Uncertainty and the Endangered Species Act

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The U.S. Endangered Species Act requires the U.S. Fish and Wildlife Service to use the "best available" information when deciding whether to list species as threatened or endangered, and when regulating conservation for species already listed. The agency has discretion to determine the types, quantity, and quality of the information it uses as "best available," but little discretion to defer decision making in cases where important scientific information is lacking. Complexities of nature, obscurity of many species' life history, and changing environmental circumstances are only some of the reasons why information is rarely complete, and why decisions are almost always made in the face of uncertainties. These uncertainties could lead to decision errors, and the consequences might be failure to prevent extinction or imposition of unnecessary regulatory requirements. Furthermore, real or perceived errors could lead to legal action and loss of the agency's credibility. This Paper discusses some recent examples of how the Fish and Wildlife Service has dealt explicitly with uncertainty in its administration of the Endangered Species Act.

INTRODUCTION

The purpose of the Endangered Species Act of 1973 (ESA),[1] as amended, is to provide "a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved."[2] This purpose has been widely interpreted as a broad federal mandate to prevent extinctions. The U.S. Fish and Wildlife Service (FWS) provides oversight of that objective for terrestrial animals, all birds, fresh-water fishes, and plants.[3] This Paper will focus on the authors' personal

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1. Endangered Species Act of 1973, Pub. L. No. 93-205, 87 Stat. 884 (codified as amended at 16 U.S.C. §§ 1531–1544 (2000)).

2. *Id.* § 1531(b).

3. The ESA assigns administrative responsibility to the Departments of Commerce and the Interior. A 1974 Memorandum of Understanding describes further delegation of classes, orders, and groups of animals to the National Oceanic and Atmospheric Administration (NOAA), Fisheries (formerly National Marine Fisheries Service), and the U.S. Fish and Wildlife Service. Memorandum of Understanding between the U.S. Fish and Wildlife Service, United States Department of the Interior and the National Marine Fisheries Service, National Oceanic and Atmospheric Administration United States Department of Commerce on jurisdictional

experiences with processing information for the FWS for decision making under the authorities of the ESA. Our views do not represent the opinions or positions of the FWS.

A primary FWS responsibility is to identify and publish a list of species that are at risk of extinction. The ESA defines endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range."[4] A threatened species is "any species which is likely to become an endangered species within the foreseeable future."[5] Once on the list, federal agencies must take precautions to ensure that their actions are "not likely to jeopardize the continued existence" of listed species.[6] From a FWS practitioner's perspective, the definitions of "endangered," "threatened," and "jeopardy" require assessment of how environmental circumstances influence extinction likelihood and incremental changes of extinction risk.

The ESA and its implementing regulations outline strict timeframes for deciding whether a species's status meets any of these statutory or regulatory definitions. The FWS has one year to assess extinction risk and propose a listing.[7] To ensure that these timeframes are enforced, Congress directed that listing decisions be based "solely on the basis of the best scientific and commercial data available."[8] In effect, using the best available data means that decisions may not be delayed while waiting for new and better information. In the interagency consultation process, FWS has only 90 to 120 days to assess whether proposed federal actions will incrementally increase the risk of extinction of an already listed species.[9] The FWS can request extensions of these timeframes to allow for the collection of additional information, but project proponents may be unwilling to grant extensions because of other imperative concerns.

New provisions under the Information Quality Act of 2000 (IQA) require explicit evaluation of information quality in federal decision-making documents.[10] These provisions do not prohibit use of less-than-perfect information, nor do they require resolution of uncertainty; rather, agencies must identify sources and types of information and solicit independent opinions on the use of information through peer review and other conventions. The IQA does not alter, or give cause for extending, statutory and regulatory deadlines or allow deferment of decision making in the presence of uncertainty and missing information.

Vague terminology and scientific uncertainty make ESA regulatory decisions difficult. In this Paper, we highlight some key semantic issues and types of scientific uncertainty, and give real-world examples of ESA decisions made in this context. We describe how using structured decision processes and standardized criteria for

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responsibilities and listing procedures under the Endangered Species Act of 1973 (Aug. 8, 1973) (on file with authors).

4. 16 U.S.C. § 1532(6) (2000).

5. *Id.* § 1532(20).

6. *Id.* § 1536(a)(2).

7. *See id.* § 1533(b)(3).

8. *Id.* § 1533(b)(1)(A).

9. Section 7(a)(2) of the ESA requires that each federal agency, in consultation with the FWS or NOAA, ensure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of a listed species. *Id.* § 1536(a)(2). Joint counterpart regulations for interagency consultation are published under 50 C.F.R. pt. 402 (2006).

10. *See* Information Quality Act of 2000, *in* Treasury and General Government Appropriations Act for Fiscal Year 2001, Pub. L. No. 106-554, sec. 515 (2000), *available at* http://www.fws.gov/informationquality/section515.html.

classification of species under the ESA would help the FWS to make defensible decisions in the face of semantic and scientific uncertainty.

I. VAGUE TERMINOLOGY

Vague terminology in the ESA and implementing regulations, data gaps, and confusion between scientific information and social values all combine to fuel disagreements over how best to implement the ESA. The words "in danger of extinction" convey a sense of immediacy, and indeed congressional testimony during the 1973 deliberations on passage of the ESA confirms that endangered is a "critical point."[11] Given sufficient data, scientists can estimate how immediate the threat of extinction is, but society sets the threshold for acceptable risk through its elected leaders and their political appointees and policies.

Definitions of endangered, threatened, and jeopardized rely on risk terminology, such as "in danger,"[12] "likely to become an endangered species,"[13] and "reduce appreciably the likelihood of both survival and recovery."[14] These definitions can lead to inconsistency in implementation because they do not establish conventional metrics or contain explicit thresholds by which we can compare extinction risk estimates. The FWS usually delegates primary analytical responsibilities to field office staff[15] with varying experiences and expertise. Thus, acceptable risk is decided on a case-by-case basis, inevitably leading to unevenness in analytical approaches and management judgments.

"*Jeopardize the continued existence of* means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species."[16] The word "appreciable" is not defined and reasonable people can argue over how much and what type of change triggers a regulatory response for any given situation.

II. INFORMATION NEEDS AND DATA GAPS

Complexities of nature, obscurity of many species' life history, and changing environmental conditions make it difficult to assess the accuracy of extinction risk models. Proposals to list very small populations with known threats and unequivocal population status are the exception today in the coterminous United States. There are

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11. *See* 119 CONG. REC. 30,167 (1973) (statement of Rep. Don H. Clausen).

12. 16 U.S.C. § 1532(6) (2000).

13. *Id.* § 1532(20).

14. 50 C.F.R. § 402.02 (2006).

15. The FWS delegates responsibilities for administration of the ESA to its Ecological Services Program. Most states have at least one Ecological Services office. The FWS usually delegates lead analytical responsibilities to one of these offices. *See* U.S. FISH AND WILDLIFE SERV., ENDANGERED SPECIES LISTING HANDBOOK: PROCEDURAL GUIDELINES FOR THE PREPARATION AND PROCESSING OF RULES AND NOTICES PURSUANT TO THE ENDANGERED SPECIES ACT 157–164 (4th ed. 1994), *available at* http://training.fws.gov/EC/Resources/ES_Listing_and_Candidate_Assessment/ESA%20Folder/FWS%20Listing%20Handbook.pdf.

16. 50 C.F.R. § 402.02 (2006) (emphasis in original).

few, if any, of the California condor-like species that are not already listed. Many of the species we evaluate now are wide-ranging, with little information available on their life histories. Some of these species have population trend data suggesting declines, but populations may remain in the tens to hundreds of thousands of individuals.

It is difficult to design affordable studies to collect demographic, life history, and population trends and abundance that allow range-wide inferences about extinction risk within the given statutory or regulatory timeframe. The following three examples illustrate this point.

The Indiana bat (*Myotis sodalis*), an endangered species, occurs in Midwestern and New England states. Most of the population hibernates in a handful of caves in the winter, and in the summer individuals virtually disappear into the eastern hardwood forests. Hibernating Indiana bat numbers are thought to have dropped from approximately 900,000 to around 450,000 individuals in the past forty years.[17] Early losses were attributed to anthropogenic loss of hibernacula, but the population may be continuing its decline even with cave protections in place. The causes of the decline and the effect that forest management practices have on bat populations during the summer remain unknown. Nevertheless, the FWS must determine whether the incremental effects of individual land use projects will jeopardize the species within the 90- to 120-day consultation timeframe.

The cerulean warbler (*Dendroica cerulea*) occurs in twenty-nine states and migrates between two continents. Using breeding bird survey information from 1966 to 2000,[18] the estimated range-wide population change per year is -3.04% (95% credible interval between -4.02% and -2.07%).[19] Population estimates were also derived from breeding bird survey data, but producing reliable population estimates for cerulean warblers using these data can be problematic because the mathematical formulas do not incorporate measures of variance, and because biases in data collection[20] may lead to over- or under-estimation. Because of these problems with using breeding bird survey trend-estimation data to generate population estimates, the best available total population estimate is imprecise: somewhere between 280,000 to 840,000 individuals in 1995.[21] Causes of the species' decline are speculative, and it is difficult to make reliable projections of future population trends from data collected in the past if the factors causing the decline are undetermined. Yet, the FWS had to decide whether to protect this species under the ESA without this information.[22]

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17. U.S. FISH AND WILDLIFE SERV., DRAFT INDIANA BAT RECOVERY PLAN (2007), *available at* http://www.fws.gov/midwest/Endangered/mammals/documents/inba_fnldrftrecpln_apr07.pdf.

18. John R. Sauer, James E. Hines & J. Fallon, *The North American Breeding Bird Survey, Results and Analysis 1966–2005. Version 6.2.2006*, U.S.G.S. PATUXENT WILDLIFE RESEARCH CENTER, LAUREL, MD. (2005), http://www.mbr-pwrc.usgs.gov/bbs/bbs.html.

19. William A. Link & John R. Sauer*, A Hierarchical Analysis of Population Change with Application to Cerulean Warblers*, 83 ECOLOGY 2832, 2837 (2002).

20. Breeding bird survey data are collected by listening for and documenting bird calls from established stations along roadways. This may lead to a higher detection rate of species associated with edge habitats and lower detection rate of species that occur in habitats without edges.

21. PARTNERS IN FLIGHT, NORTH AMERICAN LAND BIRD CONSERVATION PLAN (2004). The population size was estimated from data collected between 1990 and 2000. The year 1995 is the mid-point for that data series.

22. The FWS published its decision not to list the cerulean warbler in 2006, stating that,

Bull trout in the Pacific Northwest occur in about 120 river basins in five western states. The species was listed as threatened in 1999.[23] Bull trout have evolved multiple life history strategies which may reduce risk in a complex environment, but fragmentation of its habitat by dams, water diversions, and culverts has disrupted this strategy. A review to determine whether the listing status should be changed is underway even though many of the more remote river basins have never been censused and quantitative forecasts of population size do not exist.

Population status is only part of the required evaluation when determining whether to list a species. The FWS must also evaluate threat factors affecting the species' status by reviewing and analyzing information relevant to the following five categories: "(A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence."[24]

The FWS would need unequivocal information on population abundance and trends, demographic rates, life history attributes, and threats in order to have all the information necessary for irrefutable conclusions in evaluations of species' status. This level of information completeness and quality is rarely available.

III. Analytical Approaches for Dealing with Uncertainty

The challenges imposed by data gaps and strict ESA deadlines are not insurmountable. The FWS uses a variety of analytical approaches in response to missing information. Some of these analytical approaches are institutionalized by official guidance documents and others are developed using best professional judgments on a case-by-case basis. The FWS is implementing approaches to deal with uncertainty using decision analysis and modeling. New approaches must be subjected to and withstand scientific scrutiny.

The ESA's "citizen suit" provision, in concert with the Administrative Procedures Act,[25] ensures that any analytical approach used by the FWS may also be subject to thorough review in the federal court system.[26] Published case law interpreting the ESA is expansive, and well beyond the expertise of these authors and the scope of this Paper. Suffice it to say, any approach to biological uncertainty must survive judicial, as well as scientific, scrutiny.

Traditionally, the lack of concrete evidence of cause (threats) and effect (population response) relationships, exacerbated by not having formally-adopted quantitative

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although declining in numbers, the species was unlikely to become extinct within the foreseeable future because of the large population size. *See* 71 Fed. Reg. 70,717, 70,732 (Dec. 6, 2006).

23. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for Bull Trout in the Coterminous United States, 64 Fed. Reg. 58,910 (Nov. 1, 1999).

24. 16 U.S.C. § 1533(a)(1)(A)–(E) (2000).

25. 5 U.S.C. §§ 511–599, 701–706 (2000).

26. Examples of litigation pursuant to the citizen suit provision are numerous. Two examples with which the authors are familiar are *Southwest Center for Biological Diversity v. Norton*, No. 98-0934, 2002 WL 1733618, at *1 (D.D.C. July 29, 2002) and *Defenders of Wildlife v. Norton*, 258 F.3d 1136 (9th Cir. 2001).

standards for measuring extinction risk, have led the FWS to produce "everything but the kitchen sink" syntheses of information about, or related to, the species in question. In some cases, this tendency to "cover the bases" has led to serious consideration of speculative and highly unlikely threats. For example, in the proposal to list slickspot peppergrass (*Lepidium papilliferum*) as an endangered species,[27] the FWS included the following discussion of military activities in its analysis of the plant's extinction risk:

> An additional potential threat to *Lepidium papilliferum* on the Juniper Butte ETR within the primary ordnance impact area is the impact of dropping bombs on slickspots. Each bomb weighs approximately 11 kilograms (25 pounds) (Air Force 2000), and even though they are inert and will not explode, dropping them from planes onto slickspots could compact the soil and crush plants. Because the slickspots are relatively small, it would be difficult to avoid them on the bombing range. However, this threat is considered minimal as the Air Force intends to use only 121 ha (300 ac) or 2.5 percent of the entire Juniper Butte ETR as the actual bombing impact area (Air Force 2001), and because this area contains only 3 percent of the total occupied *L. papilliferum* habitat.[28]

Serious analysis of highly speculative threats can result in the impression that the FWS builds cases for listing, instead of conducting objective and rigorous scientifically-based assessments of the factors affecting extinction risk. The reverse is also true. Failure to analyze potential threats because evidence is insufficient to conclude with certainty that a threat will occur can lead to the impression that the FWS builds cases against listing for political or other reasons.

Our experiences suggest that decisions about which information to consider and which to disregard are usually based on honest attempts to use the "best available" information and minimize the chances of making faulty decisions. However, people react differently to uncertainty, and FWS biologists are no exception. The result is inconsistent use of information, because some biologists may discard information for lack of certainty that others would include in analyses.

The National Research Council proposed standard statistical methods for evaluating decision error.[29] The thought process behind this approach is also useful when deciding how to use information in decision making. There are two types of decision errors (Table 1): failing to protect a species when protection is needed (Type II) or protecting when it is not needed (Type I).[30] Explicit descriptions of how specific information may bias the decision toward a certain type of error will aid decision makers in understanding the strength of the bases for their decision and the associated risk of errors.

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27. Endangered and Threatened Wildlife and Plants; Listing the Plant *Lepidium papilliferum* (Slickspot Peppergrass) as Endangered, 67 Fed. Reg. 46,441 (July 15, 2002).

28. *Id.* at 46,446.

29. *See* NAT'L RESEARCH COUNCIL, SCIENCE AND THE ENDANGERED SPECIES ACT 148–78 (1995).

30. *See id.* at 166. Theoretically, either type of error can have serious, unintended consequences, such as a species' extinction or unnecessary regulatory requirements with economic consequences.

Table 1. Depiction of types of error possible when making ESA listing decisions testing the proposition that a species is, or is not endangered.

	FWS does not list as endangered	FWS lists as endangered
Species is not endangered	**Correct Decision** – FWS does not list the species when listing is not warranted	**Type I error** – FWS lists species when listing is not warranted
Species is endangered	**Type II error** – FWS does not list the species when listing is warranted	**Correct Decision** – FWS lists species when listing is warranted

Source: adapted from NAT'L RESEARCH COUNCIL, *supra* note 29, at 148–78 (crediting Reed F. Noss, *Biodiversity: Many Scales and Many Concerns*, *in* PROCEEDINGS OF THE SYMPOSIUM ON BIODIVERSITY OF NORTHWESTERN CALIFORNIA 17 (Hannah F. Kerner ed., 1992), with the original idea for their table).

The FWS uses several different tools and techniques to explicitly address how information gaps influence decision making, and to appropriately address uncertainty. First, decision makers and observers can clearly understand how information influences decisions when analysts structure problems into component parts and provide transparent documentation of the information used to inform decisions. Similarly, explicit identification of sources and types of uncertainty enables FWS decision makers to understand the ways uncertainty might influence decision outcomes and errors. Explicit identification and treatment of uncertainty also enhances managers' abilities to target research and monitoring strategies toward the information most likely to influence the effectiveness of their decisions.

Several other methods are useful for dealing with uncertainty when assessing extinction risk.[31] Methods include Bayesian belief networks,[32] information gap theory,[33] population viability analysis,[34] and a variety of other modeling techniques.[35] These methods require certain types and amounts of information and highly skilled practitioners. The FWS has few such practitioners on staff, but may contract with experts. These methods may help ensure transparency and minimize subjectivity in

31. *See* MARK BURGMAN, RISKS AND DECISIONS FOR CONSERVATION AND ENVIRONMENTAL MANAGEMENT (2005).

32. STEVEN C. AMSTRUP, BRUCE G. MARCOT & DAVID C. DOUGLAS, FORECASTING THE RANGE-WIDE STATUS OF POLAR BEARS AT SELECTED TIMES IN THE 21ST CENTURY (2007), *available at* http://www.usgs.gov/newsroom/special/polar_bears/docs/USGS_PolarBear_Amstrup_Forecast_lowres.pdf; J. Douglas Steventon, Glenn D. Sutherland & Peter Arcese, *A Population—Viability-Based Risk Assessment of Marbled Murrelet Nesting Habitat Policy in British Columbia*, 36 CAN. J. FOREST RES. 3075, 3075–86 (2006).

33. Emily Nicholson & Hugh P. Possingham, *Making Conservation Decisions Under Uncertainty for the Persistence of Multiple Species*, 17 ECOLOGICAL APPLICATIONS 251 (2007).

34. Martin Drechsler & Mark A. Burgman, *Combining Population Viability Analysis with Decision Analysis*, 13 BIODIVERSTIY & CONSERVATION 115 (2004); Cheryl B. Schultz & Paul C. Hammond, *Using Population Viability Analysis to Develop Recovery Criteria for Endangered Insects: A Case Study of the Fender's Blue Butterfly*, 17 CONSERVATION BIOLOGY 1372 (2003).

35. *See* BURGMAN, *supra* note 31.

decision making because inputs, outputs, key uncertainties, and tradeoffs are explicitly identified.

Many other qualitative methods exist, including structured elicitation of expert opinion. The FWS recently used expert opinion to assess the status of Indiana bats in order to inform and help complete a recovery plan and contribute to consistent analysis of the jeopardy definition by FWS staff. These methods result in transparent discussion of information, but they do not eliminate subjectivity because they do not resolve differences in individually held attitudes about risk and uncertainty.

IV. Solutions to Value Terminology

Establishment of decision thresholds will improve consistency in administration of the ESA. The FWS is currently working with the NOAA to establish standard criteria[36] for evaluating and adding species to the endangered and threatened species list. These criteria will improve consistency in application of relevant definitions and establish conventional units of measure that will fit the types of information available for the species in question. The difficulty in establishing standard criteria is in picking the threshold of unacceptable risk. This type of policy formulation is done through public process[37] and deciding whose norms of risk tolerance matter most is a difficult challenge. Although working through this public process to establish standard criteria would solve problems of inconsistency, it will not eliminate conflicts rooted in subjective differences about acceptable risk and uncertainty.

Conclusion

The ESA mandates expeditious consideration of species for listing and prompt evaluation of the effects of proposed federal projects on already listed species. To meet these timeframes, the FWS uses the best available information at the time of the decisions, but this can drive a decision process with a great deal of uncertainty. Sometimes the influence of uncertainty appears to outweigh that of what is known. This is not an obstacle if we are explicit the about sources and types of uncertainties, and carefully evaluate how these uncertainties influence risk and consequences of making errors. The FWS is experimenting with a variety of decision analysis techniques to help ensure reliable decision making in the face of uncertainty. Establishing quantitative evaluation standards for decision making will improve consistency in application of statutory and regulatory definitions.

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36. While not a match to the ESA, standard criteria for species classification do exist. They all involve establishment of acceptable levels of risk over time. A well-known example is the International Union for the Conservation of Nature (IUCN) Red List Criteria. *See* IUCN Species Survival Commission, IUCN Red List Categories and Criteria: Version 3.1, at ii–30 (2001).

37. *See* 5 U.S.C. §§ 551–559 (2000).