Data contradict common perceptions about a controversial provision of the US Endangered Species Act

Jacob W. Malcolm1 and Ya-Wei Li

Defenders of Wildlife Endangered Species Conservation Program, Washington, DC 20036

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Separating myth and reality is essential for evaluating the effectiveness of laws. Section 7 of the US Endangered Species Act (Act) directs federal agencies to help conserve threatened and endangered species, including by consulting with the US Fish and Wildlife Service (FWS) or National Marine Fisheries Service on actions that authorize, fund, or carry out. Consultations ensure that actions do not violate the Act’s prohibitions on “jeopardizing” listed species or “destroying or adversely modifying” these species’ critical habitat. Because these prohibitions are broad, many people consider section 7 the primary tool for protecting species under the Act, whereas others believe section 7 severely impedes economic development. This decades-old controversy is driven primarily by the lack of data on implementation: past analyses are either over 25 y old or taxonomically restricted. We analyze data on all 88,290 consultations recorded by FWS from January 2008 through April 2015. In contrast to conventional wisdom about section 7 implementation, no project was stopped or extensively altered as a result of FWS finding jeopardy or adverse modification during this period. We also show that median consultation duration is far lower than the maximum allowed by the Act, and several factors drive variation in consultation duration. The results discredit many of the claims about the onerous nature of section 7 but also raise questions as to how federal agencies could apply this tool more effectively to conserve species. We build on the results to identify ways to improve the effectiveness of consultations for imperiled species conservation and increase the efficiency of consultations.

Endangered Species Act | section 7 consultation | imperiled species | US Fish and Wildlife Service

Without accurate information about how the government implements a law, public perceptions of the law may be driven by anecdotes, unsupported generalizations, or misinformation. Controversial laws may be particularly susceptible to this problem because inaccurate information can solidify deeply held beliefs about those laws, impeding efforts to ground legal reforms in science. Advances in data analytics are helping to overcome these problems by enabling researchers to systematically analyze how laws are actually implemented. By distinguishing perception from reality, researchers can offer novel insights on how to more effectively administer laws (1–3). Some of the most controversial aspects of biodiversity laws, however, have rarely been systematically evaluated, despite polarized public opinion on those laws. In 1973, President Richard Nixon signed into law the US Endangered Species Act (Act) in response to the growing number of species threatened with extinction. The Act remains the premier law in the United States for protecting the 1,591 species listed as threatened or endangered species threatened with extinction. The Act contains section 7 prohibitions in the law—whether or not on paper. These individuals argue that federal agencies are failing to strictly apply section 7 prohibitions in the face of increasing pressure to minimize the economic impacts of protecting wildlife. This decreased chance of recovery.

Despite these conflicting stories about section 7, there have been few systematic analyses of the tool. The US House of Representatives report to Congress on the 1982 amendments to the Act considered 8,817 informal and 1,945 formal FWS consultations from 1979 to 1981 (8). The report found 192 (1.8%) consultations resulted in jeopardy and only two projects were stopped, partly because of the Act (8, 9). A white paper from World Wildlife Fund (10) examined 71,560 informal and 2,000 formal FWS consultations from 1987 to 1991 and found that only 350 (0.47%) consultations resulted in jeopardy. Of those projects, only 18 (0.02%) were blocked or cancelled because of section 7. Owen (11) analyzed 4,048 biological opinions for fish species from both Services between 2005 and 2009 and found that jeopardy and destruction/ adverse modification conclusions were rare (7.2% and 6.7% of formal consultations, respectively). Thus, our current amendments to reduce or remove the protections of the Act, such as the National Defense Authorization Act (5). Many of the proposals target section 7 of the Act (Box I) because it contains some of the strictest prohibitions in the law—at least on paper. Conservationists often tell a different narrative about section 7. These arguments suggest that the section 7 of today is a paper tiger, leaving many species vulnerable to further habitat loss and diminished chances of recovery.

Significance

The US Endangered Species Act is the most comprehensive law any nation has enacted to protect imperiled species. Many of its protections come from section 7 of the Act, but how government regulators use this tool is poorly understood. Our analysis is the first to systematically evaluate how the US Fish and Wildlife Service has implemented section 7 over an extended timeframe and across all listed species. The results inform current efforts to improve the conservation effectiveness of section 7 and rebut certain claims about the regulatory burdens of complying with section 7.

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1To whom correspondence should be addressed. Email: jmalcolm@defenders.org.

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The numbers of both informal and formal consultations have decreased through time (mean change per year, $-0.1477$), which is likely because the Service must suggest “reasonable and prudent alternatives” (RPAs)—conservation measures that reduce or partly offset the harm from the proposed action, to avoid jeopardy or adverse modification. If no such alternatives are available, the action cannot proceed without violating the Act unless it is exempted by a special committee known as the “God Squad.” Formal consultations end with a Service “biological opinion,” which must be finalized within 135 d after formal consultation begins, unless an extension is agreed on.

Box 1: Overview of section 7 consultations and key terms

Section 7 of the Act requires all federal agencies to ensure that the actions they fund, authorize, or carry out are not likely to “jeopardize” a species or “destroy or adversely modify” critical habitat. Federal agencies must consult with the US Fish and Wildlife Service (FWS) or the National Marine Fisheries Service (NMFS) to fulfill this mandate. Consultations typically start as discussions between the Service and a federal agency to determine whether the agency’s proposed actions may affect a listed species. How FWS biologists are assigned to consultations varies by field office: in some cases, species experts take the lead; in other cases, biologists cover specific geographic areas or particular activities. This “informal consultation” ends if the Service determines that the activity is not likely to adversely affect a species. Otherwise, “formal consultation” is required. During formal consultation, the Service evaluates whether the proposed action will violate the prohibitions on jeopardy or destruction/adverse modification. If neither of these outcomes is likely but take is expected, then the Service will prescribe “reasonable and prudent measures” (RPMS) that are designed to minimize the effects of the action and the amount of take. If either jeopardy or destruction/adverse modification is likely, the Service must suggest “reasonable and prudent alternatives” (RPAs)—conservation measures that reduce or partly offset the harm from the proposed action, to avoid jeopardy or adverse modification. If no such alternatives are available, the action cannot proceed without violating the Act unless it is exempted by a special committee known as the “God Squad.” Formal consultations end with a Service “biological opinion,” which must be finalized within 135 d after formal consultation begins, unless an extension is agreed on.

Results

The TAILS database shows that 1,394 FWS biologists (1,394 FWS biologists per year; range, $379–690$) recorded 81,461 informal and 6,829 formal consultations from January 2008 through April 2015 (Fig. 1A). These numbers exclude 110,850 consultations recorded as informal and formal consultations recorded by FWS from 2008 through April 2015. We obtained the records for these consultations from FWS’s Tracking and Integrated Logging System (TAILS) database and verified questionable entries by reviewing original documents. Using this data (described in detail in Materials and Methods) we find that, unlike during previous decades, no project has been stopped or extensively altered as a result of FWS concluding either jeopardy or destruction/adverse modification of critical habitat. We also find that the median duration of formal consultations is well within the maximum timeframe allowed by the Act. We discuss how these results can help identify opportunities to improve the efficiency of consultations without sacrificing their effectiveness at conserving species. Lastly, we describe a web application that allows any interested user, from citizens to lawmakers, to explore the consultation data in detail.

The durations of 1,381 formal consultations were longer than the 135-d limit prescribed in Services regulations absent an extension approved by the consulting agency (20% of formal). Of these, FWS had marked 1,297 consultations as not being completed on time, indicating $i0$ consultations were completed under a mutually agreed extension. We observed significant variation in the duration of formal consultations among FWS regional offices ($P = 27.77; df = 8$ and $6,112; P < 2.2 	imes 10^{-16}$), with more formal consultations generally corresponding to longer average duration. Beyond simple descriptive statistics of consultation duration, we also sought to explain why the duration varies. Using regression analysis (Materials and Methods), we found that the best predictors of variation in duration were whether the consultations were formal, the identity of the FWS biologist performing the consultation, and the number of species evaluated in the consultation. Although the identity of the lead biologist had the
largest sum of squares, whether consultations were formal had the largest mean square (Table 1); formal consultations add an estimated 43.8 d (SE = 0.436) to consultation duration. TAILS does not include data on the quality, comprehensiveness, or scope (e.g., area affected by the action) of the consultations, each of which can affect the duration.

Educating policy makers and the public is key to improving policy implementation. To that end, we created a web-based application that allows users to explore our version of the TAILS database, which corrected for errors we found in the FWS dataset (defenders.org/section7; also see Materials and Methods). After selecting a state, species, or any of 10 other variables of interest, the application generates interactive plots and maps to visualize the results. The application also allows users to run two separate searches simultaneously and compare the results. Any of the TAILS data can be downloaded by users for additional analyses; the only data masking we applied was hashing the names of the FWS biologists to protect their identity while still allowing future analyses to consider biologist identity as a covariate.

Table 1. Whether consultations are formal or informal explains more variation in consultation duration than any other variable examined

<table>
<thead>
<tr>
<th>Predictor variable</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P (&gt; F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead biologist</td>
<td>1,233</td>
<td>20,890,804</td>
<td>16,943</td>
<td>26.905</td>
<td>&lt;2 x 10^-16</td>
</tr>
<tr>
<td>Formal consultation (true)</td>
<td>1</td>
<td>6,428,433</td>
<td>6,428,433</td>
<td>10,208.088</td>
<td>&lt;2 x 10^-16</td>
</tr>
<tr>
<td>Fiscal year</td>
<td>7</td>
<td>40,640</td>
<td>5,806</td>
<td>9.219</td>
<td>1.88 x 10^-11</td>
</tr>
<tr>
<td>Number species evaluated</td>
<td>1</td>
<td>10,5127</td>
<td>105,127</td>
<td>166.937</td>
<td>&lt;2 x 10^-16</td>
</tr>
<tr>
<td>Consultation complexity</td>
<td>3</td>
<td>190,026</td>
<td>63,342</td>
<td>100.585</td>
<td>&lt;2 x 10^-16</td>
</tr>
<tr>
<td>Action category</td>
<td>91</td>
<td>338,187</td>
<td>3,716</td>
<td>5.901</td>
<td>&lt;2 x 10^-16</td>
</tr>
<tr>
<td>Residuals</td>
<td>84,485</td>
<td>53,203,515</td>
<td>630</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SS, sum of squares; MS, mean square.

Discussion

Deciding policy based on anecdote rather than comprehensive data are fraught with problems. The Act is widely considered the strongest law in the world for protecting imperiled species and their habitat (12), but little is known about how federal agencies actually implement one of the most important provisions of the law—section 7 consultations. As a result, some view implementation as a significant hindrance to economic development (13, 14) while others view it as not halting or modifying enough development projects that harm listed species. Using data that span all consultations recorded by FWS since 2008, we show that FWS very rarely concludes jeopardy or destruction/adverse modification and that the median duration of formal consultations is far below the statutory limit. The first result questions the extent to which consultations are adequately protecting species, and both results counter many of the claims about the regulatory burdens and delays of complying with section 7.

None of the 88,290 actions consulted on with FWS during the past 7 y has been stopped or extensively altered as a result of FWS finding jeopardy or destruction/adverse modification. After considering court-ordered revisions of one consultation,
There are at least three likely reasons for the observed change in jeopardy or adverse modification outcomes. First, and perhaps the most consistent reason for the drop in jeopardy findings is that FWS is coordinating more closely with FWS to shape the projects they are negotiating the scope of their proposed projects in response to FWS issuing a draft biological opinion with a jeopardy or destruction/adverse modification conclusion (19). A second reason is a policy failure arising from insufficient resources and sociopolitical support for FWS (17). A third explanation is that federal agencies are now more inclined to continue negotiating the scope of their proposed projects in response to FWS issuing a draft biological opinion with a jeopardy or destruction/adverse modification conclusion (18). If negotiations are successful, the final biological opinion will have neither of those conclusions. We understand that all three scenarios are likely at play, but we do not know their prevalence.

Although the number of jeopardy conclusions is far lower than the numbers found in previous studies, it is unclear whether listed species are receiving less protection as a result. One reason is that the rate of formal consultation from 2008 to 2015 (7.7%) is considerably lower than the 22.1% from 1979 to 1991 (10) but considerably lower than the 22.1% from 1979 to 1991, when there were far fewer consultations and formal consultation procedures were not yet clarified. Most of the 18,000 formal consultations in our dataset likely require permittees to apply RPMs, which are minor project modifications intended to minimize harm from the project (19) and are not required for projects that end with informal consultation. An example is avoiding construction during a listed bird's nesting season. Between the conservation benefits of RPMs and the likelihood that some federal agencies are now proposing projects with fewer harmful effects, other conservation measures are generally not designed to fully offset the harmful effects of projects and implementation of RPMs is rarely monitored. The cumulative effect of hundreds of these small projects is reduced populations or habitat, an effect that some people refer to as "death by a thousand cuts" (20). Exploring the effects of the over 88,000 consultations on species recovery is essential to understanding the effectiveness of the Act.
Improving the efficiency of section 7 consultations is a goal that would benefit the Services and the regulated community. We found that although the median duration of formal consultations is approximately one-half the maximum allowed by statute, a substantial proportion (20%) of formal consultations take longer than the 135 d allowed (absent an extension). One possibility for improving the speed of consultations is for the Services to find ways to expedite analyses of the effects of an action on listed species. To that end, FWS is currently creating the Information for Planning and Conservation (IPaC) system, which is expected to dramatically streamline informal consultations and introduce both efficiencies and needed standards for formal consultations (21). However, there are limits to how much the duration of consultations can be shortened, particularly for complex activities. Consultations often require months or years to complete because of inadequate data on species, which may suspend FWS’s analysis until better data are collected and provided. Delays may also arise because federal agencies provide incomplete information about their proposed projects.

Our analyses show that the regulated community has two particular opportunities to contribute significantly to both conservation of listed species and to improved consultation efficiency. The variable with the largest mean square was whether consultations were formal, with formal consultations adding an estimated 43.8 d to the expected consultation duration. This result indicates that the most direct way to reduce consultation duration is for action agencies to plan and design projects that are not likely to adversely affect listed species and, hence, do not require formal consultation. That is, species benefit by not being adversely affected by federal actions, and the regulated community benefits by faster (informal) consultations. As noted above, one possible explanation for the lack of jeopardy or destruction/ adverse modification conclusions is that agencies have learned to modify actions before or during section 7 consultation to avoid such conclusions. If FWS increases the use of informal consultations to enhance efficiency, it would also need to improve the commitment to ensure that permits actually implement required conservation measures.

The data also show the efficiencies introduced through consultations on federal agency programs that authorize future actions under the program (e.g., a Bureau of Land Management program to begin developing solar energy projects in six western states). Although these initial, program-level consultations take slightly longer than standard consultations, subsequent formal consultations on the individual activities tied to the program take less than half the time of standard formal consultations (e.g., consultations on the individual solar energy projects). In theory, wider adoption of programmatic consultations would allow better analysis of the overall effects on listed species than if those actions were each approved separately through standard consultations. In practice, however, federal agencies need to improve how they assess the cumulative effects of individual projects (22). If they succeed at this, individual projects could be approved more quickly without undermining conservation.

Although the TAILS data and our analyses can address certain questions about section 7 consultations, these data cannot address the broader conservation question: Has consultation improved the conservation of listed species? There are at least two components to this question. First is the question of whether species are improving, stable, or declining (23) and then determining what proportion of the trends are attributable to consultation. Key to understanding the mechanism is determining whether the analyses underlying consultations are robust enough to afford protections as intended in the Act. Our analysis of consultation duration reflects what FWS reports in its annual budget justification: the majority of formal consultations are completed on time (FWS 2015). In contrast, NMFS reported that less than 30% of its consultations in 2014 were completed on time (24). A recent analysis that included comparisons of consultations found that NMFS used better science than FWS (25), which may explain the difference in consultation duration. Although addressing the cause of this difference is beyond the scope of the present paper, we expect that more detailed and thorough consultations require more time to complete but will improve conservation outcomes in the long run.

The second question is perhaps the most important for conservation and yet the least understood: Are federal actions improving—or at least not impairing—the status of listed species? We currently have limited information on whether agencies are consulting with the Services to the full extent required by the Act. By extension, we do not know the extent to which state and local governments or private parties have pursued permits or funding from federal agencies that should have triggered consultation. We also do not know whether biological opinions and other consultation documents accurately describe the location and scope of projects as completed. Furthermore, we do not know whether permittees actually comply with the conservation requirements from biological opinions and assessments. NMFS has enabled the public to more easily answer some of these questions by posting the results of all their consultations online on the Public Consultation Tracking System website (https://pcts.nmfs.noaa.gov). What neither of the Services have made readily accessible, however, are the monitoring reports required by many biological opinions. Without these documents, it is often impossible to know whether RPMs and other conservation commitments have been performed, much less if they are effective for species (15). Although these important questions cannot be answered with the TAILS data, determining the answers is crucial to understanding the effectiveness of the Act. The significant drop in the number of jeopardy and destruction/ adverse modification findings makes the answers especially important to evaluating whether consulted-on projects are impairing the conservation status of listed species.

Actual data and their analysis are essential to understanding how laws and policies are implemented, and that understanding is core to making informed decisions that improve outcomes and efficiency. The framers of the Act recognized the central importance of using the best available data and science for conserving imperiled species. Using the best available data and very simple statistics, we have shown that FWS rarely finds jeopardy or destruction/adverse modification and that the duration of most formal consultations is far shorter than the maximum allowed by law. Not one project has been stopped or significantly altered as a result of FWS reaching either of these findings. Although our analyses raise a host of questions—e.g., whether consultation is improving conservation outcomes for listed species—our findings should lay to rest some of the common misconceptions about the law. With those misconceptions aside, effort can focus on improving both the conservation

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**Table 2. Rate at which the US Fish and Wildlife Service calls jeopardy has varied over the past three decades and decreased substantially since 2008**

<table>
<thead>
<tr>
<th>Time frame (years)</th>
<th>US House of Representatives 1982 Report</th>
<th>Barry et al. (10)</th>
<th>Owen (11)</th>
<th>Present study</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979 to 1981</td>
<td>8,817</td>
<td>71,560</td>
<td>2,000</td>
<td>350 (17.5%)</td>
</tr>
<tr>
<td>Informal consultation</td>
<td>1,945</td>
<td>1,945</td>
<td>1,945</td>
<td>1,945</td>
</tr>
<tr>
<td>Formal consultation</td>
<td>173 (8.9%)</td>
<td>173 (8.9%)</td>
<td>173 (8.9%)</td>
<td>173 (8.9%)</td>
</tr>
</tbody>
</table>

*No. includes only FWS fish-related consultations.*
We acquired a copy of the data for all formal and informal consultations as recorded in the TAILS database by FWS biologists since 2008, from FWS in July 2014, and a data update in mid-May 2015. The variables and an explanation of each are provided in SI Appendix. After the update, the dataset consisted of over 2 million rows of data, with each species evaluated in each consultation afforded a single row because conclusions are made on a per-species basis rather than per-consultation basis.

We performed extensive data checks and corrected errors in our copy of TAILS: errors are expected when >1,300 people working over 7 y are entering data. We corrected apparent date errors for the start and end of consultation, most of which were simple typos; homogenized the names of action agencies; corrected work categories for which duplicates occurred because of simple typos; and set the Boolean “formal consultation” field to “true” if the conclusions for any species in a consultation could only be reached through formal consultation (e.g., if a jeopardy determination had been recorded). Because FWS uses different species names and style conventions between different databases (e.g., TAILS vs. annual expenditure reports to Congress), we homogenized all names against the most recent expenditure report (2013) names and style convention [i.e., common group, common specific (Genus species var)] to improve interoperability. Last, because there are effectively only a small number of possible conclusions (e.g., not likely to adversely affect vs. likely to adversely affect, no jeopardy, no adverse modification) but a variety of ways the conclusions were recorded in TAILS, we standardize all conclusions following Table S1.

During the data check phase, we identified 198 consultations that were recorded in TAILS as formal consultations but lacked lists of species evaluated during consultation, or for which the TAILS record included either jeopardy or destruction/adverse modification conclusions. To ensure the species and conclusion were not corrected biologically or by other original consultation documents from FWS through a Freedom of Information Act request. We reviewed all responses and updated the data as necessary. During the updating, we identified another four consultations with questionable conclusions and used phone calls and emails to FWS biologists to obtain the correct data. Although such a large dataset likely contains other minor errors that we were unable to detect, we assume here that those errors are unbiased and equally distributed above and below the median and mean estimates.

To facilitate analysis and data sharing, we created several additional variables from the TAILS data. Consultation duration (in days) was calculated as (i) conclusion date minus start date for informal consultations and (ii) conclusion date minus start of formal consultation date for formal consultations. The clock for meeting the regulatory deadline of 135 d for formal consultation starts when the action agency requests formal consultation. The duration calculation, however, may be an overestimate because the clock stops when FWS requires the action agency to provide more information. To protect the identity of FWS biologists performing the consultations while still allowing analysis of individual-level effects on consultation duration and other factors, we used the Message Digest 5 (MD5) algorithm in the digest package for R 3.12.2 (26) to hash the names. Last, to reduce the size of the database and improve the efficiency of the web applications (see below), we collapsed the TAILS data from species x consultation per row to a single row per consultation with lists of species and conclusions embedded in each row.

We calculated median consultation durations and approximate 95% CIs of the median after removing missing data. Standard analysis of variance was used to test for differences in means among categories. To evaluate the factors most likely to influence consultation duration, we removed 2,468 consultations (2.8%) with duration above the 98th percentile of all durations; these extreme values are strongly influenced by factors other than those recorded in TAILS, and their removal dramatically improved the fit of the models (from $R^2 \approx 0.17$ to $R^2 = 0.34$). We then used a linear model, with the functions lm and aov in R, to estimate the effects of six variables (identity of the lead biologist, whether the consultation was formal or not, the fiscal year of the consultation, the number of species evaluated, the complexity of the consultation, and the type of action being consulted on) on consultation duration. The distribution of residuals was checked to ensure the normality assumption was met.

A primary goal of this work is to help the public understand how consultations are implemented. We used the Shiny framework for R (shiny.rstudio.com) to create an interactive web application for different audiences. The code for the application and used in the analyses described above is available at GitHub (https://github.com/Defenders/section7_explorer). The application is licensed under a Creative Commons Attribution-Share-Alike license so that figures, maps, and other details can be used (with attribution) by anyone who is interested. Because the TAILS data are created by US Government employees, the data are in the public domain and can be downloaded from within the application. We will be updating the data underlying the application on a quarterly basis.

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