

Same law, different results: comparative analysis of Endangered Species Act consultations by two federal agencies

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Evaluating how wildlife conservation laws are implemented is critical to determining how best to protect biodiversity. Two agencies, the U.S. Fish and Wildlife Service and National Marine Fisheries Service (FWS and NMFS; Services collectively), are responsible for implementing the U.S. Endangered Species Act (ESA). This creates a “natural experiment” for understanding how implementation of the same law varies between agencies with different histories, cultures, and funding levels. We take advantage of this natural experiment to quantify differences in how FWS and NMFS implement a core component of the ESA, section 7 consultations. The ESA requires federal agencies to consult with the Services if an action an agency proposes might affect ESA-listed species or their habitats. We quantified the quality of consultations by comparing >120 consultations to the requirements laid out in the Services’ consultation handbook. These analyses were complemented with in-person interviews of biologists from the Services to help understand how some observed variation arises. We found consultations from NMFS had significantly higher quality scores than those from FWS. A common shortcoming from both agencies, but especially severe for FWS, was the lack of accounting for effects that were previously authorized through consultations. The biologist interviews indicated some discrepancy between how they perceive consultations and the outcomes from our quantitative analysis. Building from these results, we recommend several actions that can improve quality of consultations, such as using a single database to track and integrate previously authorized harm in new analyses, and the careful but more widespread use of programmatic consultations.

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10 ABSTRACT

11 Evaluating how wildlife conservation laws are implemented is critical to determining how best to protect biodiversity. Two
12 agencies, the U.S. Fish and Wildlife Service and National Marine Fisheries Service (FWS and NMFS; Services
13 collectively), are responsible for implementing the U.S. Endangered Species Act (ESA). This creates a “natural
14 experiment” for understanding how implementation and interpretation of the same law varies between agencies with
15 different histories, cultures, priorities and funding levels. We take advantage of this natural experiment to quantify
16 differences in how FWS and NMFS implement a core component of the ESA, section 7 consultations. The ESA requires
17 federal agencies to consult with the Services if an action an agency proposes might affect ESA-listed species or their
18 habitats. We quantified the quality of consultations by comparing >120 consultations to the requirements laid out in the
19 Services’ consultation handbook. These analyses were complemented with in-person interviews of biologists from the
20 Services to help understand how some observed variation arises. Among these consultations, we found those from NMFS
21 had significantly higher quality scores than those from FWS. A common shortcoming from both agencies, but especially
22 severe for FWS, was the lack of accounting for effects that were previously authorized through consultations. The biologist
23 interviews indicated some discrepancy between how they perceive consultations and the outcomes from our quantitative
24 analysis. Building from these results, we recommend several actions that can improve quality of consultations, such as
25 using a single database to track and integrate previously authorized harm in new analyses, and the careful but more
26 widespread use of programmatic consultations.
27

28 INTRODUCTION

29 The U.S. Endangered Species Act (ESA) is considered one of the strongest wildlife laws in the world (Gosnell
30 2001). Signed into law in 1973 by President Richard Nixon in response to rising concern over the number of
31 species threatened by extinction, the ESA provides over 1,650 U.S. species with protection as of 2017
32 (USFWS 2017). Today, the ESA remains the primary piece of environmental legislation for protecting
33 imperiled species and recovering them to the point that the law’s protections are no longer needed. With such
34 a crucial role, the ESA must be implemented correctly.

35 Section 7 of the ESA directs federal agencies to use their authorities to conserve listed species, and is a
36 key reason for the law’s strength. Under section 7(a)(2), federal agencies are instructed to ensure, in
37 consultation with the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service
38 (NMFS), that any action authorized, funded, or carried out by such agency (“action agency”) is not likely to
39 jeopardize (see Box 1, Glossary) the continued existence of any endangered or threatened species or destroy
40 or adversely modify designated critical habitat. The assessment of these actions by federal agencies and the
41 Services are classified as informal consultations for actions that are deemed not likely to adversely affect
42 listed species or their critical habitat, or formal consultations for those that are likely to adversely affect either.
43 If an action agency concludes not likely to adversely affect, it must request Service concurrence on that
44 finding. If the Service concurs, the consultation is completed. In addition to implementing other programs,
45 e.g., Magnuson-Stevens, the National Wildlife Refuge System, NMFS and FWS share administration of the

46 ESA and are responsible for consulting with federal agencies on actions affecting listed species under their
47 respective jurisdictions. Generally, NMFS has jurisdiction over marine species while FWS manages
48 terrestrial and freshwater species (USFWS and NOAA 1974), but both Services have jurisdiction over some
49 listed species, such as anadromous salmonids and sea turtles. Action agencies consult with both Services on
50 these joint-jurisdiction species. If done properly, consultations minimize the negative effects of an action and
51 ensure that it does not violate the jeopardy and adverse modification prohibitions.
52

53

54 **Box 1: Glossary**

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

57

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

60 **Action agency** The federal agency proposing the action.

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

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

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

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

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

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

81

82 The Services collaborated to create the Section 7 Handbook to "promote efficiency and nationwide
83 consistency [of consultations] within and between the Services" (USFWS and NMFS 1998). The Handbook
84 guides biologists to ensure consultations are serving their purpose of adequately protecting listed species, for
85 example by specifying required analyses. But the Handbook is a guidance document for a national program
86 and not all details of a consultation are prescribed, allowing enough discretion for variation in consultation
87 quality to arise. Two general observations suggest consultation quality may differ between the Services,
88 which may reduce consultation effectiveness. First, Malcom and Li recently analyzed data on all 88,290
89 section 7 consultations recorded by FWS between 2008 and early 2015 (Malcom and Li 2015). Among other

90 results, they found that the duration of the consultations was typically much shorter than the maximum
91 allowed by regulation, with 80% of formal consultations completed within the time limits set by the
92 Handbook. (The proportion of on-time consultations is likely higher because the data do not include
93 information on legitimate “pauses” during consultation; JWM and Y-WL, pers. obs.) In contrast, NMFS
94 consultations are often behind schedule, with only ~30% of formal consultations completed within the
95 required 135-day timeframe (NMFS 2014). One possible explanation for the time difference between the
96 Services that could be problematic for conservation is that FWS may be rushing consultations because the
97 agency has to consult on many more actions but has similar overall funding as NMFS. Second, in reading
98 hundreds of consultation documents, the authors have observed extensive variation in what we loosely refer
99 to as “quality” and “consistency.” The variation appears to be structured (e.g., by species or office) rather than
100 random, and our impression is that the largest differences are between the Services. These observations are
101 set against a backdrop of two agencies with different histories, levels of funding, and cultures — often varying
102 by region and office within each Service — that we expect generate the variation (see, e.g., Lowell and Kelly
103 2016). To our knowledge, there has never been a systematic analysis of these differences in consultation
104 quality.

105 To evaluate variation in how section 7 is implemented by the Services, we examined the quality of
106 consultations relative to the requirements of the Section 7 Handbook. We expect consultations that follow the
107 requirements of the Handbook are more likely to result in better conservation outcomes—that is, are higher
108 quality—because the Handbook provides the best available description of protections to comply with section
109 7. We hypothesized that the quality of NMFS consultations was significantly higher than the quality of FWS
110 consultations. To test our hypothesis, we read and scored the quality of > 120 consultations from the Services
111 and conducted interviews with consultation biologists to better understand the basis of variation. We
112 considered completely random sampling, but consultations are often highly context-specific and can vary
113 widely depending on action type, species consulted upon, and other factors. Much like Owen (2012) did in
114 his analysis, we chose a specific subset of consultations to make comparisons between the Services more
115 direct. To control for extraneous sources of variation, we restricted the consultations to those:

- 116 1. From Florida, to minimize geographic variation;
- 117 2. Focused on sea turtles, to minimize natural history variation of the consulted-on species that could
118 confound analyses;
- 119 3. Involving Army Corps of Engineers as the action agency, to maximize the similarity of the types of
120 actions evaluated; and
- 121 4. From the period 2008 through mid-2015, to match temporal conditions.

122 We found significant differences in the quality of both the formal and informal consultations between the
123 Services. The results highlight ways the Services can systematically improve the quality of consultations, in
124 particular, in tracking and analyzing previously authorized take.

125

126 **METHODS**

127 **Consultation Selection**

128 *Biological opinions* from NMFS consultations are available to the public through their Public Consultation
129 Tracking System (PCTS; <https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts>). This database allows users to
130 search for specific consultations or all consultations within specified search parameters. The Tracking And
131 Integrated Logging System (TAILS) is FWS’s database for recording consultation data. While PCTS allows
132 users to download consultations in full, TAILS is designed to help coordinate record-keeping between field
133 and regional offices of FWS and does not provide the consultation documents. Instead, the TAILS database
134 offers records of each of the consultations completed by FWS, and interested parties must obtain the
135 consultation documents by other means. TAILS has no public interface, but Malcom and Li (2015) created a
136 web application, the Section 7 Explorer (https://cci-dev.org/shiny/open/section7_explorer/), that allows the
137 public to search for consultations of interest using a number of parameters. The data in the Section 7 Explorer

138 are updated periodically when FWS provides a new batched data release.

139 Using PCTS and the Section 7 Explorer, we randomly selected 30 formal and 30 informal consultations
140 from each Service from 2008 to mid-2015. To minimize natural history and geographic variation of the species
141 consulted on by NMFS and FWS, we limited our consultations to those dealing with sea turtles in Florida
142 (green sea turtle [*Chelonia mydas*], loggerhead sea turtle [*Caretta caretta*], Kemp's ridley sea turtle
143 [*Lepidochelys kempii*], leatherback sea turtle [*Dermochelys coriacea*], and hawksbill sea turtle [*Eretmochelys*
144 *imbricata*]). To minimize confounding variation that could arise if different action agencies were evaluated, we
145 limited consultations to those with the Army Corp of Engineers. We acquired the NMFS consultations directly
146 from PCTS, while those from FWS we acquired through FWS South Florida Field Office's online document
147 library for biological opinions ([https://www.fws.gov/verobeach/verobeach_old-](https://www.fws.gov/verobeach/verobeach_old-dontdelete/sBiologicalOpinion/index.cfm)
148 [dontdelete/sBiologicalOpinion/index.cfm](https://www.fws.gov/verobeach/verobeach_old-dontdelete/sBiologicalOpinion/index.cfm)) or through a Freedom of Information Act (FOIA) request. While
149 evaluating the original selection of NMFS formal consultations, we discovered some that did not assess sea
150 turtles in the biological opinion despite search parameters constrained to sea turtles. To account for this
151 discrepancy, we removed those not assessing sea turtles and randomly selected an additional 10 formal NMFS
152 consultations for evaluation from the PCTS database. All of the consultations analyzed in this work are
153 archived at Open Science Framework (OSF) under <https://dx.doi.org/10.17605/OSF.IO/KAJUQ>.

154 Evaluation Criteria

155 We recorded general information for each consultation, such as the start and end dates of the consultation,
156 year it was completed, regional office it was filed through, species of sea turtles concerned, and page length.
157 The full dataset and metadata describing all variables are provided alongside the consultations at OSF
158 (<https://dx.doi.org/10.17605/OSF.IO/KAJUQ>). Below we describe the scoring methodology, noting that
159 formal and informal consultations required different scoring rubrics because they involve different content.
160 All scoring rubrics are provided in SI Appendix 1 (formal consultations) and SI Appendix 2 (informal
161 consultations). It is important to note that it is not feasible to blind scorers as to the Service that wrote a
162 biological opinion because of the nature of the documents: any familiarity with the consultation process
163 makes the Service immediately apparent. Therefore, the reviewers were not blind to the Service when
164 analyzing quality. To minimize bias, we used a strict set of standards from the section 7 Handbook to analyze
165 quality to the best of our ability. When there was any ambiguity as to the appropriate score, a second reviewer
166 (JWM) would read the consultation in question, then decide on the appropriate score with the primary
167 reviewer (ME).

168 For formal consultations, we selected the four core sections from the Handbook to score the quality of
169 each biological opinion: "Status of the Species," "Environmental Baseline," "Effects of the Action," and
170 "Cumulative Effects." While not an exhaustive list of biological opinion sections, these four sections contain
171 the bulk of the information and analysis of the species and the proposed action. Each section received a score
172 from 0-5 or 0-2 based on how well they met the specific requirements set out for that section by the Handbook.
173 In developing the scoring system, we found that rating the quality of these core sections of the biological
174 opinion was clear because criteria set by the Handbook allowed for a simple present/absent scoring system.
175 These present/absent scores were summed for each of the four core sections, giving them a maximum possible
176 score of 2 or 5 points. We calculated total quality by summing the scores across all four sections. The overall
177 quality was normalized by calculating the ratio of the summed score to the total points possible for each
178 consultation.

179 Scoring the informal consultations used a simpler rubric because informal consultations are much shorter,
180 rarely have individual sections, and the Services generally have not prescribed the type of contents that
181 informal consultation documents must contain. We surveyed a selection of informal consultation documents
182 from both Services and several regions, and considered what information Services personnel need to evaluate
183 the effects of actions and to monitor the action after consultation is complete. We identified five criteria to
184 evaluate the quality of informal consultations: mentioning the action, analysis of the action, analysis of the
185 impacted species, mentioning the reason the consultation stayed informal, and including a map of the area
186 affected by the action. These criteria were worth 1 point each, and thus informal consultations received a

187 quality score from 0-5.

188 During the preliminary work we noticed the use of “sticker concurrences,” in which the FWS South
189 Florida Office record of their analysis consisted only of a sticker of consent applied to the request for
190 concurrence provided to FWS (SI Figure 1). This sticker of approval for the action worked in lieu of a
191 complete informal consultation, and no additional consultation documentation to detail any analysis on the
192 action was supplied.

193 **Statistical Analyses**

194 Our goal was to understand patterns and associations of variation in consultation quality. We used basic
195 summary statistics (e.g., mean, standard deviation) and simple correlations (Pearson’s) to describe basic
196 patterns. The analyses proceeded from the broadest scope (factors associated with overall quality, across all
197 consultations) to increasingly detailed analyses of the quality components. We used two basic modeling
198 approaches across this hierarchy: a binomial generalized linear model (GLM; McCullagh and Nelder 1989)
199 on the proportions of total possible points, and ordinal logistic regression (OLR; Kleinbaum and Klein 2010)
200 of the individual quality component scores. We considered seven variables that we thought were most likely
201 to affect consultation quality: the Service that performed the consultation, whether the consultation was
202 formal or informal, the year the consultation took place, the species of turtle assessed, the type of action
203 assessed, and whether the consultation was part of a programmatic consultation. We incorporated these
204 variables into a set of nine candidate models for the analysis of overall quality using the GLM (Table 1, “GLM
205 binom.”). Our global model (Model 1) contained all seven variables. We also considered that the particular
206 office within the Service might be an important predictor of consultation quality. However, given that our
207 focus is on the potential differences between the Services and that the offices are nested within the Services,
208 the office variable was not included in our candidate model set. Because of the fundamental differences
209 between formal and informal consultations and the difference in total possible score, we calculated the
210 response variable as the proportion of possible points for each consultation. When we investigate within formal
211 and informal consultations, we used reduced candidate model sets, dropping variables that were not useful. This
212 meant removing the formal consultation variable from formal analyses, and the formal and programmatic variables
213 from the informal analyses.

214 To evaluate the quality components, we used a set of three candidate ordinal regression models (Table 1,
215 “Ord. regress”) with random effects for the consultation document in which the components were nested.
216 While programmatic consultation was an important predictor of quality in the overall analysis, the Hessian
217 was singular (presumably because of the lack of NMFS programmatic consultations) for the components and
218 we were not able to include programmatic as a variable in these analyses. In lieu of more complex analysis,
219 we evaluated simple summary statistics to investigate the role of programmatic consultations in shifting
220 quality scores. We used package `ordinal` (Christensen 2015) for the ordinal regression.

221 We used Akaike’s Information Criterion adjusted for small sample sizes (AIC_C) for model selection
222 (Anderson and Burnham 2002) using the AICcmodavg package (Mazerolle 2011). All analyses were done in
223 R 3.3 (R Core Team 2016) and are available as a package vignette in the project’s OSF repository
224 (<https://dx.doi.org/10.17605/OSF.IO/KAJUQ>).

225 **Biologist Interviews**

226 To better understand the consultation process, one of the authors (ME) conducted semi- structured interviews
227 (see, e.g., Pienaar 2015 for an example of this) with biologists from both Services and one biologist from the
228 Florida Fish and Wildlife Conservation Commission who works closely with the Services. Interviews were
229 conducted concurrent with our scoring of the consultations, in August 2015, and the interview questions were
230 based on our understanding of the Handbook and preliminary examination of the consultations we reviewed.
231 We asked the same questions of all interviewees regarding their views on the consultation process and how
232 well consultations serve their intended purpose (SI Appendix 3). We interviewed all biologists under the
233 condition of anonymity. Although the sample size is too small for statistical analysis, we reviewed and scored
234 the notes from the interviews to summarize recurring themes.

235

236 RESULTS

237 We retrieved, read, and scored 123 consultations from the two Services (Table 2). Summary statistics for both
238 formal and informal consultations are provided in Table 3. On average, the analyzed consultations assessed
239 the effects of the action on seven species. Formal consultations ranged in length from 1 page to 120 pages and
240 took over a year on average to complete. Of the core quality sections evaluated, ‘Status of the Species’ was
241 by far the longest, with an average of 18.65 pages. We noted that this section often contained extensive
242 extraneous material that was not relevant to the species’ life history in the area of the action, nor was the
243 information relevant to the effects of the action. In our random sample of FWS informal consultations, only
244 one had the sticker concurrence that we observed in the preliminary work.

245 Overall Consultation Quality

246 Model 9 was the best supported among our candidate model set for the quality sections of consultations (Table
247 4). This model, which included all predictors except action type, indicated that a consultation done by NMFS
248 was 1.40 times (95% CI = 1.25 - 1.57; Figure 1a) as likely to receive a positive score for quality components
249 as a consultation done by FWS; FWS’s programmatic consultations provided a significant quality boost (OR
250 = 1.35; 95% CI = 1.17 - 1.56); but formal consultations were about as likely (OR = 1.0; 95% CI = 0.89 –
251 1.13; Figure 1b) to score positively as informal consultations (Table 5). We found that the duration of
252 consultations was positively associated with overall quality in a simple univariate analysis ($r = 0.20$; $p = 1.04e^{-6}$),
253 but disappeared in the multivariate analysis. Similarly, the length (in pages) of consultations was also
254 correlated with quality in a univariate analysis ($r = 0.2$, $p = 0.0037$). However, after accounting for the Service
255 performing the consultation and for programmatic consultations in a binomial GLM, there was no relationship
256 ($z = 1.024$, $p = 0.306$).

258 Quality Components

259 We next examined the sources of variation in the components of overall consultation quality. The only
260 component of formal consultations that exhibited a strong signal with any predictors was the Environmental
261 Baseline, for which Service was a significant and strong predictor of quality ($z = 5.3993$, $p = 6.691e-08$;
262 $OR_{NMFS} = 2.6e^4$ [95% CI = $6.5e^2 - 1.1e^6$]). These patterns are readily visible (Figure 2), and suggest that NMFS
263 consultations tended to score better even though there were few statistically supported differences. For the
264 Environmental Baseline section, NMFS consultations tended to include previous consultations in the action
265 area and discuss critical habitat or lack thereof, neither of which were consistently present in FWS
266 consultations.

267 Most of the quality components of informal consultations were relatively homogenous (Figure 3), with two
268 exceptions. The analysis of the action and the reason the consultation was informal were significantly (at a
269 nominal $\alpha = 0.05$) associated with the duration of consultation: the longer the informal consultation, generally,
270 the more likely these components were included. Second, although not required by the Consultation
271 Handbook, half of NMFS informal consultations included a map of the proposed action but only 15% of FWS
272 informal consultations did.

274 Interviews

275 We interviewed seven biologists from FWS and NMFS who consult on section 7 actions and tallied their
276 responses to our questions (Table 6; full response notes in SI Appendix 4). When asked how the consultation
277 process could be improved, most biologists (6/7) mentioned they found the process frustrating and many
278 stated that they were overwhelmed with work. One biologist pointed to the fear of possible litigation resulting
279 from shorter consultations as a reason for the overly comprehensive and highly time-consuming consultations
280 that are currently the norm. Five of seven biologists also favored expanding the use of consultation “keys,”
281 which are designed to help the biologists improve the timing and consistency of consultations (see, e.g.,
282 <http://www.fws.gov/panamacity/resources/WoodStorkConsultationKey.pdf>; SI Appendix 5) when

283 appropriate for a species or on a case-by-case basis. All biologists interviewed except one mentioned that they
284 keep a record of cumulative incidental take to the best of their ability. The method of recording authorized
285 take varied from notes kept on a whiteboard to Excel spreadsheets. However, only three consultations (all from
286 NMFS) received a positive score for incorporating previously authorized take in the analysis of the effects of
287 the current action on sea turtle populations.

288

289 **DISCUSSION**

290 The ESA is considered the strongest national wildlife protection law in the world, and section 7 is a key reason
291 for this strength. The quality of section 7 consultations can alter conservation outcomes because the
292 protections afforded by the section can only be realized if the scientific and regulatory analyses are robust.
293 Despite the importance of consistently high-quality consultations, no analyses have critically evaluated the
294 strengths and weaknesses of these regulatory documents. Our analysis is a first step for understanding the
295 quality of past consultations to inform and improve future consultations. Across all 123 consultations
296 evaluated, we found that quality varied significantly between the Services and our hypothesis that the quality
297 of NMFS consultations is higher than FWS consultations was supported. In combination with the biologist
298 interviews, which shed light on some of the causes of variation, our results suggest ways that consultations
299 can be improved.

300

301 **Quality Differences**

302 The quality scores of NMFS consultations were significantly higher than those of FWS for both formal and
303 informal consultations, consistent with our hypothesis. This is also consistent with the findings of Lowell and
304 Kelly (2016), who found NMFS scored higher than FWS in three of seven metrics characterizing the use of
305 “Best Available Science” in recovery plans, lawsuits, listing decisions, and literature cited in biological
306 opinions. The ultimate cause of the difference is unclear, but one likely explanation comes from our interviews.
307 FWS biologists in particular spoke repeatedly about the lack of time and resources for an ever-increasing
308 consultation workload. This sentiment reflects the broad-scale funding shortfall that the FWS endangered
309 species program faces: it receives about the same amount of funding as the Office of Protected Resources at
310 NMFS, even though Ecological Services within FWS is responsible for 15 times as many ESA-listed species
311 (Lowell and Kelly 2016). We do not have data on how the Services allocate funding to consultations versus
312 other endangered species program components, such as listing and recovery, but spending per consultation is
313 likely much lower for FWS.

314 Our scoring of the individual sections of biological opinions allows us to better understand why FWS
315 consultations are lower quality and where both Services deviate from the expectations of the Handbook. The
316 Environmental Baseline section of consultations we evaluated consistently earned a score less than the
317 maximum possible (= 5 points) because previously authorized incidental take in the action area was rarely
318 analyzed. The lack of this analysis was problematic for both Services, but FWS scored significantly lower (\bar{x}_{FW}
319 $s = 2.44$) in the Environmental Baseline than NMFS ($\bar{x}_{NMFS} = 3.59$) because the take analysis was missing
320 from all prior consultations in the action area we evaluated. This may seem a minor point, but the lack of this
321 analysis is one of the more pernicious problems of implementing the ESA (Owen 2012). The occurrence of
322 hundreds or thousands of small actions can too easily result in “death by a thousand cuts,” whereby individual
323 actions are insignificant for the species, but the cumulative effects across many actions may severely damage
324 their populations (USFWS 2012). A 2009 Government Accountability Office report on FWS’s implementation
325 of the ESA highlighted this concern and recommended that the Services track authorized take across a
326 species’ entire range to better inform consultations (GAO 2009). The three consultations that included an
327 analysis of previously authorized take were all done by NMFS, enhancing the quality difference between the
328 Services for this core section. However, it is worth noting that FWS’s programmatic consultation for beach
329 work across Florida (Activity Code 41910-2010-F-284) did list previous formal consultations. Unfortunately,
330 those data were not analyzed in the consultation and there was no evidence they played a role in the
331 Environmental Baseline or the Effects Analysis. Why previously authorized take in the action area is not

332 analyzed is unclear, especially in light of the interviews in which many biologists stated that they personally
333 track cumulative take. Future work should investigate the disconnect between the information that Services
334 biologists record and the information used in consultations.

335 The Handbook requires certain components for each section. Unfortunately, several sections of many
336 FWS consultations consisted only of the boilerplate language from the Handbook and little or no analysis,
337 which lowered FWS scores. This was particularly true of the Cumulative Effects section of FWS
338 consultations, which often mention the obligation to “include the effects of future State, tribal, local or private
339 actions that are reasonably certain to occur,” then simply stated that there would be no cumulative effects. In
340 contrast, most NMFS consultations more thoroughly analyzed the cumulative effects, which are critical to
341 understanding the effects on species recovery.

342 The Handbook guidance for informal consultations is much less prescriptive than for formal consultations,
343 but our analysis shows FWS lagging behind NMFS for this large set of consultations. Three components —
344 the analysis of the action, the species analysis, and a map of the action area — were systematically missing or
345 insufficient in the informal FWS consultations we reviewed. On one hand, we recognize that detailed analysis
346 of actions covered by an informal consultation is unlikely to benefit ESA-listed species because the main
347 purpose of those consultations is to determine if a more detailed formal consultation is needed. But the trade-
348 off is that some of the most important components of the administrative record are missing. Perhaps the most
349 obvious example of this missing component comes from the use of “sticker” concurrences, observed both in
350 our preliminary work and in one randomly sampled informal consultation. While these stickers may save time,
351 they provide no record of why FWS approved the action, which is critical to understanding whether FWS is
352 properly implementing the ESA. In contrast, all informal consultations from NMFS explained why the
353 consultation was informal. The shortcomings of FWS informal consultations can likely be explained by the
354 resource constraints discussed above, but highlight the need for the agency to critically evaluate whether it
355 has sacrificed some conservation in the name of efficiency.

356 357 **Consultation Efficiency**

358 High quality consultations are essential to properly implementing the ESA, but there is also a need for efficiency.
359 Ideally, the Services should commit to spending enough time on each consultation to maximize the
360 conservation benefit to a listed species across its entire range. Any additional negotiation with project
361 proponents is inefficient, taking resources away from other tasks that could deliver greater conservation
362 benefits. Converse and colleagues (2011) used a decision-analytic approach to identify a point of diminishing
363 returns for bull trout (*Salvelinus confluentus*) consultations in an FWS field office with a global optimum in
364 mind. Such an analysis of the optimal allocation of effort for FWS and NMFS consultations evaluated here is
365 beyond the scope of the present work. Instead, we focus on efficiencies— and potential pitfalls of efficient
366 approaches — indicated by our results.

367 Programmatic consultations are one promising way to improve consultation efficiency. The effects
368 analysis should provide a better description of cumulative effects because many planned or potential projects
369 within a program are evaluated together rather than individually. We expect that when the cumulative impacts
370 are properly acknowledged, the assessment of jeopardy or adverse modification is more likely to reflect real-
371 world conditions. Another benefit is that because the overall program has already been evaluated, the
372 consultations for future individual projects are faster and can contain less analysis. Malcom and Li (2015)
373 found that project-level consultations that tiered off of a program-level consultation were completed nearly
374 three times faster than the average standard consultation. In the set of consultations we evaluated, the single
375 FWS program-level programmatic consultation for beach renourishment across Florida was a “tide that raised
376 all boats.” Whether this is an outlier or representative of programmatic consultations in general is unclear, but
377 deserves further investigation. The project-level programmatic consultations that tiered off of the program-
378 level programmatic consultation “inherited” the (generally) high scores of the program-level consultation and
379 significantly increased the quality of FWS consultations. But the converse is also possible: low-quality
380 program-level programmatic consultations would mean that tiered consultations inherit low-quality analyses
381 that would likely lead to poor conservation outcomes. While the results from this set of consultations are

382 promising, the Services need to continually evaluate their programmatic consultations to ensure that the speed
383 benefits of these consultations do not overshadow the need for high-quality analyses.

384 Our interviews with biologists from the Services may be preliminary, but provided important context for
385 interpreting the results and indicated other possibilities for improving consultation efficiency. The lack of
386 consistency among offices and between Services was frequently mentioned as a frustrating aspect of the
387 consultation process during the interviews. The differing approaches to consultations can be difficult for
388 action agencies as well, who can see the approval of a project depend largely on the consulting office (Y-WL
389 and JWM, pers. obs.). One possible solution that we did not test is the use of consultation keys, as have been
390 developed for Army Corps of Engineers consultations for a few species, including wood storks (*Mycteria*
391 *americana*) and indigo snakes (*Drymarchon couperi*). The Services use these documents to promote
392 appropriate standards for certain construction activities. Creating similar documents for other frequently-
393 consulted species may streamline consultations and increase inter-office and inter-Service consistency. The
394 use of consultation keys would also increase the transparency of the consultation process, making it easier for
395 action agencies or their applicants to plan their projects.

396 Last, we note one particular aspect of consultations that was not amenable to quantitative analysis but
397 suggests efficiency improvements: inclusion of extensive material seemingly irrelevant to evaluating the
398 effects of the action. For example, several consultations we reviewed included >20 pages of information on
399 red knots (*Calidris canutus*), of which one paragraph was relevant to evaluating the action (JWM, pers. obs.).
400 Including such inconsequential background information requires additional time not only for Services'
401 biologists, but also for the action agency or their applicants who read the opinion. By way of explanation, one
402 FWS biologist mentioned that such information was included to buffer against any potential legal action,
403 ensuring all “bases are covered.” However, this approach conflates “more” with “better” — the added time and
404 cost does not always produce commensurate benefits for legal defensibility or conservation (Restani and
405 Marzluff 2002). We encourage the Services to critically evaluate the information in biological opinions, and
406 exclude irrelevant material. The Recovery Enhancement Vision (REV) project being developed by FWS at this
407 time (SI Appendix 6) can help with this extraneous information problem. One component of REV is a single,
408 continually updated Species Status Assessment (SSA) for each ESA-listed species, which would be
409 incorporated by reference in consultations, conservation permits, five-year reviews, and other aspects of ESA
410 implementation (SI Appendix 7). Widespread adoption of SSAs would improve efficiency and, because they
411 should include an analysis of previously authorized take, improve the effectiveness of section 7 consultations.

412

413 **Policy Recommendations**

414 Our analyses shed new light on how the Services implement section 7 consultations. Do the consultations that
415 we selected reflect all consultations, nationwide? Perhaps not, but the results are sufficient to make two main
416 policy recommendations for the Services to implement:

- 417 1. *Develop and require the use of a single database for recording and querying authorized take.* A centralized take
418 database was recommended by the GAO seven years ago (GAO 2009) but has not yet been implemented by the
419 Services. The component most commonly missing from consultations we reviewed was an analysis of
420 previously authorized take in the action area. This is not surprising because the Services lack a unified way for
421 their biologists to record authorized take, much less to tally previously authorized take to use in the jeopardy
422 and adverse modification analyses. Implementing this recommendation would dramatically improve the quality
423 of the Environmental Baseline analysis of consultations. In turn, we expect better conservation outcomes for
424 consulted-on species. Beyond consultations, an authorized take database would be invaluable for informing
425 ESA-required five-year status reviews, such that harmful effects from consultations can be compared to beneficial
426 effects from conservation activities.
- 427 2. *Establish a systematic review protocol to ensure that programmatic consultations, which can increase efficiency, do*
428 *not reduce the effectiveness of consultation.* Programmatic program-level consultations can increase consultation
429 effectiveness and efficiency – in theory – but the Services must ensure that the quality of project-level
430 consultations is not sacrificed. In our results, the programmatic consultation was the “rising tide that lifted all
431 boats.” Ensuring that other and future programmatic consultations are similarly well-crafted can result in high
432 quality, consistently- implemented consultations. The Services have expressed an interest in increasing the use

433 of programmatic consultations, but such an increase must formally guard against a loss of effectiveness. Regular
434 reviews at the field office, regional, and national levels, guided by a robust “checklist” of effectiveness measures,
435 should be instated as part of an expansion of using programmatic consultations.

436 In addition to the differences we found in our analyses, we observed more variation in consultations than
437 we expected. If we had chosen a wider selection of consultations then this variation would have only
438 increased. This highlights the need to promote standardization as a means of improving the efficiency and
439 effectiveness of consultations. One simple and transparent way to improve consistency that we did not test is
440 for the Services to develop and use consultation keys. Not every species and every type of action is amenable
441 to consultation keys, but their use could significantly improve the parts of consultations where keys are
442 possible. To reduce the rote workload for consultation biologists and consulting agencies, the Services should
443 transition to referencing SSAs in consultations, which dovetails with FWS’s current REV and SSA programs.
444 Improving efficiency through standardization should not mean cutting corners, however. The informal
445 concurrence stickers are a form of standardization but, as currently used, do not provide an adequate record
446 of why decisions were made. They may be sufficient if modified slightly, such as by adding simple check
447 boxes and short note fields to indicate the reason a consultation qualified as informal.

448 We expect that implementing these recommendations would significantly improve the conservation
449 benefit conferred by section 7 consultations and clarity for those engaged in the process. We also think that
450 these recommendations can help reduce the workload for biologists. By improving the quality of the
451 consultations through these methods, the Services can work toward improving the effectiveness of the ESA
452 as a whole.

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457 and R. Dreher for helpful feedback on earlier drafts.
458
459

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- 509

510 **TABLES**

511 **Table 1.** Candidate models evaluated for predicting overall consultation quality and conservation action
 512 specificity.

513

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

514 * Binomial logistic generalized linear model
 515 ** Ordinal logistical regression
 516 *** The notation “(1|var)” indicates a random effects variable

517 **Table 2.** Number of consultations evaluated for each Service, by consultation type.

518

	FWS	NMFS
Informal	25	30
Formal	30	38
Total	55	68

519

520 **Table 3.** Summary statistics across all consultations

521

Group	Variable	Mean	Min	Max	SD	N*
Formal consultations	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 Consultations	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

522

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

527 **Table 4.** Model selection results for overall quality across all FWS and NMFS consultations

528

Model	K	AICc	Delta AICc	Model Likelihood	Akaike Weight	Log Likelihood	Cum. Wt.
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

529

530 **Table 5.** Odds ratios (OR), confidence intervals, and parameter statistics for model 9, the best-supported
 531 candidate set for predicting overall consultation quality.

532

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

533

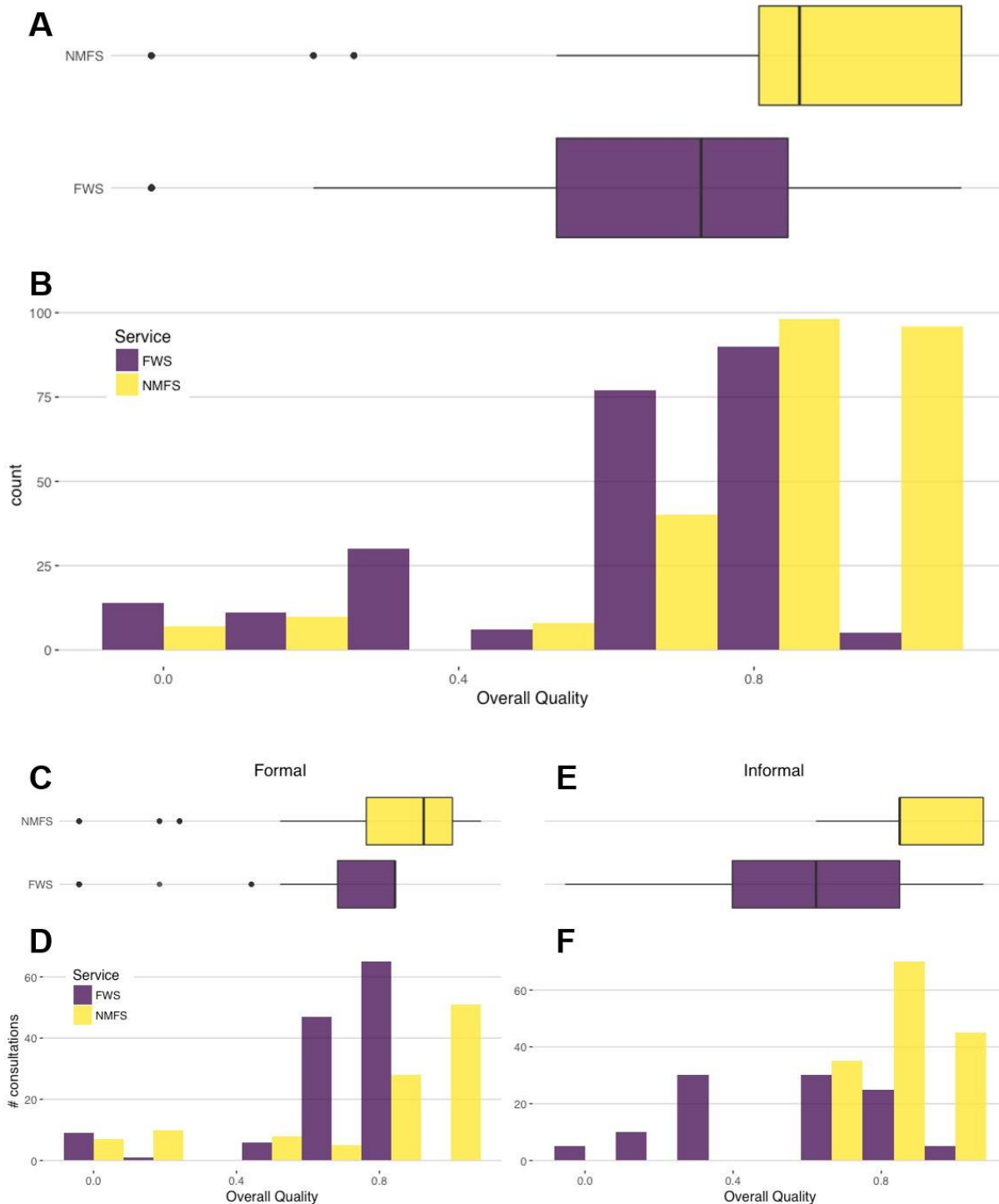
534 **Table 6.** Responses to a selected sample of interview questions asked of FWS/NMFS biologists.

535

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

536

537 **FIGURES**



538

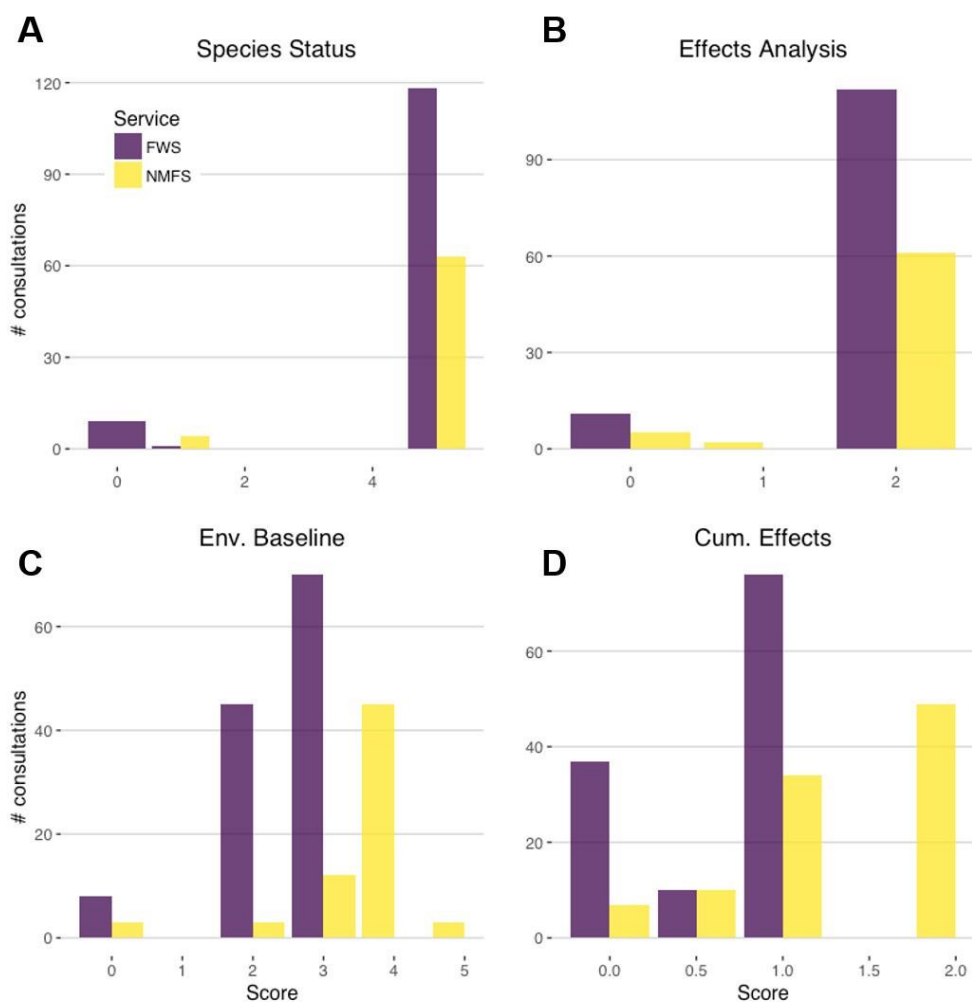
539 **Figure 1. The quality scores for NMFS consultations were higher on average than the scores for FWS**

540 **consultations across all consultations (A), formal consultations (B), and informal consultations (C).** The overall

541 score for each consultation is the sum of points scored divided by the sum of points possible. *Top panel:* Histogram and

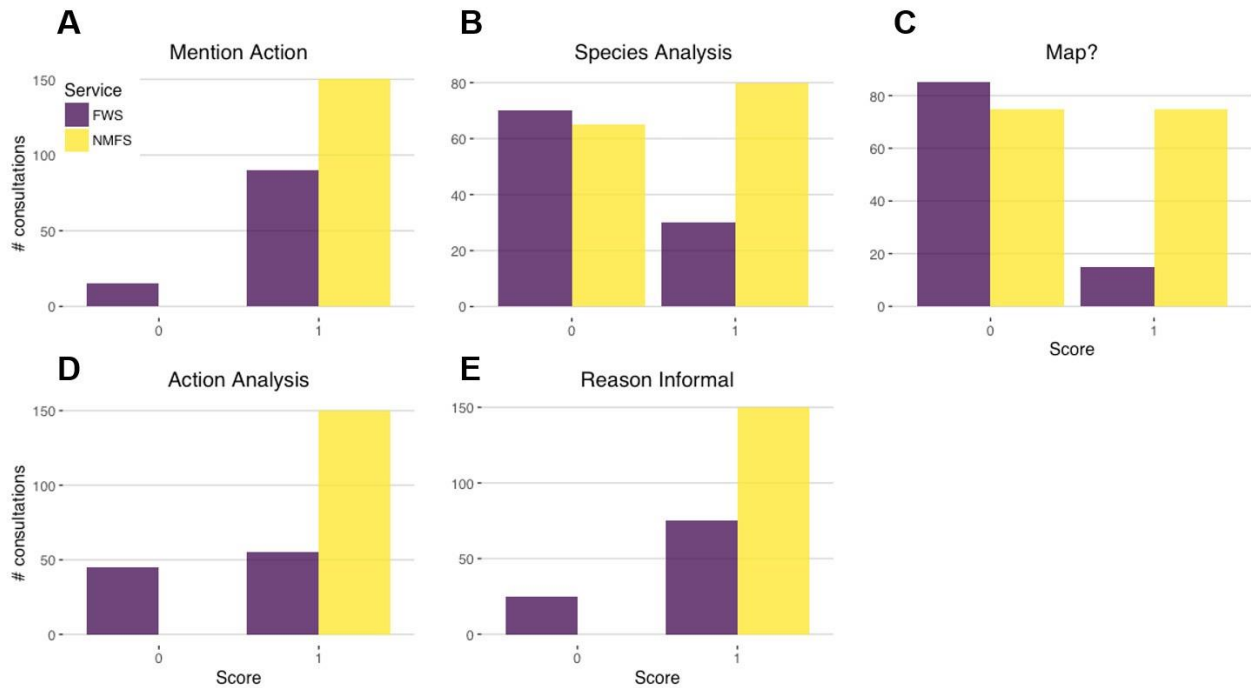
542 boxplots of all consultations (formal and informal, including programmatic consultations) for each Service. *Bottom panel:*

543 Overall scores plotted by Service for formal and informal consultations separately.



544

545 **Figure 2. Individual components of consultations from NMFS tended to have higher scores than those from**
 546 **FWS.** However, only component with a strong statistical signal for differences between the Services was the
 547 Environmental Baseline ($z = 5.3993$, $p = 6.691e-08$; $OR_{NMFS} = 2.6e^4$ [95% CI = $6.5e^2 - 1.1e^6$]). The scores are the raw
 548 scores for formal consultation components, rather than a proportion as in the overall scores in Figure 1.



549

550 **Figure 3. Informal consultations from NMFS tended to have more information and therefore tended to have**
 551 **higher scores than those from FWS, but few differences were statistically significant.** The components of
 552 informal consultation quality scores were binary (presence/absence) in the consultations.

553

SI FIGURE 1: INFORMAL STICKER CONCURRENCE

554



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

564

Complete informal consultation included in Open Science Framework archive at

565

<https://dx.doi.org/10.17605/OSF.IO/KAJUQ>. Note that there is no accompanying analysis to

566

clarify why this informal consultation was found not likely to adversely affect the species or any

567

listed critical habitat.

568 **SI APPENDIX 1: SCORING RUBRIC FOR FORMAL ESA SECTION 7 CONSULTA-**
569 **TIONS**

570 **Environmental Baseline (EB) Quality (Total Points: 5)**

- 571 1. Does the EB address the status of the species in the action area? (1)
572 2. Is there a mention of past/ongoing threats to the species in the action area? (1)
573 3. Does the EB take past consultations in the action area into consideration? (1)
574 4. Is there mention of critical habitat (or lack thereof) for the species? Does said critical habitat overlap
575 with the action area? (1)
576 5. Does the baseline include State, tribal, local and private actions already affecting the species that will
577 occur contemporaneously with the consultation in progress, as per the handbook? (1)

578 **Effects of the Action Quality (Total Points: 2)**

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

581 **Species Status Quality (Total Points: 5)**

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

588 **Cumulative Effects Quality (Total Points: 2)**

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

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

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

- 595 1. Mentions the action (1)
596 2. Some analysis of the action (1)
597 3. Some analysis of the impacted species (1)
598 4. Reason the consultation stayed informal is mentioned (1)
599 5. Map of the area affected by the action (1)

600 **SI APPENDIX 3: INTERVIEW QUESTIONS FOR FISHA ND WILDLIFE SERVICE,**
601 **NATIONAL MARINE FISHERIES SERVICE, AND FLORIDA FISH AND WILDLIFE**
602 **CONSERVATION COMMISSION BIOLOGISTS**

- 603 1. Can you tell me a bit about how the consultation process usually begins for you?
- 604 2. How frequently do you work on consultation? Has this number increased or decreased in recent
605 years? Why might that be so?
- 606 3. How common is it to ask the action agency to provide more information on the action?
- 607 4. Have you seen a change over time in the way consultations are completed?
- 608 5. The number of consultations for FWS in Florida has been steadily decreasing since 2008
609 (according to the TAILS database there were 1099 in 2008 vs. 347 in 2014). Do you have an
610 impression of how often you aren't consulted on things?
- 611 6. Is there a consultation key for sea turtles, similar to the FWS Wood Stork Consultation Key? If
612 not, is this something the Service would consider doing? Would this be an improvement to the
613 process? Would you be in favor of a more standardized way to approach the consultation
614 process? (Keys, a standardized ITP, etc.)
- 615 7. Can you explain the process of going through the literature and files on hand to satisfy the "best
616 possible science" condition?
- 617 8. How do you exercise precaution when dealing with scientific uncertainty surrounding the effects
618 of an action on a species/critical habitat? How much benefit of the doubt do you give to the
619 species? Does it differ depending on the situation? Is this an issue you deal with on a regular
620 basis?
- 621 9. How much time do you spend on the average consultation? FWS TAILS database says the
622 average days for approval for formal consultations is 89 (13 for informal) days. Does that seem
623 right?
- 624 10. Is pervious take ever tallied (formally or informally) to get a sense of how much has been done to
625 a species over time? In your view, would this be a feasible/helpful thing to implement?
- 626 11. How often do you consult the section 7 Handbook?
- 627 12. Do you ever get requests for re-initiation of consultations?
- 628 13. NMFS is taking the lead on the revision of the handbook this year. What would you like to see in
629 the revision? In your opinion, is there something that should be clarified?
- 630 14. What is your opinion on making all of the final documents publicly available (NMFS has PCTS,
631 Vero Beach has the formal consultations online but not the informal documents)?
- 632 15. Where is there the most room for improvement in the consultation process? Does it work well as
633 is?

634 **SI APPENDIX 4: INTERVIEW RESPONSES**

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

636

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

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

639

640 **SI APPENDIX 6: RECOVERY ENHANCEMENT VISION PRESENTATION**

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

642

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

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