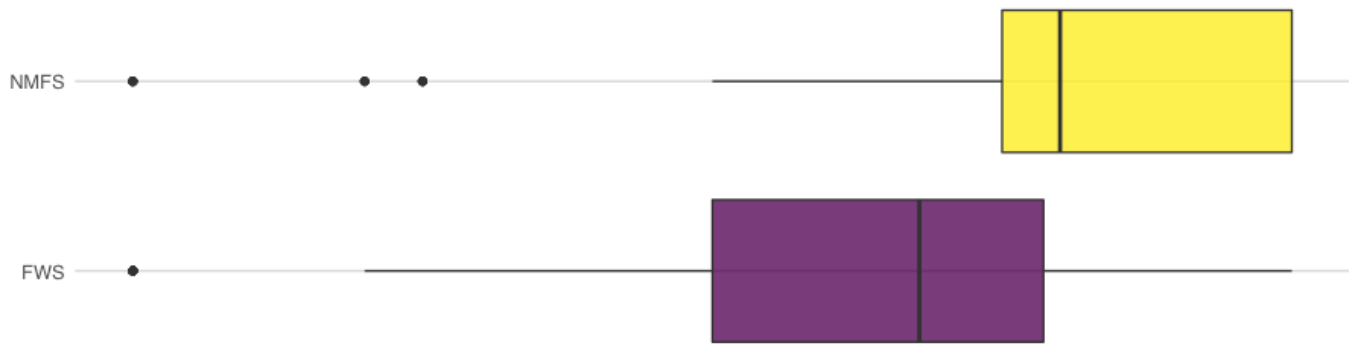
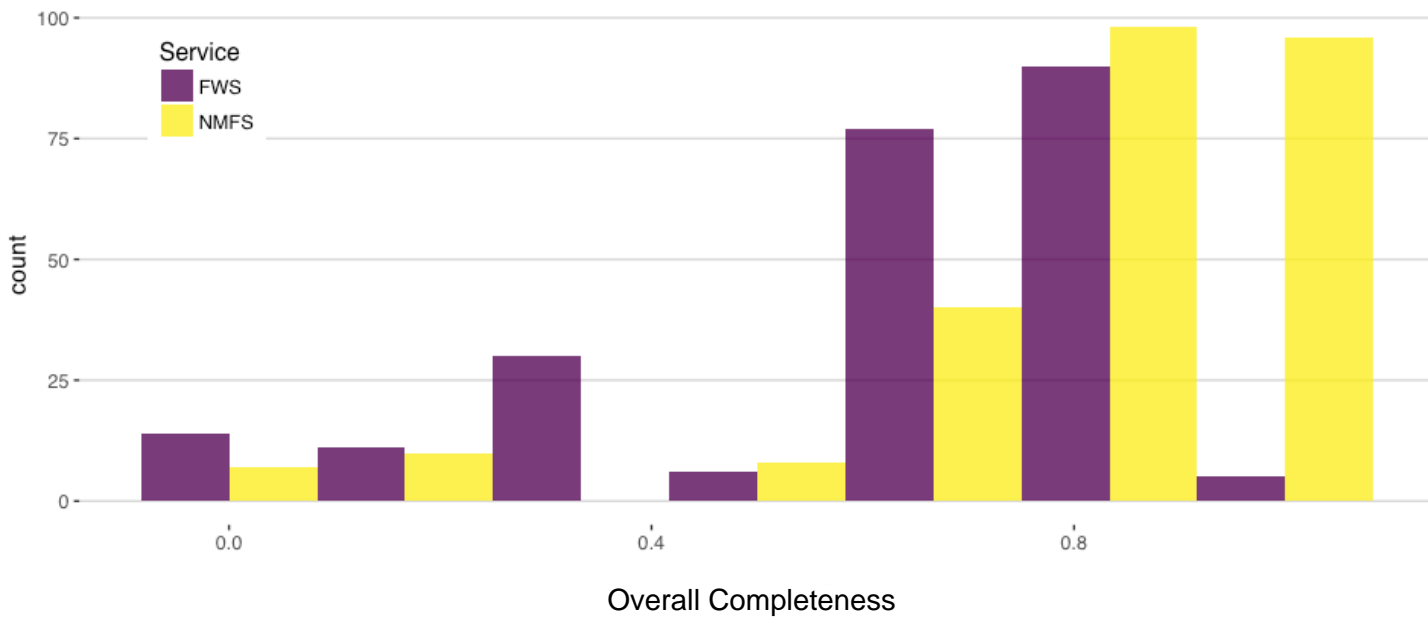
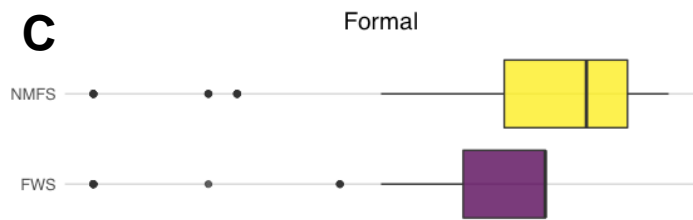
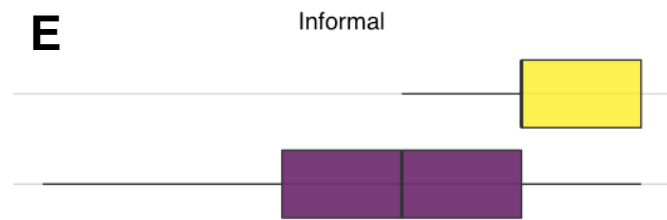
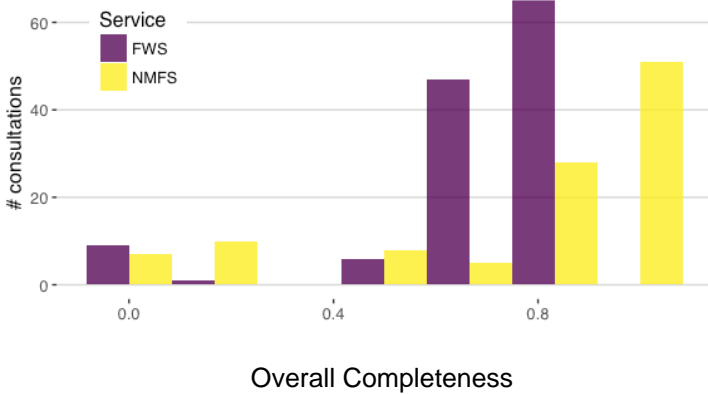
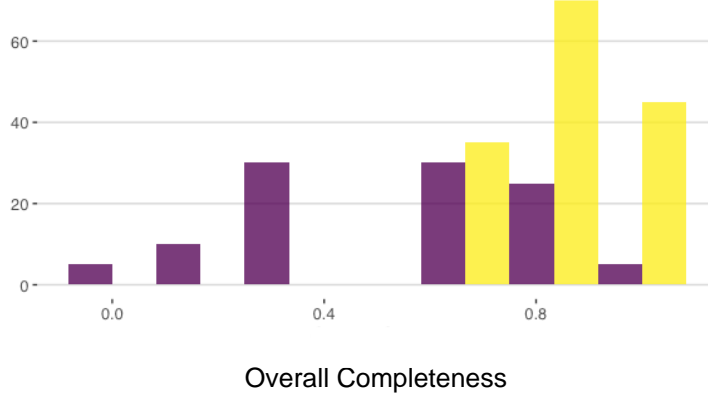
736 **SI APPENDIX 6: RECOVERY PLANNING AND IMPLEMENTATION FACT SHEET**

737 Included in Open Science Framework archive at <https://dx.doi.org/10.17605/OSF.IO/KAJUQ>

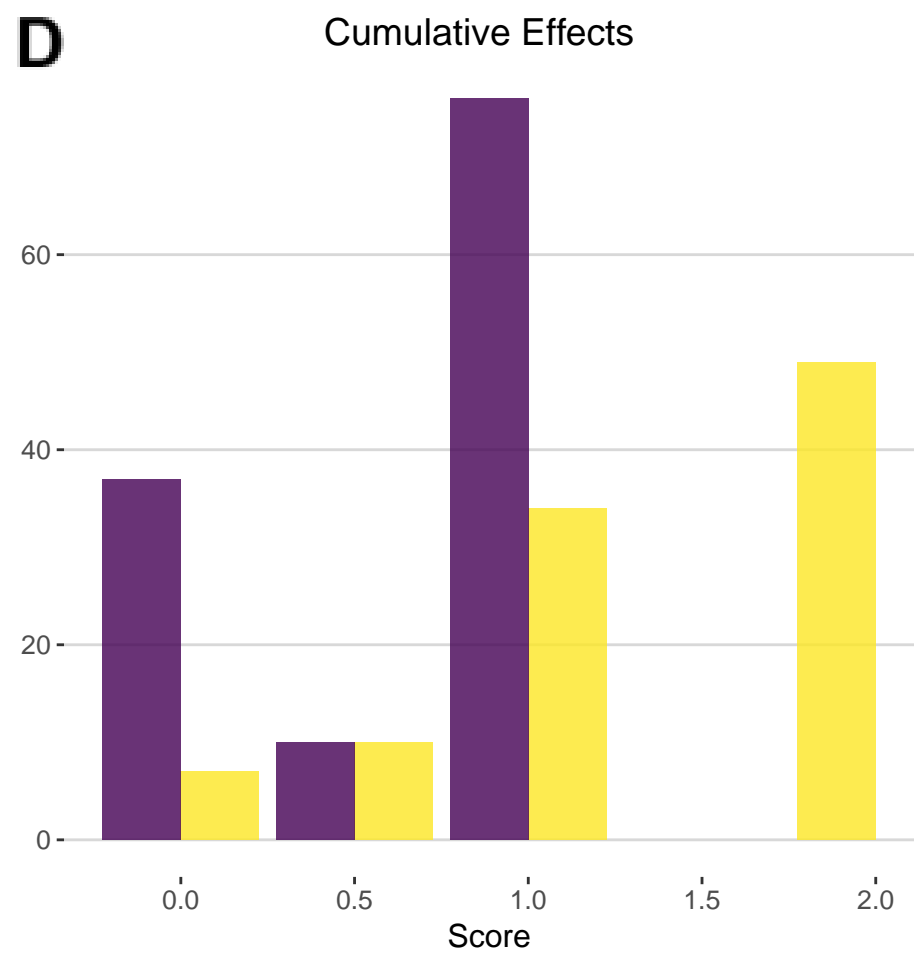
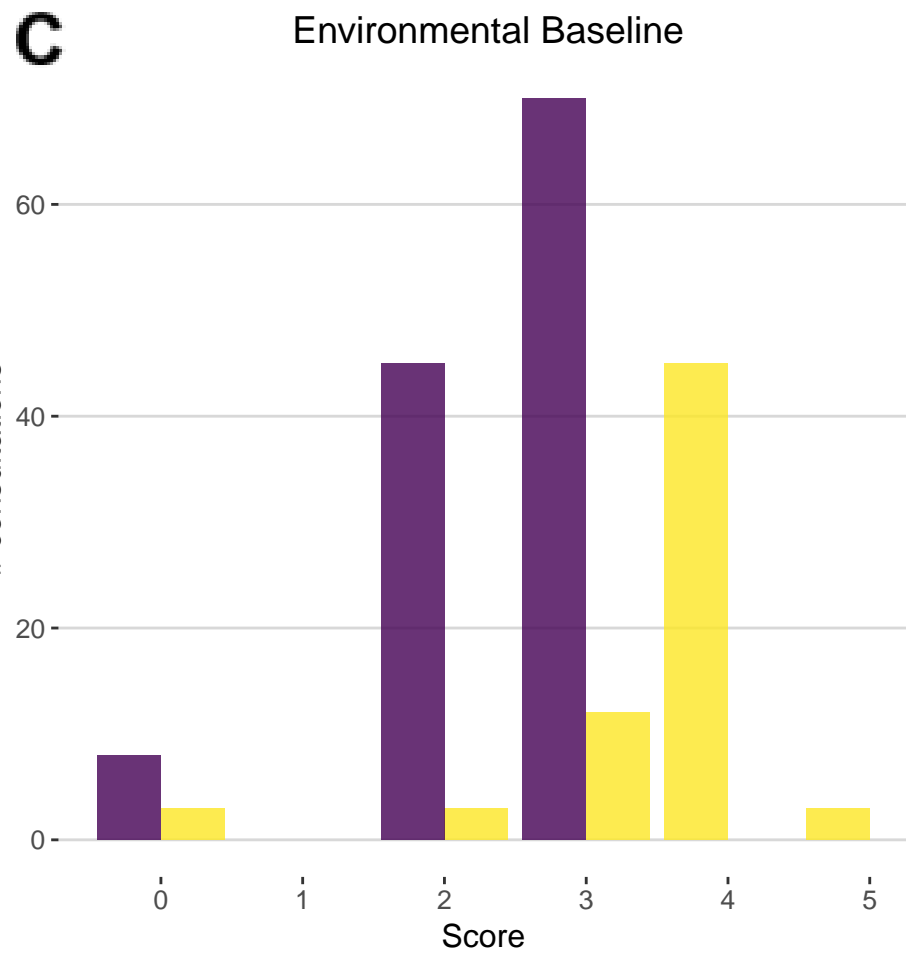
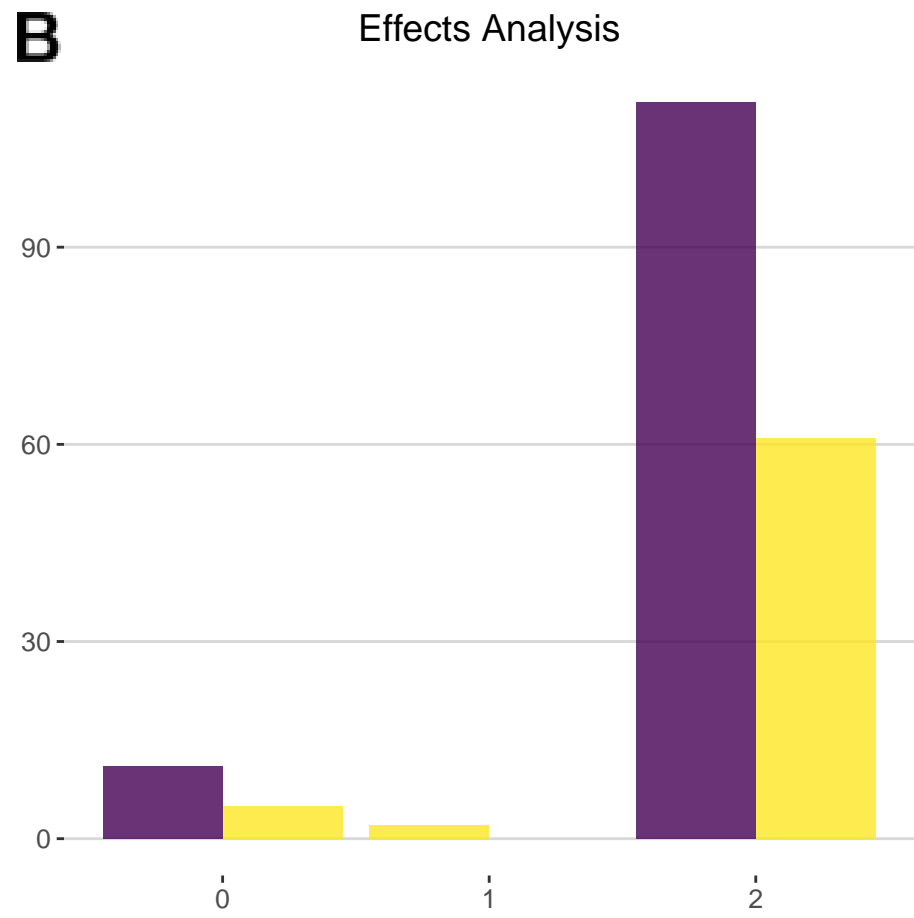
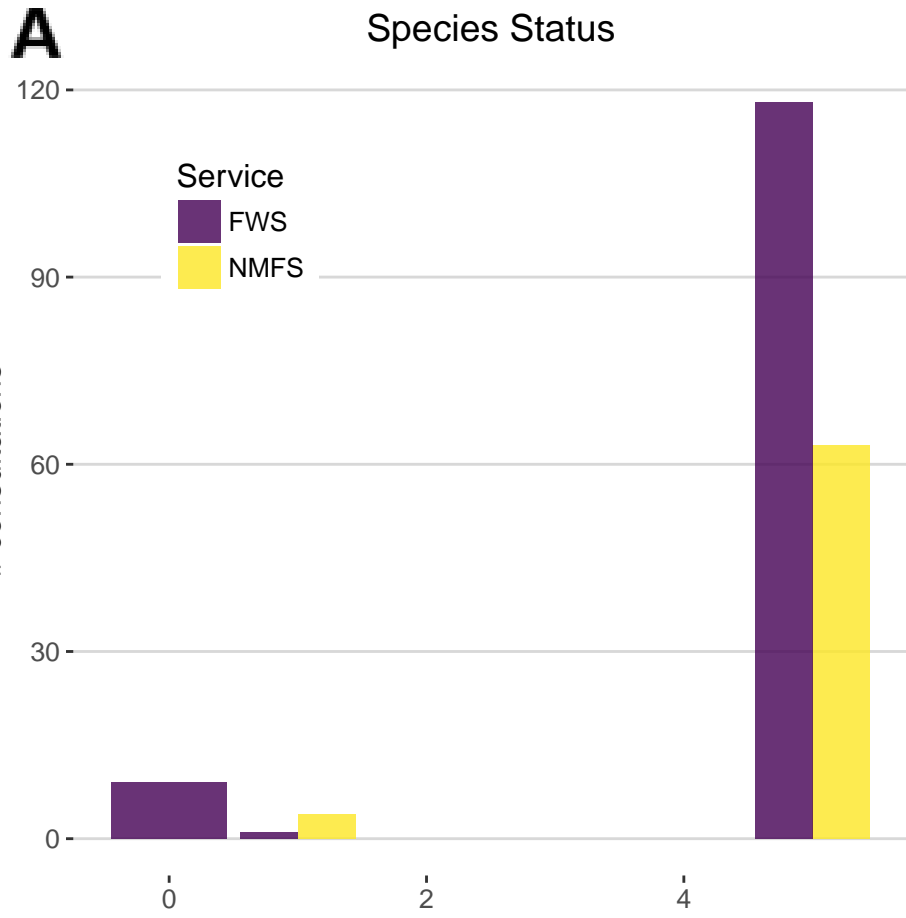
738

739 **SI APPENDIX 7: SPECIES STATUS ASSESSMENT PRESENTATION**

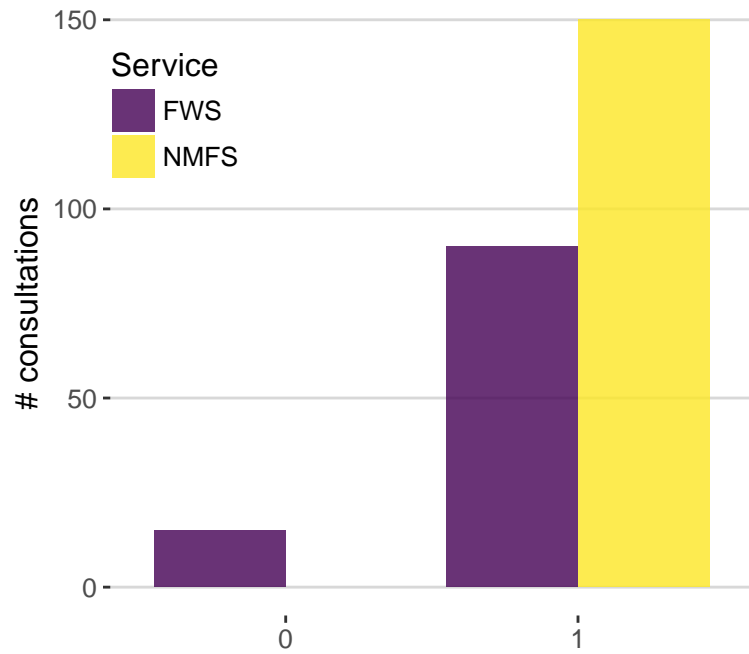
740 Included in Open Science Framework archive at <https://dx.doi.org/10.17605/OSF.IO/KAJUQ>

**A****B****C****E****D****F**

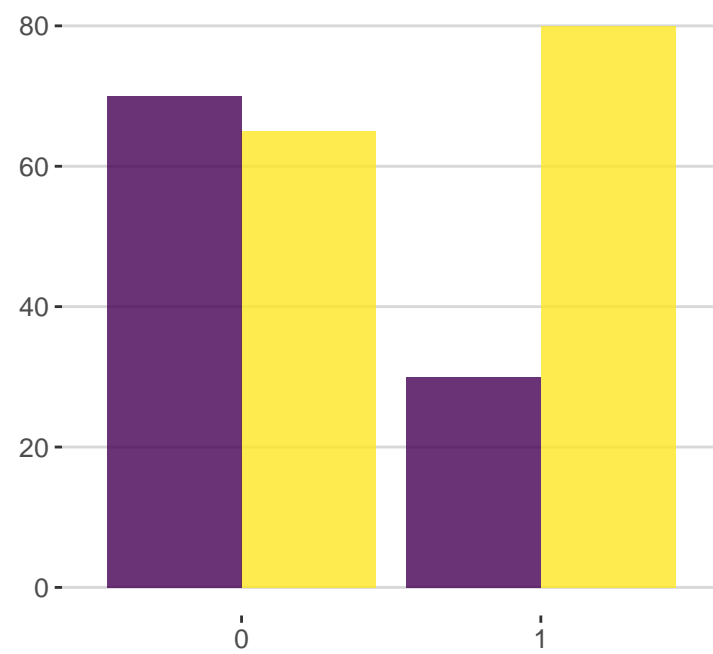




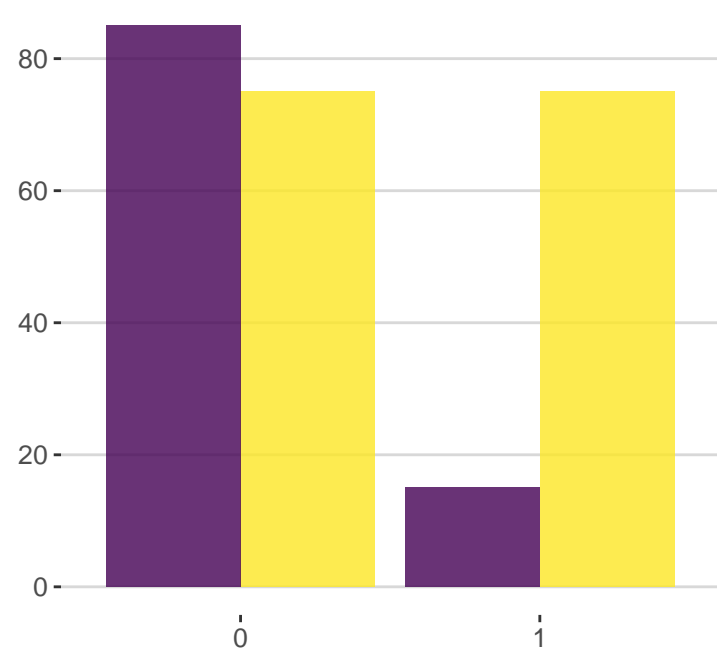
### Mention Action



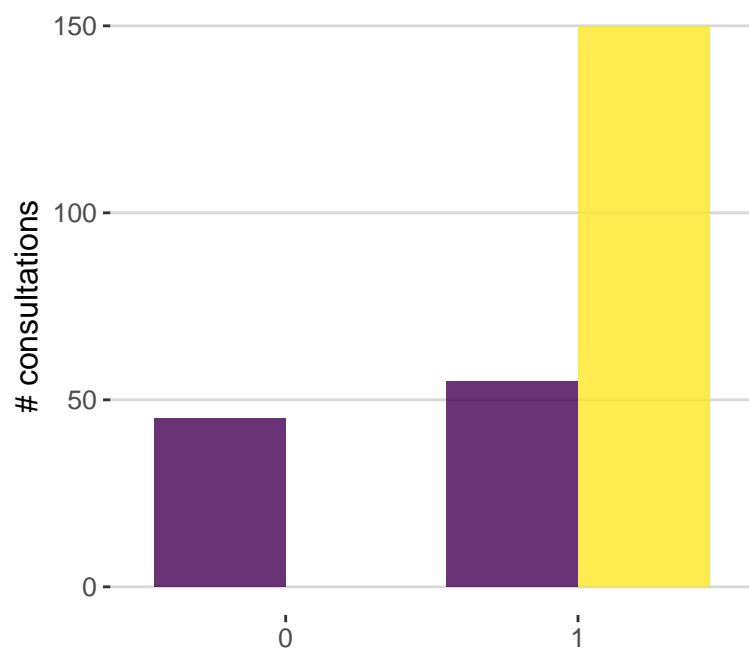
### Species Analysis



### Map Included



### Action Analysis



### Reason Informal

