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ARTICLES

LISTING DECISIONS UNDER THE ENDANGERED SPECIES ACT: WHY BETTER SCIENCE ISN'T ALWAYS BETTER POLICY

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I. INTRODUCTION

The Endangered Species Act[1] ("ESA" or "the Act") has aroused substantial controversy in recent years.[2] Four years have passed without

1. 16 U.S.C. §§ 1531-1544 (1994).
2. *See, e.g.*, Margaret Kriz, *Caught in the Act*, NAT'L J., Dec. 16, 1995, at 3090 (describing the President and Congress as "bracing for an all-out conflagration over rewriting the 1973 Endangered

Congressional reauthorization, despite the devotion of substantial resources to reauthorization efforts. Much of the controversy stems from divergent views of the need for, and efficacy of, the legal protections the Act affords endangered and threatened species. Environmentalists believe the ESA does too little for too few species, while their opponents claim it provides too much protection for too many.[3]

In this rhetorical battle, both sides look to science for support. Environmentalists insist the Act has been ineffective because the implementing agencies have refused to take the protective steps science shows to be necessary.[4] Those who see the ESA as excessively protective respond that failure to apply science rigorously has created unjustified impediments to economic development. They complain that species are listed without scientific justification[5] as a stratagem to block economic activity.[6]

Species Act"). In 1995, the House Resources Committee's Endangered Species Task Force held field hearings in several Western states. Protests, demonstrations, and extreme rhetoric on both sides accompanied these hearings. *See, e.g.*, Les Blumenthal, *Controversy over Public Hearings Is Far from Endangered*, NEWS TRIBUNE (Tacoma, Wash.), Apr. 23, 1995, at F5, *available in* LEXIS, News Library, ARCNWS File; Joel Connelly, *Factions Square Off at Vancouver Hearing: War of Words over Endangered Species Act*, SEATTLE POST-INTELLIGENCER, Apr. 25, 1995, at A1; Nancy Vogel, *Environmental Law Attacked: Foes Rip Endangered Species Act*, SACRAMENTO BEE, Apr. 29, 1995, at A1.

The controversy has not been entirely a war of words. The Carson City, Nevada, office of United States Forest Service Ranger Guy Pence was bombed, as was Pence's car, apparently as a protest over cancellation of grazing leases on the Toiyabe National Forest to protect the habitat of the threatened Lahontan cutthroat trout. Ted Williams, *Defense of the Realm: Is the Endangered Species Act Really Working?*, SIERRA, Jan.-Feb. 1996, at 34. Meanwhile, Fish and Wildlife Service agents investigating the death of a reintroduced gray wolf in Idaho nearly faced a physical confrontation not only with the rancher suspected of improperly killing the wolf, but also with the local sheriff who came to the rancher's defense. *Id.* at 37-38.

3. Environmentalists point with alarm to the recent report that one-fourth of mammal species worldwide are nearing extinction. *See* Alex Barnum, *Many Mammal Species Described as Endangered*, S.F. CHRON., Oct. 4, 1996, at A1. On the other side, developers contend that trivial species are being used to block important development activities. *See, e.g.*, *A Fairy Shrimp Tale* (Editorial), WALL ST. J., Oct. 21, 1994, at A14 (deriding proposal to protect fairy shrimp in California's Central Valley, the Journal writes, "What next—ripping up the streets of San Francisco to return it to pre-European condition?"); *The Emotional Species Act* (Editorial), WALL ST. J., Nov. 2, 1993, at A22 (criticizing implementation of the ESA as "absurd," and controlled by "the BANANA movement: Build Absolutely Nothing Anywhere Near Anything").

4. They charge, for example, that many groups scientifically deserving of protection have been denied listing for political reasons. *See, e.g.*, Oliver A. Houck, *The Endangered Species Act and Its Implementation by the U.S. Departments of Interior and Commerce*, 64 U. COLO. L. REV. 277, 280-96 (1993). This view is supported by several General Accounting Office Reports noting flaws in the listing process. U.S. GENERAL ACCOUNTING OFFICE, ENDANGERED SPECIES: FACTORS ASSOCIATED WITH DELAYED LISTING DECISIONS (1993); U.S. GENERAL ACCOUNTING OFFICE, ENDANGERED SPECIES: SPOTTED OWL PETITION EVALUATION BESET BY PROBLEMS (1989); U.S. GENERAL ACCOUNTING OFFICE, ENDANGERED SPECIES: A CONTROVERSIAL ISSUE NEEDING RESOLUTION (1979) [hereinafter GAO, A CONTROVERSIAL ISSUE].

5. The most common criticism opponents level at listing decisions is that they are not supported by adequate data. *See, e.g.*, Determination of Endangered Status for the Bruneau Hot Springsnail in

Even as they appeal to science for support, both advocates and critics of the ESA seek to extend the debate beyond the boundaries of science. A forest industry lawyer, for example, calls for the overthrow of "the cult of biology" the ESA has established, and the defrocking of its "high priests."[7] In turn, preservation advocates seek protective measures even in the absence of strong scientific evidence, basing their appeals on ethical obligations and principles of caution.[8]

These competing, superficially inconsistent claims reflect a more general ambivalence concerning the appropriate role of science in the creation and implementation of conservation policy. All agree that science has an important role to play, but also recognize that other factors merit consideration. To date, no one has successfully articulated where the boundaries of the scientific role should lie, or how to apply science most effectively within those boundaries.

Congress has repeatedly emphasized the importance of science in conservation decisions, behaving as if the science of conservation has no limits. Federal conservation statutes consistently invoke the mantra of science, demanding that executive branch agencies base their actions on the

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Southwestern Idaho, 58 Fed. Reg. 5938, 5940 (1993) [hereinafter Bruneau Hot Springsnail Rule]. An editorial against one recent listing decision illustrates a widespread popular perception that listing decisions are not justified. Editors of the Sacramento Bee wrote: "To declare that something's endangered, the feds don't actually have to prove there's a real threat; they just have to find someone who'll claim there is." *Fairy Shrimp Tales*, SACRAMENTO BEE, Aug. 15, 1994, at B14. *See also* William F. Lenihan, *The National Biological Survey: A Prescription for Federal Regulation of All Land Uses?* 9(15) THE LEGAL BACKGROUNDER (Washington Legal Found.) May 20, 1994, *available in* LEXIS, Nexis Library, ARCNWS File ("Sometimes, listing petitions are filed by scientists as a vehicle to attract funding for research about obscure species"). Media reports of improbable listings, such as that of the sasquatch (also known as "Bigfoot") in Kings County, Washington lend some credibility to these complaints. *CBS Evening News: Washington State Farmer Protests Inclusion of Big Foot on Endangered Species List* (CBS television broadcast, Feb. 6, 1996, *available in* 1996 WL 3465456).

6. *See, e.g.*, Laurence Michael Bogert, *That's My Story and I'm Stickin' to It: Is the "Best Available" Science Any Available Science Under the Endangered Species Act?*, 31 IDAHO L. REV. 85, 142 (1994).

7. Kathie Durbin, *Attorney for Industry Group Hits "Cult of Biology*," PORTLAND OREGONIAN, Feb. 2, 1992, at C4. Others also complain about lack of public participation in the listing process or object to the decisionmaking authority the ESA delegates to scientists. *See The Impact of the Endangered Species Act on the Nation: Oversight Hearing Before the Task Force on Endangered Species Act of the House Comm. on Resources*, 104th Cong. 37 (1995) [hereinafter *Oversight Hearing*] (testimony of Bruce Smith, Chairman of the National Association of Home Builders Endangered Species Act Working Group); ALSTON CHASE, IN A DARK WOOD: THE FIGHT OVER FORESTS AND THE RISING TYRANNY OF ECOLOGY (1995); CHARLES C. MANN & MARK L. PLUMMER, NOAH'S CHOICE: THE FUTURE OF ENDANGERED SPECIES 220 (1995).

8. *See, e.g.*, Rodger Schlickeisen, *Protecting Biodiversity for Future Generations: An Argument for a Constitutional Amendment*, 8 TUL. ENVTL. L.J. 181, 190-97 (1994).

"best available scientific information,"[9] a term not defined in any statute. The ESA goes even further, requiring that the threshold decision to add a species to the endangered or threatened list be made *solely* on the basis of the best available scientific information.[10] The executive branch,[11] legislators,[12] and many commentators[13] agree that science should play the paramount role in endangered species policy.

This article challenges the assumption that better science alone can resolve the problems plaguing the ESA. The distinction between scientific

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9. This phrase, or a close variant, occurs in the following statutes: the ESA, 16 U.S.C. §§ 1533(b), 1536(c), 1537a(c) (1994); the Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. §§ 1851(a) and 1881d (1997); the Marine Mammal Protection Act ("MMPA"), 16 U.S.C. §§ 1362(19) and (27), 1371(a), 1373(a), 1374, 1378, 1383b(a), 1386(a) and (b) (1994); the Salmon and Steelhead Conservation & Enhancement Act of 1980, 16 U.S.C. § 3311(c) (1994); the Pacific Salmon Treaty Act of 1985, 16 U.S.C. § 3638 (1994); the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, 16 U.S.C. §§ 4711(a) and (b), 4722(e) (1994); the Wild Bird Conservation Act of 1992, 16 U.S.C. § 4905(a) (1994); the Atlantic Coastal Fisheries Cooperative Management Act, 16 U.S.C. § 5104(a)(2) (1994); and the National Fishing Enhancement Act of 1984, 33 U.S.C. § 2102 (1994).

Although they occur with particular frequency in conservation statutes, best available science requirements are not limited to that context. A provision of the Toxic Substances Control Act concerning removal of asbestos from school buildings requires consideration of the best available scientific evidence. 15 U.S.C. § 2643(d)(7) (1994). The Safe Drinking Water Amendments of 1996 require that the Environmental Protection Agency use "the best available, peer-reviewed science." Pub. L. No. 104-182, § 103, 110 Stat. 1613, 1621 (codified at 42 U.S.C.A. § 300g-1(b)(3)(A) (1996)). A Clinton Administration executive order detailing general procedures for internal executive branch review of proposed regulations requires that agencies base regulatory decisions on the best reasonably obtainable scientific and other information. Exec. Order No. 12,866, 3 C.F.R. 638 (1993 Comp.), *reprinted as amended in* 5 U.S.C. § 5601 app. at 557-61 (1994).

10. 16 U.S.C. § 1533(b)(1)(A) (1994).

11. A package of administrative reforms offered by the Clinton administration to defuse the ESA controversy begins with a commitment to base decisions on sound, objective science. *See* United States Department of the Interior, Protecting America's Living Heritage: A Fair, Cooperative, and Scientifically Sound Approach to Improving the Endangered Species Act 5 (Mar. 6, 1995).

12. The major reauthorization vehicles in the 104th Congress included provisions ostensibly intended to ensure the use of sound science. *See* H.R. 104-2275, Title III (1995); S. 104-768, Title I (1995). It is open to question, however, whether the authors of those bills sought sounder science or simply barriers to listing. For a general discussion of the inconsistency of the Republican majority's statements extolling sound science in the 104th Congress with their actions see Robert L. Glicksman, *Regulatory Reform and (Breach of) the Contract with America: Improving Environmental Policy or Destroying Environmental Protection?*, 5(2) KAN. J.L. & PUB. POL'Y 9, 11 (1996).

13. *See, e.g.*, Bogert, *supra* note 6, at 85; Kevin D. Hill, *The Endangered Species Act: What Do We Mean By Species*, 20 B.C. ENVTL. AFF. L. REV. 239 (1993); Daniel J. Rohlf, *Six Biological Reasons Why the Endangered Species Act Doesn't Work–And What To Do About It*, 5 CONSERVATION BIOLOGY 273 (1991); Martha Rojas, *The Species Problem and Conservation: What Are We Protecting?*, 6 CONSERVATION BIOLOGY 170 (1992); William W. Stelle, Jr., *Major Issues in Reauthorization of the Endangered Species Act*, 24 ENVTL. L. 321 (1994); Robert J. Taylor, *Biological Uncertainty in the Endangered Species Act*, NAT. RESOURCES & ENV'T, Summer 1993 at 6. *But see* James Drozdowski, Note, *Saving an Endangered Act: The Case for a Biodiversity Approach to ESA Conservation Efforts*, 45 CASE W. RES. L. REV. 553, 569 (1995) (the ESA "has minimal foundation in scientific principles").

questions and "science policy" questions has long been recognized in the context of assessing the risks posed by toxic chemicals.[14] But it has not received much attention in connection with endangered species protection. Close comparison of the nature of scientific information with ESA listing decisions shows that science alone cannot answer all the relevant questions. Science cannot tell us whether a group of organisms has value to society, or what risk of extinction society should tolerate. Thus, while the scientific foundations of the ESA no doubt are sound,[15] they are incomplete.

Consequently, the ESA's current requirement that listing decisions rest only on science sets the agencies responsible for those decisions, the United States Fish and Wildlife Service of the Department of Interior ("FWS") and the National Marine Fisheries Service of the Department of Commerce ("NMFS"),[16] an impossible task. In effect, Congress has forced the listing agencies into a "science charade,"[17] in which they must pretend to make non-scientific decisions entirely on the basis of science. The result is an inconsistent, incoherent listing program.[18] In their effort to make listing decisions appear scientific, the agencies overlook many of the values Congress intended to protect. Moreover, the apparent failure of science to resolve these problems threatens to undermine political support both for the ESA itself and, ultimately, for the use of science as a foundation for other policy decisions. Calls for better science simply reinforce the science charade, exacerbating the problems it has created.

Some aspects of the ESA listing determination do properly fall within the realm of science. Again the current process is flawed, but even here simply calling for better science will not fix it. The ESA directs the agencies to apply the best available science. Because so little is known about so many disappearing species, the best available scientific evidence is often highly

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14. *See, e.g.*, Howard Latin, *Good Science, Bad Regulation, and Toxic Risk Assessment*, 5 YALE J. ON REG. 89 (1988); Thomas O. McGarity, *Substantive and Procedural Discretion in Administrative Resolution of Science Policy Questions: Regulating Carcinogens in EPA and OSHA*, 67 GEO. L.J. 729 (1979); NATIONAL RESEARCH COUNCIL, SCIENCE AND JUDGMENT IN RISK ASSESSMENT (1994) [hereinafter SCIENCE AND JUDGMENT].

15. NATIONAL RESEARCH COUNCIL, SCIENCE AND THE ENDANGERED SPECIES ACT 17 (1995) [hereinafter SCIENCE AND THE ESA].

16. *See infra* note 108.

17. Wendy Wagner, *The Science Charade in Toxic Risk Regulation*, 95 COLUM. L. REV. 1613 (1995).

18. *See infra* Part IV. These inconsistencies may contribute to the public perception, reported in a 1995 study by The Nature Conservancy, that the ESA is not based on sound science. *See* THE NATURE CONSERVANCY, THE WORKINGS OF THE ENDANGERED SPECIES ACT: A SUMMARY OF OUR FINDINGS 2-7 (1995), *cited in* J.B. Ruhl, *Section 7(a)(1) of the "New" Endangered Species Act: Rediscovering and Redefining the Untapped Power of Federal Agencies' Duty to Conserve Species*, 25 ENVTL. L. 1107, 1139-40, n.157 (1995).

uncertain. Instead of pretending that uncertainty can be avoided, we must learn how best to factor it into decisions.

If they are genuinely interested in improving conservation policy, rather than disingenuously trying to undermine it, critics of the ESA's scientific underpinnings should focus on the process by which decisions are made and communicated to the public. The strictly science directive has encouraged the agencies to apply the closed, technocratic decisionmaking process typical in the scientific community. That process is inappropriate in the endangered species context because the relevant scientific questions are both intractable and closely intertwined with controversial value choices. These are not the objective decisions the public typically associates with science. In fact, they leave a great deal of room for hidden discretionary choices.[19] Both scientific and political legitimacy can be improved by subjecting these decisions to full and effective public oversight.

This Article offers an alternative approach to ESA listing determinations which would better combine scientific credibility with democratic legitimacy. As background to the current problem, Part II explains the origins of the ESA's stringent strictly science mandate. Part III considers the nature and limits of scientific information and explains how the scientific process can identify the best available scientific information. Part IV evaluates the specific decisions required for ESA listings in light of the strictly science mandate, explaining why these decisions require input from beyond the realm of scientific information. Part IV goes on to demonstrate that the incompatibility of the strictly science mandate with reality has led to inconsistent and incoherent policy choices. Finally, Part V suggests improvements to the listing process. Congress should acknowledge the subjective elements of listing determinations and open those parts of the decision to a more democratic process. The agencies may, indeed must, continue to rely on highly uncertain scientific data in making listing decisions, but should do so through a process which facilitates broad public review. These changes would allow the agencies to bring the best scientific knowledge to bear on the problem of species extinction without overriding the legitimate public role in non-scientific policy choices.

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19. *See generally* STEVEN LEWIS YAFFEE, PROHIBITIVE POLICY: IMPLEMENTING THE FEDERAL ENDANGERED SPECIES ACT (1982).

II. DEVELOPMENT OF THE LEGISLATIVE SCIENCE MANDATE

A. Background

1. Ambivalence Toward Science

The ESA's science mandate must be viewed against a background of enduring American ambivalence toward science. On one hand, America is the land of pragmatic realists, its culture rooted in a tradition of experimental adaptation closely akin to the scientific method. Yet on the other, America sees itself as fiercely democratic and egalitarian, characteristics not compatible with basing policy on science, given science's inaccessibility to large portions of the population.

Science has been called "the American faith."[20] The description is an oxymoron, but an apt one. Science, the skeptical evaluation of hypotheses in light of empirical data,[21] is the direct opposite of faith, a "belief in the absence of evidence."[22] Nonetheless, many Americans with little understanding of science unquestioningly accept both its process and its products. This faith in science has permeated American society since the colonial era, shaping our culture as well as our social and governmental institutions.[23] Science continues to command special respect.[24]

The American tradition of faith in science is hardly surprising. Science offers both material and moral appeal. Together with its technological offspring, science promises continual improvement in living standards.[25]

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20. John Veilleux, Note, *The Scientific Model in Law*, 75 GEO. L.J. 1967, 1967 (1987).

21. *See infra* text accompanying notes 156-82.

22. This definition of faith comes from the late astronomer and science popularizer Carl Sagan. *See* Kate Seago, *Carl Sagan*, DALLAS MORNING NEWS, June 2, 1996, at 1J.

23. *See* BRUCE L.R. SMITH, THE ADVISERS 13 (1992) ("The scientific ethos, or the experimental method, thus permeated American culture, politics, and society almost from the beginning of the republic."). *See generally* I. BERNARD COHEN, SCIENCE AND THE FOUNDING FATHERS: SCIENCE IN THE POLITICAL THOUGHT OF JEFFERSON, FRANKLIN, ADAMS, AND MADISON (1995).

24. In surveys from 1979 through 1995, large majorities agreed that scientific discoveries had made their lives healthier and more comfortable. *See* JON D. MILLER, THE AMERICAN PEOPLE AND SCIENCE POLICY: THE ROLE OF PUBLIC ATTITUDES IN THE POLICY PROCESS 51 (1983) (1979 results); Daniel S. Greenberg, *Thumbs Up for Science*, WASH. POST, July 8, 1996, at A15 (discussing the results of six polls between 1983 and 1995). More than half of the respondents to a 1992 poll considered science and medicine occupations of "very great prestige." Sheila Jasanoff, *The Dilemma of Environmental Democracy*, ISSUES IN SCI. & TECH., Fall 1996, at 63.

25. Leon Lederman, a physicist and former president of the American Association for the Advancement of Science, offers a particularly rose-colored view of the future as science can make it: "Science research and scholarship offer new horizons, new wealth, an inherent and contagious optimism, and the possibility of restoring the planet and also restoring our own society via the immense power of rational thought molded by aesthetics, compassion, and wise self-interest." Leon Lederman, *The Advancement of Science*, 256 SCI. 1119, 1123 (1992).

Philosophically, science fits the American egalitarian ideal, seeming to offer its better life equally to all without reference to social class, race, or gender.[26] It also suits the pragmatic American approach to institutions and politics, an approach more comfortable with empirical experimentation than with theory or ideology.[27]

As a basis for public policy, science carries an important additional advantage: it appears to be shielded from the evils of politics. Science is thought to provide an objective source of certain knowledge,[28] a sure guide for trained policymakers, free of the corrupting influences that taint ordinary politics.[29] It seems natural to delegate technically-complex decisions to scientists, who both possess the required expertise to understand them and enjoy a high level of public confidence.[30]

The public appeal and apparent objectivity of science provide an irresistible political combination. Decisions attributed to science gain instant legitimacy through science's image as a pure pursuit above the concerns of the partisan political wórld.[31] Furthermore, characterizing a decision as strictly scientific can allow politicians to evade difficult value choices, placing those choices instead in the hands of technical experts.[32] Not surprisingly, political appeals to science are often disingenuous; politicians who describe policy choices as scientific are often more interested in cloaking their favored policies with the prestige of science than in choosing

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26. STEVEN GOLDBERG, CULTURE CLASH: LAW AND SCIENCE IN AMERICA 38 (1994).

27. *See, e.g.*, Abrams v. United States, 250 U.S. 616, 630 (1919) (Holmes, J., dissenting) (the United States Constitution "is an experiment, as all life is an experiment"); New State Ice Co. v. Liebmann, 285 U.S. 262, 311 (1932) (Brandeis, J., dissenting) (states should be permitted to serve as laboratories, trying "novel social and economic experiments").

28. Yaron Ezrahi, *Utopian and Pragmatic Rationalism: The Political Context of Scientific Advice*, 18 MINERVA 111, 117 (1980).

29. SHEILA JASANOFF, THE FIFTH BRANCH: SCIENCE ADVISERS AS POLICYMAKERS 9 (1990). The structure of the early independent regulatory agencies founded during the Progressive era rested on this view of science. Those agencies were deliberately insulated from the political process to facilitate nonpartisan application of expertise in the public interest. *See* Marshall J. Breger, *Thoughts on Accountability and the Administrative Process*, 39 ADMIN. L. REV. 399, 399-401 (1987).

30. The National Science Foundation ("NSF") has commissioned a series of public opinion surveys over the past 25 years to investigate public attitudes toward science and scientists. Asked to rank their "confidence in the people running various institutions," respondents have consistently ranked scientists second, well ahead of legislators. Greenberg, *supra* note 24. The most recent survey again puts scientists second only to physicians in public esteem. Andrew Lawler, *Support for Science Stays Strong*, 272 SCI. 1256 (1996).

31. SMITH, *supra* note 23, at 12. *See also* JASANOFF, *supra* note 29, at 171.

32. Kathryn D. Wagner, *Congress, the Environment, and Technology Assessment*, *in* SCIENCE, TECHNOLOGY, AND POLITICS: POLICY ANALYSIS IN CONGRESS 43, 48 (Gary C. Bryner, ed. 1992) (quoting Harvey Brooks, *The Resolution of Technically Intensive Public Policy Disputes*, 9 SCI., TECH., AND HUMAN VALUES 39-50 (1984)).

policies which accurately reflect scientific knowledge.[33]

Suspicion of science is also strongly rooted in the American psyche.[34] A substantial portion of the public believes that science causes more problems than it solves[35] and views the technology made possible by scientific advances as a threat rather than a boon.[36] The opacity of science to those lacking specialized education no doubt feeds such public suspicions.[37] Only a select few are able to participate in or understand the process through which scientific knowledge is created. Indeed, a substantial portion of the American population is not only unaware of much well-established scientific knowledge, but also unable to evaluate even simple scientific concepts.[38] Recognizing their ignorance, many view science as "a form of magic practised [sic] by an elite priesthood."[39]

Public suspicion of science seems to have risen in recent years.[40] A number of factors may contribute to increasing distrust of science and

33. SMITH, *supra* note 23, at 13; Ezrahi, *supra* note 28, at 114. Technical experts themselves often seek a similar form of political cover, either by hiding value choices implicit in their supposedly technical decisions, or by sending those choices back to the political sphere. *See, e.g.*, Jane Lubchenco, *The Role of Science in Formulating a Biodiversity Strategy*, 45(6) BIOSCIENCE S-7, S-8 (Supp. 1995); Jerry F. Franklin, *Scientists in Wonderland*, 45(6) BIOSCIENCE S-74, S-76 (Supp. 1995).

34. Anti-science views were present, albeit not ascendent, in colonial America. *See* GERALD HOLTON, SCIENCE AND ANTI-SCIENCE 112 (1993) (describing political risks of Jefferson's championing of science); SMITH, *supra* note 23, at 12 (anti-federalists like Luther Martin who rejected the authority of science lost the political struggle).

35. For example, in a 1979 survey, roughly half of the respondents agreed that "scientific discoveries make our lives change too fast." MILLER, *supra* note 24, at 51. About 40% of those who described themselves as not attentive to science issues thought future research would be more likely to create new problems than to solve existing ones. *Id.*

36. *See* André Cournand, *The Code of the Scientist and Its Relationship to Ethics*, 198 SCI. 699, 699 (1977).

37. *See* Howard T. Markey, *Law and Science—Equal But Separate*, 15 NAT. RESOURCES LAW. 619, 620 (1983) (warning that "people may grow tired and, more importantly, ever more fearful of servants they cannot understand, of servants who are isolated from them, of servants shielded from them by an impregnable complexity curtain"). A recent NSF survey of American adults seems to confirm this intuition. While 90% of college graduates believed that the benefits of scientific research outweigh its risks, only 48% of those without a high school diploma agreed. *Only 25% of American Adults Get Passing Grades in Science Survey*, L. A. TIMES, May 24, 1996, at A22.

38. A 1990 report to the NSF concluded that less than seven percent of U.S. adults could be considered scientifically literate. *See* HOLTON, *supra* note 34, at 197 (citing J. Miller, The Public Understanding of Science and Technology in the United States, Draft Report to the NSF (1990)). In a 1996 survey, the NSF found that just over one-fifth of American adults could adequately explain a scientific experiment, while nearly two-thirds had no understanding of scientific inquiry. Lawler, *supra* note 30, at 1256. Apparently many are equally unfamiliar with even the most well-established scientific information. Less than half of the survey respondents knew how long it takes the earth to orbit the sun, or whether early human beings co-existed with dinosaurs. Charles Petit, *Americans Flunk Science Basics*, S.F. CHRON., May 24, 1996, at A1.

39. ROBIN DUNBAR, THE TROUBLE WITH SCIENCE 7 (1996).

40. For example, although a majority of Americans viewed science as a prestigious occupation in 1992, far more had held that view in 1977. Jasanoff, *supra* note 24, at 63-64.

scientists. One is the attack mounted by some sociologists on science's claims to objectivity.[41] This attack undercuts the logical foundations of deference to scientist's decisions. After all, if scientists construct facts, rather than discovering them, their conclusions may be driven by personal financial or political interest. The growing public recognition of the inability of science to provide absolutely certain answers to many questions also undermines trust in science.[42] Finally, highly publicized accounts of scientists serving as hired guns, promoting the interests of groups that pay them or fund their research, rather than searching disinterestedly for the truth, further erode public confidence in science.[43]

2. The Historic Dominance of Science in Conservation Policy

Conservation policy in this country is strongly rooted in a tradition of science. The Forest Service, the first federal agency to focus on conservation policy, grew out of the conservation movement of the late 19th and early 20th centuries; that movement in turn was closely tied to the progressive crusade, which emphasized science and expert decisionmaking.[44] Gifford Pinchot, the first head of the Forest Service, emphasized scientific training and established a meritocratic selection process for his foresters.[45] He sought to create an agency of experts who would stand above the conflicts of interest groups and classes,[46] ensuring their decisions would be guided solely by

41. *See infra* notes 190-93 and accompanying text.

42. *See* DON K. PRICE, AMERICA'S UNWRITTEN CONSTITUTION 4 (1983); YARON EZRAHI, THE DESCENT OF ICARUS: SCIENCE AND THE TRANSFORMATION OF CONTEMPORARY DEMOCRACY 271-74 (1990). For an account of how scientific unpredictability and chaos theory have come to permeate popular culture, *see* HARRIETT HAWKINS, STRANGE ATTRACTORS: LITERATURE, CULTURE AND CHAOS THEORY (1995).

43. "Hired gun" charges are often leveled against scientists who appear as expert witnesses in litigation. *See, e.g.*, Leslie Roberts, *Science in Court: A Culture Clash*, 257 SCI. 732 (1992); Gina Kolata, *Legal System and Science Come to Differing Conclusions on Silicone*, N.Y. TIMES, May 16, 1995, at D6.

These charges are not limited to the litigation context, however. In any dispute over a scientific issue with important policy implications, charges that one side or another has sold out to special interests are likely to surface. These charges, which are difficult for nonscientists to evaluate, fuel public cynicism about science. *See, e.g.*, Tom Spears, *Science for Hire: As "the Experts" Square Off Like Hired Guns, Public Trust in Scientists Erodes*, OTTAWA CITIZEN, Dec. 3, 1995, at C1; Julie Titone, *Hired Scientists Defy Credibility: Public Grapples for Answers in Wake of Questionable Reports*, SPOKESMAN REV. (Spokane, Wash.), Jan. 14, 1996, at A1; Victor Dricks, *Science for Sale*, PHOENIX GAZETTE, Nov. 7, 1993, at G3.

44. *See* SAMUEL TRASK DANA & SALLY K. FAIRFAX, FOREST AND RANGE POLICY: ITS DEVELOPMENT IN THE UNITED STATES 69 (1980); *see also* ROBERT H. NELSON, PUBLIC LANDS AND PRIVATE RIGHTS: THE FAILURE OF SCIENTIFIC MANAGEMENT 48 (1995).

45. *See* SAMUEL P. HAYS, CONSERVATION AND THE GOSPEL OF EFFICIENCY: THE PROGRESSIVE CONSERVATION MOVEMENT, 1890-1920 at 71 (1959).

46. JAMES L. PENICK, JR., PROGRESSIVE POLITICS AND CONSERVATION: THE BALLINGER-

reason and science.[47] Although they were not universally embraced,[48] Pinchot's appeals to neutral science proved politically effective.[49]

Not until the 1970s did the Forest Service and the younger conservation agencies face a serious challenge to this technocratic tradition. New federal statutes such as the National Environmental Policy Act[50] and National Forest Management Act[51] responded to increased public suspicion of experts, and government in general, by granting the public a role in the resource planning and management process. Public involvement, a radical departure from the norms of scientific decisionmaking,[52] forced the experts to confront the differences between public and expert preferences.[53] These differences, and the distinction between technical evaluations and value choices, are now widely recognized.[54]

Nonetheless, resource managers and conservation agencies continue to cling to science as a legitimizing bulwark for their decisions. Many of the environmental laws enacted in the 1960s and 1970s reinforce that response by mandating that decisions governing conservation policy be made scientifically. These mandates, reflecting as they do the continuing faith in science, co-exist uneasily with requirements for greater public access, which reflect suspicion of technocratic experts.

B. Mandating Reliance on Science

Responding to the political attractions of science and following in the technocratic footsteps of early conservation policy, Congress has repeatedly and explicitly mandated that federal policy decisions concerning the conservation of biological resources rest on the best available science.[55] This requirement takes its strongest form in the ESA's listing provisions, which

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PINCHOT AFFAIR 188 (1968).

47. *See* DAVID A. CLARY, TIMBER AND THE FOREST SERVICE 16 (1986).

48. Western resource users criticized Theodore Roosevelt's scientific experts as dictatorial bureaucrats. HAYS, *supra* note 45, at 249.

49. Indeed, Robert Nelson has argued that the Forest Service had more political than scientifical astuteness from its inception. Nelson describes the Service's claims to scientific decisionmaking as a "political device to marshal public support for the Forest Service in an age that worshipped science." NELSON, *supra* note 44, at 43-44; *see also id.* at 53.

50. 42 U.S.C. §§ 4321-4370d (1994).

51. 16 U.S.C. §§ 1600-1614 (1994).

52. *See infra* note 181 and accompanying text.

53. *See* DANA & FAIRFAX, *supra* note 44, at 296.

54. *See, e.g.*, Franklin, *supra* note 33, at S-76; Lubchenco, *supra* note 33, at S-8; NATIONAL RESEARCH COUNCIL, UNDERSTANDING RISK: INFORMING DECISIONS IN A DEMOCRATIC SOCIETY 26 (1996) [hereinafter UNDERSTANDING RISK]; SCIENCE AND JUDGMENT, *supra* note 11; NATIONAL RESEARCH COUNCIL, WETLANDS: CHARACTERISTICS AND BOUNDARIES 63 (1995).

55. *See supra* note 9.

forbid consideration of any other factors.

1. Testing the Waters: Requiring Consideration of Science

The early emphasis on science as the foundation for the national government's first sustained conservation effort, management of the national forests, came from Pinchot and the executive branch under Teddy Roosevelt.[56] The legislature did not endorse that scientific emphasis until the 1960s. Although delayed, this legislative science mandate arrived with a vengeance. The rash of new conservation statutes adopted in the late 1960s and early 1970s uniformly required reliance on science.

a. Early Endangered Species Legislation

The Endangered Species Preservation Act of 1966 ("1966 Act")[57] marked the first comprehensive federal attempt to address the problem of species extinction. Sought by the Department of the Interior ("Interior") after Congress refused to appropriate funds for Interior's endangered species program,[58] the 1966 Act authorized federal land acquisition to conserve species facing extinction.[59] It also directed the Departments of Interior, Agriculture, and Defense to protect those species and their habitats.[60]

The 1966 Act directed the Secretary of Interior to determine which species were threatened with extinction.[61] Although the Act did not explicitly require that these determinations rest on scientific evidence, Congress assumed that science would supply the foundation for listings. To that end, it directed the Secretary to "seek the advice and recommendations of interested persons and organizations including, but not limited to, ornithologists, ichthyologists, ecologists, herpetologists, and mammalogists."[62]

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56. *See supra* notes 44-49 and accompanying text; *see also* DANA & FAIRFAX, *supra* note 44, at 40-65.

57. Pub. L. No. 89-669, 80 Stat. 926 (1966). For an overview of the 1966 Act's provisions, *see* MICHAEL J. BEAN, THE EVOLUTION OF NATIONAL WILDLIFE LAW 319-21 (revised and expanded ed. 1983).

58. *See* S. REP. NO. 89-1463, at 1, 2, 17 (1966), *reprinted in* 1966 U.S.C.C.A.N. 3342, 3343, 3357.

59. Pub. L. No. 89-669, §§ 1(c), 2, 80 Stat. 926, 926-27 (1966).

60. *Id.* § 1(b). *See also id.* § 2(d) (requiring that the Secretary of Interior, "to the extent practicable," use the department's other programs to further the purpose of conserving species threatened with extinction).

61. *Id.* § 1(c).

62. *Id.* This provision was added to "requir[e] the Secretary to consult . . . with various scientific groups having an expertise in this field" before making listing determinations. S. REP. NO. 89-1463, at 3, *reprinted in* 1966 U.S.C.C.A.N. at 3344-45; H.R. CONF. REP. NO. 89-2205, at 3 (1966), *reprinted in* 1966 U.S.C.C.A.N. 3358.

The Endangered Species Conservation Act of 1969 ("1969 Act")[63] made the role of science explicit. In addition to other changes,[64] the 1969 Act commanded the Secretary to make listing determinations on the basis of "the best scientific and commercial data available."[65] Despite its recognition in the statutory language, the role of commercial data under this provision has always been minor. Congress initially added the reference to commercial data at the request of the fur industry, which sought to insure consideration of data supplied by industry sources.[66] The legislature has since made it clear that the term refers not to alternatives to scientific data but rather to objectively verifiable data concerning the impact of commercial trade on species.[67] Thus, allowing consideration of commercial data did not blur the 1969 Act's scientific focus.

The legislative history offers little insight into the legislature's understanding of "the best scientific data available." One plausible explanation is that Congress intended through this language to continue the 1966 Act's requirement that Interior seek the input of independent biologists before making listing decisions. Both houses admonished the Secretary to consult with appropriate scientific organizations and specialists in relevant fields.[68]

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63. Pub. L. No. 91-135, 83 Stat. 275 (1969). For an overview of the 1969 Act's provisions, *see* BEAN, *supra* note 57, at 374-79.

64. The 1969 Act expanded protection to invertebrate species, made additional funds available for land acquisition, and tightened restrictions on interstate and foreign commerce in protected species. *See* Pub. L. No. 91-135, § 1(2), 2, 4(d), 12(a), 83 Stat. 275 (1969).

65. *Id.* § 3(a). The 1969 Act carried over the requirement that the Secretary consult with "interested persons" before making listing decisions. *Id.*

66. *See Bills to Prevent the Importation of Endangered Species of Fish or Wildlife into the United States: Hearings Before the Subcomm. on Fisheries and Wildlife Conservation of the House Comm. on Merchant Marine and Fisheries*, 91st Cong., 107 (1969) (statement of James R. Sharp, counsel to the Fur Merchants Association)

> The fur trade is pretty close to this picture. Failure to consult with that trade could lead to inadequate determinations. We do have from time to time considerable data obtained from the unions and other sources relating to the number of species that are available in various areas. We therefore suggest that after the word "scientific" there be inserted the words "and commercial" so that the clause would read: "based on the best scientific and commercial data available to him."

Id.

67. H.R. REP. NO. 97-567, at 20 (1982), *reprinted in* 1982 U.S.C.C.A.N. 2807, 2820. Such data may be relevant to determining whether commercial overutilization presents a threat to a species, *see* 16 U.S.C. § 1533(a)(1)(B) (1994), or to evaluating historic population trends, *see* Withdrawal of Proposed Rule for Endangered Status and Critical Habitat for the Alabama Sturgeon, 59 Fed. Reg. 64,794, 64,798 (1994) [hereinafter Alabama Sturgeon Withdrawal].

68. S. REP. NO. 91-526, at 4-5 (1969), *reprinted in* 1969 U.S.C.C.A.N. 1413, 1417; H.R. REP. NO. 91-382, at 6 (1969). Both the House and Senate specifically mentioned the International Union for the Conservation of Nature ("IUCN"), an organization of independent scientists, and stressed that its Red Data Book of rare and endangered species "should be especially valuable in identifying" species in need of protection. S. REP. NO. 91-526, *supra*, at 5; H.R. REP. NO. 91-382, *supra*, at 6. The IUCN is

b. The Marine Mammal Protection Act

Like the early endangered species legislation, the Marine Mammal Protection Act of 1972 ("MMPA") [69] required that conservation decisions rest on the "best available scientific data." The MMPA represented a compromise between two major competing interest groups, "managers" and "protectionists." Each group claimed some scientific expertise. The managers consisted of scientists and wildlife managers who favored continued harvest of marine mammals at sustainable levels, with additional protection for seriously depleted species. The protectionists included scientists and animal rights activists who sought a complete ban on harvest.[70] In a nod to the protectionists, Congress declared that the primary objective of marine mammal management "should be to maintain the health and stability of the marine ecosystem."[71] At the same time, managers won recognition that continued commerce in marine mammals was a major goal of the MMPA.[72]

The MMPA established a moratorium on the taking[73] of marine mammals,[74] but authorized waiver of that moratorium upon a finding, "on the basis of the best scientific evidence available," that a waiver would be "in accord with sound principles of resource protection and conservation."[75] Any harvest permitted was to be regulated, using the best available science, to ensure that it would not work to the disadvantage of the protected mammals.[76]

The science mandate of the MMPA grew out of an established tradition of scientific management of fish and wildlife populations. The managers

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an international non-governmental organization formed in 1948 to provide scientific expertise free of political influence in support of international conservation efforts. *See* ROBERT BOARDMAN, INTERNATIONAL ORGANIZATION AND THE CONSERVATION OF NATURE 42, 47, 74-75 (1981). It produced the first Red Data Book in 1960. *Id.* at 55.

69. Pub. L. No. 92-522, 86 Stat. 1027 (1972) (codified, as amended, at 16 U.S.C. §§ 1361-1431).

70. Sanford E. Gaines & Dale R. Schmidt, *Wildlife Population Management Under the Marine Mammal Protection Act of 1972*, 6 Envtl. L. Rep. (Envtl. L. Inst.) 50096, 50101 (1976); *see also Ocean Mammal Protection: Hearings before the Subcomm. on Oceans and Atmosphere of the Senate Comm. on Commerce*, 92d Cong., pt. 2, at 884 (1972) [hereinafter *Senate MMPA Hearings*] (statement of John Burns, Alaska Dept. of Fish & Game); *id.*, pt. 1 at 358 (statement of Dr. Kenneth Norris, Marine Mammal Council).

71. Pub. L. No. 92-522, § 2(6), 86 Stat. 1027 (1972).

72. *Id.* § 2(5).

73. "The term 'take' means to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." *Id.* § 3(13) (codified at 16 U.S.C. § 1362(13) (1994)).

74. Pub. L. No. 92-522, § 101(a) 86 Stat. 1027 (1972).

75. *Id.* § 101(a)(3)(a). The MMPA divides regulatory authority between the Departments of Commerce, which controls decisions regarding cetaceans—whales and porpoises—and seals, and Interior, which is responsible for other marine mammals. *Id.* § 3 (12) (codified at 16 U.S.C. § 1362(11) (1994)); H.R. REP. NO. 100-970, at 14 (1988), *reprinted in* 1988 U.S.C.C.A.N. 6154, 6155.

76. Pub. L. No. 92-522, § 103(a), 86 Stat. 1027 (1972).

espoused management of mammal populations for maximum sustained yield,[77] a standard familiar to agencies and legislators by the early 1970s through its use in a number of international agreements.[78] Bowing to the appeals of the protectionists, the MMPA also incorporated a goal of ecosystem health.[79] Congress was convinced that this new standard, which it called "optimum sustainable population,"[80] could be determined on the basis of science alone.[81]

Testimony at the legislative hearings on the MMPA provides some inkling of the origins of its science mandate. The hearing record suggests that legislators embraced science as an objective, apolitical decisionmaking device[82] which would facilitate rational management.[83] Scientific management was presented as an alternative to management based on economic demand.[84] It was also embraced as the converse of management on

77. Maximum sustained yield refers to the population level at which a stock is "capable of producing on a continuing basis the largest amount (either in weight or numbers) of harvestable surplus." BEAN, *supra* note 57, at 264 n.44 (quoting Department of Commerce, National Oceanic and Atmospheric Administration, International Whaling Commission and Related Activities 8 (July, 1976)). *See also Senate MMPA Hearings*, *supra* note 70, pt. 1, at 440 (testimony of Walter Kirkness, Acting Director, Office of Resource Management, National Marine Fisheries Service) (maximum sustained yield means the level which will "provide the greatest harvest year after year"). For a graphic illustration *see* Giulio Pontecorvo, *Fishery Management and the General Welfare: Implications of the New Structure*, 52 WASH. L. REV. 641, 643 n.6 (1977).

78. These agreements included the Interim Convention on Conservation of North Pacific Fur Seals, Feb. 9, 1957, 8 U.S.T. 2283, 314 U.N.T.S. 105; the Convention on Fishing and Conservation of the Living Resources of the High Seas, Apr. 29, 1958, 17 U.S.T. 138, 559 U.N.T.S. 285; and some twenty others. BEAN, *supra* note 57, at 257-61.

79. Pub. L. No. 92-522, § 2(6), 86 Stat. 1027 (1972).

80. *Id.* § 2(2). "Optimum sustainable population" is "the number of animals which will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element." *Id.* § 3(9).

81. The Marine Mammal Commission, however, quickly realized that determining optimum sustainable populations required value judgments in addition to scientific ones. BEAN, *supra* note 57, at 293, *quoting* Marine Mammal Commission, The Concept of Optimum Sustainable Populations 1 (undated).

82. For example, the Sierra Club supported the Marine Mammal Commission concept as an opportunity for people other than "exploiters" to develop sound management prescriptions. *Senate MMPA Hearings*, *supra* note 70, pt. 1 at 265 (testimony of Robert Hughes, Sierra Club Wildlife and Endangered Species Committee). Legislators seemed to share this view of science as an objective, neutral basis for decisions. They were clearly impressed with the fact that "[e]xperienced, independent scientists, not representing hunters, entrepreneurs or other interest groups," argued for controlling certain marine mammal population levels. H.R. REP. NO. 92-707, at 19 (1972).

83. *See* H.R. Rep. No. 92-707, at 16 (criticizing existing regulatory structure for failing to provide an "integrated rational program for management of all marine mammals").

84. *See, e.g.*, *Legislation for the Preservation and Protection of Marine Mammals: Hearings Before the Subcomm. on Fisheries and Wildlife Conservation of the House Comm. on Merchant Marine and Fisheries*, 92d Cong., 163 (1971) [hereinafter *House MMPA Hearings*] (statement of Rep. Kyros) ("As I understand it, scientific management is what the herd and environment will sustain. The second problem will be economic demand for the particular animal."). Several witnesses had charged that managers more interested in maximizing harvest than in the long-term health of the stock

the basis of emotion, a characterization that was repeatedly applied to the protectionists' pleas for an absolute ban on the harvest of marine mammals.[85]

c. The Fishery Conservation and Management Act of 1976

In 1976, Congress enacted comprehensive fisheries legislation which, like the earlier endangered species and marine mammal protection statutes, mandated reliance on the best science available. The Fishery Conservation and Management Act of 1976,[86] also known as the Magnuson Act, took a somewhat different view of what science encompassed. The Magnuson Act established regional fisheries management councils, made up of persons knowledgeable about fisheries conservation or harvest, but not necessarily scientifically trained.[87] These councils were directed to set harvest quotas at levels which would provide "the greatest overall benefit to the Nation," a concept mixing science with other considerations.[88] These quotas were then implemented through management plans based upon the best scientific information available.[89] The "scientific information" considered was intended to include economic and sociological, as well as biological,

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sometimes misused science. *See, e.g., Senate MMPA Hearings, supra* note 70, pt. 1, at 384 (testimony of Judson E. Vandevere, Biological Investigator, Hopkins Marine Station of Stanford University) ("It is imperative that the men chosen to oversee the protection of marine mammals be men who are scientifically trained, not management trained."); *id.* at 309 (statement of Christine Stevens, Secretary, Society for Animal Protective Legislation) ("The International Whaling Commission exemplifies everything that we hope the Commission proposed under S. 2871 and S. 3112 will not be.... Industry with a scientific veneer is a dangerous enemy of true conservation."). Congress sought to ensure the primacy of biology over economics by requiring that members of the Marine Mammal Commission, the expert advisors upon whom the Secretary was to rely, not have a financial interest in the harvest of marine mammals. Pub. L. No. 92-522, § 201(b), 86 Stat. 1027 (1972).

85. Witnesses at Congressional hearings on the legislation repeatedly called for management on the basis of science rather than emotion. *See, e.g., Senate MMPA Hearings, supra* note 70, pt. 2, at 907 (statement of Ernest Muller, President, Alaska Conservation Society) ("[I]t is equally essential that the restriction of harvesting of marine mammals be made upon a scientific base. Not based upon emotion and pathos."); *id.*, pt. 1, at 519 (statement of Kenneth R. Hampton, National Wildlife Federation) ("[W]e are convinced that any recommendation or decision relating to the proper handling of wildlife must be based upon factual research data and experience . . . but not on the basis of emotional, philosophical, or moral judgments."); *id.* at 511 (statement of Daniel A. Poole, President, Wildlife Management Institute) ("What really is at issue is whether these resources are to be administered professionally or emotionally.").

86. Pub. L. No. 94-265, 90 Stat. 331 (1976) (codified as amended at 16 U.S.C.A. §§ 1801-1882 (1994)).

87. *Id.* § 302(a). The current version specifically mentions scientific training as one potential source of the required knowledge. *See* 16 U.S.C. § 1852(b) (1994).

88. *See* Pub. L. No. 94-265, § 301(a)(1), 90 Stat. 331 (1976) (fishery management plans to achieve "optimum yield"); *id.* § 3(18)(A) (optimum means the amount of fish "which will provide the greatest overall benefit to the Nation").

89. *See id.* § 301(a)(2).

information.[90]

d. The Convention on International Trade in Endangered Species of Wild Fauna and Flora

The Convention on International Trade in Endangered Species of Wild Fauna and Flora[91] ("CITES") was yet another product of the era in which science became legislatively enshrined as the foundation of conservation policy. Negotiated and signed concurrently with consideration of the 1973 ESA,[92] CITES regulates international trade in disappearing species.[93] Like the domestic conservation legislation of the same era, CITES invoked science as the standard for resource management decisions. It required each member state to designate a "scientific authority"[94] to review the impact of proposed trade activities on protected species.[95] Science also supplied the basis for designating protected species. Although the Convention itself did not enumerate the criteria for designation, the parties subsequently agreed that listing decisions should rest on biological evaluations.[96] "Scientific reports" on population size or geographic range are now the preferred basis for listing under CITES.[97]

e. Summary: The Origin and Meaning of the Science Mandates

The science mandates created in the federal conservation statutes of the

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90. *See* S. REP. NO. 94-416, at 30 (1975) (indicating the regional councils were expected to consider the impacts of their plans on human users of the fisheries resource as well as on the fisheries themselves).

91. Mar. 3, 1973, 27 U.S.T. 1087, 993 U.N.T.S. 243 [hereinafter CITES].

92. *See* H.R. REP. NO. 93-412, at 3 (1973); CONGRESSIONAL RESEARCH SERVICE, A LEGISLATIVE HISTORY OF THE ENDANGERED SPECIES ACT OF 1973, AS AMENDED IN 1976, 1977, 1978, 1979, AND 1980, at 142 (1982) [hereinafter ESA LEGISLATIVE HISTORY].

93. *See* CITES, *supra* note 91, at art. II.

94. *See id.* at art. IX, cl. 1(b). The Secretary of Interior, acting through the Fish and Wildlife Service, serves as the Scientific Authority for the United States. *See* 16 U.S.C. § 1537a(a) (1994). *See infra* notes 133-40 and accompanying text.

95. *See* CITES, *supra* note 91, at art. III, cls. 2(a), 3(a), and 5(a); *id.* art. IV, cls. 2(a), 3, and 6. The Convention does not explain what makes an authority "scientific," or how the scientific authority should determine the impact of trade on species survival.

96. The criteria for listing, adopted at the first meeting of the Conference of the Parties in Berne, Switzerland, in 1977, are generally known as the Berne Criteria. *See* DAVID S. FAVRE, INTERNATIONAL TRADE IN ENDANGERED SPECIES: A GUIDE TO CITES 32 (1989).

97. The Berne criteria authorize reliance on various indicators that a species is threatened with extinction. In order of preference, these indicators are: scientific reports on population size or geographic range over a number of years; scientific reports based on single surveys; "reports by reliable observers other than scientists" over a number of years; and "reports from various sources on habitat destruction, heavy trade or other potential causes of extinction." *Id.*

1960s and 1970s combined the historic primacy of science in conservation policy with a new distrust—inflamed by the Vietnam War and the Watergate scandals—of unsupervised government. No longer trusting executive officials to apply science where it would serve the public interest, the legislature began to insist that scientists be given a strong role in conservation decisions.

Little thought was given to the specific meaning or application of these mandates. They were intended generally to ensure objective, value-neutral, unemotional decisionmaking by experts with special training.[98] No one openly questioned the feasibility of scientific decisionmaking in these contexts. Legislators may simply have sought to capture the political advantages of presenting policy questions as scientific, whether or not science was actually capable of supplying the answers. Or they may have assumed that the relevant decisions were strictly technical and within the reach of existing scientific methodologies.

Several factors could have produced excessive legislative faith in science. Scientists often encourage unjustified reliance on science,[99] and they did so during the legislative consideration of these statutes.[100] Moreover, legislators were concerned primarily with the clearest cases, charismatic animals unquestionably in need of protective measures.[101] This focus on groups obviously close to extinction and widely agreed to be worth protecting allowed legislators to ignore the possibility that in more difficult cases science might not be able to identify groups needing or deserving protection. Finally, because the vast majority of legislators lacked scientific training,[102] many likely shared the lay public's blind trust in science.

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98. The role of economics was unclear. The MMPA appeared to preclude consideration of economic factors, while the Magnuson Act endorsed it. *See supra* text accompanying notes 82-84, 90.

99. Wagner, *supra* note 17, at 1671-73.

100. For example, during legislative consideration of the ESA, "managers" convinced Congress that optimum sustainable populations could be scientifically determined. *See supra* notes 80-81 and accompanying text.

101. *See* YAFFEE, *supra* note 19, at 34-35.

102. In 1969 only one member of the House of Representatives and one Senator claimed to have prior occupational experience in science. NORMAN J. ORNSTEIN ET AL., VITAL STATISTICS ON CONGRESS, 1982, at 18, 21 (1982). An additional five Representatives had prior experience in medicine, implying some scientific training. *Id.* at 18. By 1981, not a single Senator or Representative had an occupational background in science. *See id.* at 18; NORMAN J. ORNSTEIN ET AL., VITAL STATISTICS ON CONGRESS 1993-1994 at 22-23 (1994). The dearth of legislator-scientists persists. In early 1996, Vice President Al Gore reported that the House and Senate together harbored only six scientists, two engineers, and one science teacher. *See* Kathy Sawyer, *Gore's Scientific Approach to GOP Cuts*, WASH. POST, Feb. 28, 1996, at A17.

2. *Taking the Plunge: Making Science the Only Factor*

In the statutes and international agreement discussed above, the legislature demonstrated both its faith in science and its mistrust of executive branch regulators by mandating use of the best available science to support conservation policy choices. In the Endangered Species Act, it followed this path to its logical conclusion, ultimately forbidding reliance on anything but science in listing determinations.[103]

a. *Overview of the ESA*

The ESA of 1973 marked a substantial departure from the 1969 Act which preceded it. The new law offered protection to plants as well as animals;[104] authorized protection of species that had not yet reached the very brink of extinction;[105] added prohibitions on private actions harmful to listed species;[106] and subjected all federal agencies to an obligation not to jeopardize the continued existence of listed species.[107]

Under the ESA, the Secretary of Interior maintains a formal list of endangered and threatened species.[108] Listed species benefit from two important safeguards, provided by sections 7 and 9. Under section 7, federal agencies must insure that actions they take, fund, or authorize are not likely to jeopardize the continued existence of any listed species.[109] Section 9, meanwhile, prohibits both commerce in and "take" of endangered species.[110]

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103. The MMPA currently applies an equally stringent standard to the determination of whether marine mammal stocks are depleted, and hence entitled to protection. *See* 16 U.S.C. § 1383b(a)(2) (1994). Added in 1988, this provision was deliberately patterned after the ESA's strictly science mandate. *See* H.R. REP. NO. 100-970, at 28-29 (1988), *reprinted in* 1988 U.S.C.C.A.N. 6154, 6169-70.

104. Pub. L. No. 93-205, § 3(11), 87 Stat. 884, 886 (1973).

105. *See id.* §§ 3(15), 4(d).

106. *See id.* § 9.

107. *See id.* § 7.

108. While Interior bears the final responsibility for all listings, the Department of Commerce makes the initial determination that certain marine species meet the standards for listing. *See* 16 U.S.C. § 1533(a) (1994); Reorg. Plan No. 4 of 1970, 35 Fed. Reg. 15,627 (1970). The Secretaries of Interior and Commerce have delegated their listing duties to the U.S. Fish and Wildlife Service ("FWS") and the National Marine Fisheries Service ("NMFS"), respectively. *See* Interagency Cooperation; Endangered Species Act of 1973, 48 Fed. Reg. 29,990, 29,990 (1983); 50 C.F.R. § 402.01(b) (1995).

109. *See* 16 U.S.C. § 1536(b) (1994). Section 7 also prohibits federal destruction of habitat which has been formally designated as "critical" for a listed species. *Id.* § 1536(b)(2). Critical habitat encompasses those areas of a species' range which are essential to its conservation and may require special management considerations. *See id.* § 1532(5). Although the ESA nominally requires designation of critical habitat concurrently with listing in most cases, that designation has been undertaken for only a small proportion of listed species. *See id.* § 1533(b)(6)(C); Houck, *supra* note 4, at 302-03.

110. *See* 16 U.S.C. § 1538(a)(1) (1994).

The prohibition on taking, which applies only to animals,[111] encompasses not only deliberate killing or capturing, but also harm caused by significant habitat modification.[112] Threatened species do not automatically receive the full scope of section 9's protection, but can be afforded some or all of that protection through administrative regulations.[113]

By contrast to the substantial protections it affords listed species, the ESA does little or nothing for others.[114] Most unlisted species receive no protection at all. Species believed to qualify for listing but awaiting action behind higher-priority species receive a minimal level of protection.[115] Interior must monitor their status, initiating emergency listing procedures if necessary.[116] Once a species is formally proposed for listing, other federal

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111. Endangered plants may not be removed from or maliciously destroyed on federal land, or damaged in knowing violation of state law. *See id.* § 1538(a)(2)(B).

112. *Id.* § 1532(19); 50 C.F.R. § 17.3 (1995); *see also* Babbitt v. Sweet Home Chapter of Communities for a Great Oregon, 515 U.S. 687 (1995).

113. 16 U.S.C. § 1533(d) (1994). FWS follows a default practice of applying section 9 to threatened species, issuing a special rule for a few exceptions. 50 C.F.R. § 17.31 (1995). As of 1995, special rules had been issued for approximately 34 domestic species. *Id.* §§ 17.40 to 17.48.

Under Secretary Babbitt, FWS has taken a greater interest in utilizing the flexibility offered by section 4(d). *See, e.g.*, Special Rule Concerning Take of the Threatened Coastal California Gnatcatcher, 58 Fed. Reg. 65,088 (1993), 50 C.F.R. § 17.41(b) (1995); Proposed Special Rule for the Conservation of the Northern Spotted Owl on Non-Federal Lands, 60 Fed. Reg. 9484 (1995). NMFS, which is responsible for many fewer species, issues individual regulations for each species designated as threatened. 50 C.F.R. §§ 227.11 to 227.72 (1995).

114. As one commentator has put it, "Although characterized as the 'pit bull of federal environmental statutes,' the ESA is as meek as a kitten unless an imperiled creature appears on the statute's lists of threatened and endangered species." Daniel J. Rohlf, *There's Something Fishy Going On Here: A Critique of the National Marine Fisheries Service's Definition of Species Under the Endangered Species Act*, 24 ENVTL. L. 617, 619 (1994).

115. Interior may refuse to add species to the list if it finds that a listing, while warranted by the species' status, is precluded by the need to complete work on other pending proposals. 16 U.S.C. § 1533(b)(3)(B)(iii) (1994). FWS has established a system of priority guidelines to rank its perpetual backlog of pending listings. In order to claim that a listing is "warranted but precluded," Interior must show that it is actively working on other pending proposals, Carlton v. Babbitt, 900 F. Supp. 526, 536 (D.D.C. 1995), and making "expeditious progress," 16 U.S.C. § 1533(b)(3)(B)(iii)(II) (1994). It may also have to defend its priority rating for the species. *See* Friends of the Wild Swan, Inc. v. United States Fish & Wildlife Serv., 945 F. Supp. 1388, 1396-1400 (D. Or. 1996). Nonetheless, the category of species which qualify but are awaiting action "has become a black hole for unlisted endangered species." Houck, *supra* note 4, at 286. At the end of fiscal year 1991, 114 species had been in this category for at least two years, 56 of those for more than eight years. *See* U.S. GENERAL ACCOUNTING OFFICE, ENDANGERED SPECIES ACT: TYPES AND NUMBER OF IMPLEMENTING ACTIONS 23 (1992). As of September 1996, there were 183 species for which FWS believed the available information warranted listing. *See* Extension of Listing Priority Guidance for Fiscal Year 1997, 61 Fed. Reg. 48,962 (1996).

116. 16 U.S.C. § 1533(b)(3)(C)(iii) (1994). Interior tries to provide candidate species with some protection through the § 7 consultation process. FWS notifies consulting agencies of the presence of candidate species in the project area, and encourages them to take conservation actions to protect those species. *See* 50 C.F.R. § 402.12(d) (1995); United States Fish and Wildlife Service, Draft Endangered Species Consultation Handbook: Procedures for Conducting Section 7 Consultations and Conferences

agencies must consult with Interior regarding actions likely to jeopardize its continued existence.[117]

b. The ESA's Science Mandate

The ESA explicitly requires application of the best available science in a number of contexts. For example, federal agencies must use the best available scientific data to fulfill their duty under section 7 not to jeopardize the continued existence or destroy the critical habitat of a listed species.[118] FWS, in turn, must use the best scientific data available, in combination with other information, to identify critical habitat.[119]

With respect to listing determinations, however, the ESA imposes a qualitatively different mandate. The listing agencies must determine whether species qualify for the ESA's protections "solely on the basis of the best scientific and commercial information available."[120] No other factors may be considered. The evolution of this uncompromising "strictly science" mandate[121] merits closer examination.

i. The Endangered Species Act of 1973

The ESA of 1973 directed the Secretary of Interior to determine whether any species was endangered or threatened due to habitat modification, over-utilization, disease or predation, inadequacy of existing regulatory mechanisms, or other natural or man-made factors.[122] The Secretary was to make these determinations "on the basis of the best scientific and commercial data available."[123] The legislative history contains no discussion of this

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3-4 (1994).

117. 16 U.S.C. § 1536(a)(4) (1994).

118. *Id.* § 1536(a)(2).

119. *See id.* § 1533(b)(2). No doubt Congress expected Interior to rely on science for other ESA decisions as well, even where it failed to include an explicit mandate to that effect. For example, Congress likely expected science to form the basis for determining whether experimental populations are essential to the continued existence of the species, *id.* § 1539(j)(2)(B), and for devising recovery plans, *id.* § 1533(f). Some legislative history suggests that recovery plans must rest solely on the best available science. *See* 134 CONG. REC. 19,273 (1988) (statement of Sen. Mitchell), *quoted in* Fund For Animals v. Babbitt, 903 F. Supp. 96, 110 n.4 (D.D.C. 1995).

120. 16 U.S.C. § 1533(b)(1) (1994).

121. The inclusion of "commercial data" in the mandate does not compromise its strictly science rigidity. It simply allows the agency to consider the extent of trade in a species as a potential threat to its survival. *See supra* text accompanying notes 63-67.

122. *See* Pub. L. No. 93-205, § 4(a), 87 Stat. 884 (1973) (codified at 16 U.S.C. § 1533(a)(1) (1994)). Regulatory mechanisms were added to the list in 1973. The remaining factors were carried over from the 1966 Act. Pub. L. No. 89-669, § 1(c), 80 Stat. 926 (1966).

123. Pub. L. No. 93-205, § 4(b)(1), 87 Stat. 884 (1973).

requirement, which was simply carried over from the 1969 Act.[124]

ii. The 1978 Amendments

In 1978, the Supreme Court ruled in *Tennessee Valley Authority v. Hill*[125] that the ESA gave survival of the tiny snail darter priority over completion of a major federal dam.[126] Congress rushed to revise the law, adding an administrative exemption process that effectively reversed the Court's determination that the ESA protects species at all costs.[127]

At the same time, Congress took the opportunity to reconsider other controversial aspects of the ESA. One issue acrimoniously debated in both House and Senate was the scientific foundation of listing decisions. An ongoing General Accounting Office ("GAO") investigation of listing practices underlay this debate. Although GAO had yet to release its final report,[128] its conclusion that listing decisions were often driven more by politics than by science had been widely circulated on Capitol Hill.[129] GAO noted that FWS had avoided listing several species despite substantial scientific evidence of imperilment. Legislators, on the other hand, concentrated on the opposite charge, that species had been listed without adequate scientific justification.[130] For example, Senator Garn (R-Utah) introduced an amendment to require that listing decisions rest on "sound" scientific data.[131] This view, however, did not prevail. The science mandate emerged unscathed, and indeed was extended to the new requirement that Interior formally designate critical habitat at the time of listing.[132]

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124. *See supra* note 65.
125. 437 U.S. 153 (1978).
126. *See id.* at 193-95.
127. *See* Pub. L. No. 95-632, § 3, 92 Stat. 3751, 3755 (1978).
128. *See* GAO, A CONTROVERSIAL ISSUE, *supra* note 4.
129. *See* H.R. REP. NO. 95-1625, at 13 (1978), *reprinted in* 1978 U.S.C.C.A.N. 9463.
130. *See, e.g.*, 124 CONG. REC. 35,961, 37,115 (daily ed. Oct. 12, 1978) (statement of Rep. Trent Lott) ("The worst abuses, I am told, have occurred in the listing process whereby species of plants or animals have been listed as endangered without even a scintilla of adequate supporting evidence."), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 796; 124 CONG. REC. 21,136 (1978), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 969 (statement of Sen. Wallop) (complaining that FWS should not have listed the American alligator because "biologically the alligator never did qualify as endangered, . . . its listing as such was an example of emotional rather than biological reason").
131. *See* 124 CONG. REC. 21,556-73 (1978), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 1073-1101. Sen. Garn withdrew his amendment when it became clear that it did not have the support needed for passage. 124 CONG. REC. 21,574, *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 1105.
132. *See* Pub. L. No. 95-632, § 11(3), 92 Stat. 3751 (1978) ("Any proposed or final regulation which specifies any critical habitat of any endangered species or threatened species shall be based on the best scientific data available . . ."). This provision was not mentioned in the Committee Reports,

iii. The 1979 Amendments

Because the 1978 Amendments failed to resolve the controversy which followed the snail darter decision, Congress revisited the ESA in 1979. Once again, legislators debated the scientific basis for listing decisions, this time in light of the final GAO report.[133] Again the science mandate survived intact. Nonetheless, the 1979 Amendments shed some additional light on the prominent role Congress envisioned for science in endangered species policy.

The most controversial of the 1979 Amendments involved the scientific authority appointed to implement CITES.[134] President Ford had created the Endangered Species Scientific Authority ("ESSA"), an independent commission with members drawn from several federal agencies.[135] Representatives of the fur industry, complaining that the ESSA, exercising "unchecked discretion," had imposed excessive trade restrictions, called for greater political accountability.[136] Others expressed concern that ESSA decisions sometimes conflicted with those of FWS, which had management responsibilities under CITES.[137]

Responding to these concerns, the House voted to transfer the CITES scientific authority functions to an advisory panel under the direct control of the Secretary of Interior.[138] The Conference Committee endorsed the designation of Interior as the Scientific Authority, but elevated the advisory panel to independent status in order to insure that it would render "unbiased

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and received little attention on the floor.

133. *See* GAO, A CONTROVERSIAL ISSUE, *supra* note 4; *Endangered Species Act Oversight: Hearings Before the Subcomm. on Fisheries and Wildlife Conservation and the Environment of the House Comm. on Merchant Marine and Fisheries*, 96th Cong., 207-356 (1979) [hereinafter *1979 Oversight Hearings*].

134. *See supra* note 94 and accompanying text.

135. *See* Exec. Order No. 11,911, 3 C.F.R. 112 (1976).

136. *See 1979 Oversight Hearings*, *supra* note 133, at 69-73 (1979) (statement of Paul A. Lenzini, Counsel, International Association of Fish and Wildlife Agencies); *id.* at 76-80 (statement of Allan L. Egbert, Assistant Director, Division of Wildlife, Florida Game and Fresh Water Fish Commission).

137. *See id.* at 189 (statement of Rep. Breaux, criticizing the issuance of inconsistent regulations by ESSA and FWS on alligator export).

138. *See* 125 CONG. REC. 29,434, 29,435 (1979), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 1365. Before agreeing to support the bill, Rep. McCloskey sought assurances that transfer of the Scientific Authority to Interior would not undermine its ability to render "scientific judgment[s] made on a scientific basis." *See* 125 CONG. REC. 29,438 (1979), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 1371; *see also* 125 CONG. REC. 29,440 (1979), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 1374 (statement of Rep. Evans) ("It is my hope that to the extent they are able, the Scientific Authority continues to make its judgment [sic] in an independent fashion."). The floor manager of the bill, Rep. Breaux, responded that the judgments of the Authority would continue to be "based on science and the biology of the species." *See* 125 CONG. REC. 29,438 (1979), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 1371.

scientific advice."[139] The final bill also required that all members of this advisory body "be scientifically qualified."[140] Thus the legislature endorsed the concept of independent scientific advice, but left the ultimate decision to the more politically responsive agency.

A second interesting feature of the 1979 Amendments was the addition of an explicit requirement that Interior perform a formal status review to determine whether sufficient "scientific and biological data" existed to justify a listing proposal.[141] Displaying its ambivalence toward technocratic governance, Congress directed Interior to communicate with "experts in the field" as part of the status review process, but included both scientists and "local citizens" under that heading.[142]

iv. The 1982 Amendments

In 1982, Congress again reevaluated the ESA listing process. The Reagan administration had brought the process to a virtual standstill, primarily by requiring economic impact analysis of proposed listings.[143] Congress reacted to the listing slowdown by adopting several provisions intended both to force Interior to act promptly and to prevent economic analysts at the Office of Management and Budget, the administration's cost-benefit enforcers, from interfering.

First, the 1982 Amendments imposed new deadlines on listing decisions.[144] Interior was given one year from issuance of a proposed listing to complete or withdraw it,[145] subject to a six-month extension if the Secretary found "substantial disagreement regarding the sufficiency or

139. H.R. CONF. REP. NO. 96-697, at 17 (1979), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 1431, 1447; *see* Pub. L. No. 96-159, § 6(a), 93 Stat. 1225, 1228 (1979). The advisory panel was eliminated in 1982 on the grounds that Interior had sufficient expertise of its own to carry out its CITES duties. *See* Pub. L. No. 97-304, § 5(1), 96 Stat. 1411, 1421 (1982); H.R. REP. NO. 97-567, at 15-16 (1982), *reprinted in* 1982 U.S.C.C.A.N. 2807, 2815-16.

140. Pub. L. No. 96-159, § 6(a) 93 Stat. 1225 (1979).

141. *See* H.R. CONF. REP. NO. 96-697, at 10. Prior to this amendment, status reviews were required only when Interior was considering listing in response to a citizen petition. *See* Pub. L. No. 93-205, § 4(c)(2), 87 Stat. 884 (1973).

142. *See* H.R. CONF. REP. NO. 96-697, at 10.

143. *See* H.R. REP. NO. 97-567, at 11. Executive Order 12,291, 3 C.F.R. 127 (1981), *revoked by* Exec. Order No. 12,866, 3 C.F.R. 638 (1993), required all agencies to prepare a formal analysis of the economic impacts of proposed major regulations. Interior believed Executive Order 12,291 applied to ESA listing actions. *See* Lawrence Mosher, *Endangered Species Act May Be Off Endangered List, at Least for 1982*, 14 NAT'L J. 722 (1982). Nonetheless, Interior did not produce a formal economic analysis of all proposed listings, because some did not qualify as "major" regulations. *See, e.g.*, Listing Hay's Spring Amphipod as an Endangered Species, 47 Fed. Reg. 5425, 5426 (1982).

144. *See* Pub. L. No. 97-304, § 2(a)(2), 96 Stat. 1411 (1982).

145. *Id.*

accuracy" of the data involved.[146] This extension would apply "only in those instances where the biological information is being questioned by scientists knowledgeable about the species."[147]

Congress also expressly restricted the scope of listing decisions, requiring that they be made "solely" on the basis of the best available scientific and commercial information.[148] This change was made to "prevent non-biological considerations from affecting" listing decisions.[149] The primary "non-biological" considerations at issue were those included in the administration's economic impact analyses, that is, the economic costs of protecting species. Congress emphasized that such economic considerations had no relevance to listing decisions, which should be made entirely on the basis of the species biological condition.[150]

Finally, the 1982 Amendments extended the science mandate to CITES implementation. Unlike the other science requirements, this one intentionally expanded agency discretion. A federal court of appeals had recently ruled that the CITES scientific authority could not approve the export of bobcat pelts without first developing a reliable estimate of bobcat population size.[151] Recognizing the difficulty of obtaining absolute population numbers, Congress conferred on the ESSA the discretion to choose among scientifically accepted techniques for evaluating population status.[152] Section 8a, which implements CITES, was revised to require that all determinations made by Interior in its role as the CITES Scientific Authority rest on "the

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146. *Id.*

147. H.R. CONF. REP. NO. 97-835, at 23 (1982), *reprinted in* 1982 U.S.C.C.A.N. 2860, 2864; *see also* H.R. REP. NO. 97-567, at 22.

148. *See* Pub. L. No. 97-304, § 2(a)(2), 96 Stat. 1411 (1982).

149. *See* H.R. CONF. REP. NO. 97-835, at 19.

150. *See id.* at 20; *see* also H.R. REP. NO. 97-567, at 20. Legislators also criticized reliance on emotion and "improper biological data," *id.* at 22, but economic impact analysis was the primary concern. This rejection of economic analysis was extended to evaluation of citizen listing petitions. Prior to 1982, the Act had required Interior to undertake a species status review in response to any citizen petition presenting "substantial evidence" in support of listing or delisting. *See* Pub. L. No. 93-205, § 4(c)(2), 87 Stat. 884 (1973). The 1982 Amendments changed the standard to "substantial scientific or commercial information," Pub. L. No. 97-304, § 2(a)(2), 96 Stat. 1411 (1982), paralleling the listing test. This modification was not intended to alter the substantive standards for evaluating petitions but to clarify that only biological and not economic information was required. *See* H.R. CONF. REP. NO. 97-835, at 20.

151. CITES, implemented by ESA section 8a, forbids export of species listed in the appendices unless the Scientific Authority finds that export will not be detrimental to the survival of the species. *See* CITES, *supra* note 91, at art. III, cl. 2(a), and art. IV, cl. 2(a); 16 U.S.C. § 1537a (1994). The D.C. Circuit had held that a valid finding of "no detriment" could not be made without a reasonably accurate estimate of the total population. *See* Defenders of Wildlife, Inc. v. Endangered Species Scientific Auth., 659 F.2d 168, 176-79 (D.C. Cir. 1981). Congress specifically overruled that holding. H.R. REP. NO. 97-567, at 29.

152. *See* H.R. REP. NO. 97-567, at 29.

best available biological information derived from professionally accepted wildlife management practices."[153] The amendment specified that Interior was not required to estimate population sizes in order to determine the impact of exports on species survival.[154]

c. Summary: Reliance on Science in the ESA

The ESA's listing provisions represent the next logical step beyond the earlier science mandates. Following the pattern begun with the early endangered species protection statutes, Congress sought in the ESA to mandate objective, unemotional expert decisionmaking. Frustrated by the listing agencies' failure to give science the controlling role in these decisions, Congress ultimately precluded any other consideration. It clarified the ambiguity of the early statutes about the use of economics: economic data are not "scientific" information for the purposes of the ESA. In the ESA listing context, science is synonymous with biology. Congress repeatedly equated the two, noting that a listing petition need only present "biological information;" permitting extension of listing deadlines only for disputes over "biological information;" and emphasizing that "non-biological considerations" have no role in listing decisions.[155]

The ESA demonstrates a fervent Congressional preference for scientific decisionmaking, but offers scant evidence of any serious consideration of the nature or capabilities of such decisionmaking. Like its milder predecessors, the ESA's "strictly science" mandate rests on the assumption that conservation policy decisions can be made objectively on the basis of existing or reasonably attainable scientific knowledge. Because that assumption is wrong, the mandate has been impossible to implement.

III. INTERPRETING THE STRICTLY SCIENCE MANDATE

Congress has repeatedly chosen the term "scientific" to describe the type of information executive agencies must use to make conservation decisions, and has repeatedly demanded that agencies use the "best available" scientific information. In the ESA, Congress went so far as to prohibit the use of any other information to support listing decisions. Yet Congress has neither explained what it means by "scientific," nor offered guidance on identifying the "best" scientific information. Interpretation of the ESA's strictly science

153. Pub. L. No. 97-304, § 5(1)(c), 96 Stat. 1411 (1982).
154. *Id.*
155. *See supra* notes 148-50 and accompanying text.

mandate requires further inquiry into each of these questions.

A. The Nature of Scientific Inquiry: Progress Through Process

Although there are many possible interpretations of the nature of science, one view dominates public policy debates. Most natural scientists share this view, the Supreme Court has largely accepted it,[156] and it seems to embody the intent behind legislative demands for science in the ESA and other conservation statutes. This dominant view acknowledges that science incorporates both procedural and substantive elements.

Procedurally, science is a formalized system for gathering and evaluating information about the world. Its essential steps are observation, communication, informed criticism, and response. A scientist gathers data through observation or experimental manipulation. She then communicates those data, together with an explanation of the methods used to gather them, to the community of scientists in her field. The scientific community reviews and critiques the work, commenting in ways that may inspire the original scientist and others to seek additional data or alternative explanations.[157]

Substantively, science is the body of knowledge produced by this process. As confirming observations accumulate, a consensus builds among scientists in the field that certain observations, and the explanations derived from them, reflect reality.[158] Because the scientific community is committed to matching its explanations to empirical observations,[159] this consensus always remains tentative. Today's conclusions are always subject to re-evaluation and modification in light of tomorrow's new evidence.[160]

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156. *See* Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579 (1993).

157. DUNBAR, *supra* note 39, at 31; JOHN ZIMAN, RELIABLE KNOWLEDGE: AN EXPLORATION OF THE GROUNDS FOR BELIEF IN SCIENCE at 2-3, 108 (1978). While Dunbar describes this process as a public debate, participation is effectively limited to those with appropriate scientific credentials. *See* THOMAS KUHN, THE STRUCTURE OF SCIENTIFIC REVOLUTIONS 163 (1st ed. 1962) (scientists work "only for an audience of colleagues"); ZIMAN, *supra*, at 36; Alvin M. Weinberg, *Science and Trans-Science*, 10 MINERVA 209, 217-18 (1972).

158. ZIMAN, *supra* note 157, at 2-3.

159. This commitment differentiates knowledge derived from science from knowledge derived from faith, which is a belief not based on or requiring empirical proof. Empirical evidence is irrelevant to the faithful.

160. *See, e.g.*, Daubert, 509 U.S. at 597 ("scientific conclusions are subject to perpetual revision"); ALAN CHALMERS, SCIENCE AND ITS FABRICATION 7 (1990) ("the generality and degree of applicability of laws and theories is subject to continual improvement").

The term "falsifiable" is used instead of "verifiable" to emphasize the tentative nature of all scientific conclusions; it recognizes that no finite set of observations can ever definitively prove that a theory will accurately predict the outcome of all future observations. *See* KARL R. POPPER, *Science: Conjectures and Refutations*, *in* CONJECTURES AND REFUTATIONS, THE GROWTH OF SCIENTIFIC KNOWLEDGE 54-55 (3d ed. 1969); NATIONAL ACADEMY OF SCIENCES, ON BEING A SCIENTIST 13

Science thus builds toward ever greater knowledge by a process resembling the construction of a staircase. Data serve as the raw materials. Scientists use those materials to create a step, reinforcing it until it can bear the weight of the scientific community's skepticism. When the step is strong enough, the community climbs onto it, and begins constructing the next step. Occasionally a step collapses and must be rebuilt. Scientific knowledge thus evolves over time.[161]

While both the scientific process and the progressively more reliable knowledge it generates are important elements of science, the procedural element is of primary importance. "Doing science" would serve little purpose if it did not produce valuable knowledge. The value of scientific information, however, lies in its reliability. Since that reliability is a product of the scientific process of repeated observation and informed criticism,[162] the essence of "scientific" information or knowledge must be sought in that process.[163]

(1989) [hereinafter ON BEING A SCIENTIST]. Because a lack of correspondence between theoretical predictions and observed phenomena may be due to an experimental anomaly or incorrect starting assumptions, theories can never be finally proved false or inaccurate either, and previously-rejected theories are always subject to resurrection in light of new data. *See* Hilary Putnam, *The 'Corroboration' of Theories*, *in* THE PHILOSOPHY OF SCIENCE 127 (Richard Boyd et al. eds., 1991) [hereinafter PHILOSOPHY OF SCIENCE].

161. Darwinian language is often used to describe the progress of science. *See, e.g.*, NATIONAL ACADEMY OF SCIENCES, SCIENCE AND CREATIONISM: A VIEW FROM THE NATIONAL ACADEMY OF SCIENCES 8 (1984) (science evolves); CHALMERS, *supra* note 160, at 16 ("The history of science can usefully be understood as the survival of the fittest theory in the face of severe testing."). Another vivid metaphor describes scientific knowledge as a building constantly pelted with bricks of data, reinforced where the bricks show weak points, then pelted further until finally it withstands all attacks. *See* Dennis D. Murphy & Barry D. Noon, *Coping with Uncertainty in Wildlife Biology*, 55 J. WILDLIFE MGMT. 773, 775-76 (1991).

162. *See* ZIMAN, *supra* note 157, at 30-31, 108; H. Charles Romesburg, *Wildlife Science: Gaining Reliable Knowledge*, 45 J. WILDLIFE MGMT. 293 (1981) (failure to use scientific method properly leads to unreliable knowledge).

163. Scientists have long known that the scientific process is more important than any particular item of information it generates. *See, e.g.*, *Symposium on Law-Science Cooperation Under the National Environmental Policy Act*, 15 NAT. RESOURCES LAW. 570, 609-10 (1983) (remarks of Beatrice E. Willard, head of the Department of Environmental Sciences and Engineering Ecology, Colorado School of Mines) (relating the difficulty she had in convincing Bureau of Mines personnel that "science is not the body of facts so far discovered," but rather "a never-ending process of discovery, analysis, and synthesis, followed by further discovery, analysis and synthesis"). The Supreme Court recognized the importance of method in *Daubert*, 509 U.S. at 590-95, ("[T]he adjective 'scientific' implies a grounding in the methods and procedures of science. . . . [I]n order to qualify as 'scientific knowledge,' an inference or assertion must be derived by the scientific method. . . . The focus, of course, must be solely on principles and methodology, not on the conclusions that they generate.").

1. Data Gathering and Falsifiability

Data gathering is the first and most fundamental step in the scientific process. Science embodies a commitment to objective knowledge ultimately derived from empirical observations. It is often said that scientific theories must be falsifiable, meaning that it must, in principle, be possible to confirm or refute them through empirical observations.[164] Although the Chief Justice of the United States has professed himself mystified by the concept of falsifiability,[165] it is not difficult to understand. It incorporates two distinct elements: the ability to imagine some empirical observation which would refute the theory; and a commitment to discard the theory if a refuting observation occurs.[166] Theories are falsifiable if they lead to predictions not consistent with all conceivable observations.[167]

For example, a scientist might theorize that green plants obtain energy from light. Before testing this theory, she could imagine two results of placing plants in the dark: they might flourish or they might weaken and die. Her theory predicts the second outcome; if it is correct, plants deprived of light will die. This prediction allows her to test her theory through data-gathering: she places plants in a dark chamber, observes them over time, and records the outcome. If they die, her theory is tentatively confirmed, albeit far from proven. If they do not die, she must reject or modify her theory.

Experimental manipulation of this type is one valuable method of generating scientific data. Experiments, particularly under laboratory conditions, permit stringent control over potentially confounding variables, thus strengthening the inference that an explanatory theory is correct.[168] Our scientist, for example, could carefully match temperature, soil, and atmospheric condition for two sets of plants, varying only the amount of light. If she still observes variations in vigor between the groups, her conclusion that light provides their energy source will have been

164. *See, e.g.*, POPPER, *supra* note 160, at 33, 36-37; ZIMAN, *supra* note 157, at 35; Francisco J. Ayala & Bert Black, *Science and the Courts*, 81 AM. SCIENTIST 230, 234 (1993). Hypotheses, theories, and questions need not be testable in fact at the moment to be scientific, but if they are not *in principle* subject to some form of testing against empirical data they can never profit from the special virtues of scientific inquiry.

165. Daubert, 509 U.S. at 600 (Rehnquist, C.J., dissenting in part) ("I defer to no one in my confidence in federal judges; but I am at a loss to know what is meant when it is said that the scientific status of a theory depends on its 'falsifiability,' and I suspect some of them will be, too.").

166. The trick, of course, is distinguishing data that falsify a theory from data that simply fail to confirm it, and determining when a theory has been so falsified that it must be abandoned.

167. POPPER, *supra* note 160, at 36.

168. *See* Jared Diamond, *Overview: Laboratory Experiments, Field Experiments, and Natural Experiments*, *in* COMMUNITY ECOLOGY 3 (Jared Diamond & Ted J. Case eds., 1986).

strengthened by the elimination of some other possible explanations.

Because many natural phenomena cannot be replicated in the laboratory, laboratory experiments are not practical for all investigations. Astronomy is one example; scientists cannot create stars or galaxies in a laboratory. The study of biological communities or ecosystems is another. Because they cannot recreate most communities, ecosystems, or habitats in the laboratory, scientists interested in the functioning of these systems must rely on field experiments, observation of naturally occurring phenomena, or models.[169]

Compared to laboratory experiments, these other methods of gathering data have advantages and disadvantages. Field experiments, such as local elimination or introduction of a species, can be done on a larger scale and in a more realistic setting than laboratory experiments. However, they are often expensive and fraught with practical difficulties. They may also be precluded by ethical considerations; it might be illegal or immoral to introduce a pathogen to an island ecosystem, or to remove all members of a species from that ecosystem.[170] Even if ethically permissible, field experiments often produce less reliable data than laboratory experiments because the field experimenter cannot hope to control all of the many variables, such as climate conditions, that might influence the observed outcome.[171] While this problem can be reduced by replicating an experiment in many locations against a randomly distributed range of background conditions,[172] replication inevitably drives up costs.

Observations of naturally occurring phenomena are not subject to the ethical restrictions on deliberate experimentation, are relatively inexpensive, and may encompass larger spatial and temporal scopes than laboratory or field experiments. However, observations do not allow full control or replication. Accordingly, they do not offer the same degree of confidence as experiments that the result was not caused by chance or some confounding factor.[173] Nonetheless, carefully chosen observations, using matched sites or multiple occurrences, can produce quite reliable knowledge.[174]

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169. *See id.* at 7-21.

170. *See id.* at 9-11.

171. *See id.* at 9. Because field experiments are often impractical in ecology, ecologists often accept scientific conclusions without requiring that they be supported by field data. Recent proposals to require field testing of all data supporting ESA listing decisions would impose a burden of proof considerably higher than that imposed by the scientific community. *See* Bogert, *supra* note 6, at 146; H.R. 2275, 104th Cong. § 301(b) (1995).

172. *See* David H. Kaye & David A. Freedman, *Reference Guide on Statistics*, *in* REFERENCE MANUAL ON SCIENTIFIC EVIDENCE 331, 347 (Federal Judicial Center, 1994) [hereinafter MANUAL ON SCIENTIFIC EVIDENCE].

173. *Id.* at 13-15.

174. *See id.* at 14, 17; ERNST MAYR, THE GROWTH OF BIOLOGICAL THOUGHT: DIVERSITY,

Models are simulations of natural systems, often based on computer programs. They allow researchers to perform manipulations which would be impractical or ethically impermissible in nature, and to monitor impacts over long periods of time and large spatial areas. Model designers often face trade-offs between three important concerns: generality, the ability to represent a broad range of system behaviors; realism, the ability to represent system behavior with qualitative accuracy; and precision, the ability to represent system behavior with quantitative accuracy.[175] Moreover, models often incorporate unrealistic simplifying assumptions and rest on untestable foundations.[176]

2. Communication

The next essential step in the scientific process is the communication of the data to the appropriate audience. Our hypothetical scientist may believe, on the basis of her experiment, that plants obtain energy from light. If she asks others to adopt that belief on the basis of her word alone, however, she is appealing to faith rather than practicing science. To gain scientific support she must offer her data, together with an explanation of the conditions of her experiment, to others in the field. The explanation must be sufficiently detailed to enable others with the appropriate skills, training, and equipment to repeat her experiment.[177] It should also include a frank acknowledgment of the uncertainties in the data and any suspected shortcomings of the experiment.[178]

This communication process is largely public, but by accident rather than by design. No effort is made to reach persons outside the relevant scientific field. Data are published in peer-reviewed journals and presented at professional meetings. They are also shared through less public channels such as seminars, informal meetings of research groups, and personal contacts among scientists.

EVOLUTION, AND INHERITANCE 32 (1982).

175. Robert Costanza et al., *Modeling Complex Ecological Economic Systems*, 43 BIOSCIENCE 545, 547-48 (1993).

176. *See* SCIENCE AND THE ESA, *supra* note 15, at 181-82.

177. *See, e.g.*, ZIMAN, *supra* note 157, at 31; DUNBAR, *supra* note 39, at 31, 78. Sufficient information should be provided to permit replication of the tests and verification of the results by independent observers. *See* Ayala & Black, *supra* note 164, at 238.

178. *See* Cournand, *supra* note 36, at 700; ON BEING A SCIENTIST, *supra* note 157, at 3.

3. *Critique and Corroboration*

The purpose of communicating scientific data is to facilitate evaluation by others in the field, offering them the opportunity to debunk data or falsify interpretations. The requirement that experimental methods be communicated in sufficient detail to permit replication derives from the scientific commitment to objective or universal observations. Only those observations which do not vary with the identity of the observer can be considered to support hypotheses. In principle, any scientist with the appropriate training and equipment should obtain identical results.[179] In practice, experiments are rarely repeated precisely, but they are effectively verified through attempts to improve them, extend them, modify them, or debunk them.[180] Theories or hypotheses are constantly tested against new data, both by the scientists who first advanced them and by competitors seeking to advance their own theories.

Discussion, critical examination, and evaluation of both data and explanations also follow communication. The scientific community seeks to reach a consensus on new knowledge through debate and discussion as well as through experimental replication. The scientific debate makes no pretense to democracy; no attention is paid to the opinions of those lacking scientific qualifications, while the opinions of the field's elite often carry extra weight.[181]

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179. *See* UNDERSTANDING RISK, *supra* note 54, at 25.

180. *See* P.B. Medawar, *The Creation of Phenomena, in* REPRESENTING AND INTERVENING 220, 231(1967); *see also* ZIMAN, *supra* note 157, at 68. Extraordinary claims that challenge conventional interpretations are most likely to attract attempts at close replication or direct falsification. *See* ON BEING A SCIENTIST, *supra* note 160, at 11. For example, the 1989 claims of Martin Fleischmann and Stanley Pons to have observed nuclear fusion in an inexpensive table-top apparatus carried the promise of enormous economic value and contradicted well-established theories. The claims immediately attracted numerous attempts at replication and falsification. *See* MICHAEL W. FRIEDLANDER, AT THE FRINGES OF SCIENCE 1-5, 30 (1995); Daniel E. Koshland, Jr., *The Confusion Profusion*, 244 SCI. 753 (1989).

181. Those without the requisite scientific training are excluded from the debate without question or compunction. *See, e.g.*, ON BEING A SCIENTIST, *supra* note 160, at 12 (data should be shared, but only with "qualified colleagues").

Whether the weight assigned to opinions within the community of scientists should vary with reputation is a more controversial issue. Many scientists might state as a normative principle that claims should be evaluated on their substantive merits without reference to the author's reputation. *See* James Woodward & David Goodstein, *Conduct, Misconduct and the Structure of Science*, 84 AM. SCIENTIST 479, 480 (1996) (listing as a principle of scientific ethics that "the reputation of a scientist making a given claim is irrelevant to the validity of the claim"). In practice, however, working scientists do tend to give greater credence to claims by those recognized as leaders in the field. *See, e.g.*, *id.* at 486 (appeals to "personal warrant" are justified because experimenters vary in their skill or craft); TREVOR PINCH, CONFRONTING NATURE: THE SOCIOLOGY OF SOLAR-NEUTRINO DETECTION 205-07 (1986) ("personal warrant" of experimenter plays large role in assessments of the work by

This evaluation of new information takes place within an informal but nonetheless potent adversarial system. Scientists competing with each other for reputation and grant funds have powerful incentives to apply the full force of their knowledge and training to expose flaws in data and reasoning. This loose system of checking and double-checking consequently provides an effective long-term corrective mechanism for inaccurate data or interpretations.[182]

4. The Role of Hunches and Intuition

Hunches, intuition, and imagination have long been recognized as a valuable source of new scientific insights, theories, and ideas, as well as creative means of testing those ideas.[183] Imaginative scientists are more likely than others to solve longstanding puzzles, simply because they approach those puzzles in novel ways. Tales of such creativity become fables for the edification of aspiring scientists.[184]

But hunches include much more than such flights of creative fancy. Belief in any incompletely proven theory may be described as a hunch or educated guess.[185] Because no theory is ever proven to an absolute certainty, no bright line separates hunches from established scientific knowledge.[186] Every scientific conclusion or opinion is to some degree a hunch. Although opinions can be evaluated on the basis of the strength of the data supporting

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other scientists); STEPHEN COLE, MAKING SCIENCE: BETWEEN NATURE AND SOCIETY 198 (1992) ("One of the primary mechanisms through which the scientific community attempts to establish consensus is the practice of vesting authority in elites. . . . In the process of evaluation [of new knowledge], some opinions count more than others.").

182. DUNBAR, *supra* note 39, at 102; EVELYN FOX KELLER, A FEELING FOR THE ORGANISM: THE LIFE AND WORK OF BARBARA MCCLINTOCK 197 (1983); POPPER, *supra* note 160, at 215, 216. Inaccurate explanations eventually produce a critical mass of unexplained results and convoluted explanations sufficient to foster a jump to a new paradigm. KUHN, *supra* note 157, at 52-53, 68-69, 77. It has been argued recently that the review and replication mechanisms which are supposed to make science self-correcting are being defeated by fraud and scientific misconduct. ROBERT BELL, IMPURE SCIENCE: FRAUD, COMPROMISE AND POLITICAL INFLUENCE IN SCIENTIFIC RESEARCH xiv (1992).

183. *See, e.g.*, P.B. Medawar, *Two Conceptions of Science*, *in* REPRESENTING AND INTERVENING 119 (1967); Judith Wechsler, *Introduction*, *in* ON AESTHETICS IN SCIENCE 5 (Judith Wechsler ed., 1978) [hereinafter ON AESTHETICS IN SCIENCE]; Geoffrey Vickers, *Rationality and Intuition*, *in* ON AESTHETICS IN SCIENCE, *supra*, at 143, 153.

184. August Kekulé, inspired by a dreamlike vision to conceive a novel chemical structure which explained the properties of benzene, is a famous example. Dozing before a fire, Kekulé saw a vision of carbon atoms dancing in snakelike rows. Eventually the dancing atoms transformed themselves into a snake which seized its tail in its mouth, and whirled mockingly. *See* Vickers, *supra* note 183, at 154; George E. Hein, *Kekulé and the Architecture of Molecules*, *in* KEKULÉ CENTENNIAL (ADVANCES IN CHEMISTRY SERIES No. 61) 1, 10 (1966); MARIO BUNGE, INTUITION AND SCIENCE 83-84 (1962). Kekulé was able to translate this vision into a novel carbon ring structure. *See id.*

185. *Cf.* Romesburg, *supra* note 162, at 308 (defining a hunch as an untested theory).

186. Vickers, *supra* note 183, at 161.

them, no qualitative difference distinguishes knowledge from guesswork. Reliance on science must, by necessity, include reliance on some hunches.

Even if hunches could be separated cleanly from knowledge, reliance on scientific intuitions would remain a necessary and expected aspect of the scientific process. The evolution of science proceeds in important measure through the practice of following hunches—often those of a field's recognized leaders—to fruitful new lines of research. Rather than waiting for such intuitions to be confirmed by supporting evidence, the scientific community may proceed on the assumption that they are accurate until the data prove otherwise. Moreover, reliance on hunches is sometimes unavoidable. Ideas which are in principle falsifiable cannot always be subjected in practice to empirical testing. Some tests are too expensive or too slow to be feasible.[187] Others must await the development of new observational technologies. Still others may be feasible but subject to moral objections.[188] In the absence of a suitable model system or a fortuitous natural event, hunches or intuitions about these "trans-scientific" phenomena[189] simply cannot be tested against empirical data. If the relevant empirical tests cannot be performed, the scientific process stalls at the hunch stage. The hunches of scientists represent, for the moment at least, the best information attainable.

In sum, information is scientific if it is generated through and subjected to scrutiny according to the scientific process. Scientific information does not rely on the faith of the audience to support it; science insists on empirical evidence as the ultimate foundation of knowledge.

Scientific information is also distinct from value or policy judgments, which are determined by the preferences and ethical beliefs of the individual. Information is scientific only if its validity does not depend on the individual preferences of the beholder, that is only if it is supportable in theory if not in fact by universally repeatable observations. This ultimate empirical grounding makes science the most reliable source of information available concerning the behavior of the natural world. Nonetheless, the reliability of scientific information varies widely as the information progresses through the successive stages of the scientific process. Scientific information ranges from

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187. For example, theories about the behavior of systems over very long terms, such as the stability over thousands of years of facilities for storage of radioactive waste, cannot be directly tested. *See* KRISTIN SHRADER-FRECHETTE, ETHICS OF SCIENTIFIC RESEARCH 54 (1994).

188. For example, many theories about human health effects cannot be deliberately tested through experimental manipulation in light of the obvious moral objections to deliberately exposing human subjects to harmful substances. *See* Linda A. Bailey, et al., *Reference Guide on Epidemiology*, *in* MANUAL ON SCIENTIFIC EVIDENCE, *supra* note 172, at 121, 129.

189. Weinberg, *supra* note 157, at 209-11.

robustly confirmed knowledge to raw hunches.

B. Recognizing the Limits of Science

Science offers an attractive basis for conservation policy choices because it promises objective, reliable answers to questions about the nature and functioning of the world. Indeed, science offers the clearest window available on the natural world. Yet in order to make the most effective use of science, policymakers must realize that simply characterizing a question as scientific does not guarantee an answer which is either objective or reliable.

1. Objectivity and Its Limits

Scientific information is objective because it is rooted in universally-repeatable observations. If one scientist finds, for example, that plants with large fleshy roots survive longer without light than others, any other scientist who tries the experiment should get the same result. This objectivity carries with it a promise of value-free, neutral evaluation. If society needs to know what plants grow best with the least light, it should be able to delegate both performance and evaluation of the necessary tests to any qualified scientist, regardless of political or other views.

Some questions, however, simply cannot be answered in an objective, universally valid manner. If society asked which plants were generally preferable, responses would vary with the respondents' views of the values provided by plants. The question calls for a weighing of incommensurables, comparing beauty, productivity and other features, which cannot be performed on a wholly objective basis. It calls for a value judgment, not a scientific evaluation.

Even when the questions asked do not inherently call for such value judgments, scientific objectivity is not absolute. In recent years, some social scientists have strongly questioned the ability of science to produce knowledge which corresponds to objective truth.[190] The sociological description of science, while sometimes taken to unjustified extremes,[191]

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190. *See, e.g.*, PAUL FEYERABEND, AGAINST METHOD (1975); BRUNO LATOUR & STEVE WOOLGAR, LABORATORY LIFE: THE CONSTRUCTION OF SCIENTIFIC FACTS (2d ed. 1986); BRUNO LATOUR, SCIENCE IN ACTION: HOW TO FOLLOW SCIENTISTS AND ENGINEERS THROUGH SOCIETY (1987).

191. Radical social constructionists argue that "the empirical world has little, if any, influence on what is accepted as true by the scientific community." COLE, *supra* note 181, at 12. Virtually all natural scientists, and many social scientists, reject this extreme position. *See id.* at 5. A more plausible moderate position holds that social processes and empirical evidence both play a role in the development of science. Some theories gain wide acceptance, becoming part of the "core" of scientific

suggests that care should be exercised in applying scientific information to policy decisions. Scientists in any given field form a loose-knit community, the members of which tend to share certain views. Those views undoubtedly contribute to the choices individual scientists make regarding research topics and techniques, both directly,[192] and indirectly, through effects on funding opportunities.[193] These social effects on research choices need not unduly concern those who seek to draft science into the service of conservation policy. Indeed, they may be beneficial, helping policymakers deliberately steer the scientific research agenda in response to societal needs.

More troublesome is the charge that data interpretation is socially rather than objectively determined.[194] While this charge is often exaggerated, it does have some truth to it. Where reasonably possible, scientists tend to interpret their observations as consistent with whatever theory currently commands the most adherents, even if other interpretations are equally or even more plausible.[195] A shared community aesthetic also plays a role in the

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knowledge, because they correspond well to the empirical evidence. Other claims fail to gain acceptance because they are not supported by any data. In many cases, however, particularly at the research frontier, the data do not provide a clear basis for choosing between competing theories. In those circumstances, social interactions among scientists play an important role in determining how contributions are evaluated. *Id.* at 14-30.

192. Kuhn, *supra* note 157, at 10, 35-42.

193. Most research scientists today depend upon government funding to finance the expensive equipment and supplies needed for their projects. *See* JOSEPH P. MARTINO, SCIENCE FUNDING: POLITICS AND PORKBARREL 141 (1992) (over half the scientists in the U.S. receive federal support); GOVERNMENT-UNIVERSITY-INDUSTRY RESEARCH ROUNDTABLE, FATEFUL CHOICES: THE FUTURE OF THE U.S. ACADEMIC RESEARCH ENTERPRISE 14 (1992) (two-thirds of the $15 billion expended on academic research in 1990 came from government sources outside the institution where the research was conducted).

Grant funds are typically distributed by peer review boards made up of distinguished scientists in the field. *See* DARYL E. CHUBIN & EDWARD J. HACKETT, PEERLESS SCIENCE: PEER REVIEW AND U.S. SCIENCE POLICY 20-24 (1990) (describing peer review systems used by National Institutes of Health and National Science Foundation). Researchers can increase their funding, and consequently their career success, by adapting their interests to the prevailing views of peer reviewers. As one scientist put it in response to a survey, "'My own approach [to the peer review system] has been to bow to the opinions of study sections. If they say 'no,' I either substantially change my approach to a given problem, or take a new problem.'" MARTINO, *supra*, at 64.

The political trends of the moment also affect grant success. In recent years, Congress has increasingly responded to pressure from special interest groups by targeting research funds to specific topics. *See id.* at 91-97.

194. *See generally* the papers collected in 11 SOCIAL STUDIES OF SCIENCE 3-158 (1981).

195. *See* Kuhn, *supra* note 157, at 80. Indeed, if the divergence is too great to be rationalized away, data are more likely to be discarded than a widely accepted theory. Putnam, *supra* note 160, at 124-27. For example, when it was observed that the orbit of Uranus did not correspond to predictions derived from Newton's theory of universal gravitation scientists, instead of rejecting the theory (which had successfully explained a large number of other observations) postulated an additional undiscovered planet exerting a gravitational force on Uranus. *Id.* As one ecologist has commented, "it is best not to put too much faith in facts until they have been confirmed by theory." R. MacArthur, *Coexistence of Species*, *in* CHALLENGING BIOLOGICAL PROBLEMS 253, 258 (J.A. Behnke ed., 1972),

choice of explanation;[196] scientists favor simple[197] or "elegant"[198] explanations, even when others are equally consistent with the data.[199] Individual aesthetics, personality traits, and motivations also may influence data interpretation.[200]

These subjective forces do not rob science of its claim to reliability because they are limited by the scientific commitment to empirical data. They may strongly influence the views of individual scientists, but they dominate community views only at the borders or frontiers of science, where lack of data leaves more room for subjective interpretation. Over the long term, in the scientific community as a whole, the scientific process of repeated observation and critical evaluation exerts powerful checks, ensuring that scientific knowledge reflects the external world reasonably accurately.[201]

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quoted in John T. Lehman, *The Goal of Understanding in Limnology*, 31 LIMNOLOGY & OCEANOGRAPHY 1160 (1986).

196. A recent issue of the journal, Science, demonstrates the important role aesthetics plays in scientists' evaluation of their peers' work. One article details an "elegant experiment" in microbial genetics. Christine Mlot, *Microbes Hint at a Mechanism Behind Punctuated Evolution*, 272 SCI. 1741 (1996). In another, a biochemist describes the newly-discovered arrangement of light-harvesting molecules in a photosynthetic alga as "'a beautiful structure, aesthetically pleasing,'" and another remarks on its "elegant design." Anne Simon Moffat, *Form Follows Function When Plants Harvest Light*, 272 SCI. 1743, 1744 (1996). *See also* Francis Crick, *The Double Helix: A Personal View*, 248 NATURE 766, 768 (1974) (attributing the appeal of the Watson and Crick structure for DNA in part to "the intrinsic beauty of the DNA double helix").

197. Scientists often appeal to the principle known as Occam's (or Ockham's) razor, which provides that "assumptions should not be unnecessarily complicated." JACK COHEN & IAN STEWART, THE COLLAPSE OF CHAOS: DISCOVERING SIMPLICITY IN A COMPLEX WORLD 225 (1994). In other words, a simple explanation is to be preferred over a more complicated one, provided all other things are equal. *See* DAVID OLDROYD, THE ARCH OF KNOWLEDGE: AN INTRODUCTORY STUDY OF THE HISTORY OF THE PHILOSOPHY AND METHODOLOGY OF SCIENCE (1986). The pursuit of simplicity has been an express goal of science since the days of Newton, and continues to command much force. *See* EDWARD TELLER, THE PURSUIT OF SIMPLICITY 17, 152 (1980). But like many other stated principles, that of preferring simplicity is not always honored. *See* Richard Boyd, *Observations, Explanatory Power, and Simplicity: Toward a Non-Humean Account*, in PHILOSOPHY OF SCIENCE, *supra* note 160, at 349, 373.

198. "Elegant" is a term scientists often use to describe experiments and theories deemed worthy of admiration. *See supra* note 196; COHEN & STEWART, *supra* note 197, at 295 (scientists want their theories "to be elegant, not held together with chewing gum and string"). The term carries connotations of beauty, simplicity, coherence, and intellectual power. The National Academy of Sciences has described it as a "more refined cousin" of simplicity. ON BEING A SCIENTIST, *supra* note 160, at 6.

199. *See, e.g.*, KUHN, *supra* note 157, at 150; HOLTON, *supra* note 34, at 98; Howard E. Gruber, *Darwin's "Tree of Nature" and Other Images of Wide Scope*, *in* ON AESTHETICS IN SCIENCE, *supra* note 183, at 121, 123. Of course simplicity, parsimony, and elegance are in the eye of the beholder. Furthermore, the aesthetic preferences of individual scientists vary. Many are attracted by the intricate beauty of complexity, as well as the austere beauty of simplicity. *See id.* at 124.

200. *See generally* KELLER, *supra* note 182.

201. *See supra* note 182 and accompanying text; *see also* ALLAN FRANKLIN, EXPERIMENT, RIGHT OR WRONG (1990). For example, the additional planet predicted to save Newton's gravitational theory from the vagaries of Uranus's observed orbit was later discovered in the expected location. *See*

In the shorter term, however, and especially at the limits of scientific understanding, these checks may not operate effectively.[202] Consequently, subjective factors including personal and community biases may profoundly, and even unconsciously, influence decisions which appear on their face entirely scientific.

Subjective factors play a crucial role in the evaluation of equivocal data. Just as all interpretations of scientific data are to some degree hunches, all data is to some degree equivocal. Observations of the natural world are an unavoidably messy business. Measurements are always subject to error, and random background variation, sometimes referred to as scatter or noise, often masks responses to experimental stimuli.[203] Observations, therefore, are never completely reliable, and never perfectly match theoretical predictions.[204] Some measure of expert judgment is inevitably required to determine which observations are reliable and whether, considering the experimental uncertainties, they validate or contradict the theory being tested.[205]

These judgments, which cannot be made on any objective basis, are instead governed by the social conventions of the relevant scientific community. For example, even data that diverge substantially from the predictions of accepted theories will often be viewed as supporting those theories,[206] whereas data contradicting a prevailing paradigm must be exceptionally strong to be taken seriously.[207] The scientific community has developed conventions for dealing with these kinds of choices. Scientists learn socially accepted methods for distinguishing "good" data from "bad" data during their scientific apprenticeships.[208] Moreover, because of the recognized possibility that conscious or unconscious bias may influence this data "massaging," convention requires that data selection be openly acknowledged and explained in the communication step.[209]

Putnam, *supra* note 160, at 127. If Neptune had not appeared as detection methods improved, Newton's theory of gravity might eventually have been reconsidered.

202. *See* ZIMAN, *supra* note 157, at 40 ("The physics of undergraduate text-books is 90% true; the contents of the primary research journals of physics is 90% false.").

203. *Id.* at 64-70; DAVID P. BEACH & TORSTEN K.E. ALVAGER, HANDBOOK FOR SCIENTIFIC AND TECHNICAL RESEARCH 113-14, 118-19 (1992).

204. ZIMAN, *supra* note 157, at 26, 35-36; Kuhn, *supra* note 157, at 145.

205. ZIMAN, *supra* note 157, at 36.

206. *See supra* note 195 and accompanying text.

207. *See* John Maddox et al., *"High-Dilution" Experiments a Delusion*, 334 NATURE 287 (1988).

208. ON BEING A SCIENTIST, *supra* note 160, at 3, 5-6.

209. *Id.* at 5-6, 14. This norm is not always followed; several celebrated historic deviations from it are familiar to most scientists. For example, physicist Robert Millikan's oil-drop experiments successfully demonstrated that all electrons have the same charge because he, unlike his major competitors, aggressively separated what he saw as the "good" data from the bad. Millikan published

2. Reliability and Its Limits

Science also attracts policymakers because of its potential to produce highly reliable knowledge deserving of strong public confidence. Again the scientific process accounts for this reliability; observations which have been successfully repeated many times by a variety of observers under various circumstances are likely to be highly reliable. Such information is likely to support the accurate predictions of future events policymakers crave.

The reliability of scientific data and theories, however, varies widely, and is often quite difficult to evaluate.[210] Not only does reliability vary with the extent to which confirming data have been sought or collected, it also varies with the nature of the question posed. Some disciplines are capable of producing highly reliable data which support very accurate predictions. Others simply are not.[211] The high reliability end of the spectrum is illustrated by some branches of physics which, because they deal with relatively simple, uniform systems susceptible to strong experimental control, permit highly accurate measurements and highly reliable predictions. For example, the behavior of electrons in response to gravitational or electrical stimuli can be predicted with great reliability because all electrons have the same charge and mass. Furthermore, measurements of electron behavior can be expected to closely match theoretical predictions because electrons can be manipulated under highly controlled experimental conditions, minimizing confounding variables.

Biology, at least at the organism, community, or ecosystem levels of organization, offers no such certainty because it offers no such simplicity. Individual organisms and communities vary substantially from one another, producing the kind of background noise which can confound experimental

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only about 40% of his experimental observations; his publications did not reveal the data selections he had made. *See id.* at 3; Gerald Holton, *On the Art of Scientific Imagination*, 125 DAEDALUS 183, 204-06 (1996).

210. *Cf.* Dayton L. Alverson, *The Role of Conservation and Fishery Science Under the Fishery Conservation and Management Act of 1976*, 52 WASH. L. REV. 723, 731 (1976):

> In a strictly qualitative sense, one could assume that, in judging between two properly documented sets of data, the information having the higher reliability in a mathematical sense should be the basis upon which a decision is made. The selection between sets of data is likely to be more intricate, however, as there does not seem to be any quantitative mechanism to evaluate methodology, underlying assumptions, and techniques behind such proffered information.

There simply is no numeric formula for rating the strength of scientific information or the reliability of a theory.

211. *See* Richard A. Carpenter, *Ecology in Court, and Other Disappointments of Environmental Science and Environmental Law*, 15 NAT. RESOURCES LAW. 586-89 (1983), for a discussion of the differences in reliability, predictive capacity, and influence of subjective values among various "hard" and "soft" sciences.

interpretation. Furthermore, biologists studying organisms or communities typically cannot hope to control all the factors which might influence their experimental subjects. Even when controlled experimental manipulation is theoretically possible, it is likely to be extremely costly. Scientists studying these systems may be forced to choose between expensive and time-consuming experiments, and less costly, more practical, but less reliable ones.[212]

Because the reliability of scientific data varies so greatly, scientists have developed statistical significance tests to measure reliability. These tests help scientists discriminate between random and meaningful variation. For example, a biologist might hypothesize that elimination of old-growth trees would reduce the suitability of a conifer forest for spotted owls. This hypothesis could be tested through a field experiment; the scientist might measure owl populations in a single area before and after logging of mature trees, or in matched logged and unlogged areas. Alternatively, if experiments are impractical or undesirable, the hypothesis could be tested against carefully chosen observations; the scientist could count owls in stands which already have, for one reason or another, different numbers of old-growth trees.

Suppose the biologist finds two owls per acre in tracts with numerous old-growth trees, and one owl per acre in other tracts. She cannot be confident, *a priori*, that the difference in tree ages has caused the variation in owl numbers. She would expect to encounter some variation in population measurements whether or not spotted owls require old growth trees. Chance differences in the number of owls using a particular parcel from day to day would cause some random variation. Measurement errors would produce more variation, since the biologist probably would not find every owl each time she surveyed.

In order to decide whether the observed differences in owl density result from such random variation, the biologist could use statistical tests. First, she would calculate the expected distribution of owl sightings, taking into account background sources of variability. Using that distribution, she could decide what part of the variation she observed to attribute to chance. For example, if the background variation were extremely (and unrealistically) low, her observations in old-growth forests might be distributed about a mean of 2 owls per acre, with 95 out of 100 observations expected to fall between 1.5 and 2.5 owls per acre. In that case, there would be less than a 5%

212. *See supra* text accompanying notes 169-76; Romesburg, *supra* note 162, at 305. This trade-off is a non-scientific one, based on the researcher's subjective estimation of the incremental value of greater reliability.

chance that her count of one owl per acre in areas without old growth occurred by chance, and more than a 95% probability that it reflected a real difference in habitat suitability.

By convention, scientists in a variety of biological disciplines commonly accept data that would be expected to occur by random chance less than 5% of the time as "statistically significant."[213] Statistically significant observations are regarded as confirming that the experimental manipulation (or the feature varied between observations) caused an observed effect.[214] While statistical tests are a common and useful aspect of the scientific process, the choice of significance level is entirely arbitrary, based on the social conventions of the relevant field and the purposes the data is intended to serve.[215]

Accordingly, there is nothing magic about a "statistically significant" result. It does not prove with certainty that the tested variable caused the observed effect. Nor does the failure to obtain a statistically significant result establish conclusively that the tested variable does not cause an effect. Even if no single observation reaches the level accepted in the field as statistically significant, several close to that level may in the aggregate, especially if accompanied by an elegant explanation, persuade scientists of a theory's validity.[216]

3. *The Risks of Hunches*

Hunches and incompletely confirmed intuitions are both less objective and less reliable than theories which have been strongly confirmed by empirical data. Nonetheless, just as they have a role in the scientific process, they have value for policymakers. In particular, the hunches of scientists may represent the most reliable answer available to questions which have not yet been tested, or which for some reason cannot be tested at this time.[217]

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213. NORMAN T.J. BAILEY, STATISTICAL METHODS IN BIOLOGY 31-37 (3d ed. 1995). For a readable general account of significance tests, *see* Kaye & Freedman, *supra* note 172, at 373-85.

214. Also by convention, scientists often claim to be testing the "null hypothesis" that the variable they are testing does not affect the outcome. In this formulation, our scientist would say that her data refute the null hypothesis that the presence of old-growth trees is not an important element of spotted owl habitat.

215. *See* McGarity, *supra* note 14, at 748 ("'[S]tatistical significance' is an issue of pure policy.").

216. Informal, subjective evaluation of multiple studies has long been a common practice. Recently, statisticians have developed a method for quantitatively aggregating the results of multiple individual studies. This technique, known as "meta-analysis," is still highly controversial. *See* Ida Simm and Mark H. Hlatky, *Growing Pains of Meta-Analysis*, 313 BRIT. MED. J. 702 (1996); Gary Taubes, *Looking for the Evidence in Medicine*, 272 SCI. 22 (1996); Charles Mann, *Meta-Analysis in the Breech*, 249 SCI. 476 (1990).

217. *See supra* notes 187-89 and accompanying text.

Neither scientists nor laypersons can know the answers to such questions with any degree of certainty. There is good reason to believe, however, that the educated intuitions of scientists may prove more trustworthy than the guesses of non-experts.[218] For one thing, successful scientists are likely to have developed special observational skills in their area of expertise.[219] Their choice of career demonstrates a powerful personal interest likely to motivate careful, insightful observation,[220] and their success at that career depends in part upon their ability to distinguish reliable data and theories worthy of further pursuit from unreliable data and unproductive theories.[221] In addition, experts in the field will be more familiar than the lay public with the background knowledge against which novel data and theories must be interpreted.[222]

While they can provide a useful foundation for policy when empirical data is not available, expert hunches should be treated with caution. They certainly do not fit the classic image of objective certainty many laypersons, legislators, and even scientists associate with science.[223] Reliance on untested

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218. *See, e.g.*, Richard Boyd, *On the Current Status of Scientific Realism*, *in* PHILOSOPHY OF SCIENCE, *supra* note 160, at 195, 201 (scientists "have a pretty good idea which predictions not to trust"); Ian Hacking, *Experimentation and Scientific Realism*, *in* PHILOSOPHY OF SCIENCE, *supra* note 160, at 247, 256 (reporting the hunches of scientists are based on a "hard-won sense" of the nature of phenomena they have studied closely).

Perhaps on the basis of this sort of intuition, Professor Cheever has expressed a preference for reliance on the intuitions of scientists in the context of endangered species recovery. *See* Federico Cheever, *The Road to Recovery: A New Way of Thinking About the Endangered Species Act*, 23 ECOLOGY L.Q. 1, 76 (1996) (the understanding recovery team biologists have of the dynamics of species recovery "makes them by far the best qualified people to make intelligent choices on controversial issues.").

219. KELLER, *supra* note 182, at 200; *see also* BUNGE, *supra* note 184, at 70 (trained specialists will see relationships and complexities that the novice will miss); Woodward & Goodstein, *supra* note 181, at 486-87 (discussing the craft of experimentation).

220. The financial rewards of a career in science are not so great as to draw young persons into the field. Most scientists regard their work primarily as a vocation, and only secondarily as a means of financial support.

221. *See* BUNGE, *supra* note 184, at 89. Scientists without sound judgment of this sort are not likely to have productive careers. After all, a scientific career is built on successful gambles on untested hypotheses. Scientists invest time, resources and prestige in experiments whose value depends on the validity of their favored theories. *See* Ayala & Black, *supra* note 164, at 238. The most successful scientists are those whose gambles repeatedly pay off. Their success tends to demonstrate an accurate intuition for fruitful hypotheses.

222. *See* ZIMAN, *supra* note 157, at 138 ("only the expert can read, interpret and weigh" the unselected, contradictory knowledge at the "research frontier"). For example, Linnaeus managed to produce reasonably natural taxonomic classifications even though his theories were wholly artificial because he ignored the theories when they conflicted with his intuitions. MAYR, *supra* note 174, at 189-90. Linnaeus himself admitted to sorting species "under the table," when the result dictated by theory did not feel right. *Id.* at 179.

223. *See supra* text accompanying notes 28-30; *see also* George Singer, *Conjecture and Hearsay Demean Science*, WISCONSIN ST. J., May 25, 1996, at A9 ("Conjecture, no matter how logically or

hunches in situations in which the public has been led to expect certainty may cause distortions of the political process. Furthermore, hunches will often prove wrong. They have not passed through the full series of critical filters imposed by the scientific process. Since the majority of scientific intuitions, predictions, and hypotheses do not survive the filtering process unchanged,[224] guesses not yet subjected to it are likely to prove unreliable.[225] Finally, because they are only weakly constrained by data, hunches may be strongly influenced by subjective preferences.

These potential problems are not insurmountable, but do demand careful separation of reliable from less reliable data. The danger of political distortion arises not from reliance on hunches per se, but rather from incomplete communication of the nature of those hunches. The political community cannot effectively evaluate expert opinions unless it is fully informed of their basis and the limits of their reliability. Provided with this additional information, however, the political community should be capable of deciding whether or not it is desirable to base policy choices on expert hunches. Nor should the inherent unreliability of hunches be an absolute barrier to their use as a foundation for policy, although again it counsels caution. Hunches may be the best or only information available, if extensive data have not been, or at present cannot be, gathered. If the costs of delay appear higher than the costs of potentially mistaken action, hunches are an appropriate foundation for action.

In evaluating the reliability of hunches, policymakers should consider not only the lack of data, but the possibility that a hunch has been influenced by the biases or personal preferences of its authors. Experts, like lay persons, are subject to various unconscious psychological biases that tend to make their guesses unreliable.[226] Some observers consider scientists to be as error-prone and overconfident as the lay public when they are not relying on empirical

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morally compelling, is still only conjecture.").

224. *See supra* note 202.

225. Indeed, lending credence to such hunches may blur our concept of science, reducing public confidence in knowledge that has passed through its full system of filters. *See* Ayala & Black, *supra* note 164, at 230.

226. Even trained statisticians suffer from representativeness bias, in which they erroneously believe samples are very similar to one another or to the population; availability bias, in which they assess the probability of an event on the basis of the ease with which examples come to mind; and anchoring bias, in which decisions are reached by incremental adjustment of an initial response, underestimating the probability of failure. *See* UNDERSTANDING RISK, *supra* note 54, at 11-13; Daniel Kahneman & Amos Tversky, *Subjective Probability: A Judgment of Representativeness*, *in* JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES 32, 46 (Daniel Kahneman et al. eds., 1982) [hereinafter JUDGMENT UNDER CERTAINTY]; Daniel Kahneman & Amos Tversky, *On the Psychology of Prediction*, *in* JUDGMENT UNDER UNCERTAINTY, *supra*, at 48, 68.

data.[227] Indeed, scientists may be subject to a special form of self-deception, mistaking their political views or value judgments for scientific knowledge.[228]

Scientific norms are designed to limit the role of personal preferences in evaluation of scientific data. Research scientists have traditionally been trained to prefer false negative results, in which a true hypothesis is incorrectly rejected, to false positives, in which a false hypothesis is wrongly adopted.[229] Scientists profess a norm of conservative data interpretation.[230] Furthermore, scientists take pride in their ability to minimize the impact of their personal biases and desires on their observations and interpretations.[231]

Nonetheless, these traditional professional norms will not always be effective in limiting the role preferences play in hunches. The constraints usually provided by empirical observations obviously operate less effectively on untested, and not at all on untestable, hunches. Freed of these constraints, scientists are no more likely than the general population to adhere to their stated ethical norms.[232] In evaluating the weight to give scientific hunches, policymakers should be aware that pressures to publish, desires for reputational or pecuniary gain, and strong feelings about the consequences of their studies may all drive scientists outside the bounds of their stated professional norms.[233]

C. Identifying the Best Available Scientific Information

Congress has done more than mandate application of scientific information to listing decisions. Recognizing that the quality of scientific

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227. *See* Kahneman & Tversky, *Subjective Probability*, *supra* note 226, at 46. Scientists may even be more overconfident, as they "often suffer from hubris." Franklin, *supra* note 33, at S-76.

228. *See* Ezrahi, *supra* note 28, at 118.

229. Kristin S. Shrader-Frechette, *Science, Environmental Risk Assessment, and the Frame Problem*, 44 BIOSCIENCE 548 (1994); SCIENCE AND THE ESA, *supra* note 15, at 17.

230. Franklin, *supra* note 33, at S-76; Murphy & Noon, *supra* note 161, at 774 ("As scientists, we have been trained (or, better, should have been trained) to treat facts with doubt.").

231. Cournand, *supra* note 36, at 700. For example, a federal research scientist told my research assistant, quite sincerely, that he and other scientists "consciously suppress biases" when engaged in peer review, judging only the technical aspects of the work.

232. *See* C. Ian Jackson & John W. Peados, *Honor in Science*, 71 AM. SCIENTIST 462 (1983) ("[S]cientists are subject to the same temptations that afflict the general population."). There seems little reason to suppose that scientists do a better job than others of resisting those temptations.

233. Pressures to attract funding and to publish large numbers of papers may encourage researchers to exaggerate the significance of their research results, or even to fabricate results. *See* NATIONAL ACADEMY OF SCIENCES ET AL., 1 RESPONSIBLE SCIENCE: ENSURING THE INTEGRITY OF THE RESEARCH PROCESS 69, 75 (1992); Cournand, *supra* note 36, at 700-02; BELL, *supra* note 182, at xii-xiii, 183-84 (shrinking federal funding and pressure to publish increase incentives to cut scientific corners).

information varies, it has commanded application of the best available scientific information. That standard does not rule out hunches or uncertain information. It does require the listing agencies to critically evaluate the available information, preferring that which is most reliable. The scientific process can be used to make these distinctions.

1. The Best Available Science May Be Uncertain

Science by its very nature cannot produce absolutely certain, unshakeable knowledge.[234] Simply by mandating reliance on science, Congress implicitly sanctioned some uncertainty. By calling for reliance on the "best available" scientific information, Congress explicitly recognized that in some circumstances the scientific evidence supporting listing determinations might be weak.[235] Both the listing agencies and the courts have recognized that the evidence supporting ESA listing determinations need not be conclusive.[236]

Use of uncertain data is an appropriate policy choice in this context. Two major concerns have been expressed about reliance on shaky data in other contexts. The first is that the decisionmaker might be fooled into giving the data more weight than it deserves. The second is that overzealous regulators might use the mere possibility of a threat to a species to protect it unnecessarily. Neither is a serious concern in the ESA listing context.

Although both judges and legislatures have been uneasy about permitting the use of uncertain scientific data in court, agency decisions do not present the same concerns. Restrictions on scientific testimony in court have been driven to a substantial degree by fears that scientifically-illiterate juries will be unable to evaluate evidence presented in scientific garb.[237] Regulation simply does not implicate those fears. The listing agencies are scientifically

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234. *See supra* notes 160-63, 182 and accompanying text; *see also* Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579, 590 (1993) (noting that "arguably, there are no certainties in science").

235. In *Industrial Union Dept., AFL-CIO v. American Petroleum Inst.*, 448 U.S. 607 (1980), the Supreme Court held that courts reviewing agency decisions under a section of the Occupational Safety and Health Act, which calls for application of the "best available evidence," must give the agency "some leeway where its findings must be made on the frontiers of scientific knowledge."

236. Defenders of Wildlife v. Babbitt, 958 F. Supp. 670, 679 (D.D.C. 1997) ("The statute contains no requirement that the evidence be conclusive in order for a species to be listed."); Alabama Sturgeon Withdrawal, *supra* note 67, at 64,799 (standard "does not require the Service to possess detailed or extensive information upon the general biology of the species or an actual determination of the causes for this status"); Threatened Status for the Louisiana Black Bear and Related Rules, 57 Fed. Reg. 588, 589 (1992) (best available scientific and commercial information "need not be statistically valid population estimates or counts") [hereinafter Black Bear Rule].

237. Edward J. Imwinkelried, *Coming to Grips with Scientific Research in Daubert's "Brave New World:" The Courts' Need to Appreciate the Evidentiary Differences Between Validity and Proficiency Studies*, 61 BROOKLYN L. REV. 1247, 1247-48 (1995).

expert, not illiterate, and may be relied on to separate promising from unreliable information at the frontier of science. Indeed, Congress has deliberately delegated that responsibility to them. Nor are regulators under the same pressures courts experience to resolve disagreement "finally and quickly."[238] Agency rules may, and in the ESA context must, be re-examined periodically.[239]

Nor does the use of uncertain data in this context invite the agency to list species on a whim. Both political and legal barriers stand in the way of unnecessary listing. The political barriers are interposed by those likely to be affected by listing. The legal barrier comes from section 10 of the Administrative Procedure Act,[240] which requires courts to set aside arbitrary or capricious agency actions. That floor is adequate to prevent unjustified listings.[241]

The arbitrary or capricious review standard is deferential, affording the agency action a presumption of validity.[242] Agencies are granted substantial discretion within fairly loose legislative bounds. They can maximize this discretion by emphasizing the technical nature of their decisions, thereby discouraging intrusive judicial review.[243] Courts are properly reluctant to

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238. *Daubert*, 509 U.S. at 597.

239. The agencies must reconsider their listing decisions if new information comes to light through the petition process. *See* 16 U.S.C. § 1533(b)(3)(A) (1994). In addition, they must review the status of listed species every five years, and that of species they have designated "warranted but precluded" annually. *Id.* § 1533(b)(3)(C) and (c)(d). This regular re-evaluation should reduce the costs of any errors that occur. *See* SMITH, *supra* note 23, at 69 (work that would "not satisfy academic specialists who insist on the utmost scientific rigor" may nonetheless be useful for a regulatory agency).

240. 5 U.S.C. § 706 (1994).

241. *See* United States v. Guthrie, 50 F.3d 936, 945-46 (11th Cir. 1995) (applying the arbitrary and capricious standard to the review of ESA listings); Idaho Farm Bureau Fed'n v. Babbitt, 58 F.3d 1392, 1401 (9th Cir. 1995) (same); City of Las Vegas v. Lujan, 891 F.2d 927, 932 (D.C. Cir. 1989) (same). Indeed, it might be argued that the availability of review under the APA renders the best available scientific information requirement of the ESA irrelevant. Even without that explicit requirement, a technical decision made without taking into account all the relevant scientific data available is likely to be reversed. *Cf.* Inland Empire Pub. Lands Council v. United States Forest Serv., 88 F.3d 754 (9th Cir. 1996) (holding that analysis of habitat requirements for purposes of the National Forest Management Act was not arbitrary or capricious because it used all available scientific data); Thomas Creek Lumber & Log Co. v. United States, 32 Fed. Cl. 787, 791, *aff'd without opinion*, 73 F.3d 379 (Fed. Cir. 1995) (holding Bureau of Land Management did not act arbitrarily and capriciously in suspending a logging contract due to a spotted owl survey because the survey was conducted in a manner recognized as valid in the scientific community).

242. Citizens to Preserve Overton Park, Inc. v. Volpe, 401 U.S. 402, 415 (1971); NRDC v. EPA, 16 F.3d 1395, 1400 (4th Cir. 1993); Ethyl Corp. v. EPA, 541 F.2d 1, 34 (1976); Carlton v. Babbitt, 900 F. Supp. 526, 529 (D. D.C. 1995).

243. *See* Wagner, *supra* note 17, at 1662-66 (noting that judicial reluctance to oversee technical decisions encourages agency "science charades").

second-guess either the expert agencies' conclusions[244] or their "choice of scientific data and statistical methodology."[245] Consequently, if scientific experts disagree on the interpretation of the available data, the agency's determination is unlikely to be disturbed.[246] Furthermore, the agency may rely on weak data, provided it acknowledges the limitations of those data, explains why those limitations do not undermine its conclusion,[247] and does not ignore countervailing information.[248]

Nonetheless, even with respect to a decision carrying strong technical overtones, review under the arbitrary or capricious standard is not entirely pro forma. The agency may not simply assert that general knowledge or expertise justifies its conclusion; it must point to some scientific support in the administrative record.[249] It must consider all relevant factors and adequately explain its reasoning.[250] For example, if the agency chooses to use a computer model which generates a range of possible extinction probabilities, it may not reject the low estimates without an adequate explanation.[251] Similarly, the agency may apply data from one species to a similar species, provided it acknowledges the uncertainty inherent in extrapolations across species lines.[252] The agency has no obligation to

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244. Baltimore Gas & Elec. Co. v. NRDC, 462 U.S. 87, 103 (1983) ("[A] reviewing court must remember that the [agency] is making predictions, within its area of special expertise, at the frontiers of science. When examining this kind of scientific determination, as opposed to simple findings of fact, a reviewing court must generally be at its most deferential.").

245. Louisiana *ex rel.* Guste v. Verity, 853 F.2d 322, 329 (5th Cir. 1988) (court will not question whether agency's conclusions rest on the best scientific data available, provided they meet "minimal standards of rationality") (internal quotations omitted).

246. *See* Marsh v. Oregon Natural Resources Council, 490 U.S. 360, 378 (1991); Guthrie, 50 F.3d at 945-46 ("Having examined the articles, studies, and books relied upon by the Secretary when he concluded that the Alabama red-bellied turtle is a separate taxonomic species, we are satisfied that, despite the absence of total agreement within the scientific community, his finding is entirely reasonable. It certainly is not arbitrary or capricious."); Carlton v. Babbitt, 903 F. Supp. 96, 110 (D.D.C. 1995) ("disagreement between scientists is not sufficient to demonstrate arbitrariness by the government").

247. Friends of Endangered Species v. Jantzen, 760 F.2d 976, 983-84 (9th Cir. 1985).

248. Pyramid Lake Paiute Tribe v. United States Navy, 898 F.2d 1410, 1415 (9th Cir. 1990).

249. NRDC v. Administrator, 902 F.2d 962, 968 (D.C. Cir. 1990); Parravano v. Babbitt, 837 F. Supp. 1034 (N.D. Cal. 1993).

250. Baltimore Gas & Elec. Co. v. NRDC, 462 U.S. 87, 105 (1983); Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co., 463 U.S. 29, 43 (1983).

251. Idaho Dept. of Fish & Game v. NMFS, 850 F. Supp. 886 (D. Or. 1994), *vacated as moot*, 56 F.3d 1071 (9th Cir. 1995).

252. *See, e.g.*, Final Rule Determining Endangered Status for the Southwestern Willow Flycatcher, 60 Fed. Reg. 10,694, 10,702 (1995) ("The Service carefully considered the propriety of using information on other willow flycatcher subspecies. . . . In applying such information, the Service considered ecological similarities and dissimilarities between the subspecies. The Service believes that data from other subspecies are applicable in some cases, but not others. The Service has identified which subspecies provided data sources throughout the proposed and final rules.") [hereinafter Flycatcher Rule].

discover information not available in the general scientific literature,[253] but it must consider significant information brought to its attention by interested persons.[254]

The available scientific information must be judged in light of the stringent deadlines the ESA imposes on listing determinations. The listing agencies may not postpone determinations in order to gather additional scientific information.[255] Consequently, it is reasonable to allow them to extrapolate from a limited data set, despite the heightened potential for error, when the exhaustive observations necessary to produce more reliable information are not feasible.[256] When the agency acts under its emergency listing powers, temporarily listing a species in order to forestall its imminent extinction, it may rely on data which are quite inconclusive.[257] Nonetheless, even in this situation, a listing made without sufficient scientific evidence to warrant at least a plausible hunch likely would not survive judicial review.

2. *Using the Scientific Process*

Where the agencies have the luxury of multiple information sources, they may be faced with conflicting information.[258] In these circumstances, the

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253. *See* United States v. Guthrie, 50 F.3d 936, 944 (11th Cir. 1995).

254. *See generally* Idaho Dept. of Fish & Game, 850 F. Supp. 886; *see also* Carlton v. Babbitt, 900 F. Supp. 526, 531 (D. D.C. 1995) (decision not to reclassify population of grizzlies as endangered was arbitrary and capricious because agency rejected plaintiff's population estimate without explanation); Conner v. Burford, 848 F.2d 1441, 1454 (9th Cir. 1988) (agency "cannot ignore available biological information").

255. The agencies understand this limitation. *See* Notice of Determination to Retain the Threatened Status for the Coastal California Gnatcatcher Under the Endangered Species Act, 60 Fed. Reg. 15,693, 15,697 (1995) [hereinafter Gnatcatcher Notice]:

> [S]ection 4(b) of the Act requires the Service to make its listing decisions within set timeframes and requires the Service to base its listing decisions on the best scientific and commercial data available at the time of the decision. The Service is not authorized to delay listing decisions until all studies of arguable utility are completed, until scientific debate is exhausted, or until complete consensus occurs.

See also Determination of Endangered Status for the Delhi Sands Flower-loving Fly, 58 Fed. Reg. 49,881, 49,884 (1993) ("The Service acknowledges that more precise scientific information will benefit the fly's recovery, but is [sic] not a legitimate basis for postponing a listing decision.") [hereinafter Delhi Sands Fly Rule]. *But cf.* Roosevelt Campobello Int'l Park Comm'n v. EPA, 684 F.2d 1041, 1052-54 (1st Cir. 1982) (setting aside "no-jeopardy" determination under § 7 on grounds that additional studies were required).

256. *See* Louisiana *ex rel.* Guste v. Verity, 853 F.2d 322, 329 (5th Cir. 1988).

257. *See* 16 U.S.C. § 1533(b)(7) (1994) (permitting emergency listings, effective for no more than 240 days); City of Las Vegas v. Lujan, 891 F.2d 927, 933 (D.C. Cir. 1989).

258. In many cases, listing decisions involve species which have been the subject of only very limited study. In those cases, whatever small amount of scientific information is available necesssarily constitutes the best scientific information available; the only question is whether it is sufficient to justify listing.

agencies should apply the scientific process to identify the best available information; doing so requires that they follow the usual information-sorting conventions of the scientific community.[259] Reviewing courts should not hesitate to require an explanation if the agencies depart from those conventions.

a. Data Gathering and Evaluation

The listing agencies have developed a policy on information standards which generally tracks the scientific process with regard to the creation and evaluation of information. The policy directs agency biologists to rely on primary sources—original communications rather than subsequent retellings or explanations—when possible.[260] It also tells them to affirmatively seek data contrary to the agency's proposed action.[261] Both of these suggestions track conventional scientific practice.

FWS' draft guidance for identifying and monitoring candidate species[262] offers additional advice. It instructs agency biologists to develop a network of sources, become familiar with the scientific literature, and consult with others who might have expertise.[263] It exhorts them not to limit their searches to published data, suggesting that they also consult unpublished FWS reports, other government documents, first-hand observations, and other items from the "gray literature," that is, the wealth of information not formally reported in peer-reviewed journals.[264] This suggestion is also consistent with scientific practice. When it identifies candidate species, FWS is essentially making a judgment that those species *may* warrant listing under the ESA, and do warrant further evaluation. Scientific convention sanctions consideration of any available information, whether published or not, as the raw material from which to generate this sort of hunch or hypothesis for further evaluation. Nonetheless, recognizing that unconfirmed information is typically treated by scientists with some caution, FWS subsequently reminded its biologists that the peer-reviewed literature should be regarded as considerably more reliable

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259. FWS has acknowledged the importance of adhering to general scientific practices. *See* Gnatcatcher Notice, *supra* note 255, at 15,698 (the ESA "require[s] that we recognize and act in accordance with the concepts, conventions, and practices of the scientific method").

260. Notice of Interagency Cooperative Policy on Information Standards, 59 Fed. Reg. 34,271 (1994) [hereinafter Policy on Information Standards].

261. *Id.*

262. Fish and Wildlife Service, Endangered Species Program: Candidate Species Guidance (Draft, Nov. 1994) [hereinafter Draft Candidate Species Guidance]. To date no final guidance has been issued.

263. *Id.* at 29-31.

264. *Id.* at 30-31.

than anecdotal information.[265]

Individual listing decisions offer additional insight into the agencies' information evaluation philosophy. FWS has explicitly recognized the important role expert judgment plays in many scientific decisions. For example, in one decision it noted that mechanical statistical tests cannot substitute for the evaluation of significance by an informed investigator,[266] and acknowledged an obligation to give "due regard" to the opinions of recognized experts in the field.[267] The same decision shows that FWS is willing to accept data which have been filtered by a qualified observer, provided that filtering is adequately explained.[268] FWS also considers methodology in evaluating data. It recognizes that both established techniques which are widely accepted in the field and novel techniques based on established principles may generate reliable data.[269]

Notwithstanding its endorsement of review of the "gray literature" to identify candidate species, FWS is reluctant to rely on those sources to support actual listings. In announcing its recent decision to withdraw the proposed listing of the Alabama sturgeon, FWS rejected the use of anecdotal evidence altogether and even appeared to renounce any reliance on data not yet published in the peer-reviewed literature.[270] Nonetheless, it is clear that FWS believes some unpublished reports are reliable and can form the basis for listing decisions. In the very same document, FWS relied upon a genetic

265. Memorandum from FWS Director to Regional Directors, Petition Findings Under the Endangered Species Act; A Clarification (Nov. 30, 1995) (Appendix A to United States Fish & Wildlife Service and National Marine Fisheries Service, Endangered Species Petition Management Guidance (1996) [hereinafter Petition Findings Memorandum]).

266. Gnatcatcher Notice, *supra* note 255, at 15,697.

267. *Id.* at 15,698. "Due regard" appears to entail substantial deference. The Director's 1995 Memorandum listed "information supplied by recognized experts" among the most reliable information sources, without further qualification regarding its nature, source, or presentation. *See* Petition Findings Memorandum, *supra* note 265.

268. *See* Gnatcatcher Notice, *supra* note 255, at 15,695 (accepting explanation that one data point was excluded from analysis because it deviated greatly from the mean of other observations); *see also* Idaho Dept. of Fish & Game v. NMFS, 850 F. Supp. 886 (D. Or. 1994), *vacated as moot*, 56 F.3d 1071 (9th Cir. 1995).

269. FWS relied on both "[w]idely accepted" and "newly available" techniques to estimate the population level of the golden-cheeked warbler. Final Rule to List the Golden-Cheeked Warbler as Endangered, 55 Fed. Reg. 53,153, 53,155 (1990) [hereinafter Warbler Rule].

270. *See* Alabama Sturgeon Withdrawal, *supra* note 67, at 64,805 ("the decision whether to list this species has not been based on anecdotal information"). In the same notice, FWS appeared to concede that only articles published or accepted for publication in peer-reviewed scientific journals may be considered "taxonomic authorities." *See id.* at 64,806 ("The Service did not intend to imply that the study by Mayden and Kuhajda, which had not been accepted for publication at that time, was the taxonomic authority for" the listing); *id.* at 64,795 (indicating that "until such time as the Alabama sturgeon's taxonomic status is revised in an appropriate peer-reviewed scientific journal and accepted by the scientific community," FWS will consider it a distinct species).

test performed by a contract laboratory on a single specimen.[271] That test had not been published in the peer-reviewed literature and, given its limited interest outside the listing dispute, likely could not have been. In another listing document, FWS said that it considers not only peer-reviewed publications, but also reports from the Forest Service and Bureau of Land Management and dissertations or reports from research institutions reliable, because it assumes those studies "have undergone technical review."[272] FWS does not assume that other sources are reliable, and believes they should be confirmed before they are relied on to support a regulation.[273]

The listing agencies should not limit their consideration to published reports.[274] Science in many fields is characterized by continual, sometimes quite rapid, progress. The best available information will often be the newest information, obtained through informal channels prior to formal publication. Moreover, the most reliable information available may focus on a single attribute of a single species; it may not be of sufficiently general interest to warrant publication in the peer-reviewed literature.[275] Nonetheless, no reasonable scientist working in the field would ignore such information. Since Congress has, by requiring reliance on the best available science, instructed the agencies to follow the example of scientists in the field, the agencies should not ignore unpublished information either. Instead, they should evaluate its reliability on the basis of methodology, the presence or absence of confirming studies, the reputation of its authors in the field, and any other relevant factors.

In at least one respect, FWS' data-evaluation practices deviate significantly from scientific norms: the agency solicits and considers the input of the general public.[276] The Administrative Procedure Act mandates such consideration,[277] and this attention to public input also is consistent with the ESA's requirements that the listing agency notify the affected community of proposed decisions.[278] Nonetheless, it directly contradicts the norms of

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271. *See id.* at 64,802.

272. Flycatcher Rule, *supra* note 252, at 10,704.

273. *Id.*

274. The Environmental Protection Agency reportedly makes a practice of discussing only research already published in peer-reviewed journals in the documents which justify its national ambient air quality standards. *See* JASANOFF, *supra* note 29, at 102. An across-the-board practice of ignoring unpublished data, although understandably attractive as a strategy to deflect criticism, would be inconsistent with the ESA's requirement that the agencies apply the best available science.

275. *See infra* note 596 and accompanying text.

276. *See, e.g.*, Gnatcatcher Notice *supra* note 255, at 15,694.

277. 5 U.S.C. § 553 (1994); *see also* 16 U.S.C. § 1533(b)(4) (1994) (except as otherwise explicitly provided, 5 U.S.C. § 553 applies to regulations promulgated under the ESA).

278. *See* 16 U.S.C. § 1533(b)(5)(D)-(E) (1994).

science, which permit consideration only of informed opinions.[279] The best available science mandate requires that the agencies not give public comments any more weight than they would merit in a scientific debate, which is likely to be very little unless they come from members of the scientific community.

b. Communication and Response to Criticism

The scientific process does not end with the gathering of data. It also requires communication of that data in an appropriate form to the relevant audience.[280] While the listing agencies have generally been careful to adhere to scientific practices in the data-gathering process, they have been less conscious of the need to follow scientific convention through the subsequent stages of the scientific process.

The agencies recently made a commitment to one common element of the communication of scientific data, peer review before wide circulation of conclusions. Responding to criticism of their listing practices, the agencies adopted a policy of soliciting peer review of listing proposals by "three appropriate and independent specialists."[281] The policy does not require the agency to retreat from a proposal criticized by peer reviewers, but it does require inclusion of a summary of the reviewers' opinions in the final decision document.[282]

In other respects, however, the agencies continue to disregard scientific norms with respect to communication. Listing documents do not always

279. *See supra* note 181 and accompanying text.

280. *See supra* notes 177-78 and accompanying text.

281. Policy on Information Standards, *supra* note 260, at 34,270. The peer review policy also applies to draft recovery plans.

282. *Id.* Because this policy was adopted shortly before Congress imposed a year-long moratorium on listings, its impact cannot yet be comprehensively evaluated. A cursory review of recent listing documents suggests that the policy has not altered agency practice to any significant extent. For example, it is not even mentioned in the recent rule listing Umpqua River cutthroat trout. *See* Endangered Status for Umpqua River Cutthroat Trout in Oregon, 61 Fed. Reg. 41,514 (1996) [hereinafter Cutthroat Trout Rule]. In the willow flycatcher decision, FWS ignored the policy. In response to a request that it seek peer review, the agency explained that the public comment period and public hearings provide the mechanisms for scientific peer review. Flycatcher Rule, *supra* note 252, at 10,704. FWS did solicit analyses by independent federal biologists of the data supporting its gnatcatcher listing, but that may have been a response to litigation, rather than to the peer review policy itself. *See* Gnatcatcher Notice, *supra* note 255, at 15,694. The policy does not appear to be judicially enforceable. *See* Building Indus. Ass'n v. Babbitt, 1997 WL 595302, at *7 (D.D.C. 1997).

When it is sought, peer review does not appear to have much effect on decisions. For example, FWS submitted its proposal to reclassify the Maguire daisy to four peer reviewers, two of whom were authors of studies relied upon in the rule. Three of the four provided written comments, all agreeing with the agency's analysis. *See* Reclassification of *Erigeron maguirei* (Maguire daisy) from Endangered to Threatened, 61 Fed. Reg. 31,054, 31,055 (1996) [hereinafter Maguire Daisy Rule].

contain enough information to allow others to evaluate their scientific merit. For example, the agencies have described data as "statistically significant" without explaining the confidence level at which significance was evaluated.[283] They frequently rely on unpublished studies, personal communications, and discussions with biologists outside the agency without sufficient explanation.[284] Although unpublished data can provide an adequate foundation for agency action, such data can present a substantial obstacle to evaluation of that action. The problem is particularly acute in the ESA listing context, where outsiders to the scientific community have a strong stake in the outcome but little access to the informal channels of scientific communication.

Not surprisingly, the agencies' reliance on unpublished information has given rise to substantial criticism. In one recent example, opponents of the decision to list the California red-legged frog claimed that FWS had violated its statutory duty to rely only on scientific information by considering unpublished data, some of which had been submitted by the biologists who petitioned for the listing. Because such data would be impossible for others to verify, the opponents contended, it was not scientific.[285]

FWS replied that the challenged information was not essential to the decision.[286] The agency also asserted the alternative justification that the information was properly considered based on the acknowledged expertise of the individuals who supplied it.[287] This response misses the point. The data may well have been properly considered, but FWS' obligations under the best available science mandate should not end with its choice of information

283. *See* Proposed Endangered Status for Five ESUs of Steelhead and Proposed Threatened Status for Five ESUs of Steelhead in Washington, Oregon, Idaho, and California, 61 Fed. Reg. 41,541, 41,548 (1996) [hereinafter Proposed Steelhead Rule].

284. *See, e.g.*, Warbler Rule, *supra* note 269, at 53,155; Determination of Endangered Status for the Conservancy Fairy Shrimp, Longhorn Fairy Shrimp, and the Vernal Pool Tadpole Shrimp, and Threatened Status for the Vernal Pool Fairy Shrimp, 59 Fed. Reg. 48,136 (1994) [hereinafter Fairy Shrimp Rule]; Determination of Threatened Status for the California Red-Legged Frog, 61 Fed. Reg. 25,813 (1996) [hereinafter Red-Legged Frog Rule].

285. *See* Red-Legged Frog Rule, *supra* note 284, at 25,817.

286. *See id.*:

> The majority of the personal observations cited in the petition refer to specific aspects of California red-legged frog biology, which is relevant to the species' management, but less important in determining species' status. Many of the references to unpublished data in the petition refer to distribution and status information that had been collected by the petitioners as part of their ongoing research to follow the status of the California red-legged frog. Much of their status information is supported by surveys conducted by numerous other qualified herpetologists.

287. "The researchers who petitioned the Service to list the California red-legged frog are acknowledged experts on this taxon as evidenced by numerous peer reviewed publications on the subject. . . . The Service, therefore, finds that the data presented by the petitioners are credible . . . ." *Id.*

to consider. If FWS chooses to rely on unpublished data, scientific norms require that it communicate those data in a manner that facilitates its evaluation by others.

The listing agencies have demonstrated a lack of concern with open communication in other respects as well. One minor illustration of their attitude is the increasing issuance of listing documents without supporting reference lists.[288] This practice places unnecessary obstacles even in the way of reviewing the published evidence supporting the decision.[289]

More serious deviations from the scientific ideal of open debate have also been alleged by critics on both sides of recent endangered species disputes. At the 1995 ESA oversight hearings, a witness asserted that opponents of the fairy shrimp listing had to file a formal request under the Freedom of Information Act[290] to obtain copies of documents FWS had relied upon.[291] Similarly, proponents of the listing of the Alabama sturgeon had to file a formal statutory request in order to obtain the results of a genetic test carried out for FWS.[292] Critics also charge that they are prevented from gathering or replicating data. For example, opponents of the fairy shrimp listing charged that the agency's refusal to reveal habitat locations denied them the opportunity to perform their own surveys for the species.[293] Opponents of the Alabama sturgeon listing complained that they were not allowed to take tissue samples from a captured sturgeon or to fully examine the body after the fish died.[294]

In several recent cases, the closed nature of the agencies' listing process has led courts to remand listing decisions. The Alabama sturgeon listing was set aside because FWS had submitted data for evaluation by an expert group in proceedings from which the public was excluded in violation of the

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288. *See, e.g.*, Gnatcatcher Notice, *supra* note 255, at 15,699; Fairy Shrimp Rule, *supra* note 284, at 48,152.

289. Anyone wishing to examine the evidence must go to the effort, and suffer the delay, of requesting the reference list from the FWS office responsible for the listing.

290. 5 U.S.C. § 552 (1994).

291. *Oversight Hearing*, *supra* note 7, at 39-40 (statement of Clifford H. Moriyama, California Chamber of Commerce).

292. Ray Vaughan, *State of Extinction: The Case of the Alabama Sturgeon and Ways Opponents of the Endangered Species Act Thwart Protection for Rare Species*, 46 ALA. L. REV. 569, 630-31 (1995).

293. *Oversight Hearing*, *supra* note 7, at 39-40 (statement of Clifford H. Moriyama, California Chamber of Commerce). FWS refused to release exact locations because it was concerned about vandalism or deliberate destruction of the creatures' vernal pool habitats. Fairy Shrimp Rule, *supra* note 284, at 48,142.

294. Alabama Sturgeon Withdrawal, *supra* note 67, at 64,803. FWS explained that tissue sampling of the live fish was kept to a minimum in an effort to avoid harming it, that additional time for examining the body could have been arranged through an official request, and that tissue samples were provided after a government necropsy. *Id.*

Federal Advisory Committee Act.[295] The listing of the Bruneau hotspring snail was set aside in part because FWS had refused to provide listing opponents with a copy of a draft report upon which the listing relied.[296] Each of these decisions requires the agencies to follow conventional scientific practices of open communication. Critics of the sturgeon decision feared they would be unable to respond to arguments which were not exposed to public view. Opponents of the snail listing alleged that they were hamstrung by an inability to review and challenge the draft report.[297] Each of these decisions, however, also rests on a legal obligation independent of the ESA's best available science requirement.

The third case most directly illustrates the relationship of the best available science mandate to the decisionmaking process. In deciding to list the coastal California gnatcatcher (*Polioptila californica*), a small bird, as a threatened species, FWS relied on published taxonomic works indicating that the gnatcatcher constituted a unique subspecies.[298] The decision ignited a firestorm of criticism from listing opponents. Dr. Johnathan Atwood, the taxonomist upon whose work the decision most heavily relied, had submitted one of three petitions which initiated the listing process.[299] What is more, only a few years earlier Dr. Atwood had published a paper which concluded that the California gnatcatcher was *not* taxonomically distinct from its Mexican relatives.[300] Listing opponents charged that Dr. Atwood's taxonomic change of heart stemmed from his desire to see the species listed, rather than his objective evaluation of the data. They demanded that FWS obtain and share with them the raw data upon which Dr. Atwood based his new conclusion.[301] Contending that Dr. Atwood's motives were irrelevant to the evaluation of his scientific paper, FWS refused to obtain his raw data. A

295. Alabama-Tombigbee Rivers Coalition v. FWS, 26 F.3d 1103 (11th Cir. 1994); *see also* Kaibab Indus. v. Lujan, No. CIV 91-1155 PHX WPC (D. Ariz. Jan. 29, 1992), *cited in* Vaughan, *supra* note 292, at 627 n.316 (FACA violation found but no relief given). The Federal Advisory Committee Act is codified at 5 U.S.C. app. 2 §§ 1-15 (1994).

296. Idaho Farm Bureau Fed'n v. Babbitt, 58 F.3d 1392, 1396 (9th Cir. 1995).

297. Actually the report was of questionable importance to the listing decision, but the agency had purported to rely on it.

298. *See* Determination of Threatened Status for the Coastal California Gnatcatcher, 58 Fed. Reg. 16,742 (1993) [hereinafter 1993 Gnatcatcher Rule].

299. Endangered Species Comm. of the Bldg. Indus. Ass'n of Southern California v. Babbitt, 852 F. Supp. 32, 34 (D.D.C. 1994). It is not unusual for biologists who work with a dwindling species to submit listing petitions based on their work. *See, e.g.*, Red-Legged Frog Rule, *supra* note 284, at 25,816. After all, those biologists typically have both special access to the data and a special interest in the species' survival.

300. *See* 1993 Gnatcatcher Rule, *supra* note 298, at 16,744.

301. When asked directly, Dr. Atwood had declined to provide listing opponents with his raw data. *Endangered Species Comm.*, 852 F. Supp. at 39.

lawsuit ensued.

The federal district court for the District of Columbia concluded that, in order to satisfy the statutory requirement that its decisions rest on the "best available scientific information," FWS must not only examine and evaluate the raw data but must also make that data available to others.[302] The court correctly reasoned that the "best available scientific information" standard not only imposed limits on the data on which the agencies could rely, but also imposed an obligation to communicate the data.

However, the court misconstrued the extent of that obligation. Dr. Atwood had explained the basis for his new interpretation in a published, peer-reviewed paper. Indeed, the new interpretation more closely tracked the prevailing view of the scientific community.[303] In evaluating Dr. Atwood's conclusions, FWS stood essentially in the position of a scientific reviewer. In light of the apparent consensus of the taxonomic community, a scientific reviewer would be unlikely to demand the raw data.[304] The court's decision exceeded the requirements of scientific convention, and therefore exceeded the agency's obligations under the best available science mandate.

From the perspective of open communication, however, the gnatcatcher dispute does point out a potential shortcoming of reliance on the conventional scientific process. Different scientists may reach different conclusions based on the same data, and even completely honest scientists may engage in unconscious selection or filtering of their data. Accordingly, while reviewers often will not insist on examining an investigator's raw data, "[a]fter publication, scientists expect that data and other research materials will be shared upon request"[305] in order to facilitate evaluation and extension of the work. By the same token, critics of studies relied on by the listing agencies may find it difficult to fully evaluate those studies without the underlying data, or at least a description of any data filtering carried out in generating the studies. While the agencies should not be burdened with an obligation to collect, store, and disseminate the raw data underlying studies, they should seek to ensure that the studies they rely on contain a full discussion of any filtering steps.

The agency's apparent reluctance to share information is inconsistent both

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302. *Id.* at 37.

303. *Id.* at 34-35; 1993 Gnatcatcher Rule, *supra* note 298, at 16,744.

304. In most fields, reviewers traditionally have not examined an investigator's raw data. Practices and expectations may be changing in some fields, however. For example, some genetic research journals are now reportedly insisting that data be submitted to an Internet database prior to publication. *See* Jim Puzzanghera, *Internet Overload is Forcing Scientists to Filter Information*, SAN JOSE MERCURY NEWS, Dec. 3, 1996, at 1F.

305. ON BEING A SCIENTIST, *supra* note 160, at 12.

with the healthy functioning of the scientific process and with publicly accountable decisionmaking. It greatly increases the barriers to outside evaluation of listing decisions. In order to lower those barriers as far as possible, the agencies should prefer published studies when available. In addition to the increased indicia of reliability, published data has the advantage of being widely available to critics. The agencies should also prefer studies that openly acknowledge both any data selection undertaken, and the level and sources of uncertainty. If this information is not provided, the agencies should seek to obtain it.

When they choose to rely on unpublished reports, the agencies should be sensitive to the fact that many interested parties are not members of the scientific community, and consequently lack ready access to its informal channels of communication. The agencies should make special efforts to ensure that unpublished information is accessible to all participants in the listing debate. Supplying the name and affiliation of the source of an unpublished communication, as FWS typically does, is not sufficient. For one thing, it may be difficult to contact these observers. For another, independent scientists are under no obligation to discuss their observations with others. Like Dr. Atwood, they may not have the time or inclination to do so.[306] Finally, the mere citation of unpublished data offers no information about the data's accuracy or reliability. Nor does the agencies' promise to keep a copy of unpublished materials in the administrative record[307] solve the problem. Aside from the fact that this promise is not always kept,[308] unpublished data and personal communications are likely to be presented in an unpolished style that makes them difficult to evaluate.

The agencies should look to the scientific process to improve their treatment of such materials. They should produce a listing package containing all the data necessary to the decision, with supporting information, in a form similar to a scientific publication. Although they need not clutter the Federal Register with all this detail, they should freely share it with anyone who requests it.

IV. THE STRICTLY SCIENCE MANDATE CONFRONTS REALITY: THE SCIENCE AND ART OF LISTING

The decision to list a species under the ESA presents the listing agency with two difficult problems. The "taxonomy problem" requires the agency to

306. *See supra* note 301.
307. Policy on Information Standards, *supra* note 260, at 34,271.
308. *See* Idaho Farm Bureau Fed'n v. Babbitt, 58 F.3d 1392, 1402 (9th Cir. 1995).

determine whether a particular group of organisms constitutes a "species" within the meaning of the statute. The "viability problem" requires it to decide whether a species is "endangered" or "threatened." Superficially, each of these problems appears amenable to a strictly scientific solution. Indeed most commentators, as well as participants on both sides of the ESA reauthorization debate, agree that listing determinations are scientific.[309] In fact, however, both prongs of the listing decision force the agencies to look beyond scientific information. As a result, agency practices inevitably fail to measure up to the legislative and public vision of value-neutral scientific decisions.

A. The Taxonomy Problem: Identifying Protectable Groups

> The science of taxonomy, as we have learned too late, offers opponents of Federal public works projects a virtually limitless arsenal of weapons with which to do battle.[310]
>
> One of my worst nightmares envisions a congressional floor debate regarding the definition of 'subspecies' or 'distinct population.' This is an inherently scientific issue with no real place in the legislative process, and it should be resolved by scientists.[311]

Taxonomy, identified by one of its best known modern practitioners, Ernst Mayr, as biology's oldest branch,[312] is the discipline of identifying and classifying kinds of organisms.[313] The classification of nature has preoccupied human-kind since before the dawn of written history.[314] Yet some of the most fundamental taxonomic questions remain unanswered.[315] Perhaps the most fundamental is the question of how to delineate natural kinds, the essence of the ESA's taxonomy problem.

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309. *See, e.g.*, Patrick H. Zaepfel, *Legislating for Uncertainty: Preserving Administrative Flexibility to Interpret "Species" Under the Endangered Species Act*, 4 DICK. J. ENVTL. L. & POL'Y 152 (1995); Karl Gleaves et al., *The Meaning of "Species" Under the Endangered Species Act*, 13 PUB. LAND L. REV. 25 (1992); Stelle, *supra* note 13, at 325; *Oversight Hearing*, *supra* note 7, at 50 (statement of Daniel Taylor, National Audubon Society); *id.* at 22 (statement of Robin Rivett, Pacific Legal Foundation attorney).

310. S. REP. NO. 96-151, at 14 (1979), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 1391, 1403 (additional views of Sen. Baker).

311. Stelle, *supra* note 13, at 325.

312. MAYR, *supra* note 174, at 243.

313. *Id.* at 146. The term "systematics" is sometimes used interchangeably with "taxonomy," although some would consider systematics a broader discipline, encompassing the study of the diversity of organisms and all their interrelationships. *See id.* at 246.

314. *See id.* at 84, 134-35, 252.

315. *See id.* at 144.

1. The Meaning of "Species"

The ESA's definition of "species" is singularly uninformative. It is merely a list masquerading as a definition: "The term 'species' includes any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature."[316] The legislature's failure to further define "species," "subspecies," and "distinct population segment" could indicate either that it assumed the terms were unambiguous or that it could not devise acceptable definitions. The absence of any discussion of these terms in the early legislative history supports the former explanation, at least with respect to "species" and "subspecies".[317] At the same time, the deliberate expansion of the statutory term to include lower taxonomic categories suggests an intent to reject narrow technical interpretations of the groups within the law's scope.

At the conceptual level, the meaning of species is reasonably clear: the term refers to a natural grouping or kind distinguishable from others.[318] Nonscientists recognize two major grounds for differentiating between groups of creatures: differences in physical form, or morphology;[319] and the boundaries of sexual compatibility, the ability to mate and produce fertile offspring.[320] Both these bases for classification are consistent with an "essentialist" view of species as invariant and fundamentally distinct from one another, as in the Platonic ideal of unchanging forms or the biblical concept of unvarying kinds created by God.[321] One would expect essential kinds to appear different from, and not to be capable of interbreeding with, other essential kinds. Many people probably harbor at least an unconsciously essentialist view of species. In familiar usage, the term species still carries

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316. 16 U.S.C. § 1532(16) (1994).

317. The term "distinct population segment" did not appear until 1978. *See infra* note 349 and accompanying text.

318. As one commentator has pointed out, even children can identify many common species by their visual characteristics. *See* John Charles Kunich, *The Fallacy of Deathbed Conservation Under the Endangered Species Act*, 24 ENVTL. L. 501, 505 (1994).

319. *See, e.g.*, RANDOM HOUSE WEBSTER'S COLLEGE DICTIONARY 1285 (1995) (providing the following as the first definition of "species": "a class of individuals having some common characteristics or qualities; distinct sort or kind"). For example, experienced birdwatchers can readily distinguish house finches from purple finches based on plumage differences. *See* ROGER TORY PETERSON, A FIELD GUIDE TO WESTERN BIRDS 343 (3d ed. 1990).

320. The second definition of species in RANDOM HOUSE WEBSTER'S COLLEGE DICTIONARY 1285 (1995) is: "the major subdivision of a genus or subgenus, regarded as the basic category of biological classification, composed of related individuals that resemble one another, are able to breed among themselves, but are not able to breed with members of another species." Horses and donkeys have long been recognized as distinct groups on this basis; while the mating of a horse and donkey can produce offspring, those offspring are sterile.

321. See MAYR, *supra* note 174, at 254-56.

essentialist connotations, which may contribute to the common assumption that species are readily and objectively distinguishable from one another.

Most scientific species classification schemes also rely on morphological and reproductive distinctions, albeit largely stripped of their essentialist connotations. The earliest taxonomic classification systems relied almost entirely on morphological differences to distinguish essential, invariant natural kinds.[322] The development of evolutionary theory, however, undercut the essentialist view by showing that species are capable of gradual transformation to entirely new forms. This revelation led Darwin to conclude that all species classification schemes are inherently arbitrary.[323] So long as species were viewed as stable, invariant creations, it was reasonable to suppose that all such forms could be cleanly differentiated from one another. But with the recognition that species evolve and disappear, it became apparent that such bright line distinctions were illusory.

Nonetheless, scientists did not abandon the pursuit of classification. Taxonomic systems remained useful for indexing information, and continued to reflect readily observable differences between natural groups. But taxonomists did add an evolutionary focus: they searched for classification schemes which would both recognize obvious morphological distinctions and account for evolutionary relationships.

This search culminated in 1940 with the proposal by Ernst Mayr of the biological species concept ("BSC"),[324] which relies on sexual isolation to distinguish natural groups. Mayr's BSC defines a species as a group of actually or potentially interbreeding populations reproductively isolated from other such groups.[325] Mayr focused on reproductive isolation because of its vital role in speciation, the process by which new species evolve. Groups

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322. *See id.* at 256-63; ALEC L. PANCHEN, CLASSIFICATION, EVOLUTION, AND THE NATURE OF BIOLOGY 114-21(1992).

323. MAYR, *supra* note 174, at 269.

324. Ernst Mayr, *Speciation Phenomena in Birds*, 74 AM. NATURALIST 249 (1940).

325. Stephen J. O'Brien & Ernst Mayr, *Bureaucratic Mischief: Recognizing Endangered Species and Subspecies*, 251 SCI. 1187 (1991). In other words, "a species is a population whose members are able to interbreed freely under natural conditions." EDWARD O. WILSON, THE DIVERSITY OF LIFE 38 (1992). Reproductive isolation need not be due to sexual infertility. Creatures which are biologically capable of producing fertile offspring may be prevented from doing so by a variety of isolating mechanisms, such as difference in breeding or flowering season, occupation of different habitats, or geographic barriers. *See* MAYR, *supra* note 174, at 274.

Any barrier that prevents most cross-breeding in nature will lead to genetic divergence. While the biological species concept ("BSC") emphasizes sexual isolation, Mayr points out that the groups it separates typically occupy distinct ecological niches. *Id.* at 276; O'Brien & Mayr, *supra*, at 1187. A "niche" is the habitat and ecological role a species occupies. SCIENCE AND THE ESA, *supra* note 15, at 94. Species distinguished by the BSC are also often, but not always, morphologically distinct. *See* MAYR, *supra* note 174, at 281-82 (describing morphologically identical "sibling species").

which regularly exchange genes through interbreeding tend to remain alike because adaptive traits can spread throughout the group. But if an interbreeding group is divided by geography, behavior, or some other factor into smaller subgroups which interbreed infrequently,[326] those subgroups will gradually evolve in different ways. Eventually, they will diverge to the extent that they are unable to interbreed successfully.[327] While reproductive isolation is responsible for this process, morphology provides a rough marker for it as the diverging subgroups become increasingly morphologically distinct.[328]

In the half-century since Mayr proposed it, the BSC has become the most widely known and utilized biological definition of species.[329] It is not universally accepted, however, because it is not universally applicable. Its emphasis on interbreeding, for example, makes it inapplicable to organisms like the common dandelion which reproduce primarily through asexual methods.[330] It is equally awkward to apply the BSC to organisms which are able to interbreed readily with other groups while still maintaining their own distinct morphological and genetic identity.[331] These difficulties have led

326. Geographic separation can occur in any number of ways. For example, a few members of the group may be transported to an island separated from the main population, or a habitat corridor linking two populations may be destroyed. Reproductive isolation can also result from behavioral changes, such as development of an earlier or later breeding cycle, or morphological changes that discourage interbreeding.

327. *See* THOMAS L. ROST ET AL., BOTANY: A BRIEF INTRODUCTION TO PLANT BIOLOGY 208 (2d ed. 1984); *see also* O'Brien & Mayr, *supra* note 325, at 1188 (populations which are sexually compatible but unable to exchange genes because of geographic or behavioral isolation become more genetically distinct with longer isolation, and more likely to become ecologically distinct species); SCIENCE AND THE ESA, *supra* note 15, at 52 (isolated groups diverge and eventually "lose their ability to interbreed").

328. *See* ROST ET AL., *supra* note 327, at 208.

329. *See* WILSON, *supra* note 325, at 38 (most evolutionary biologists accept the biological species concept); Hill, *supra* note 13, at 250 n.84 ("Biologists generally accept the [biological species] definition with some reservations.").

330. Dandelions typically reproduce by apomixis, a process in which viable seeds are formed from maternal tissue alone, without fertilization. *See* ROST ET AL., *supra* note 327, at 168; ALESSANDRO MINELLI, BIOLOGICAL SYSTEMATICS: THE STATE OF THE ART 70-71 (1993). Many other plants and fungi rely primarily or entirely on asexual reproduction. *See* SCIENCE AND THE ESA, *supra* note 15, at 54; PANCHEN, *supra* note 322, at 334. Even among animals, thousands of taxa reproduce asexually. MINELLI, *supra*, at 69.

331. Again, the author of the BSC recognizes this shortcoming. *See* MAYR, *supra* note 174, at 278. One study of California plants determined that less than half the members of eleven genera could be separated cleanly into species that did not interbreed. *Id.* at 280. Many of California's native oaks, for example, hybridize readily where their ranges overlap. BRUCE M. PAVLIK ET AL., OAKS OF CALIFORNIA 44-45 (1991).

FWS is well aware that many taxonomically recognized species are not strictly reproductively isolated. *See* Proposed Policy and Proposed Rule on the Treatment of Intercrosses and Intercross Progeny (the Issue of "Hybridization"), 61 Fed. Reg. 4710 (1996) [hereinafter Proposed Hybrid Policy] ("Examples of introgression (the transfer of genetic material from one taxonomic species to biologists to develop a host of competing species concepts, each based on the authors' perception of evolutionary relationships, but varying in accordance with the authors' choice of organisms to study.[332] Although evolution and therefore reproductive relationships form the ultimate foundation for all these species concepts, morphology, often the most readily-available evidence of evolutionary relationships, remains crucially important.[333]

Thus the morphological and reproductive distinctions long used by non-scientists to distinguish natural kinds persist at the core of modern taxonomic classification. Neither ordinary nor scientific usage of the term species, however, provides a firm foundation for understanding the degree or nature of the differences necessary to justify recognition of a separate group.

2. *Legislative History and the Statutory Definition of "Species"*

The ESA rests on a mix of evolutionary and essentialist assumptions, and demonstrates a concern for both morphological and reproductive distinctions. The legislative history, however, offers few clues to the puzzle of identifying groups worthy of protection. It demonstrates little more than the statutory definition itself, that some groups not recognized as species by taxonomists are nonetheless eligible for protection.

The pattern of simply listing types of groups eligible for protection without further explanation began with the early endangered species legislation. The 1966 Act used the term "species" to describe entities eligible for listing without attempting to define the term.[334] At this early stage, protection of subspecies was considered but rejected without explanation.[335]

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another, and its spread among individuals of the second species) are found throughout the plant and animal kingdom.").

332. For a general discussion of some of these competing concepts, *see* M.F. Claridge et al., *Practical Approaches to Species Concepts for Living Organisms*, *in* SPECIES: THE UNITS OF BIODIVERSITY 1 (M.F. Claridge et al. eds., 1997); Rojas, *supra* note 14, at 168; SCIENCE AND THE ESA, *supra* note 15, at 53; PANCHEN, *supra* note 322, at 337-38; MINELLI, *supra* note 330, at 62-72. So many different species concepts are currently in scientific use that the term species has become almost vacuous, providing only the information that some taxonomists have singled out a group for some reason. *See* Rojas, *supra* note 13, at 176.

333. *See* Claridge et *al.*, *supra* note 332, at 4; MAYR, *supra* note 174, at 45; PANCHEN, *supra* note 322, at 334, SCIENCE AND THE ESA, *supra* note 15, at 58. Increasingly, characteristics observable only at the molecular level, including DNA sequences and characteristic small molecules such as alkaloids, are being used to differentiate species and determine their evolutionary relationships. Non-morphological characteristics including behavior, life history, and geography are also assuming increasingly important roles. *See* MAYR, *supra* note 174, at 236-37.

334. Pub. L. No. 89-669, § 1(c), 80 Stat. 926 (1966).

335. 111 CONG. REC. 27,187, 27,188 (1965) (quoting the House bill, which would have allowed listing of "species or subspecies of native fish and wildlife"). The language "or subspecies" was removed from the Senate version without explanation. *See* 112 CONG. REC. 21,474 (1966).

The 1969 Act extended coverage to animal subspecies,[336] again without definition. The 1969 Senate report emphasized the evolutionary element, noting the value of species as genetic resources for future exploitation.[337] It also implicitly invoked the morphological meaning, noting that "the gradual elimination of different forms of life reduces the richness and variety of our environment."[338]

Explaining the need for the extensive revisions in the 1973 ESA, the House Committee on Merchant Marine and Fisheries appealed to both genetic and morphological values. It described the "genetic heritage" represented by the species of the world as of incalculable value.[339] Yet the example the committee chose to illustrate that value was the blue whale, described as "the largest animal in the history of this world."[340] The obvious implication is that the blue whale is worth preserving for its unique morphology—its remarkable size—alone.

The new legislative definition of the term "species" in the 1973 Act further demonstrates that Congress intended to protect more than evolutionary potential. The 1973 Act defined species as including not only subspecies of animals and plants, but also "any other group of fish or wildlife of the same species or smaller taxa in common spatial arrangement that interbreed when mature."[341] This new clause closely tracks Mayr's BSC,[342] a species concept based primarily on evolutionary relationships. Yet its origin suggests different motivations.

The new clause can be traced to the MMPA, which protected both species and "population stocks," the latter defined as groups "of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature."[343] The drafters of the MMPA developed the concept of population stocks primarily to ensure protection of Alaskan polar bears in the face of

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336. Pub. L. No. 91-135, § 3(a), 83 Stat. 275 (1969).

337. The Report noted that "with each species we eliminate, we reduce the pool of germ-plasm available for use by man in future years. Since each living species and subspecies has developed in a unique way to adapt itself to the difficulty of living in the world's environment, as a species is lost, its distinctive gene material, which may subsequently prove invaluable to mankind in improving domestic animals or increasing resistance to disease or environmental contaminants, is also irretrievably lost." S. REP. NO. 91-526, at 3 (1969).

338. *Id.*

339. H.R. REP. NO. 93-412 (1973), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 140, 143.

340. *Id.*

341. Pub. L. No. 93-205, § 3(11), 87 Stat. 884 (1973). A "taxon" is "a group of organisms of any taxonomic rank that is sufficiently distinct to be worthy of being named and assigned to a definite category." MAYR, *supra* note 174, at 207.

342. *See supra* text accompanying notes 324-28.

343. Pub. L. No. 92-522, § 3(11), 86 Stat. 1027 (1972).

disagreement in the scientific community over whether Alaskan bears belonged to a separate subspecies than other arctic bears.[344] Regardless of the evolutionary relationships among polar bears, Congress deemed it important to protect the domestic population. Thus, the population stock approach borrowed in the ESA, although seemingly evolutionary, was designed to protect groups considered valuable for reasons other than their evolutionary heritage.

In 1978, Congress rejected an amendment that would have limited the ESA's protections to groups meeting the most narrow definition of the BSC: sexually reproducing groups incapable of breeding with others. The House passed a bill which would have redefined "species" as "a group of fish, wildlife, or plants, consisting of physically similar organisms capable of interbreeding but generally incapable of producing fertile offspring through breeding with organisms outside this group."[345] This definition would have withdrawn recognition from groups which had become reproductively isolated in nature, but had not yet diverged sufficiently to become sexually incompatible. Furthermore, it would have precluded protection of asexually-reproducing organisms. The Senate rejected a similar proposal,[346] leaving the definition of species untouched.[347] The Conference Committee resolved the conflict by drafting the current, inclusive definition.[348]

While leaving the undefined catchall term "species" intact, the 1978 Amendments altered the earlier definition in two respects. First, Congress substituted the words "distinct population segment" for "any other group of fish or wildlife of the same species or smaller taxa in common spatial arrangement." Second, it limited protection of population segments to vertebrates. This second change clearly eliminated the possibility of protecting groups of invertebrates below the subspecies level. Whether the first change was intended to have any effect on the meaning of the term "species" is unclear.[349]

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344. *See* H.R. REP. NO. 92-707, at 22 (1972).

345. H.R. 14104, 95th Cong., 2d Sess. § 5(2) (1978). The revision was offered "so that we do not afford protection of this legislation, to the detriment of man, to every individual creature on the face of the Earth that might differ in one degree or another from one of its brothers." 124 CONG. REC. 38,154 (1978), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 881 (statement of Rep. Duncan).

346. *See* 124 CONG. REC. 21,565 (1978), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 1105 (Sen. Garn offered a comprehensive rewrite including this definition, but withdrew it when it became clear that it would not pass).

347. *See* S. 2899, 95th Cong. (1978).

348. 16 U.S.C. § 1532(16) (1994); *see* H.R. CONF. REP. NO. 95-1804, at 2 (1978), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 1192, 1193.

349. The Conference Report provided a cryptic explanatory statement:

The existing definition of "species" in the act includes subspecies of animals and plants, Congress struggled with the definition of species again in 1979, in light of a General Accounting Office report harshly criticizing the listing process.[350] That report expressed concern that the existing definition would authorize FWS to list the squirrels in a city park as a distinct population segment.[351] Although Congress ultimately reauthorized the ESA without altering the definition of species, the Senate committee responded to GAO's concerns, admonishing the listing agencies to list populations "sparingly and only when the biological evidence indicates that such action is warranted."[352] At the same time, the Committee observed that the ESA authorized protection of domestic populations of species found in abundance outside the United States.[353] The legislature either did not notice or simply ignored the inconsistency of endorsing distinctions based on political boundaries while at the same time calling for listings based only on biological evidence.

The protracted legislative wrangling over the ESA's most fundamental definition reflects the inability of the bare term "species" to capture the nuances Congress sought to incorporate. Congress intended to protect at least distinct forms, genetic resources, and domestic populations. It recognized that none of the many species definitions employed by scientists captures all these elements. Yet it was not prepared to grant legal protection to the entire diversity of life. Struggling to find a middle ground, it adopted a vague definition which largely leaves to the listing agencies the task of identifying protectable groups.

3. Does the Strictly Science Mandate Apply?

The ESA does not explicitly limit the agencies to scientific information for the identification of species. The strictly science mandate of section 4 covers "determinations required by subsection (a)(1) of this section,"[354] which in turn commands the Secretary to "determine whether any species is

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> taxonomic categories below subspecies in the case of animals, as well as distinct populations of vertebrate "species." The definition included within the conference report would exclude taxonomic categories below subspecies from the definition as well as distinct populations of invertebrates.

H.R. CONF. REP. NO. 95-1804, at 3-4, *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92. A subsequent Congress read this provision to protect geographically separate populations. *See* H.R. REP. No. 100-467, at 4 (1988).

350. *See* GAO, A CONTROVERSIAL ISSUE, *supra* note 4.

351. *Id.* at 52.

352. S. REP. NO. 95-151, 7 (1979), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 1397.

353. *See id.*

354. 16 U.S.C. § 1533(b)(1)(a) (1994).

an endangered species or a threatened species."[355] Arguably the only "determination" required by subsection (a)(1), and therefore the only determination subject to the strictly science mandate, is the viability status of groups already identified as species.

Nonetheless, indications of legislative intent on this issue generally suggest an expectation that science would control species determinations. At a minimum, the repeated emphasis on science throughout the ESA[356] implies that the listing agencies must apply the best available scientific information to all scientific questions. It also appears that Congress viewed species identification as a scientific process which could be objectively undertaken on the basis of biological considerations alone. The Senate report accompanying the 1979 Amendments stated that distinct population segments should be listed only when the "biological evidence" warranted.[357] Moreover, the 1982 House report explaining the amendment which imposed the strictly science mandate emphasized the legislature's intent to remove economic considerations from "any phase of the listing process,"[358] replacing them with science. Determining whether a group qualifies as a "species" is a "phase of the listing process," and would therefore appear to be subject to the strictly science limitation.

The text and legislative history do not unambiguously establish whether species identification falls within the ambit of the strictly science mandate. Several commentators have simply assumed that the law either does or should require that species be identified solely through science.[359] The listing agencies embrace the description of species delineation as a strictly scientific enterprise.[360] Yet they have refused to explicitly renounce the consideration

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355. *Id.* at § 1533(a)(1).

356. *See supra* text accompanying notes 118-21.

357. *See supra* text accompanying note 352.

358. H.R. REP. NO. 97-567, at 20 (1982), *reprinted in* 1982 U.S.C.C.A.N. 2807, 2826.

359. *See* Gleaves et al., *supra* note 309, at 35; David Farrier, *Conserving Biodiversity on Private Land: Incentives for Management or Compensation for Lost Expectations?*, 19 HARV. ENVTL. L. REV. 303, 383-84 (1995) (describing the difficulty of complying with best scientific data mandate for listing decisions given prevalence of scientific uncertainty; one example given is disagreement over taxonomic status of Louisiana black bear); Hill, *supra* note 13.

Daniel Rohlf has recognized the uncertain application of the strictly science mandate. Rohlf, *supra* note 114, at 625. Rohlf appears to endorse the application of the mandate, as he criticizes NMFS for failing to apply the best available science to its species identification policy. *See id.* at 637. Curiously, Rohlf also criticizes NMFS for using claims of science to insulate the policy decisions inherent in species definition from judicial review. *See id.* at 647.

360. For example, the listing agencies have issued joint regulations providing that "[i]n determining whether a particular taxon or population is a species for the purposes of the Act, the Secretary shall rely on standard taxonomic distinctions and the biological expertise of the Department and the scientific community concerning the relevant taxonomic group." 50 C.F.R. § 424.11(a) (1996). The recent joint policies on identification of distinct population segments and treatment of hybrids also

of non-scientific factors.[361] By walking this fine line, the agencies have attempted to maximize both their discretion and their insulation from criticism.[362] Two district courts have applied the science-only mandate to species determinations, albeit without detailed analysis.[363]

4. *Is the Identification of "Species" Scientific?*

In evaluating the role of science in addressing the taxonomy problem, it is useful to distinguish between two essential components of species identification decisions. The first is the development of a species concept or definition, and the second is the application of that definition to individual classification decisions.

a. *Defining the Species Concept*

The first and most fundamental step in solving the taxonomy problem is to define the statutory concept of "species;" that is, to elucidate the characteristics that determine whether a group of organisms is eligible for protection or not. As explained above, the statutory term encompasses taxonomic species, subspecies, and distinct population segments. None of those groups can be defined entirely through objective, "scientific" methods.

As Darwin recognized more than a century ago, pinning down the

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emphasize the role of science. *See* Policy Regarding the Recognition of Distinct Population Segments Under the Endangered Species Act, 61 Fed. Reg. 4722 (1996) ("It is important in light of the Act's requirement to use the best available scientific information in determining the status of species that this interpretation follows sound biological principles.") [hereinafter Population Segment Policy]; Proposed Hybrid Policy, *supra* note 331, at 4710 ("The Act does not attempt to define 'species' in biological terms, and thus allows the term to be applied according to the best current biological knowledge and understanding of evolution, speciation, and genetics."); *see also* Policy on Applying the Definition of Species Under the Endangered Species Act to Pacific Salmon, 56 Fed. Reg. 58,612, 58,613 (1991) (noting "species and populations are biological concepts that must be defined on the basis of the best scientific and commercial data available, just as the decision to list "species" as endangered or threatened") [hereinafter Pacific Salmon Policy].

361. *Compare* 50 C.F.R. § 424.11(b) (1996) (Secretary shall determine whether a species is endangered or threatened "*solely* on the basis of the best available scientific and commercial information regarding a species' status") (emphasis added) *with* 50 C.F.R. § 424.11(a) (1996) (Secretary shall rely on standard taxonomic distinctions and biological expertise in identifying species).

362. Professor Wagner has pointed out the political advantages an appeal to science can offer agencies faced with inconsistent public expectations, vague legislative directives, and mandatory deadlines. Wagner, *supra* note 17, at 1652-54. The incentives to hide behind science in the ESA listing context have been noted by Rohlf, *supra* note 114, at 647; and by YAFFEE, *supra* note 19, at 128.

363. *See* Southwest Ctr. for Biological Diversity v. Babbitt, 926 F. Supp. 920, 927 (D. Ariz. 1996) (reviewing determination that western population of the northern goshawk is not a listable entity); Endangered Species Comm. v. Babbitt, 852 F. Supp. 32, 36 (D.D.C. 1994) (reviewing determination that coastal California gnatcatcher is a listable entity).

meaning of species is an exercise in "trying to define the undefinable."[364] The species, from the perspective of evolutionary biology, is an intangible combination of morphological distinctness, common descent, and common evolutionary future. Species change over time, evolving into new forms, often through the gradual accumulation of small mutations. Exactly where in that process the original species ends and a new one begins is inevitably indeterminate. Furthermore, evolution occurs through a variety of processes, including both sexual and asexual reproduction. No species concept captures the full variety of these processes.[365]

Although grounded in the natural world, the species concept is a tool rather than a natural phenomenon. Species are not immutable entities separated from one another by clear biological or morphological lines. Any system for dividing the fuzzy biological continuum into distinct units must be crafted to serve the ends of its developer, rather than discovered through objective, universal observation. Because these systems serve many purposes, ranging from illuminating particular evolutionary relationships to conveniently classifying organisms of interest, biologists have developed a large number of variations on the species concept. The choice of a particular species concept inevitably reflects particular ends, not the kind of value-neutral fact discovery process popularly associated with the term "scientific."

Dean James Huffman once remarked that species classification, like the arrangement of elements in the periodic table, is scientifically determined.[366] The comparison can help us understand where species definitions fall short of the notion of science as a value-neutral enterprise. Both the periodic table of the elements and species classification systems are tools for understanding aspects of the natural world. The periodic table helps chemists understand the relationships between different chemical elements. Furthermore, the arrangement of the periodic table is empirically testable. It leads to certain predictions about, for example, the effect of substituting one element for another in a reaction, which can be confirmed or refuted by experiments. Species classification systems help taxonomists understand the evolutionary relationships between groups of organisms. But the relationships between species are far less determinate than those between chemical elements. Furthermore, taxonomic classification systems do not lead to easily testable empirical predictions. As a result, while the community of chemists has long

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364. MAYR, *supra* note 174, at 267 (quoting a letter written by Darwin); *see also* SCIENCE AND THE ESA, *supra* note 15, at 52 (explaining "science cannot delineate what nature itself does not").

365. *See supra* notes 329-33 and accompanying text.

366. James Huffman, *Fish Out of Water: The Public Trust Doctrine in a Constitutional Democracy*, 19 ENVTL. L. 527, 531 (1989).

been united behind a single arrangement of the periodic table, the community of biologists is not united behind a single definition of species.

Determining what divides one species from another is a very different task than deciding what separates one chemical element from another. Elements are generally (with the exception of radioactive decay) immutable and distinct. It is not difficult to distinguish hydrogen from helium because hydrogen does not transmute into helium, and there are no intermediate forms between the two. The same cannot be said of species. Furthermore, the organization of elements in the periodic table serves the practical purposes of a broad range of chemists. Again the same cannot be said of species classification schemes.

One obvious complication in species identification as opposed to identification of chemical elements is evolutionary change. Organisms follow different evolutionary strategies, some concentrating on sexual reproduction and others on asexual propagation. Because they prefer to keep their definitions simple,[367] and because no simple species concept adequately captures all possible evolutionary strategies, taxonomists tend to choose the concept most compatible with their particular interest. Animal taxonomists, such as Mayr, tend to prefer species concepts grounded in sexual isolation.[368] Plant taxonomists look to other concepts, because so many plants employ asexual reproductive techniques.

A second complication is that species, unlike chemical elements, intergrade. From an evolutionary perspective, reproductive isolation is often said to be the hallmark of distinct species. But groups of organisms may be completely interbreeding, completely reproductively isolated, or anywhere in between. What degree of reproductive isolation would justify recognition of a distinct species cannot be answered on any objective, universally-applicable basis. Nor can this subjectivity be eliminated by moving to a strictly morphological species concept. Elements are clearly separable on the basis of atomic weights, which can only vary in discrete steps with the number of protons and neutrons in the nucleus. By contrast, biological organisms often exist on a morphological continuum. Consider, for example, domestic dogs. Great Danes are obviously distinguishable from miniature dachshunds on the basis of their morphological characteristics, but a variety of intermediate forms exist. Deciding what makes one species distinct from

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367. *See supra* note 197.

368. Indeed, Mayr explains that the purpose of his BSC is to clarify the means by which sexually reproducing organisms protect their common gene pool. Ernst Mayr, *What Is a Species, and What Is Not*, 63 PHILOSOPHY OF SCIENCE 262, 266 (1996). Given that purpose, the inapplicability of his species concept to organisms that reproduce asexually is simply irrelevant.

another is akin to deciding how to divide one color of light from another within the continuous electromagnetic spectrum. The choice is one of convenience, usefulness for a specific purpose, or aesthetic judgment, not the objective, universal sort of determination of the public expects from "science."[369]

Finally, a third complication is that species classification systems have been developed for two very different purposes, and systems that work well for one purpose often do not work well for the other. For some users, species concepts serve grand theoretical purposes, helping them understand and explain the evolutionary origins, and predict the evolutionary futures, of various groups. For others, classification schemes are convenient ways to identify and separate out organisms of particular interest. For example, a museum curator interested in creating a complete collection of butterflies of South America might look to taxonomists to tell her which butterflies are distinct enough to justify classification as separate species. But the interests of theoreticians and pragmatic classifiers may conflict. Theoretically powerful species concepts are often quite difficult to apply in practice, because they are complex and rest on characteristics that are not readily observable.[370] Thus, those with a theoretic focus are likely to be drawn to different species concepts than those with a practical focus.

Given all these complications, it is hardly surprising that, while chemists have arrived at a single periodic table to organize the elements, biologists have been unable to agree on a single species concept applicable to all organisms for all purposes. No one species concept can be all things to all biologists. Choices must be made, and no objective, value-free method exists for making them.

These difficulties loom even larger with respect to the identification of subspecies and population segments. The term species has a generally understood, albeit fuzzy and to some degree arbitrary, biological significance.[371] Although many biologists use the word subspecies, it carries

369. Some taxonomists have found this subjectivity troubling. One response has been the development of numerical taxonomy, which converts genetic or morphological differences into numeric formulae. Those groups which diverge by more than some specific amount are classified as distinct taxa. *See* MAYR, *supra* note 174, at 221-26, 241; PETER H.A. SNEATH & ROBERT R. SOKAL, NUMERICAL TAXONOMY (1973). This approach, however, cannot remove the subjective element from the species concept. Numerical taxonomists must make choices about which distinctions to count in their numeric formula, how to value them, and what threshold divergence level to apply. These choices will inevitably depend on the goals, focus, and aesthetic judgment of the taxonomist.

370. *See* D.L. Hull, *The Ideal Species Concept—And Why We Can't Get It*, *in* SPECIES: THE UNITS OF BIODIVERSITY 357, 358-59 (M.F. Claridge et al. eds. 1997).

371. *See supra* notes 318-33 and accompanying text; W. A. Fuller, *Synthesis and Recommendations*, *in* THE ROAD TO EXTINCTION 47, 51 (Richard and Maisie Fitter eds., 1987) ("most

no similar, generally recognized biological meaning. Even taxonomists recognize that subspecies are strictly units of convenience.[372] While subspecies classification reflects real differences in morphology, genetics, behavior, or geography, the taxonomic significance attributed to those differences is entirely unconstrained by empirical data.[373] "Distinct population segment," a term not used in the scientific literature,[374] has even less objective significance.

The task of defining the taxonomic groups referenced in the ESA's definition of "species," in sum, does not fit the view of science that dominates policy debates. While it it not wholly arbitrary, in the sense of wholly unconstrained, this task is not effectively constrained by empirical data, as we envision science being. The plethora of species definitions offered by biologists demonstrates that empirical data impose only loose limits. Instead, the constraints on species definitions come from the purposes for which those definitions are developed. Species concepts are tools, adopted for their ability to perform particular functions. We should not blindly apply any existing biological species concept to the ESA's taxonomy problem. Rather, we should seek a tool that fits the special purposes of the ESA. I will argue below that those purposes are not likely to be fully served by any of the schemes biologists have developed.

b. Applying the Species Definition

Once the terms species, subspecies, and distinct population segment have been defined, it should in principle be possible to apply those definitions in an objective manner, strictly on the basis of scientific information. Judged against the description of science given in Part III, the classification work of taxonomists appears scientific. The competing biological species concepts all rely on empirical observation of natural characteristics to place groups of

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biologists have some feel for what is meant by a 'good' species").

372. *See* MAYR, *supra* note 174, at 251. *See also* SCIENCE AND THE ESA, *supra* note 15, at 49 (criticizing that "variety" and "subspecies" theoretically represent distinct categories, but have been used interchangeably in listing of plants); MINELLI, *supra* note 330, at 75 (noting botanists recognize numerous categories of infraspecific taxa, while zoologists recognize only subspecies).

373. *See* MAYR, *supra* note 174, at 289 ("Because evolutionary units at [taxonomic levels below subspecies] are not discrete, but exist along a continuum, it is a policy judgment as well as a science judgment to determine the significance of an evolutionary unit. In other words, science alone does not lead to a conclusion that any objectively definable degree of distinctness is more significant than another."). SCIENCE AND THE ESA, *supra* note 15, at 56. The culture of the particular discipline strongly affects the level at which taxonomic distinctions are drawn. Some groups seldom or never recognize infraspecific taxa. *See* MINELLI, *supra* note 330, at 176.

374. *See* Population Segment Policy, *supra* note 360, at 4,722; Southwest Ctr. for Biological Diversity v. Babbitt, 926 F. Supp. 920, 926 (D. Ariz. 1996).

organisms in categories. New observations, while they cannot force a taxonomist to revisit his preferred species concept, can convince him to withdraw or modify a determination that a particular group fits that concept. Classification schemes are typically reported in the scientific literature, giving others the opportunity to confirm or refute the observations on which they rest.

In practice, however, the classification step involves as much art as science.[375] There are, of course, many easy cases involving groups which are readily distinguished from one another on the basis of reproductive isolation, morphological distinctions, and genetic differences. The greater the evolutionary distance between two groups, the larger the differences and the easier it is to differentiate between groups. For example, no one would confuse a blue whale with a bottlenose dolphin. But deciding where to draw the line between more closely related groups is unavoidably subjective.[376] No matter what special concept is invoked, there is no objective means of deciding whether the woodrats of the eastern United States are one or two distinct species.[377]

Given these difficulties, it is not surprising that the professional biases of classifiers affect not only the species concepts they choose but also the way they apply those concepts. Taxonomists tend to work in relatively narrow areas, specializing on particular groups of organisms. Each area has its own professional traditions and norms. "Lumpers," who are inclined to prefer large, inclusive taxa, and "splitters," who separate taxa on the basis of minute distinctions, occur in every area, but their relative dominance varies widely. For example, as a group ornithologists, who study birds, recognize many more subspecies than ichthyologists, who study fish.[378]

Furthermore, the ideological goals of individual classifiers can strongly influence their determinations. In his classic study of the ESA, Professor

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375. "Taxonomy is a science, but its application to classification involves a great deal of human contrivance and ingenuity, in short, of art. In this art there is a leeway for personal taste, even foibles, but there are also canons that help to make some classifications better, more meaningful, more useful than others." G. G. SIMPSON, PRINICPLES OF ANIMAL TAXONOMY 107 (1961).

376. To further complicate matters, the taxonomic status of rare or dwindling species often must be evaluated using very limited data. Often taxonomists must rely on a very small number of specimens, sometimes quite old and perhaps not well preserved. *See, e.g.*, Alabama Sturgeon Withdrawal, *supra* note 67, at 64,795 (taxonomic conclusions based on study of 32 specimens); Gnatcatcher Notice, *supra* note 255, at 15,695 (describing difficulties presented by poor specimen preservation).

377. *See* John P. Hayes & Milo E. Richmond, *Clinal Variation and Morphology of Woodrats (Neotoma) of the Eastern United States*, 74 J. MAMMALOGY 204 (1993).

378. SCIENCE AND THE ESA, *supra* note 15, at 55. Professor Minelli suggests that this difference may be attributable to the ready observability of intraspecific variation in birds, because that variation often shows up in such obvious traits as color patterns. MINELLI, *supra* note 330, at 74.

Yaffee recounts that one FWS biologist frankly admitted the temptations: "From a conservation point of view, you want to push organisms to higher levels of classification so that they get more sympathy. Also, the more splitting you make between differences in organisms, the more protection you end up with."[379]

5. The Incoherent Regulatory Approach to the Taxonomy Problem

Resolution of the taxonomy problem is crucial to the listing process; the scope of the relevant group can determine whether its population is sufficiently reduced to qualify for protection. Despite the importance of the taxonomy problem, the listing agencies have provided little public explanation of how they address it. The regulatory definition of species is identical to the unhelpful statutory definition.[380] The agencies have not even offered general guidance on their understanding of the statutory terms. The public is left to guess at the agencies' interpretation based on individual listing decisions.

Not surprisingly, protection of taxonomic species has generated little controversy.[381] Taxonomic species typically are separated by morphological discontinuities; an experienced lay observer can, in most cases, distinguish one species from another. Consequently, the public generally views them as "natural kinds" worthy of protection. Furthermore the divisions between full species, particularly among the well-studied organisms that make up the bulk of the endangered and threatened list, are often well settled within the taxonomic community.[382] Finally, the boundaries between full taxonomic species are often not worth contesting, particularly among vertebrates; even if a group is not recognized as a distinct taxonomic species, it may still qualify for protection as a subspecies or distinct population segment.[383] As a result, the agencies' choice of species concept and application of that concept

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379. YAFFEE, *supra* note 19, at 76.

380. 50 C.F.R. § 424.02(k) (1996).

381. *See* SCIENCE AND THE ESA, *supra* note 15, at 47. The only court to deal with full taxonomic species status did so only in passing. Refusing to block a white-tailed deer hunt, the court held that white-tailed deer are not protected by the ESA merely because thay are physically capable of interbreeding with the listed Key deer. *See* Fund for Animals, Inc. v. Florida Game & Fresh Water Fish Comm'n, 550 F. Supp. 1206, 1208 (S.D. Fla. 1982). Without any showing that the two types of deer interbreed in nature, the court refused to hold that they are the same "species." *Id.*

382. *See, e.g.*, Draft Candidate Species Guidance, *supra* note 262, at 25 (species relationships among birds and mammals are largely settled, remaining taxonomic questions have to do with recognition of subspecies).

383. *See, e.g.*, Alabama Sturgeon Withdrawal, *supra* note 67, at 64,795 (concluding that even if listing opponents are right and the Alabama sturgeon does not constitute a distinct species, "it would still qualify as being eligible for the Act's protection").

does not carry a great deal of practical importance.

Recognition of subspecies and distinct population groups, by contrast, has often been highly controversial.[384] The boundaries between subspecies and population groups, which can be crucial in determining whether a group is entitled to the protections of the ESA, may turn on distinctions easily made to appear trivial. For example, one recent listing dispute depended on the taxonomic status of the California gnatcatcher, a small songbird found in the southwestern United States and northwestern Mexico.[385] FWS determined that the species included two distinct subspecies, differing slightly in bill length and other minor morphological characteristics. One subspecies was found north of about 30 degrees north latitude in Baja California and the other south of that line.[386] The location of the boundary drawn between the subspecies led to listing of the northern subspecies, which was reduced to a very small population. If considered as a whole, the species likely would not have qualified for listing.[387]

a. Category Definition

The vague statutory definition of "species," combined with the strictly science mandate, effectively offers the listing agencies both vast discretion in making category determinations and shelter from their political ramifications.[388] The listing agencies have sought to maximize this combination of discretion and political shelter by emphasizing the scientific nature of their taxonomic decisions. In order to maintain their scientific cover, they avoid discussing the conceptual basis used to distinguish taxa, hiding this aspect of the decision from public view.

Although they have not openly said so, it appears that the listing agencies base their identifications of taxonomic species and subspecies primarily on differences in morphology.[389] For example, FWS identified the coastal California gnatcatcher as a distinct subspecies on the basis of analysis of five or six morphological characteristics, including bill length, wing length, tail length, and coloration.[390] Similarly, the Louisiana black bear was

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384. *See, e.g.*, Thomas Lambert, *Can an Owl Change Its Spots?*, ARIZ. REPUBLIC, July 16, 1995, at G5 (arguing that listing should be limited to species because "allowing service regulators to play the name game invites bureaucratic abuse").

385. Gnatcatcher Notice, *supra* note 255, at 15,693.

386. 1993 Gnatcatcher Rule, *supra* note 298, at 16,742.

387. *See* Endangered Species Comm. of the Bldg. Indus. Ass'n v. Babbitt, 852 F. Supp. 32, 34 (D.D.C. 1994).

388. *See* YAFFEE, *supra* note 19, at 147; Wagner, *supra* note 17, at 1654-66.

389. *See* SCIENCE AND THE ESA, *supra* note 15, at 48.

390. Gnatcatcher Notice, *supra* note 255, at 15,696.

distinguished from other North American black bears based on the distinctive shape of its skull.[391] The focus on morphology is not surprising; morphological distinctions play a large role in most modern taxonomic schemes because morphological data are relatively easy to gather. But the agencies have not explained how they determine whether the morphological differences justify recognition of a distinct species or subspecies. Rather than addressing that issue, they tend simply to defer to the views of taxonomists in the relevant field.[392]

It is similarly unclear what role the agencies assign to genetic distinctness. Some listing determinations hardly mention it, suggesting that genetic differences are of only minor importance.[393] In others, the agencies concede that no significant genetic difference exists, but nonetheless rely on morphological differences and the opinions of taxonomists to recognize distinct taxa. In listing the Louisiana black bear, for example, FWS asserted that "[m]orphological distinction, regardless of any known presence or absence of genetic differences, is sufficient to support a taxonomic entity."[394] Yet it rejected a morphological distinction without a genetic basis in the case of the Maguire daisy.[395] The agencies may well have valid reasons for treating genetic divergence differently in these different cases,[396] but their lack of explanation invites the charge that caprice or political pressure, rather than objective, value-neutral standards, drive their decisions.

Distinct population segments present an even greater challenge for the listing agencies. They cannot identify these groups by simple deference to an external taxonomic consensus because taxonomists do not employ this category.[397] After much dithering, in 1996 the agencies published a joint policy on recognition of distinct vertebrate population segments.[398] The new

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391. Black Bear Rule, *supra* note 236, at 588.

392. *See, e.g.*, Flycatcher Rule, *supra* note 252, at 10,697 (review of the taxonomic literature showed "a majority opinion that *E. t. extimus* is a valid subspecies").

393. *See, e.g.*, Red-Legged Frog Rule, *supra* note 284, at 25,823 (discussing morphological and behavioral differences between the California red-legged frog and northern red-legged frogs, and mentioning that genetic research has been proposed).

394. Black Bear Rule, *supra* note 236, at 592.

395. Maguire Daisy Rule, *supra* note 282, at 31,054.

396. In fact, there is good reason not to treat the different morphological forms of the Maguire daisy as a distinct species for ESA purposes. The daisy's different growth habits result from growth in different light conditions. *See id.* The basis of morphological variation is known, and both variants can be replicated from populations of either type. Thus the loss of one population would not entail loss of that form.

397. *See supra* note 374 and accompanying text.

398. Population Segment Policy, *supra* note 360. The inconsistent treatment of population segments prior to publication of this policy led to remand of FWS' determination that the western population of the northern goshawk was not a listable entity. *See* Southwest Ctr. for Biological Diversity v. Babbitt, 926 F. Supp. 920 (D. Ariz. 1996).

joint policy requires that a group be both "discrete" and "signficant" to qualify for listing as a distinct population segment.

Discreteness, according to the joint policy, requires "marked separation," either biologically—as a consequence of physical, physiological, ecological, or behavioral factors—or politically—as a result of an international boundary.[399] Although this list encompasses more than genetic distinctness, there is reason to believe that reproductive isolation will be emphasized. The agencies have described their new policy as "consistent with" an earlier policy developed by NMFS to delineate distinct population segments of Pacific coast salmon.[400] The salmon policy, which NMFS continues to apply, requires that a distinct population segment be "substantially reproductively isolated" from other populations.[401]

The joint policy does not explain whether other factors can ever entirely substitute for genetic isolation, and if so under what circumstances. It does, however, reject one aspect of the NMFS salmon policy. In formulating the salmon policy, NMFS stated that international boundaries could not justify the listing of a population segment in the absence of reproductive isolation.[402] The joint policy, by contrast, provides that a population segment may be considered discrete if it is either markedly separated from other populations or "delimited by an international boundary."[403]

The agencies view consideration of international boundaries as discretionary rather than mandatory. FWS, for example, has chosen not to regard the domestic population of the Pacific fisher as distinct from the Canadian population.[404] The agency's failure to adopt a consistent position on the relevance of international boundaries contributed to a recent adverse court ruling on the decision not to list the Canada lynx. The agency did not adequately explain why it regarded a healthy Canadian population as precluding listing of this species, but not others.[405]

In explaining its salmon policy, NMFS asserted that its emphasis on

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399. Population Segment Policy, *supra* note 360, at 4725.

400. Pacific Salmon Policy, *supra* note 360.

401. *Id.* at 58,612.

402. *Id.* at 58,613.

403. Population Segment Policy, *supra* note 360, at 4725. Although they conceded that international boundaries did not provide a biological basis for distinguishing between groups, the agencies concluded that recognizing the impact of such boundaries was "reasonable for national legislation." *Id.* at 4723. However, notwithstanding FWS' early practice of relying on state boundaries in certain cases, the new policy rejects distinctions based on state boundaries. *Id.* at 4723-24.

404. *See* 90-Day Finding for a Petition to List the Fisher in the Western United States as Threatened, 61 Fed. Reg. 8016, 8017 (1996) [hereinafter Fisher Petition Finding].

405. *See* Defenders of Wildlife v. Babbitt, 958 F. Supp. 670, 685 (D.D.C. 1997) ("FWS cannot be allowed to dismiss the contiguous United States population of a species merely because it is more plentiful elsewhere.").

genetic isolation gave effect to what it saw as the primary Congressional intent underlying the ESA, which was to protect genetic resources.[406] This explanation is unpersuasive. Although the ESA's legislative history does refer to genetic resources at several points, the fact that genetic values are not among those specifically enumerated in the Act's purposes section undercuts the claim that preservation of genetic resources is the Act's primary goal.[407] At the very least, the long list of other values Congress specifically listed in section 2 makes it clear that protecting genetic resources is not the only goal.

Rather than implementing Congressional intent, the agencies' emphasis on genetic distinctness more likely reflects their desire to make the identification of population segments appear scientific. The discrepancy between the treatment of genetic distinctness at the population segment level and at higher taxonomic levels supports this explanation. The agencies place the heaviest emphasis on reproductive isolation at the population segment level. Yet species or subspecies should be more distantly related, and hence more genetically distinct from one another, than population segments. If genetic distinctness is needed to justify differentiating between population segments, it should be even more essential to distinguish between species. There is, however, a significant difference in the agencies' ability to claim the mantle of science in the two cases. When identifying species or subspecies, the agencies need only refer to the views of taxonomists. They need not explain in detail how the taxonomists arrived at their conclusions,[408] and the scientific basis of those decisions is unlikely to be challenged. No such convenient political cover is available for the identification of "distinct population segments." Unable simply to attribute these decisions to the scientific community, the agencies seek to describe them in scientific terms. Emphasizing genetic divergence allows the agencies to bury their decisions in the complicated details of genetic tests, making those decisions appear strictly technical.[409] This not only permits the agencies to claim compliance with the strictly science mandate, it gains them maximum deference from reviewing courts and spares them the need to openly address the difficult

406. Pacific Salmon Policy, *supra* note 360, at 58,612.

407. If preservation of genetic diversity were in fact the principal goal of the ESA, it would make no sense to confine the Act's protection to members of the plant and animal kingdoms. Microbiologists now contend that most of the world's genetic diversity lies in the single-celled organisms. *See* Robert F. Service, *Microbiologists Explore Life's Rich, Hidden Kingdoms*, 275 SCI. 1740 (1997).

408. *See, e.g.*, Red-Legged Frog Rule, *supra* note 284, at 25,823 (responding to a comment questioning its delineation of the California red-legged frog, FWS explains: "The California red-legged frog is a recognized subspecies of the red-legged frog.").

409. *See, e.g.*, Pacific Salmon Policy, *supra* note 360, at 58,614 (discussing the use of mitochondrial and nuclear DNA comparisons).

questions of whether and for what reasons a particular group of organisms merits protection.

A desire to emphasize the scientific nature of population segment determinations also explains the agencies' unnecessarily crabbed interpretation of "significance." Their joint policy takes into account only the group's significance to its species, ignoring any of the other ways in which a population segment might further the values the ESA was adopted to protect. Under the policy, a population segment may be considered significant to the species if it inhabits an unusual ecological setting; if its loss would cause a signficant gap in the geographic range of the species; if it represents the only surviving natural occurrence within the species' historic range; if it is markedly genetically distinct from other populations; or for other unstated reasons.[410] As one might expect, the degree of significance required under any of these factors is unclear. What is clear under the policy is that a population segment may not be deemed significant simply because it inhabits a unique ecosystem and its protection would help ensure the persistence of that ecosystem.[411] Yet surely that is one form of "ecological" value.[412] The strictly science mandate, combined with the agencies' own desire for scientific camouflage, has encouraged the agencies to emphasize characteristics they believe can be objectively identified, such as genetic distinctness. This emphasis comes at the expense of other characteristics which are more difficult to evaluate on the basis of objective data, but which might more effectively fulfill the goals of the ESA.

Although the agencies' distinct population segment policy has drawn fire primarily from environmentalists,[413] it can make listing either more or less likely depending on the circumstances. The policy may increase the likelihood of listing for populations that are demonstrably reproductively isolated, as by a distinct geographic break. For example, NMFS recently reclassified the Steller sea lion, previously listed as threatened throughout its range, as two separate populations, one endangered and one threatened.[414] The split rests on evidence of a geographic barrier across which there is only limited genetic mixing.

However, the emphasis on genetic isolation makes it more difficult to protect genetic and morphological variation in species whose characteristics

410. Population Segment Policy, *supra* note 360, at 4723.

411. "The Services do not believe the Act provides authority to recognize a potential DPS as significant on the basis of the importance of its role in the ecosystem in which it occurs." *Id.*

412. *See* 16 U.S.C. § 1531(a)(3) (1994).

413. *See, e.g.*, Rohlf, *supra* note 114, at 625.

414. Change in Listing Status of Steller Sea Lion, 62 Fed. Reg. 30,772 (1997).

show a "gradual transition along a geographic or environmental cline."[415] Individuals of a single species inhabiting different geographic locations often exhibit substantial morphological and genetic differences.[416] This variation may be just as crucial to the long-term survival of the species as variation between populations characterized by discrete breaks. Clinal variation may be essential to species' ability to adapt to environmental changes, such as those which may result from global warming. Thus, the agencies' emphasis on genetic distinctness may not fully protect even the genetic resources the agencies claim to have targeted.

Moreover, the emphasis on reproductive isolation can submerge other factors which provide much more powerful reasons to protect a group than minor genetic distinctions. For example, Snake River sockeye salmon migrate nearly 900 river miles from the Pacific Ocean to Redfish Lake, 6300 feet above sea level in the Sawtooth Mountains of Northern Idaho.[417] Redfish Lake also harbors kokanee, close relatives of the sockeye which never venture from the lake. NMFS, perhaps stretching its salmon policy, listed the sockeye without clear evidence of any genetic difference between it and the kokanee. The agency simply stated that it would regard the sockeye as genetically distinct in the absence of evidence to the contrary.[418] Surely, however, whether or not the Redfish Lake sockeye are demonstrably distinct from the sedentary kokanee on the basis of some genetic test, their spectacular migratory journey alone provides reason enough to protect them.[419] Like behavioral distinctions, morphological differences do not

415. Pacific Salmon Policy, *supra* note 360, at 58,617. "A cline is some measurable gradual change over a geographic region in the average of some phenotypic character, such as size or coloration, or in gene and genotypic frequency." ROBERT LEO SMITH, ELEMENTS OF ECOLOGY 37 (3d ed. 1992).

416. *See, e.g.*, Hayes & Richmond, *supra* note 377; SMITH, *supra* note 415, at 38 ("Populations at the two extremes along the gradient may behave as different species."). The variation in size among North American white-tailed deer from the northern to southern extremes of their range is a vivid example. In Canada and the northern United States, white-tailed deer average about 300 pounds. By contrast, the white-tailed deer found in Florida weigh less than fifty pounds. These small Florida deer are considered a distinct species, called the Key deer.

417. *See* Endangered Status for Snake River Sockeye Salmon, 56 Fed. Reg. 58,619, 58,621 (1991) [hereinafter Sockeye Salmon Rule]; Erik Lacitis, *Achieving a "Balance" With a Species on the Brink*, SEATTLE TIMES, Feb. 7, 1997, at E1.

418. Sockeye Salmon Rule, *supra* note 417, at 58,622.

419. Oregon cutthroat trout present similar issues. They occur as three distinct behavioral forms: resident fish, which spend their entire life in their natal streams; anadromous fish, which are born in freshwater, migrate to the ocean, and return to freshwater to spawn; and potamodromous fish, which migrate up and down the river but do not venture to the sea. NMFS has determined that all three forms must be classified together because their reproductive isolation from one another is not complete. Cutthroat Trout Rule, *supra* note 282, at 41,516. The decision that the group is endangered therefore necessarily remains open to re-examination no matter how valuable the anadromous or river-migrating traits might be, if, as the Oregon Department of Fish and Wildlife has claimed, the resident trout are

always coincide with genetic distinctness or isolation. Mayr points out that many groups meet his definition of biological species although they appear virtually identical to other species, and that many other biological species contain a wide range of morphological types.[420] It is not immediately apparent that focusing on genetic differences better serves the range of values the ESA is intended to protect.

The agencies may believe that their emphasis on genetic isolation is most likely to advance the goal of protecting the process of speciation. The evolution of new species is undoubtedly a process worthy of protection,[421] but requiring complete genetic isolation as a condition of recognition of population segments is not always compatible with that goal. Some recent studies suggest that speciation may occur in response to differing selection pressures even when there is substantial gene flow between populations.[422]

The agencies' recently proposed hybrid policy marks a welcome retreat from this excessive emphasis on genetic distinctness. Prior to 1990, the agencies had taken the position that hybrids, the progeny of matings between species or subspecies, were not eligible for ESA protection because they lacked the genetic purity of their parents.[423] After six years without a formal hybrid policy, the agencies recently proposed a new one which emphasizes morphological similarities over minor genetic distinctions. The new policy would recognize that intercrosses, that is matings between groups, are expected in nature where the ranges of closely related groups adjoin or overlap.[424] Under the proposal, progeny of a cross between a listed and a non-listed parent would be protected if they more closely resemble the listed parent than a form intermediate between the listed and non-listed parent. Morphological, ecological, behavioral, genetic, and biochemical data could all be considered in making this determination. The policy would free the listing agencies of the difficult task of determining whether listed taxa are genetically pure,[425] pre-empting the argument that a species no longer

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abundant.

420. Mayr, *supra* note 368, at 269.

421. *See* Holly Doremus, *Patching the Ark: Improving Legal Protection of Biodiversity*, 18 ECOLOGY L.Q. 265, 282 (1991) (arguing that preservation of processes such as evolution should be the primary focus of conservation policy).

422. *See* Martin Enserink, *Life on the Edge: Rainforest Margins May Spawn Species*, 276 SCI. 1791 (1997).

423. This interpretation was never formally promulgated as a rule or policy, but was enumerated in a series of memoranda from the Solicitor's office, and applied in individual listing decisions. *See, e.g.*, Determination of Threatened Status for the Flattened Musk Turtle (*Sternotherus depressus*), 52 Fed. Reg. 22,418, 22,419 (1987) (stating "[i]ndividuals of hybrid origin are not covered" by the ESA).

424. Proposed Hybrid Policy, *supra* note 331, at 4711.

425. *See id.* at 4712.

qualifies for protection because it has interbred to some extent with an unlisted species.[426] This policy may indicate that the listing agencies are beginning to appreciate the potential importance of groups which may not be genetically pure or distinct.

b. Category Application

Just as they hide their interpretation of the species concept, the listing agencies tend to conceal their application of that concept to individual decisions. Instead, they typically emphasize deference to taxonomists in the relevant field. The agencies' joint listing regulations, for example, call for reliance on "standard taxonomic distinctions" and the agencies' own biological expertise in determining whether a group of organisms qualifies as a statutory "species."[427] FWS has explained that "the magnitude of taxonomic difference necessary to appropriately decide when subspecies should be delimited can be determined only by agreement among working taxonomists."[428] Yet "standard taxonomic distinctions," if that means distinctions which would be recognized by taxonomists across a variety of disciplines, simply do not exist below the species level.[429] In practice, therefore, the agencies have wide latitude either to apply the standards of the relevant discipline or to substitute the guidance of their own biologists.[430]

Whether the agencies defer to a taxonomic consensus appears in practice to depend on whether that consensus is consistent with the agencies' preferred course of action. For example, when it recognized the coastal California gnatcatcher as a distinct subspecies, FWS bolstered its decision by noting that the classification committee of the American Ornithologists Union, a recognized authority on avian taxonomy, agreed.[431] Yet when faced with a petition to list the western population of the northern goshawk, FWS justified its decision to reject the petition by recognizing a new subspecies of goshawk contrary to the American Ornithologists' Union classifications.[432]

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426. This argument has been raised in opposition to proposals to list the Florida panther, for example. *See* O'Brien & Mayr, *supra* note 325, at 1187.

427. 50 C.F.R. § 424.11(a) (1996).

428. Gnatcatcher Notice, *supra* note 255, at 15,698.

429. *See supra* notes 372-74 and accompanying text.

430. In making determinations of taxonomic eligibility for listing, FWS accepts as credible taxonomic authority findings by scientific societies, taxonomic monographs, and species descriptions not challenged by knowledgeable scientists. Draft Candidate Species Guidance, *supra* note 262, at 26. "When informed taxonomic opinion is not unanimous," however, FWS makes its own decisions. *Id.*

431. Gnatcatcher Notice, *supra* note 255, at 15,698.

432. *See* 90 Day Finding for a Petition to List the Northern Goshawk in the Western United States, 61 Fed. Reg. 28,834, 28,835 (1996). Based on its recognition of this additional subspecies, FWS concluded that the western population group was not a listable entity because it included members of

Similarly, FWS has simply declared, without explanation, that "plant varieties are equivalent to subspecies,"[433] and therefore eligible for listing, although plant taxonomists consider the variety a lower taxonomic category than the subspecies.[434] There may be good reasons for each of these decisions, but those reasons are not "scientific" in the sense implied by the strictly science mandate.

c. Summary

The listing agencies' struggles with the taxonomy problem illustrate the undesirable effects of Congressional insistence that the agencies rely strictly on science to solve a problem which is not, at its core, scientific. Agency practice under that mandate has been both incoherent, in the sense that the public cannot readily discern the grounds for particular actions, and inconsistent if judged against the grounds on which the agency purports to rely. To the extent possible, the agencies have avoided explaining either the nature of the species concept they apply or the method by which they apply it. They have generally deferred to the taxonomic community but occasionally, without explanation, departed from an apparent taxonomic consensus. Although their decisions seem to turn largely on morphological and genetic differences, they have never formally explained the roles morphology and reproductive isolation play in their decisions. They seem content to rely on morphology to distinguish species or subspecies, while struggling to find genetic distinctions at the less likely level of population segments. Even the recent welcome retreat from genetic fetishism in the proposed hybrid policy seems to be driven by political pressure to list the Florida panther.[435]

The strictly science mandate has cast the agencies adrift. Lacking any sound "scientific" mooring for their species identification decisions, but precluded from explicitly relying on anything else, they seem to have simply drifted with the political currents.

B. The Viability Problem: Determining If the Group Needs Protection

Identifying a group as a "species" within the meaning of the ESA does

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two distinct subspecies. *See id.*

433. Draft Candidate Species Guidance, *supra* note 262, at 24.

434. SCIENCE AND THE ESA, *supra* note 15, at 49.

435. *See* Unified Agenda, 61 Fed. Reg. 23,100, 23,103 (1996). That political pressure is strong enough to have led to introduction of a bill that would legislatively declare the Florida panther an endangered species. H.R. 226, 105th Cong. (1997).

not yet entitle it to protection; the law protects only species which are "endangered" or "threatened." Again the statutory definitions offer little assistance. An "endangered" species is one which is in danger of extinction throughout at least a significant part of its range.[436] A "threatened" species is one that is not presently endangered, but is likely to become so in the foreseeable future.[437]

1. Deciphering the Terms

The words "endangered" and "threatened" are not scientific terms of art; they have no generally accepted biological meaning. In general parlance, "endangered" means at risk, exposed to danger.[438] "Threatened" similarly connotes menace by some source of danger.[439] As a basis for policy choices, these terms are hopelessly incomplete. They suggest that species must either fall or be close to falling below some threshold viability level in order to qualify for protection, but they fail to indicate what the threshold level might be. Since all species face some finite risk of extinction, all would appear to merit protection unless some additional content is given to the statutory terms.

Congress has used the term "endanger" in other statutes. Perhaps the best known example is section 211 of the Clean Air Act, which allows the Environmental Protection Agency to regulate fuel additives which "may reasonably be anticipated to endanger the public health or welfare."[440] Professor Flournoy has noted the degree of discretion this vague standard leaves the agency.[441] Beyond requiring that the agency find that the risk is more than *de minimis*, it provides virtually no constraint. Because the Clean Air Act deals with human health, which might imply a different standard of protection, and sets up only one level of risk, its relevance to interpretation of the ESA is unclear. Reference to other statutes, therefore, does not resolve the definitional aspect of the ESA's viability problem.

The ESA's legislative history provides some scattered clues. Not

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436. 16 U.S.C. § 1532(6) (1994).

437. *Id.* § 1532(20). The regulations governing listing simply repeat the statutory language, offering no additional clarification. 50 C.F.R. § 424.02(e), (m) (1995).

438. *See, e.g.*, RANDOM HOUSE WEBSTER'S COLLEGE DICTIONARY 440 (1995) (defining "endanger" as "to expose to danger, imperil," or "threaten with extinction").

439. *See id.* at 1390 (defining "threaten" as, among other things, "to be a menace or source of danger"); *see also* Ethyl Corp. v. EPA, 541 F.2d 1, 13 (D.C. Cir. 1976) (en banc) ("When one is endangered, harm is *threatened.*").

440. 42 U.S.C. § 7545(c)(1) (1994).

441. Alyson C. Flournoy, *Legislating Inaction: Asking the Wrong Questions in Protective Environmental Decisionmaking*, 15 HARV. ENVTL. L. REV. 327, 347-48 (1991).

surprisingly, given their close similarity in ordinary speech, the words "endangered" and "threatened" were used interchangeably in the early legislation. The two terms were explicitly equated in both the 1966 and 1969 Acts: a species was "threatened with extinction" if Interior found that "its existence [was] endangered."[442] Underlying that determination was an inquiry into whether the species required assistance to survive.[443]

In 1969, Congress responded to concerns that species had been listed arbitrarily[444] by trying to give more content to the listing standards. It did so indirectly, not by clarifying the meaning of "endangered," but instead by adding new substantive and procedural impediments to listing. Substantively, protection was limited to species whose survival was at risk worldwide, a limitation subsequently revoked in the 1973 ESA.[445] Procedurally, the legislature imposed new requirements that Interior consult with various interested parties, and that it base its listing determinations on the best available scientific data.[446]

Both House and Senate committees recommended consultation with the International Union for the Conservation of Nature and Natural Resources ("IUCN") and reference to the IUCN's Red Data Books as a step in the listing process.[447] Although legislators may not have realized it, the Red Data Books placed species in different categories based on the degree of extinction risk they faced.[448] The early Red Data Books designated species as either "rare," meaning occurring only in a restricted habitat or in very small numbers; or "endangered," that is, in immediate danger of extinction and unlikely to survive without special protective measures.[449] By 1972, the

442. Pub. L. No. 89-669, § 1(c), 80 Stat. 926 (1966); *see also* Pub. L. No. 91-135, § 3(a), 83 Stat. 275 (1969).

443. Pub. L. No. 89-669, § 1(c), 80 Stat. 926 (1966).

444. *See* H.R. REP. NO. 91-382, at 6 (1969).

445. Pub. L. No. 91-135, § 3(a), 83 Stat. 275 (1969). The 1973 ESA removed this restriction. Pub. L. No. 93-205, § 3(4), 87 Stat. 884 (1973).

446. *See supra* note 65 and accompanying text.

447. *See supra* note 68.

448. The IUCN categories were not discussed in the congressional debate. Instead, the IUCN lists were repeatedly referred to as a single list, and a single "Main List" was submitted more than once into the record. *See, e.g., Endangered Species: Hearings Before the Subcomm. on Marine Mammals & Fisheries of the Senate Comm. on Commerce*, 90th Cong., 57-68, 97 (1968) (statement of Russell Train) (single list submitted for record); *Fish & Wildlife Legislation: Hearings Before the Subcomm. on Fisheries & Wildlife Conservation of the House Comm. on Merchant Marine & Fisheries*, 90th Cong., at 20-31 (1967) (involving submission of "Main List" of animals "believed to be rare and endangered but concerning which data currently available are not adequate to permit a reliable assessment of status"); *Endangered Species: Hearings Before the Subcomm. on Fisheries & Wildlife Conservation of the House Comm. on Merchant Marine & Fisheries*, 91st Cong., 20 (1969) (Russell Train again refers to "Main List").

449. *See* Paul Munton, *Concepts of Threat to the Survival of Species Used in Red Data Books and*

IUCN had introduced a new category of "vulnerable" species, those likely to move into the endangered category in the near future unless circumstances changed.[450]

In the 1966 and 1969 Acts, Congress seems to have envisioned a standard modeled on the IUCN's "endangered" category. Not only did Congress employ the same term, the reference in the 1966 Act to species whose "survival requires assistance"[451] closely parallels the IUCN's description of endangered species as unlikely to survive without special protective measures.[452] In addition, although legislators did not clearly distinguish between IUCN categories, they did indicate that not all species on the IUCN's complete list would require protection.[453] This suggests that the new law would cover only those species the IUCN identified as at greatest risk.

Because the 1969 Act failed to quickly bring threats to species under control, Congress revisited the problem. Interior had interpreted the 1969 Act to permit listing only if species faced very dire immediate threats.[454] Both the President and legislators had come to view this deathbed intervention as ineffectual.[455] Accordingly, the 1973 ESA created a new protected category: species could be listed as "threatened" if, while not currently endangered, they might become so in the foreseeable future.[456] The accompanying House

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Similar Compilations, *in* THE ROAD TO EXTINCTION, *supra* note 371, at 72, 75.

450. *Id.* at 76. The categories shifted several times in the early years of the Red Data Books. In 1969, the IUCN added the designation "indeterminate" for species suspected of being endangered or rare, but for which no reliable assessment had been made. *Id.* at 75.

451. Pub. L. No. 89-669, § 1(c), 80 Stat. 926 (1966).

452. The IUCN standard was later revised to read "survival is unlikely if the causal factors continue operating." Munton, *supra* note 449, at 75.

453. *See, e.g.*, H.R. REP. NO. 91-382, at 3 (1969) (describing the Red Book as including about 275 mammals and more than 300 birds, but stating that "[p]rotection is not needed for all species").

454. *See* 119 CONG. REC. 922 (1973), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 72 (statement of House sponsor, Rep. Dingell) (concluding the revisions will provide better consideration for species which "are in trouble, but are not yet on the brink of extinction, according to the Department of the Interior").

455. President Nixon stated in his 1972 Environmental Message to Congress that the existing law "simply does not provide the tools needed to act early enough to save a vanishing species." *Quoted in* S. REP. NO. 93-307, at 3 (1973), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 300, 302. Many members of Congress agreed with Nixon. *See, e.g.*, 119 CONG. REC. 30,164 (1973) (statement of Rep. Goodling) ("Experience has taught us that, under existing laws, the Federal Government was unable to adequately provide conservation and protection measures to those species which had not yet met the legal and technical definition of 'extinct,' but due to a variety of factors were closely approaching that population level."); 119 CONG. REC. 30,165 (1973) (statement of Rep. Leggett) ("existing law just does not provide the kind of management tools we need to act early enough to save a vanishing species"); 119 CONG. REC. 30,167 (1973) (statement of Rep. Clausen) ("In the past, little action was taken until the situation became critical and the species was dangerously close to total extinction. This legislation provides us with the means for preventive action.").

456. Pub. L. No. 93-205, § 3(15), 87 Stat. 884 (1973). In recognizing more than one category of protected species, the ESA followed the lead of the MMPA and CITES. The MMPA protected

report encouraged the listing agencies to interpret this authority broadly, applying the new category to any species under "a measurable risk" of extinction.[457]

Legislators believed the new category could be widely applied without unduly harsh impacts because it provided less rigid protections than the "endangered" category. Section 4(d) offered the listing agencies the flexibility to issue such regulations as they might deem necessary to protect a threatened species; Congress encouraged the agencies to use that flexibility to tailor protections to the needs of species while minimizing impacts on economic activity.[458] In addition, the new category allowed the gradual withdrawal of protection as species drew back from the brink of extinction.[459]

Although the ESA no longer explicitly defines protected species as those whose survival depends upon legal protection, it implicitly retains that concept. The ESA's stated purposes include "provid[ing] a program for the conservation" of listed species.[460] "Conservation" means the use of all necessary methods to bring the species to the point at which the law's protective measures "are no longer necessary."[461] Together these provisions imply that species will be removed from the list when the ESA's protections are no longer essential to their survival. In reality, however, we can rarely be certain that a species will disappear if it is not protected. The challenge of the viability problem is to define a tolerable level of extinction risk, and to decide what to do when that risk is uncertain or unknown.

Together, the text and legislative history justify only a few sharply limited

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"depleted" species or stocks as well as those listed as endangered. Pub. L. No. 92-522, § 101(a)(3)(B), 86 Stat. 1027 (1972). Depleted stocks included those which had: declined significantly over a period of years; declined to the point that if the decline continued or resumed they would become endangered; or fallen below the maximum population level supportable without damage to the habitat. *Id.* § 3(1), (8).

CITES recognized three categories of species of concern: species "threatened with extinction;" those "not necessarily now threatened with extinction" but which "may become so;" and those unilaterally designated by any party as protected under domestic law. CITES, *supra* note 91, art. II. In the 1973 ESA, Congress considered but rejected a goal of maximum supportable population levels for all listed species. *See* ESA LEGISLATIVE HISTORY, *supra* note 92, at 392-94.

457. H.R. REP. NO. 93-412, at 11 (1973).

458. *See id.* at 12 ("Once an animal is on the threatened list, the Secretary has an almost infinite number of options available to him with regard to the permitted activities for those species."); *see also* 119 CONG. REC. 25,669 (1973) (statement of floor sponsor Sen. Tunney) ("The two levels of classification facilitate regulations that are tailored to the needs of the animal while minimizing the use of the most stringent prohibitions.").

459. BEAN, *supra* note 57, at 389-90, n.64 (Assistant Secretary of the Interior Nathaniel P. Reed testified that species would progress from the endangered to the threatened list as they recovered, as in "a hospital where the patient is transferred from the intensive care unit to the general ward until he is ready to be discharged.").

460. 16 U.S.C. § 1531(b) (1994).

461. *Id.* § 1532(3).

conclusions. Protected species must face more than a *de minimis* threat; protective measures must appear necessary to ensure survival; and endangered species should face a greater or more immediate threat than threatened ones. The vagueness of the categories leaves a great deal of discretion to the agencies.

2. Is the Identification of Endangered and Threatened Species Scientific?

Like the delineation of protectable groups, the identification of groups sufficiently at risk to warrant protection requires defining those categories and then applying them. Like "species," the terms "endangered" and "threatened" cannot be defined strictly on the basis of scientific information as that term is understood by the public, scientists and the legislature. Furthermore, because the science involved is often highly uncertain, application of any chosen definition leaves substantial room for discretionary choices.

a. Category Definition

As a necessary prerequisite to implementing the ESA, the listing agencies must supply the content Congress omitted from the statutory terms "endangered" and "threatened." Congress neglected to specify, in even the most general terms, either the relevant degree of extinction risk, or the relevant time period over which extinction risks should be evaluated.

The statue's vagueness is not unusual; Congress often leaves large policy gaps for implementing agencies to fill. The ESA's strictly science mandate, however, makes this particular gap problematic. It is impossible to specify a viability level which will qualify species for protection without looking beyond the realm of science. Like acceptable health risks from toxic substances,[462] acceptable risks of species extinction are social policy decisions. Determining those acceptable risks requires value judgments which the agencies cannot make without stepping out of their assigned "scientific" role.[463]

462. *See, e.g.*, Wagner, *supra* note 17, at 1618; Flournoy, *supra* note 441, at 340-42.

463. Many scientists have endorsed specific proposals for acceptable risk levels or time lines of concern. Some openly admit that these choices are not "scientific." *See, e.g.*, Mark L. Shaffer, *Minimum Population Sizes for Species Conservation*, 31 BIOSCIENCE 131, 132 (1981) ("arbitrarily propos[ing]" definition of minimum viable population as "the smallest isolated population having a 99% chance of remaining extant for 1000 years despite the foreseeable effects of demographic, environmental, and genetic stochasticity, and natural catastrophes"); Mark S. Boyce, *Population*

Once the choice of acceptable risk has been made, science is essential to achieving the goal of limiting extinction risks to that level. For example, scientific data can show how the life span and generation time of a species affect its vulnerability to extinction as a result of chance environmental events. In turn, that information may suggest that the probability of survival should be evaluated over different time periods for different species. Similarly, once an appropriate degree of risk has been selected, science can in principle translate that risk into observable data, such as population numbers or trends.[464] Science cannot, however, dictate the socially acceptable level of extinction risk or the time line against which risks should be measured.[465]

b. Category Application

Even if detailed definitions of the acceptable risk level were agreed upon, the listing agencies would still face substantial challenges in applying those definitions. Although this categorization step can in principle be performed solely on the basis of scientific information, in practice the data available are insufficient to support even a rough estimate of risk for most species.[466]

Nor is it currently feasible to create a general model capable of translating data such as population numbers or trends into risk values. Direct experimental determination of minimum viable population sizes is generally impractical, and in some cases ethically impermissible.[467] Consequently, many studies in this area rely on observation of isolated natural experiments.

Viability Analysis, 23 ANN. REV. ECOLOGY AND SYSTEMATICS 481, 482 (1992) ("[d]efinitions and criteria for viability, persistence, and extinction are arbitrary, e.g., ensuring a 95% probability of surviving for at least 100 years."). Some, however, do not. *See, e.g.*, Murphy & Noon, *supra* note 161, at 777 (extolling scientific virtues of federal owl protection plan without questioning "scientific" nature of plan's viability standard, "a high likelihood of persistence to 100 years"); Ronald Carroll et al., *Strengthening the Use of Science in Achieving the Goals of the Endangered Species Act: An Assessment by the Ecological Society of America*, 6 ECOLOGICAL APPLICATIONS 1, 6 (1996) (urging adoption of viability standard of "90% probability of persisting for 200 years").

464. Some suggestions for conversion of observed data into categories of concern are given in Fuller, *supra* note 371; Munton, *supra* note 449; and William K. de la Mare, *On the Definition of Threats to the Survival of Species*, *in* THE ROAD TO EXTINCTION, *supra* note 371, at 113-21.

465. The NRC's Endangered Species Committee has recommended, "from a scientific standpoint," use of time frames that will avoid a preference for short-term increases in population at the expense of long-term harm. *See* SCIENCE AND THE ESA, *supra* note 15, at 153. While this recommendation is eminently reasonable, it is not "scientific."

466. SCIENCE AND THE ESA, *supra* note 15, at 153; Georgina M. Mace & Russell Lande, *Assessing Extinction Threats: Toward a Reevaluation of IUCN Threatened Species Categories*, 5 CONSERVATION BIOLOGY 148, 151 (1991); Barbara L. Taylor, *The Reliability of Using Population Viability Analysis for Risk Classification of Species*, 9 CONSERVATION BIOLOGY 551, 553 (1995).

467. Boyce, *supra* note 463, at 482; Shaffer, *supra* note 463, at 132.

There is little basis for generalizing this work to the particular circumstances facing many declining species.[468]

Where direct experimentation is impractical, computer models are sometimes used to generate risk estimates. At their current level of development, however, these models generate only minimally reliable predictions. Because the mechanisms of extinction are still only poorly understood, the models necessarily rely on a number of simplifying assumptions, many of which have not been, and perhaps cannot be, validated by comparison with field or laboratory data.[469] Given their high levels of uncertainty, the risk estimates generated by these models are more accurately described as hunches than as scientific data.[470] Furthermore, in many cases the computer simulation models used to predict population viability are not published, or are published without full explanations of the assumptions on which they are based, making replication virtually impossible.[471]

The viability problem runs even deeper than these theoretical shortcomings. The most basic data underlying any viability analysis, such as population levels and population trends, are sometimes extraordinarily difficult to gather. For example, determining whether the marbled murrelet, "an extremely secretive seabird"[472] which travels inland to nest high in the canopy of old-growth forests of the Pacific coast, even uses an area requires repeated visits by multiple trained observers to remote sites. These observers search the dawn sky and forest canopy, looking and listening for murrelets rushing past through the morning mist.[473] With data on the simple presence or absence of a species so difficult to collect, determining nesting success or evaluating population trends can be nearly impossible.

Data gathered under such conditions inevitably suffer from large amounts of random variation, making interpretation a highly uncertain task. For example, one intensive study of northern spotted owls measured a population

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468. *See* Boyce, *supra* note 463, at 496-98; Shaffer, *supra* note 463; SCIENCE AND THE ESA, *supra* note 15.

469. SCIENCE AND THE ESA, *supra* note 15, at 141.

470. *Cf.* Romesburg, *supra* note 162, at 309 ("[T]he [computer simulation] model is an informed guess, a mixture of knowledge and error, about a process of nature."). Population viability analysis using computer models may provide the best estimate of extinction risk where limited data are available. While the agencies must certainly consider it in such cases, they must also recognize its limitations, as NMFS did in its recent evaluation of the status of the steller sea lion. *See* Change in Listing Status of Steller Sea Lions Under the Endangered Species Act, 60 Fed. Reg. 51,968, 51,969 (1995) [hereinafter Sea Lion Proposed Rule].

471. *See* Boyce, *supra* note 463, at 481.

472. *See* Marbled Murrelet v. Babbitt, 83 F.3d 1060, 1062 (9th Cir. 1996).

473. *See* Marbled Murrelet v. Pacific Lumber Co., 880 F. Supp. 1343, 1350-52 (N.D. Cal. 1995); C. John Ralph et al., Methods for Surveying for Marbled Murrelets in Forests: A Protocal for Land Management and Research, March 1994 (unpublished manuscript on file with author).

decline of roughly 4.5% per year. Despite the effort put into this study, the data proved far from unequivocal. The scatter was so great that standard statistical tests, used at the 95% confidence level, did not rule out rates of decline between 0.7% and 8.4%.[474] In other words, by the standards of ordinary biological practice, the data justified only the conclusion that the population was declining at a rate somewhere between negligible and catastrophic.[475] This uncertainty is often compounded when population data are manipulated in predictive models. One model of Steller sea lion population dynamics, for example, predicted a 100 percent probability of extinction within 100 years when applied to data collected from 1985 to 1994, but only a 10 percent probability of extinction if the data were limited to the period from 1989 to 1994.[476]

Agencies seeking data on dwindling species must also contend with legal complications. More than half of all listed species occur exclusively on private property.[477] Because the discovery of listed species on private land restricts development potential, landowners are often reluctant to permit biological surveys.[478] At present, the law provides no authority for entering private land to survey its biota against the wishes of the owner.[479] A landowner's refusal to allow on-site surveys can effectively limit the listing agencies to reliance on historic occurrence records, remote sensing methods,[480] and surveys of government-owned property. Given these

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474. Kent E. Holsinger, *Population Biology for Policy Makers: Promises and Paradoxes*, 45(6) BIOSCIENCE S-10, S-14 to S-15 (1995). Because of non-random sampling practices and the use of untested assumptions, even this measure may understate the uncertainty in the data. *See* de la Mare, *supra* note 464, at 116.

475. A decline of 8.4% per year would reduce the population by more than half in eight years.

476. Sea Lion Proposed Rule, *supra* note 470, at 51,977.

477. Jim McKinney, et al., *Economic Incentives to Preserve Endangered Species Habitat and Biodiversity on Private Lands*, *in* BUILDING ECONOMIC INCENTIVES INTO THE ENDANGERED SPECIES ACT 1, 2 (Wendy E. Hudson ed., 1993).

478. *See, e.g.*, Weston Kosova, *It Came From the Outback*, OUTSIDE 70, 156 (Nov. 1995); *Oversight Hearing*, *supra* note 7, at 53 (statement of Rep. George P. Radanovich) (because a plant he allowed The Nature Conservancy to identify on his property was subsequently proposed for listing, "[t]here is no way on God's green earth I am going to let anybody on that property again."); Red-Legged Frog Rule, *supra* note 284, at 25,816 ("In surveying suitable habitat, access to some areas was denied by private landowners.").

479. *See* Stephen Polasky & Holly Doremus, When the Truth Hurts: Endangered Species Policy on Private Land with Incomplete Information 9-11 (July 1997) (unpublished manuscript on file with author); *see Babbitt Announces Renaming of National Biological Survey*, 6 Env't Rep. (BNA) 7 (June 10, 1995) (Interior Secretary forbids biological survey staff to enter private land without clear permission).

480. In some cases, remote sensing may provide a powerful means of mapping suitable habitat. *See, e.g.*, Warbler Rule, *supra* note 269, at 53,155 (satellite imaging found to accurately identify potential habitat for the golden-cheeked warbler). However, a recent Interior appropriations bill prohibited the use of federal funds to gather or analyze remote sensing data for ESA purposes without the consent of affected property owners. Omnibus Consolidated Rescissions and Appropriations Act of

obstacles, it may be virtually impossible in some cases to demonstrate that a species is approaching extinction before it is too late.[481]

Because the data are typically so sketchy, assessments of species status must rest on educated guesses. Biologists often rely on rough rules of thumb to estimate the likelihood of population persistence. Some of these "rules" can only be described as hunches; they extrapolate well beyond existing data.[482] Where the data are not sufficient even to support these rough guesses, the agencies may resort to using habitat loss or threats to habitat as a rough indicator of species decline.[483] Unless habitat needs are relatively well understood, however, even habitat degradation may be difficult to assess.

In sum, although determination of the viability status of species is in principle scientific, it involves much more than objective data interpretation. What assumptions to include in viability models, which data to feed into those models, how to interpret equivocal data, and whether or not to apply a rule of thumb in the absence of data are some of the more common subjective elements hidden in viability determinations.

Even extinction is often not objectively determinable. The term extinct hides no value choices; it unambiguously connotes the death of the last member of the group. But only in rare cases, when all individual members of a species are known, is it clear when that last death occurs.[484] Typically, the determination of extinction must be made on the basis of less than absolute certainty. Science can help the agencies decide how likely it is that a survivor has escaped notice, but it cannot tell them how much time they must allow to

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1996, Pub. L. No. 104-134, 110 Stat. 1321 (1996).

481. *See* Sidney J. Holt, *Categorization of Threats to and Status of Wild Populations*, *in* ROAD TO EXTINCTION, *supra* note 371, at 19, 20.

482. Perhaps the best known of these rules of thumb is the "50 / 500 rule" for minimum viable populations, which estimates that a minimum effective population of 50 is required to prevent deleterious inbreeding in the short run, and a minimum effective population of 500 is needed to maintain long-term evolutionary potential. *See* Shaffer, *supra* note 463, at 133. When first put forward, these estimates were based on guesses about the genetic impacts of population size. Boyce, *supra* note 463, at 498. Empirical evidence gathered since that time suggests they are probably in the right ballpark, at least for certain taxa. *Id.* Thus the 50/500 rule provides an example of a hunch that appears to have paid off.

483.

> Comprehensive, long-term population data are not necessarily required for making listing determinations. Rather, these decisions often rest upon data on loss and modification of habitat and other threats, which are reasonably assumed to result in population declines. In many cases, population declines are inferred from decline in habitat availability. However, in this and other listing determinations, the Service seeks to measure such inference against whatever population trend data are available.

Flycatcher Rule, *supra* note 252, at 10,699.

484. *See, e.g.*, Holt, *supra* note 481, at 20 ("it is notoriously difficult to be sure that the last individual of a population has died").

pass, or how much effort they must put into the search, before declaring the species extinct.[485]

3. *The Incoherent Regulatory Approach to the Viability Problem*

The agencies have been just as close-mouthed about the basis for their viability determinations as they have about their taxonomy determinations. They repeatedly insist that viability determinations are strictly scientific,[486] and firmly deny that "political considerations" play any role.[487] Yet their unexplained and inconsistent practices have left them open to charges of standardlessness from advocates of both greater and lesser protection. Indeed, it has long been clear that political factors sometimes do affect at least the timing, if not the substantive outcome, of listing decisions.[488] Rather than freeing these decisions from political influences, the strictly science mandate has helped the agencies hide the impact of those influences.

a. *Category Definition*

The listing agencies have been as unforthcoming concerning the definitions of "endangered" and "threatened" as they have concerning the definition of "species." Their listing regulations simply repeat the unhelpful statutory definitions,[489] and they have offered little additional guidance. FWS has noted that recovery, the threshold for removal from the protected list,[490] means attaining "viable, self-sustaining" status.[491] These terms, however, are no more self-explanatory than "endangered" or "threatened." FWS interprets

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485. Suggestions range from as little as five to as much as fifty years of fruitless efforts to locate the species. *See* Munton, *supra* note 449, at 72 (quoting William T. Hornaday, author of a 1913 ancestor to the Red Books for the five year figure); F. Wayne King, *Thirteen Milestones on the Road to Extinction*, *in* THE ROAD TO EXTINCTION, *supra* note 371, at 7, 17 (suggesting fifty years, but noting that species have been rediscovered after longer intervals).

486. *See, e.g.*, Red-Legged Frog Rule, *supra* note 284, at 25,817; Determination of Threatened Status for the Washington, Oregon, and California Population of the Marbled Murrelet, 57 Fed. Reg. 45,328, 45,332 (1992) ("The Service bases its decisions on the listing of species solely upon biological information, as required by the Act.").

487. *See* Final Rule to Reclassify the Bald Eagle from Endangered to Threatened in All of the Lower 48 States, 60 Fed. Reg. 36,000, 36,006 (1995) [hereinafter Bald Eagle Rule].

488. *See, e.g.*, GAO, A CONTROVERSIAL ISSUE, *supra* note 4, at 16. The Bruneau hotspring snail provides a recent example. Despite its stated belief that the snail was near extinction, FWS delayed listing it to mollify Idaho's senators. *See* Idaho Farm Bureau Fed'n v. Babbitt, 58 F.3d 1392, 1396 (9th Cir. 1995).

489. *See supra* note 437.

490. *See* 16 U.S.C. § 1533(f)(1)(B)(ii); (g) (1994).

491. Bald Eagle Rule, *supra* note 487, at 36,001.

"endangered" to mean in imminent danger of extinction,[492] but has never explained what "imminent" means or how it is evaluated. FWS also has not explained how it distinguishes between "endangered" and "threatened" species, an important distinction in light of the lesser protections which may be given threatened species under section 4(d).[493]

NMFS has discussed threshold viability or risk levels more openly than FWS. In its proposed rule to reclassify the Steller sea lion, NMFS acknowledged that "[t]he ESA does not provide objective criteria or specific guidance for determining when a population should be listed as endangered or threatened." It described the listing determination as calling for a subjective determination of what extinction risk "is too high to be acceptable to society."[494] Despite conceding the subjective nature of this determination, NMFS sought guidance only in the scientific literature. Because conservation biologists frequently mention a 95% probability of survival over 100 years as an appropriate standard of viability, NMFS adopted that figure.[495] Yet in another listing document just a few months later, NMFS did not even mention that 95% standard.[496]

b. Category Application

The lack of clear definitions of "endangered" and "threatened," together with variation in risk factors and species biology, make it difficult to evaluate the consistency of agency viability decisions. An empirical study of listings between 1985 and 1991 found that listed species had, as a rule, declined to extremely low population levels prior to listing, and that those listed as endangered were notably more reduced than those listed as threatened.[497] The correlation was not perfect, however; some taxa were listed as threatened at extremely low population levels.[498]

Because population level alone is not a perfect indicator of the risk of

492. *See, e.g.*, Black Bear Rule, *supra* note 236, at 592 ("Endangered status is not chosen because the threats are not believed to place the Louisiana black bear in imminent danger of extinction.").

493. *See supra* note 113.

494. Sea Lion Proposed Rule, *supra* note 470, at 51,971.

495. *Id.* at 51,972.

496. *See infra* notes 503-05 and accompanying text.

497. David S. Wilcove et al., *What Exactly Is an Endangered Species? An Analysis of the U.S. Endangered Species List: 1985-1991*, 7 CONSERVATION BIOLOGY 87 (1993). Followup studies showed the same pattern through 1994 listings. *Endangered Species Moratorium: Hearing Before the Subcomm. on Drinking Water, Fisheries & Wildlife of the Sen. Comm. on Environment & Public Works*, 104th Cong., 126-128 (1995) (statement of David Wilcove, Senior Ecologist, Environmental Defense Fund).

498. Wilcove et al., *supra* note 497, at 92.

extinction,[499] it may not provide an adequate measure for evaluating listing decisions. NMFS has identified several factors as indicators of species viability, including: present population levels; historic population levels and carrying capacity; population trends; factors likely to cause population variability over time; threats to genetic integrity; and recent events with predictable short-term consequences for population levels.[500] FWS has cited declines in population, declines in habitat, and vulnerability to known or potential threats as important considerations in addition to absolute population levels.[501] Just how the agencies apply these factors, however, is far from clear. Not only do the agencies refuse to formulate explicit listing standards, they offer no apology for the apparent inconsistency of their decisions. When opponents of the recent listing of four species of fairy shrimp complained that the shrimp did not meet standards applied to other listed crustaceans, for example, FWS responded that because so many factors go into listing decisions consistency should not be expected.[502]

The lack of openly-discussed standards for determining whether species are endangered, threatened, or ineligible for listing effectively leaves the agencies free to adopt virtually any decision with virtually no discussion and little fear of judicial reversal. For example, in a recent proposed rule evaluating fifteen steelhead stocks, NMFS concluded with very little explanation that five were endangered, five were threatened, and five did not warrant listing.[503] NMFS did not even purport to apply the viability standard used in its Steller sea lion proposal.[504] Instead, it applied an undefined but apparently very demanding standard for classification as endangered: the runs it proposed for endangered status were reduced to populations of fewer than 500 fish in many streams, down eighty to ninety percent from their levels just 30 years earlier.[505]

Indeed, it is far from clear that NMFS applied uniform standards to the fifteen steelhead groups evaluated in this proposal. At one point, NMFS

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499. *See, e.g.*, Delhi Sands Fly Rule, *supra* note 255, at 49,884-85; Bruneau Hot Springsnail Rule, *supra* note 5, at 5941.

500. Proposed Steelhead Rule, *supra* note 283, at 41,548.

501. Draft Candidate Species Guidance, *supra* note 262, at 32. One reviewing court has declared that the agencies must consider at least mortality levels and population trends in addition to population size. *See* Carlton v. Babbitt, 900 F. Supp. 526, 533 (D. D.C. 1995).

502. The agency also suggested that consistency could not be recognized by the untutored. "The multiplicity of factors and relationships that must be considered and interpreted in assigning the appropriate status to listed taxa is sufficiently complex that patterns of consistency may not be necessarily agreed upon by all parties." Fairy Shrimp Rule, *supra* note 284, at 48,140.

503. Proposed Steelhead Rule, *supra* note 283.

504. *See supra* note 495 and accompanying text.

505. *See* Proposed Steelhead Rule, *supra* note 283, at 41,553.

suggested that groups which might not be self-sustaining under current conditions would qualify for listing.[506] Yet it did not propose to list steelhead in southwestern Washington, depite finding that the group was experiencing rapid decline and subject to pervasive genetic threats.[507] A systematic study of listings from 1975 to 1991 suggests that the steelhead confusion is not an isolated case. Andrea Easter-Pilcher found no consistency in the factors cited in final listing documents to justify the agencies' decisions, and no correlation between the use of descriptive terms such as "rare" or "extremely rare" and quantitative data such as measured population numbers.[508]

The lack of consistent standards, or even consistent attention to the same factors, lends credence to the contention that raw politics plays a major role in the agencies' viability determinations. One frequently cited example is the 1978 downlisting of the gray wolf in Minnesota from endangered to threatened. Critics charge this change had more to do with local hostility to wolves than with the animal's viability status.[509] FWS' recent treatment of bald eagles shows similar hallmarks of political malleability. FWS determined recently that bald eagle populations in many areas of the continental United States are doubling every six to seven years. Yet rather than delist the eagle in any part of its range, the agency, faced with strong public opposition to delisting, reclassified it as threatened.[510]

Even relatively uncontroversial decisions seem sensitive to the agencies' perception of the direction of the political winds. For example, FWS listed the Alabama red-bellied turtle as endangered in 1987, after having proposed to list it as merely threatened.[511] Yet there was virtually no change in the agency's description of the turtle's condition; FWS simply deleted, without further explanation, the proposed rule's statement that the species was not

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506. For example, NMFS proposed to list the Oregon Coast ESU as threatened because it was "concerned that the majority of natural steelhead populations in this ESU may not be self-sustaining." *Id.* at 41,552.

507. *Id.* at 41,550.

508. *See* Andrea Easter-Pilcher, *Implementing the Endangered Species Act*, 46 BIOSCIENCE 355, 357 (1996).

509. *See* ROGER L. DISILVESTRO, THE ENDANGERED KINGDOM: THE STRUGGLE TO SAVE AMERICA'S WILDLIFE 97 (1989). Support, or the lack of it, within the listing agency itself may also be crucial. *See* YAFFEE, *supra* note 19, at 82 (noting that although some FWS staff were dubious about the data supporting listing of certain molluscs, the presence of "an assertive malacologist" in the Office of Endangered Species assured their listing).

510. Bald Eagle Rule, *supra* note 487, at 36,009. In response to an advance notice of its proposal, FWS had received 140 individual and 23 citizen-group comments. Of those, 135 of the individuals and 19 of the citizen groups opposed reclassification or delisting. *See* Reclassify the Bald Eagle from Endangered to Threatened in Most of the Lower 48 States, 59 Fed. Reg. 35,584, 35,588 (1994).

511. *Compare* Determination of Endangered Status for the Alabama Red-Bellied Turtle, 52 Fed. Reg. 22,939 (1987) *with* Proposed Threatened Status for the Alabama Red-Bellied Turtle, 51 Fed. Reg. 24,727 (1986).

faced with imminent extinction. It is tempting to speculate that the proposed rule was used to test the political waters; when no opposition to the listing materialized during the comment period,[512] the agency felt free to adopt the more restrictive endangered listing.

Of course, political pressures do not always favor species. FWS originally proposed to list the California red-legged frog as endangered based on information showing that it had been eliminated from approximately three-fourths of its historic range and that the remaining frog populations faced numerous risks. During the comment period, a number of new populations were found, most within the range already identified by FWS. In light of this new data, FWS slightly revised its estimate of reduction from historic range; the agency now estimated the frog had disappeared from only 70%, not 75%, of the area it once occupied. This minor revision was translated into a change in status from endangered to threatened.[513] Because FWS did not elaborate further on the foundation for this distinction, it is easy to suspect that the change was prompted by the administration's reluctance to extend the full protection of the ESA to a lowly amphibian during a hotly contested Presidential election.[514]

Other agency about-faces are less obvious because they occur during internal review before a formal proposal is issued. In 1991, the FWS regional office, following the advice of its staff scientists, recommended listing the delta smelt as endangered. Following a vigorous "lobbying blitz" by real estate and agricultural interests, joined by California state officials and members of Vice President Dan Quayle's staff, officials at the agency's headquarters directed the region to revise its recommendation to threatened.[515]

The status quo, that is whether the species is being considered for listing

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512. Only eight comments, all favorable, were received on the proposed listing. Furthermore, the landowners most affected by the listing openly supported the agency's conservation efforts. Determination of Endangered Status for the Alabama Red-Bellied Turtle, 52 Fed. Reg. 22,939, 22940 (1987).

513. Red-Legged Frog Rule, *supra* note 284, at 25,823.

514. *See* Margaret Kriz, *The Center Folds*, NAT'L J., July 6, 1996 (Rep. Don Young characterized the listing of the frog as threatened rather than endangered as political manipulation); Mollie H. Beattie, *Saving the Jumping Frog and the Natural Heritage*, SAN DIEGO UNION-TRIBUNE, May 23, 1996, at B9 (Beattie, then Director of FWS, writes that "there need be no outcry over the effects" of the listing because protection of the frog "need not have significant consequences for Californians"); Marla Cone, *Red-Legged Frog Is Added to List of Threatened Species*, L.A. TIMES, May 21, 1996, at A3 (stating the frog "was one of the most controversial among the species" whose listing was temporarily stalled by the moratorium; representative of the building industry forecasts great economic disruption as a consequence of listing).

515. Charles McCoy, *Lobbyists' Smelt-and-Bird Campaign is Assault Against Endangered Species Act Itself, Some Say*, WALL ST. J., Aug. 29, 1991, at A14.

in the first instance or whether it is already on the list and being considered for removal, also seems to have a strong impact on the agencies' treatment of the viability issue. The agencies tend to place the burden of proof on the party seeking to change the status quo, leaving some species at high extinction risk off the list, while retaining on the list others which are at lesser risk. The bald eagle is one species which remains on the list although it is likely far healthier than many unlisted species.[516] The contrasting treatment NMFS accorded the Steller sea lion, a listed species, and the unlisted northwest steelhead runs also shows the importance of the status quo. NMFS adopted a much more protective stance toward the sea lion than toward the steelhead. Having concluded that the western and eastern sea lion populations should be considered independently,[517] NMFS proposed to list the western population as endangered based on a decline of roughly 70% between the 1960s and 1989, with continuing declines even after the species was listed as threatened in 1990.[518] By contrast, while the eastern population segment had also shown severe declines before 1980, its population level had increased about 17 percent since the 1990 listing. Although it attributed some of this increase to improved counting techniques, NMFS conceded that the eastern population segment, considered alone, did not appear vulnerable to extinction in the foreseeable future.[519] Yet, because it was not convinced that the threats to the western population would not move east, NMFS proposed to continue the listing of the eastern population as a threatened species.[520]

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516. *See supra* note 510 and accompanying text.

517. *See supra* note 414 and accompanying text.

518. Sea Lion Proposed Rule, *supra* note 470, at 51,971. Population viability analysis predicted a probability of between 10 and 100 percent of extinction within the next 100 years, depending on the trend data considered.

519. *Id.* at 51,972.

520. *Id.* at 51,973. NMFS also pointed out that, because the populations are not strictly geographically separate, "animals from the western population could be affected by a lack of protective management mechanisms." *Id.* FWS has also relied on the endangered status of some populations of a species as a basis for continuing to regard other populations as threatened, despite considerable improvements in population status. *See* Reclassification of Saltwater Crocodile Population in Australia from Endangered to Threatened with Special Rule for the Saltwater and Nile Crocodiles, 61 Fed. Reg. 32,356, 32,357 (1996).

FWS treatment of the Maguire daisy further illustrates the agencies' reluctance to alter the status quo. A revision in taxonomic treatment increased the agency's population estimate from ten individuals in a single population up to roughly 3,000 in twelve separate populations. While this population level far exceeds the level at which most recent listings have been made, *see* Wilcove, et al., *supra* note 497, FWS did not delist the daisy but instead reclassifed it as threatened. Maguire Daisy Rule, *supra* note 282, at 31,054.

c. Recognizing Extinction

The status quo also plays an important role in formal findings of extinction. The agencies are more likely to declare a group extinct if that group is not yet listed. Agency regulations provide that, unless all individuals of the species are known to be extirpated, enough time must pass to clearly demonstrate that the species is extinct before it may be removed from the list.[521] FWS recently applied this regulation in refusing to delist the Maryland darter.[522] Petitioners claimed fifteen years had passed since the last darter sighting, and that the fish could no longer be found in its only known recent location. FWS disagreed. Although it acknowledged that eight years had passed since a confirmed sighting, the agency concluded that in light of past gaps between observations the recent hiatus did not "provide definitive evidence" of extinction.[523] Because it could not rule out the species' continued existence, FWS refused to consider delisting.[524]

By contrast, the agency applied quite a different standard of proof when considering the addition of the Alabama sturgeon to the list. After substantial controversy and litigation,[525] FWS withdrew a proposal to list the Alabama sturgeon as endangered, finding a "lack of evidence that the sturgeon still exists."[526] Yet there was at least as much evidence for the Alabama sturgeon's continued existence as for the Maryland darter's. A verified specimen had been collected in 1993; several commercial fishermen reported catches since 1985; and there had been a pattern of seven- to eight-year gaps between collections since the early 1950s. Furthermore, FWS acknowledged that the scientific literature contained numerous examples of fish rediscovered long after they were thought to be extinct.[527]

The current listing status of the species may serve as a marker for political support; politically popular species are more likely to have found their way to the list than unpopular ones.[528] Attention to the status quo may be another form of attention to the political climate. Alternatively, the agencies may be

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521. 50 C.F.R. § 424.11(d)(1) (1995).

522. 90-Day Finding for a Petition to De-List the Maryland Darter (*Etheostoma sellare*), 61 Fed. Reg. 5971 (1996) [hereinafter Maryland Darter Petition].

523. *Id.* at 5971.

524. *Id.* at 5972.

525. *See* Vaughan, *supra* note 292, at 604-32.

526. Alabama Sturgeon Withdrawal, *supra* note 67, at 64,808.

527. *Id.* at 64,800.

528. A recent study found both body size and position in the evolutionary hierarchy correlated with listing status. Andrew Metrick and Martin L. Weitzman, *Patterns of Behavior in Endangered Species Preservation*, 72 LAND ECON. 1, 7-8 (1996). Larger species and higher life forms are likely to be "charismatic," and thus to enjoy stronger political support than others.

relying on legislative indications that the decision to delist was to be made with special caution.[529] In either case, however, the decision is a value choice, not a scientific one. Moreover, in the absence of an explanation, the apparent inconsistency of the decisions leaves the agencies open to political, if not judicial,[530] attack.

V. GETTING REAL: DESIGNING A SCIENTIFICALLY AND POLITICALLY CREDIBLE LISTING PROGRAM

Congress was right to look to science as an important basis for implementing biological conservation policy. An effective conservation policy must be grounded in the best available understanding of the natural world, an understanding science is uniquely qualified to provide. But science cannot answer all questions, even about the natural world. Consequently, it cannot bear the weight of the strictly science listing mandate. Because listing decisions inevitably incorporate non-scientific elements, the mandate has not produced the objective, value-neutral decisions the law leads the public to expect.

Nor has the appeal to science produced the political credibility Congress may have sought. The listing agencies have been excoriated as political hacks from both sides throughout the ESA's history. Public perceptions that agency staff and other scientists have used the law to serve their own political ends have fueled the recent controversy over the ESA.

Rather than achieving either value-neutral or politically invulnerable decisionmaking, the strictly science mandate has encouraged the listing agencies to devise an inscrutable listing policy hidden behind a wall labeled science. The mandate has produced listing decisions which are often incomprehensible even to informed observers,[531] and nearly inaccessible to the general public. Furthermore, the mandate has not effectively advanced the values Congress intended the ESA to protect. It is time to try a new approach.

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529. *See, e.g.*, 119 CONG. REC. 922 (1973) (statement of Representative Dingell during floor debate on conference report) (making listing easier than delisting is appropriate because "we should act cautiously").

530. Some courts appear to view the listing status quo as an appropriate consideraton. For example, a federal district court recently called on to evaluate the agency's refusal to reclassify a population of grizzly bears from threatened to endangered focused not on the absolute level of risk, but rather on whether that level had increased since the animal was first listed as threatened. *See* Carlton v. Babbitt, 900 F. Supp. 526, 532 (D.D.C. 1995).

531. *See, e.g.*, Easter-Pilcher, *supra* note 508 (describing the lack of apparent standards against which listing decisions can be evaluated).

A. General Principles

Fashioning a sensible policy in this area requires two major steps. First, to the extent possible, scientific decisions interpreting empirical data should be separated from policy judgments. As explained in Part IV, both the identification of protectable groups and the determination of acceptable extinction risks require the kinds of policy choices typically left to the political process. Scientists with expert knowledge of a particular species have a special ability to inform society of the need to protect that species and the potential costs of its loss. However, they have no special ability to weigh the relative costs and benefits of extinction, once identified. Indeed, because scientific data do not provide a basis for undertaking that comparison, scientists asked to make it will necessarily do so nonscientifically.

Even conceding that these choices are not scientific, it would make sense to delegate them to scientists if doing so would help achieve the ESA's goals. The legislature might, for example, guess that biological scientists would be particularly sensitive to the values served by species, and consequently particularly resistant to political pressure against listing.[532] In other words, the legislature might rationally decide to delegate listing decisions to scientists inclined to protect species in order to counteract the political power of industry and landowner interests opposed to species protection.

Although it is plausible to suppose that the strictly science mandate would counteract such focused pressures, experience does not bear out that assumption. The listing agencies have not been able to resist focused political pressures, either for or against listing. Instead of counteracting such pressures, the strictly science mandate has allowed the agencies to shield their political decisions from public view. Furthermore, the scientists to whom these decisions have been delegated have not proven themselves sensitive to all the values the ESA seeks to protect.

Instead of remaining hidden, the non-scientific elements of the listing decision should be consigned to a more openly political process. A public deliberative process, facilitating full articulation of a range of viewpoints,

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532. Experts who have devoted their working lives to particular organisms are likely to place a high value on those organisms. *See, e.g.*, ERNST MAYR, TOWARD A NEW PHILOSOPHY OF BIOLOGY: OBSERVATIONS OF AN EVOLUTIONIST 89 (1988) (immersion in investigation of evolution is likely to lead to special regard for the products of evolution); Carol M. Rose, *Environmental Lessons*, 27 LOYOLA L.A. L. REV. 1023, 1046 (1994) ("knowledge of natural things often enhances one's passionate engagement in them"). Biologists are more apt than the general public to view the natural world and its species as having intrinsic worth. *See* Paul A. Sabatier & Matthew Zafonte, *The Views of Bay/Delta Water Policy Activists on Endangered Species Issues*, 2 HASTINGS WEST-NORTHWEST J. ENVTL. L. & POL'Y 131, 145 (1995).

could lead to an informed choice by a politically-responsive body.[533] Such a process would permit the airing of all relevant viewpoints, provide a forum to educate the public concerning the range of benefits provided by species, and ultimately provide a more solid political foundation for conservation policy.[534]

Once the value choices are made, science can do much to help society achieve its conservation goals. Scientific information is the most reliable basis for evaluating the importance of particular individuals or groups to their taxonomic species, community, and ecosystem; their evolutionary relationship to other organisms; their unique or unusual morphological, ecological, genetic, and behavioral characteristics; their population status; their habitat requirements; and their current risk of extinction. If these scientific questions are separated from the political ones, science can do its job with reasonable objectivity, earning the public trust it deserves.

B. Solving the Taxonomy Problem: The Limits of Science

1. Recognizing the Problem

The taxonomy problem results from confusing value judgments with scientific determinations. A number of commentators, assuming that the identification of groups meriting protection under the ESA is strictly a scientific problem, have offered suggestions to improve the scientific credibility of those determinations.[535] Even as practiced by taxonomists, however, the division of groups into taxa is hardly an objective, value-neutral exercise. Furthermore, the identification of groups eligible for protection under the ESA should take into account values not typically considered by taxonomists.

Congress enacted the ESA in order to protect the "esthetic, ecological, educational, historical, recreational, and scientific value" of the disappearing

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533. Allowing and encouraging participation by affected persons in the decisionmaking process can both increase the acceptance of the ultimate decision by those affected and produce a decision which is substantively more responsive to community needs. *See* Ellison Folk, *Public Participation in the Superfund Cleanup Process*, 18 ECOLOGY L. Q. 173, 185 (1991).

534. *See* SCIENCE AND THE ESA, *supra* note 15, at 159 ("Many citizens are willing to allow public officials to make [value judgments] on their behalf, but those involved might be more comfortable if the values informing those judgments and their effects on ESA decisions were articulated more clearly.").

535. *See infra* notes 541-52 and accompanying text. While Rohlf noted that the uncertainty of science in this area leaves a great deal of room for the exercise of value-based discretion, he failed to recognize the fundamentally non-scientific nature of the issue. *See* Rohlf, *supra* note 114, at 646-47.

biota.[536] It acknowledged the value of species both as irreplaceable genetic resources and as unique morphological, behavioral, and ecological kinds.[537] Taxonomy, because it was not developed to serve the same goals, does not look to the same list of values. Taxonomists seek to conveniently catalogue the range of biological variation and to elucidate evolutionary relationships. They are not concerned with esthetic, historic, educational or recreational values. As a result, the taxonomic distinctions the ESA relies on can actually hinder protection of some of the values the law seeks to protect.

The delegation of listing decisions to taxonomists, together with the demand that those decisions be made on a strictly scientific basis, has led the listing agencies to emphasize genetic distinctness at the expense of other important values.[538] The shortcomings of this focus on genetics are illustrated by taking it to its logical extreme. Paul Munton has seriously suggested that the IUCN might produce a Red Data Book listing rare or endangered genes or sets of genes rather than species.[539] "Indeed," Munton says, "a time can be foreseen when genetic engineering will allow huge numbers of valuable genes to be stored as part of a composite living organism, an animal with multiple features from many species or a vast polyploid plant bearing a hundred different flowers and fruits from its branches."[540] Even if the creation of such a composite creature were possible, it would surely be a poor substitute for the species which provided its component parts.

2. Better Science Is Not the Answer

Several commentators, recognizing the haphazard nature of the current process for identifying protected groups, have proposed "scientific" improvements. Most prominently, the National Research Council ("NRC"), in a recent report to Congress, simply assumed that science provides the appropriate basis for species delineation under the ESA. "Given the intent of the ESA to protect biological diversity," the report asserted, protection of all species and subspecies is scientifically sound.[541] Furthermore, species and

536. 16 U.S.C. § 1531(a)(3) (1994). Even this list does not encompass all possible reasons for protecting species. There may, for example, be ethical obligations to protect some portions of the biota. *See* Doremus, *supra* note 421, at 269-75. Nonetheless, the list as it stands plainly encompasses much more than genetics. Daniel Rohlf is one of the few commentators to recognize that the ESA protects more than genetic resources. However, Rohlf unnecessarily limited his focus to ecosystem health and the protection of domestic populations. Rohlf, *supra* note 114, at 626-29.

537. *See supra* text accompanying notes 334-53.

538. *See supra* text accompanying notes 400-09.

539. Munton, *supra* note 449, at 87-88.

540. *Id.*

541. SCIENCE AND THE ESA, *supra* note 15, at 57.

especially subspecies can only be identified through "the judgments of competent systematists."[542] Like the listing agencies, the report's authors viewed genetic and evolutionary distinctness as the only important values to be protected by the ESA.[543] Consequently, they proposed that recognition of distinct population segments be limited to "evolutionary units," groups sharing a common evolutionary history and the potential for a unique evolutionary future.[544] This proposal, which closely parallels the agencies' strategy for identifying distinct population segments, suffers from the same shortcomings as that strategy.[545]

More surprisingly, a number of non-scientists have endorsed similar views. Professor Hill, for example, recommends that the legislature adopt Ernst Mayr's BSC[546] as a "more scientifically accurate" basis for ESA listing decisions.[547] He proposes that "species" be defined as a group that shares a common evolutionary fate and occupies an identifiable ecological niche.[548] As explained in Part IV, the BSC has serious shortcomings as a "scientific" definition of species.[549] More importantly, its narrow focus on reproductive compatibility and evolutionary relationships would exacerbate the major flaw of the strictly science mandate, its inability to protect the full range of values served by the ESA. Perhaps for these reasons, Congress has already once considered and explicitly rejected use of the BSC to define listable entities.[550]

Other commentators have called for reliance on DNA comparisons to delineate groups.[551] This solution is even less desirable. Like adoption of the evolutionary unit concept or the BSC, it would underprotect values other than genetic diversity. Furthermore, genetic comparisons suffer from the same lack of agreement on what characteristics matter to what extent that plagues morphological comparisons. Comparisons may be based on full

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542. *Id.* The listing agencies take a very similar view. *See supra* note 360.

543. *See* SCIENCE AND THE ESA, *supra* note 15, at 56.

544. *Id.* at 57.

545. The NRC committee agrees that its proposal for identifying "evolutionary units" closely resembles, and will generally produce the same results as, NMFS' policy for identifying distinct population segments of salmon. SCIENCE AND THE ESA, *supra* note 15, at 57 n.2. For a discussion of the problems that policy has created, *see supra* notes 398-422 and accompanying text.

546. *See supra* notes 324-28 and accompanying text.

547. Hill, *supra* note 13, at 263.

548. *Id.* at 263. Gleaves and co-authors advocate a similar solution, calling for species delineations on the basis of "biological and scientific judgment" about reproductive isolation and importance to the genetic and ecological resources of the taxonomic species. Gleaves et al., *supra* note 309, at 50.

549. *See supra* notes 329-33 and accompanying text.

550. *See supra* notes 345-48 and accompanying text.

551. *See* Taylor, *supra* note 13, at 8; Kevin W. Grierson, Comment, *The Concept of Species and the Endangered Species Act*, 11 VA. ENVTL. L. J. 463, 486-89 (1992).

sequencing or on restriction fragment analysis; on nuclear or mitochondrial DNA, or on ribosomal RNA; on specific genes or whole genomes.[552] As yet, no consensus exists as to which comparison best reflects evolutionary histories or potentials. Furthermore, sequence data are likely to be more expensive to collect than data on morphological characteristics; these additional expenditures would do little to improve listing decisions.

All of these suggestions miss the point. The identification of groups eligible for protection is simply not a scientific exercise. No universal basis exists for evaluating the extent to which any group of organisms embodies the full range of values the ESA protects. Although many scientists and environmentalists would prefer not to have to face these difficult choices, they cannot be avoided. It is plainly impossible to preserve every individual creature, or even every identifiable group.[553] Much as we might prefer to avoid them, choices will inevitably be made, and they cannot be made on the objective basis envisioned by advocates of "better" scientific distinctions.

3. *Solving the Taxonomy Problem*

A more effective approach to the taxonomy problem would be to broaden the narrow focus on science as a basis for listing, and offer persons other than scientists a role in the identification of protectable entities. Although only congressional amendment of the ESA could give full effect to such a broadening, the agencies could take substantial steps toward it through administrative action.

a. *Legislative Correction*

Congress could correct the taxonomic "science charade" in a number of different ways. The most extreme option would be for Congress to directly designate groups eligible for protection, in the same way that it has directly listed hazardous air pollutants under section 112 of the Clean Air Act.[554] Whatever its merits in the Clean Air Act context, direct legislative listing would not offer a practical means of addressing the ESA taxonomy problem. Congress simply does not have the time to individually evaluate the boundaries of all possible candidate groups. Adopting a list generated by an

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552. *See* Panchen, *supra* note 322, at 220-24.

553. Even Norman Myers, long one of the most vocal advocates of biodiversity protection, concedes that we cannot realistically expect to preserve all species. *See* Norman Myers, *Biodiversity and the Precautionary Principle*, *in* LAW, VALUES, AND THE ENVIRONMENT: A READER AND SELECTIVE BIBLIOGRAPHY 42, 49 (Robert N. Wells, Jr., ed., 1996).

554. 42 U.S.C. § 7412(b) (1994).

agency or non-governmental organization would not solve the problem either, because all current lists suffer from excessive deference to the judgments of taxonomists.

Less drastically, Congress could attempt to draft a general definition of the characteristics which make an entity listable, a definition which the agencies could apply objectively in accordance with the strictly science mandate. This solution is also impractical. Prior searches for such a general definition have failed precisely because there is no single formula which captures all the diverse values biological resources serve.[555] The legislature essentially has no choice but to delegate these value decisions. The real question, then, is what form that delegation should take.

Delegation to the current listing agencies remains appropriate. Although Congress could delegate these decisions in the first instance to an advisory body, creation of such a body would probably not much improve the ultimate decisions. An advisory body made up exclusively of scientists would probably not adequately consider all the relevant values. Nor, because the values concerned are so many and so varied, does it seem useful to attempt to craft an advisory body with a membership which would be sensitive to all of them. Instead, Congress should simply leave these decisions with the listing agencies, which have both scientific expertise and political accountability, the two most important qualifications for these decisions.

Although it should not change the bodies to whom it has delegated species delineation decisions, Congress should revise the terms of that delegation. It should free these determinations from the grip of the strictly science mandate, which has caused the agencies to over-value taxonomic categories and genetic distinctness and under-value esthetic, recreational, symbolic, and other kinds of distinctness. Listable entities should be identified through a process which encourages consideration of all the values a group might serve.

In order both to keep the process relatively simple and to ensure a minimum level of protection, the ESA should continue to require protection of all groups recognized in the taxonomic community as full species. Although current species concepts reflect the particular goals of taxonomists, virtually all groups distinct enough to merit recognition as taxonomic species represent the intuitively recognized natural kinds that, at a minimum, the ESA intended to protect.[556] The political factors which have led the listing agencies to avoid politically unpopular listings in the past will undoubtedly

555. Others have recognized the need for flexibility in listing standards, although not necessarily for the reasons asserted here. *See, e.g.*, Zaepfel, *supra* note 309, at 152-53.

556. *See supra* text accompanying note 381.

inhibit the listing of any species which truly lacks the values recognized in the ESA. The exemption process offers an adequate mechanism for authorizing the extinction of any such species which does reach the protected list.[557]

Below the taxonomic species level, any identifiable group that is significantly different from other groups with respect to esthetic, ecological, educational, historical, recreational, or scientific value should be eligible for listing. "Identifiable" should be construed broadly to include any group sufficiently distinguishable from others to permit differential regulatory treatment. Geographic boundaries and morphological differences would be the most likely markers for distinctness. The current practice of recognizing international boundaries as a basis for delineating protectable groups should continue. State lines could also mark the boundaries of a listable group, even if the group moves or interbreeds to some extent across those lines, if maintaining it in both states would advance ecological, historical, recreational, or other values. Geographic breaks between populations could also justify differential treatment, even if some gene flow occurs between those populations.

By analogy to the current practice for identifying distinct population segments, identifiable groups should be evaluated for their "significance" or contribution to the broad range of values protected by the ESA. This wide-ranging inquiry would address the concern expressed by one Congressman, who asked during the 1995 oversight hearings whether science can "determine whether or not a subspecies is important enough to preserve."[558] Indeed science cannot, but perhaps a broader deliberative process can. The range of values considered in that process should encompass all of the reasons society might consider a group of organisms worth protecting. At a minimum, it should include the full list of values Congress identified as important in the ESA's purposes provision.[559] Each of these values should be construed broadly to effectuate the Act's purposes. Ecological value, for example, should include the role "umbrella," "keystone," and "indicator" species[560] can play in protecting unique or imperiled ecosystems.[561]

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557. *See* 16 U.S.C § 1536(e) - (h) (1994). Because virtually all taxonomic species are important sources of the values Congress focused on in enacting the ESA, the heavy burden of proof imposed by the exemption process is justified. *See id.* 1536(h)(1).

558. *Oversight Hearing*, *supra* note 7, at 24 (statement of Rep. Gilchert).

559. *See* 16 U.S.C. § 1531(a)(3) (1994).

560. *See* Carroll et al., *supra* note 463 (explaining the "umbrella" concept); Doremus, *supra* note 421, at 306-07 (defining "keystone" and "indicator" species).

561. The agencies' current practice of construing the ecological value of distinct population segments to encompass only ecological characteristics unique to the species should be disapproved.

The range of possible contributions a distinct group might make to any of these values could be fleshed out gradually in individual listing decisions. However, in light of the incoherence that has resulted in the past from ad hoc listing determinations, it might be preferable for Congress to delegate to Interior the task of formally identifying some of the ways in which groups might serve one or more of the ESA values. If it takes this route, Congress should direct Interior to consult with various knowledgeable groups including scientists, historians, recreation groups, amateur natural historians, and others. But Interior should also consider the views of the non-expert general public. Some of the values the ESA protects, such as esthetic values, are very much in the eye of the beholder. Leaving the determination of protectable groups entirely to an elite group of experts could lead to the kind of disjunction from public opinion that has brought such controversy to the National Endowment for the Arts in recent years.[562]

Below the taxonomic species level, the same standards should apply to invertebrates and plants as to vertebrates. The recent NRC report pointed out that no biological justification exists for treating these groups differently.[563] There may be valid political reasons for different treatment, but those should be dealt with in the evaluation of significance. While it may prove more difficult to establish that plant or invertebrate groups below the taxonomic species level offer significant value to society, groups for which that showing can be made should be eligible for protection.

A relatively simple modification of the statutory definition of species could effect this change, correcting the science charade. I offer the following possible definition as a starting point for debate:

> The term "species" includes any recognized taxonomic species, and any other identifiable group of fish or wildlife or plants which provides esthetic, ecological, educational, genetic, historical, recreational, scientific or other value significantly distinct from, or substantially additional to, that provided by other identifiable groups.

If enacted, this definition should be accompanied by a report stating clearly

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The protection of ecosystems as a means of preventing extinction was recognized as the "primary purpose" of the ESA in 1978. *See* H.R. REP. 95-1625 (1978), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 725, 729. *See also* 124 CONG. REC. 38,154 (Oct. 14, 1978), *reprinted in* ESA LEGISLATIVE HISTORY, *supra* note 92, at 825 (statement of Rep. Leggett) ("The ultimate goal of the Endangered Species Act is the conservation of the ecosystem on which all species, whether endangered or not, depend for survival.").

562. *See, e.g.*, Jacqueline Trescott, *Arts Termed Elitist; NEA's 'American Canvas': A Gloomy Picture*, WASH. POST, Oct. 14, 1997, at E4.

563. *See* SCIENCE AND THE ESA, *supra* note 15, at 55.

that, while the listing agencies are not limited to scientific information in making species delineations, they are not to consider the economic costs of protecting a particular group at this stage. The economic costs of protection can be fully considered through existing provisions such as the exemption process, critical habitat designation, and, indirectly, the incidental take provisions of section 10. While those costs are important to the ultimate societal decision on the level of resources to devote to species protection, their evaluation is logically distinct from this first step, identifying those groups of organisms which are of significant value to society.

The evaluation of a group's significance should be open to public scrutiny. The agencies should solicit and respond to public comments. They should be required to hold a public hearing if one is requested. The current ESA requires opportunities for public input,[564] but those procedures serve little function. The agencies typically gather available scientific information prior to the public comment period, and rarely modify their taxonomic determinations in light of public comments. Indeed, the strictly science mandate essentially forbids the agencies to act on the basis of comments from the nonexpert public.[565] Freeing the identification of listable entities from that mandate would raise the public input procedures from their current status as largely empty gestures to a substantive role in the listing process.

b. Administrative Correction

Should Congress refuse to address the problem of species identification, the agencies could take some steps to loosen the grip of the strictly science mandate. As explained in Part IV, the mandate does not expressly cover species identification.[566] Accordingly, regulations or policies requiring consideration of factors beyond scientific information would likely survive judicial review. The agencies could not, of course, limit protection of species or subspecies, which are explicitly protected under the current statute. Nor could they offer protection to population segments of invertebrates or plants. They could, however, revise their policy concerning recognition of distinct population segments to reflect all the values the ESA is intended to serve. Furthermore, they could enhance the consistency and coherence of their listing policies by consciously considering and forthrightly explaining how they address the taxonomy problem.

It seems unlikely that the agencies will voluntarily take steps to correct

564. *See* 16 U.S.C. § 1533(b)(5)(E) (1994).
565. *See supra* text accompanying note 279.
566. *See supra* notes 354-55 and accompanying text.

the science charade or provide a coherent explanation of their decisionmaking process. The current system provides substantial advantages to the agencies, maximizing their discretion, discouraging intrusive judicial review, and minimizing public oversight.[567] But the agencies should view the constant barrage of criticism they face from both sides as an incentive to bring their decisions out from behind the pseudo-scientific curtain. Although claiming the mantle of science is often thought to shield government decisions from public criticism, that shield has proven ineffective in the case of the ESA. Greater public involvement in the listing process might actually offer the agencies greater political cover than they currently have. Forced to make highly controversial decisions, the agencies might find it advisable to perform "boundary work," separating the scientific aspects of their decisions from the political ones in order to protect the sanctity of their scientific work.[568] Nor has the science charade brought the agencies complete freedom from judicial review. Although casting their decisions as strictly technical does discourage intrusive judicial review, the apparent inconsistency of the decisions invites closer oversight. The recent decision remanding FWS' refusal to list the Canada lynx, for example, relied in part on the inconsistency of agency practice.[569] Articulation by the agencies of a more coherent general rationale for their listing decisions, which would require rejection of the science charade, would improve the consistency of those decisions and thereby help them survive judicial review.

c. Anticipating Criticisms

Because it cuts against the grain of current proposals to fortify the scientific basis for listing, this proposal to open the identification of protectable groups to factors other than science is likely to be received with skepticism. This section responds to anticipated criticisms.

First, this proposal may be criticized as increasing the complexity, and hence the administrative costs, of listing decisions. In light of the historic and continuing underfunding of ESA implementation and the long backlog of species awaiting listing,[570] both Congress and the agencies should resist changes that would unnecessarily increase listing costs. The administrative costs of the process proposed, however, would likely not prove as high as they might at first appear. The agencies already must solicit and respond to

567. *See supra* note 388 and accompanying text.

568. *See* JASANOFF, *supra* note 29, at 236; *see also supra* note 33.

569. *See* Defenders of Wildlife v. Babbitt, 958 F. Supp. 670, 685 (D.D.C. 1997).

570. *See supra* note 115.

public comments, and hold a public hearing on request.[571] Rather than adding new procedural requirements, the proposal would make better use of existing procedures. Indeed, by giving those procedures a substantive role to play, the change might reduce public cynicism.

Moreover, even if the proposal did increase administrative costs, its benefits would likely exceed those additional costs. It would provide increased opportunities to educate the public concerning the value of listed groups. In contrast to the current law, which encourages the listing agencies to hide behind the opaque screen of taxonomy, the proposed scheme would require them to engage the public in an open conversation about the values provided by an identified group. That public debate would offer a forum for those who care deeply about the group to communicate its special values to the public. The proposed process would preclude the listing of patently worthless groups, like the squirrels in a city park,[572] while permitting the listing of the coastal California gnatcatcher as an important indicator of the health of the sage scrub ecosystem, without requiring an extended and ultimately unproductive investigation into minor morphological distinctions.[573] It would also allow the listing of anadromous fish which coexist and may even interbreed with more abundant nonanadromous relatives if the migration to and from the ocean itself offers significant esthetic, recreational, scientific or other values, that is, if it is a characteristic worth preserving.[574]

Another potential criticism of this proposal is that it might reduce the number of groups actually protected. Eliminating the automatic eligibility of subspecies for listing would certainly impose a new barrier to their protection. The Mount Graham red squirrel and California red-legged frog could be allowed to disappear if their supporters failed to demonstrate that they offer significant value to society. There are several answers to this criticism. The most obvious is that species protection imposes substantial costs on society, and in particular on those individuals who own or otherwise depend on the use of land which harbors the species. Proponents of species protection must be prepared to explain what benefits justify the costs they seek to impose.

Furthermore, the protection of biological resources is a long-term goal. There is little point in protecting many groups for a few years if that strategy ultimately undermines support for their long-term protection. Effective

571. *See supra* note 278.
572. *See supra* note 351 and accompanying text.
573. *See supra* notes 385-87 and accompanying text.
574. *See supra* text accompanying notes 417-20.

species protection over a biologically significant period of time is unlikely without the continuing support of a majority of the political community. By focusing attention on characteristics actually valued by the public, such as the Redfish Lake sockeye's amazing swim to the ocean, instead of the details of technical genetic studies, the proposal should enhance political support for species preservation. And by allowing protection to be denied truly unloved subspecies or populations, the proposed scheme would trade short-term pain for long-term political gain.

Finally, it is by no means certain that fewer groups would be protected under this new scheme. For one thing, the change would make invertebrate and plant populations eligible for protection. For another, the agencies are already reluctant to list, or even evaluate for listing, species they perceive to be politically unpopular.[575] Under the proposed system, the agencies could at least be forthright about their reasons for giving short shrift to such groups. Should their perception of the group's public standing prove incorrect, they might reconsider their decision.

C. The Viability Problem: Applying Science Effectively Within Its Limits

Like the taxonomy problem, the viability problem requires separating value judgments from scientific ones. Because significant aspects of the viability decision are indeed scientific but must be made in light of highly uncertain science, this decision presents the additional challenge of making the most effective use of the available scientific information.

1. Defining the Terms

Providing content to the statutory terms "endangered" and "threatened" requires policy judgments concerning acceptable extinction risks, time periods of concern, and the relative desirability of over- and under-protection. Congress has not yet made these judgments.[576] Legislators may have deliberately avoided wrestling with these difficult social choices, hoping to gain political support by advocating species protection without directly facing the difficult and potentially divisive issues beneath the law's surface. Alternatively, legislators may have naively believed that all species faced either great or negligible risks, and that science could readily sort

575. As of October 31, 1996, a total of 1049 species which inhabit the United States were listed as endangered or threatened. That total included only 20 insects. *See* Fish & Wildlife Service, U.S. Dept. of the Interior, Endangered Species Bulletin 28 (Nov./Dec. 1996). Yet roughly half of all known species are insects. *See* WILSON, *supra* note 325, at 133.

576. *See supra* text accompanying notes 436-61.

species into those two categories.

Whatever its origin, the legislature's failure to provide content to the terms "endangered" and "threatened" should be corrected. In combination with the strictly science mandate, the current vacuous definitions have left the listing agencies unable to develop coherent or consistent standards for listing determinations. In turn, the agencies' lack of clarity and consistency has bred public cynicism, fueling suspicion on all sides that decisions turn primarily on the listing agencies' political preferences.[577] Furthermore, the failure to address these issues means that in the thirty years federal law has protected endangered species there has never been a public discussion of society's willingness to accept extinction risks, or of the time period over which conservation efforts should be evaluated.

Congress, with its institutional ability to consider the broad spectrum of public views and competing values, is the most appropriate forum for this debate. It should air the issues and endeavor to add content to the currently empty statutory terms. The legislature need not, and should not, tie the definitions to specific population levels or trends. Different species may face very different threats at identical population levels.[578] Nor should the terms be translated into specific probabilities of extinction. Current knowledge does not allow precise estimation of extinction risks.[579] Enshrining precision in the law would not make that precision any more attainable. It would, however, tend to mislead the public and might inhibit listing. Furthermore, species have a range of biological characteristics, and face a range of threats; any definition must leave the listing agencies enough flexibility to respond to these differences.[580]

Rather than seeking quantitative formulations, Congress should express the acceptable degree of risk in general qualitative terms. It could continue to apply the same standard to all species, or it could apply more protective standards to the groups it views as most valuable.[581] In light of the irreversibility of extinction and the uncertain extent of its costs, a strongly

577. *See, e.g.*, GAO, A CONTROVERSIAL ISSUE, *supra* note 4, at 24-27; Easter-Pilcher, *supra* note 508.

578. Moreover, although many species may have a critical minimum population threshold, the magnitude of that threshold is virtually impossible to determine. De la Mare, *supra* note 464, at 115.

579. *See supra* notes 466-83 and accompanying text.

580. Congress has long recognized the need for flexibility. As early as 1969 it concluded that variability among species made legislative adoption of specific across-the-board standards for listing undesirable. H.R. REP. NO. 91-382, at 26 (1969).

581. Applying identical standards to all groups would have the advantage of decreasing administrative costs. Especially if Congress were to adopt the suggestion that the significance of the group should play an explicit role in determining its eligibility for listing, the benefits of applying different risk standards to different groups might not justify the added costs.

protective standard may be desirable.[582] Indications in the legislative history that Congress intended to give species the benefit of the doubt support a cautious approach.[583] The fact that observable declines may lag habitat degradation or other changes that can lead to extinction also counsels caution.[584] De la Mare has suggested one cautious standard: an endangered species is "one for which extinction is possible within the time span which would be required for conservation measures to take effect," and a threatened species is "one which is *likely* to decline in abundance for the foreseeable future."[585]

The time line over which risks should be evaluated might be expressed as a specific term of years. The conservation biology literature, for example, frequently mentions 100 years as a measure of viability.[586] Congress need not, however, limit itself to such relatively short periods. Because biodiversity conservation is a long-term goal, it may deserve or require a long-term vision.[587] Alternatively, Congress might employ a more general term, such as "the foreseeable future," a term currently used in defining threatened species, to describe the relevant temporal focus. Such a standard

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582. The "precautionary principle" urges protection of the environment as the default decision if the costs and benefits of protection cannot be reliably compared. *See* Daniel Bodansky, *Scientific Uncertainty and the Precautionary Principle*, 33(7) ENV'T 4 (1991); Ellen Hey, *The Precautionary Concept in Environmental Policy and Law: Institutionalizing Caution*, 4 GEO. INT'L ENVTL. L. REV. 303 (1992). Several commentators have argued that the precautionary principle should apply to threats to species or biodiversity. *See, e.g.*, Myers, *supra* note 553, at 42; Farrier, *supra* note 359, at 387. Of course, the precautionary principle alone does not provide adequate guidance. Unless all impacts on species are forbidden, an acceptable level of risk must still be determined.

583. *See, e.g.*, H.R. REP. NO. 93-412, at 5 (1973) ("sheer self-interest impels us to be cautious. The institutionalization of caution lies at the heart" of the ESA); 119 CONG. REC. 42,913 (1973) (statement of Representative Dingell during floor debate on conference report) (making listing easier than delisting is appropriate because "we should act cautiously"); *see also* Tennessee Valley Auth. v. Hill, 437 U.S. 153, 194 (1978) ("Congress has spoken in the plainest of words, making it abundantly clear that the balance has been struck in favor of affording endangered species the highest of priorities, thereby adopting a policy which it described as 'institutionalized caution.'").

584. *See* Daniel F. Doak, *Source-Sink Models and the Problem of Habitat Degradation: General Models and Aplications to the Yellowstone Grizzly*, 9 CONSERVATION BIOLOGY 1370, 1377 (1995) (because of the lag time between habitat impacts and detectable population declines, "census data may provide extremely poor measures of population safety or health under conditions of ongoing habitat degradation").

585. De la Mare, *supra* note 464, at 114 (emphasis in original).

586. *See supra* note 463.

587. Extremely long time lines have been employed in other regulatory contexts. For example, Environmental Protection Agency regulations require evaluation of the probability of release of radioactive wastes from long-term disposal sites for 10,000 years after disposal. *See* 40 C.F.R. §§ 191.13, 191.15 (1995); *see also* NRDC v. EPA, 907 F.2d 1146, 1158 (D.C. Cir. 1990) (upholding Environmental Protection Agency regulation requiring a showing that hazardous waste injected into deep wells will not migrate for 10,000 years). The usefulness of such long-term predictions is, of course, always limited by their reliability; it may not be feasible to project the fate of species nearly that far into the future.

could accommodate a wide range of data availability and predictive ability. A third alternative would be to employ a functional approach, directing the agencies to consider, as De la Mare suggests, the time required for conservation measures to become effective or perhaps a specified number of generations of the species in question.

If Congress is unwilling or unable to provide greater content to these key terms, it should explicitly direct the listing agencies to do so, freeing them from the strictly science directive for that purpose. In deciding whether or not to delegate these decisions, Congress should consider what effect the agencies' scientific expertise may have on their view of acceptable extinction risks. The predominance of biologists on the agencies' staffs may increase the agencies' inclination to act protectively. That might well be a good thing; an agency inclined by its nature to be highly protective might represent the diffuse concerns of many members of the political community,[588] providing an effective counterweight to industry and property rights groups which invest in vigorous lobbying.

On the other hand, despite their abundance of biologists, the listing agencies may not in fact prove especially protective. The heads of both FWS and NMFS, like their bosses the Secretaries of Interior and Commerce, are political appointees. They answer to the President, who responds to political pressures. The political nature of the agencies' senior staff may overcome any tendency on the part of their scientific staff to act in a highly protective manner.[589]

Congress should also reconsider the existing statutory list of potentially endangering factors it has directed the agencies to consider.[590] If a species is at sufficient risk to merit protection, the source of that risk is of little consequence. The agencies surely are aware of the most common threats. The statutory list is more likely to present a barrier to a legitimate listing than to inform an agency decision which otherwise might be incorrect.

At the very least, Congress should seriously consider removing the inadequacy of existing regulatory mechanisms from the list. The listing agencies are not particularly expert at evaluating such mechanisms.

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588. The ESA continues to enjoy widespread public support. Sixty-three percent of respondents to one 1995 survey, for example, opposed any reduction in protection for endangered species. Richard Lacayo, *This Land Is Whose Land?*, TIME, Oct. 23, 1995, at 68. In another recent survey, large majorities expressed support for the general proposition that extinction should be prevented, even for species which lack utilitarian value. WILLETT KEMPTON ET AL., ENVIRONMENTAL VALUES IN AMERICAN CULTURE 111 (1995).

589. History tends to support this view. *See generally* GAO, A CONTROVERSIAL ISSUE, *supra* note 4; YAFFEE, *supra* note 19.

590. *See supra* note 122 and accompanying text.

Furthermore, existing regulations are not particularly germane to the listing decision. If adequate protective mechanisms are already in place, listing, while perhaps not necessary, will impose few additional costs[591] but offer substantial benefits. Should those other regulations ever prove inadequate, federal listing would already be in place as a backstop. Furthermore, listing under the ESA serves important educational and symbolic purposes, informing the public that a species is near extinction and expressing a national commitment to bring it back from the brink.

As with the taxonomy problem, if Congress fails to act on the viability problem, the agencies could achieve much on their own. They could adopt regulatory definitions of "endangered" and "threatened" that supply additional content, rather than simply repeating the words of the statute. Creation of such regulatory definitions could plausibly be described as distinct from individual listing determinations, and therefore outside the strictly science mandate. As already noted, however, the agencies have little incentive to undertake such actions voluntarily.[592]

2. Identifying the Best Available Science

Once the value choices implicit in the terms "endangered" and "threatened" have been addressed, science offers the best source of the information needed to evaluate whether particular species fall into those categories. The strictly science mandate is entirely appropriate for these evaluations; the listing agencies should make them solely on the basis of the best available scientific information. The scientific process can help the agencies identify the best available information and put it to effective use.

a. Putting the Scientific Process to Work

The scientific process has been developed specifically to produce and identify reliable information. Accordingly, the agencies should adhere to scientific conventions in evaluating data. When faced with conflicting data, they should prefer that which has been subjected to the most stringent tests. In the many situations where little or no empirical data is available, the agencies should rely on the hunches of leading scientists in the field. Hunches or intuitions strong enough to attract the investigatory interest of

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591. The § 7 consultation requirement should not impede federal actions because the existing regulatory mechanisms would justify "no jeopardy" opinions. *See* 16 U.S.C. § 1536(a)(2) (1994). By the same token, permits would be available to allow incidental take of the species. *See id.* § 1539(a).

592. *See supra* note 567 and accompanying text.

research scientists should be considered strong enough to support a listing decision.[593]

Listing documents should communicate all the information necessary to support publication in a peer-reviewed scientific journal, including the data on which they are based, the methods by which those data were gathered, and a clear acknowledgement of the uncertainties implicit in the data. Should this material prove too bulky for publication in the Federal Register, an abstract in much the form of a current listing document should be sufficient, provided it specifically references a more complete document which is made available to all requesters. The major references on which the proposal is based should always appear in the Federal Register document.

b. The Role of Peer Review

Some recent ESA reauthorization proposals would add a statutory requirement for outside peer review to the listing process.[594] This change is largely unnecessary in light of the recent adoption by FWS of a policy requiring independent peer review of all listing decisions before they are finalized.[595] More significantly, a statutory peer review requirement would add to the administrative burdens of listing without noticeably increasing the reliability or accuracy of listing decisions.

Peer review is a peculiar institution developed to serve the needs of grant distributors and scientific journal editors. In the granting context, peer review is expected to identify the most promising lines of research, that is, those most likely to produce valuable or exciting future discoveries. In the publication context, reviewers are often asked to evaluate whether a paper will interest journal readers.[596] This sort of peer review has no role in ESA

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593. In order to reduce the gap between information and regulatory needs, the federal government should sponsor a strong program of basic and applied research on the biology of listed or candidate species, using the power of the purse to attract researchers to studies which will serve regulatory needs. *See supra* note 193 and accompanying text.

594. The major reauthorization vehicle under consideration in the current Congress, the Kempthorne-Chafee bill, would require peer review of listing decisions. *See* S. 105-1180, § 2(b) (1997). *See also* Bogert, *supra* note 6, at 144, n.285 (quoting S. 103-1521, § 101 (1993)); S. 104-768, § 101 (1995). Peer review is currently popular with legislators in a variety of contexts, as illustrated by the Safe Drinking Water Amendments of 1996, Pub. L. No 104-182, § 103, 110 Stat. 1613, 1621 (1996) (requiring use of "the best available, peer-reviewed science and supporting studies conducted in accordance with sound and objective practices").

595. *See supra* note 281 and accompanying text.

596. For example, *Science*, the journal of the American Association for the Advancement of Science, evaluates papers "for their interest and overall suitability" before sending them for in-depth review. Reviewers look for "novelty and general significance," as well as evaluating technical merit. *See 1997 Information for Contributers*, 275 SCI. 98 (1997).

listing decisions. The listing agencies are evaluating the accuracy and reliability of data and interpretations, not whether those findings will interest an audience or inspire future research.

The supporters of mandatory peer review may expect it to ensure the accuracy of data on which the listing agencies rely. However, the peer review process has only limited value for this purpose. Peer reviewers are not expected to authenticate the data presented to them.[597] Rather, their role is to evaluate the methods employed and the facial plausibility of the conclusions drawn.[598] Traditional peer review functions as a very coarse screen; reviewers ask whether an author's conclusions are one plausible interpretation of the data, not whether they are the only or even the most plausible interpretation. Editorial peer review is a process of negotiation over whether the author's claims fall within a broad range of acceptability, not an up or down vote on their reliability.[599]

Formal peer review of this sort would add little of value to the listing process.[600] The listing agencies already must perform this coarse screening function under the mildly watchful eye of the courts.[601] Because they typically do not generate most of the data on which listing determinations are based, the agencies should not have the kind of personal attachment to that data peer review guards against.

Editorial and grant peer review can serve an additional political function,

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597. CHUBIN & HACKETT, *supra* note 193, at 87. Peer review is therefore not an effective protection against outright scientific fraud. *Id.* at 138. Nor does it correct all errors. A recent study found that most peer reviewers failed to detect errors which had been deliberately introduced into a manuscript. THE ECONOMIST, Sept. 27-Oct. 3, 1997, at 89.

598. *See* Brief of the American Medical Association as Amici Curiae in Support of Respondent, Daubert v. Merrell Dow Pharmaceuticals, Inc., No. 92-102 (LEXIS, Genfed Library, Briefs) (Peer review requires "the scientist to devise methods of data collection that are replicable and to explain precisely how the scientist performed the experiment. Peer reviewers then can analyze the methods and identify potential flaws in the techniques, in the data, or in the statistical methods employed."); Brief of Amici Curiae Daryl E. Chubin in Support of Petitioners Daubert v. Merrell Dow Pharmaceuticals, No. 92-102 (LEXIS, Genfed Library, Briefs) ("[P]eer review referees and editors limit their assessment of submitted articles to such matters as style, plausibility, and defensibility; they do not duplicate experiments from scratch or plow through reams of computer-generated data in order to guarantee accuracy or veracity or certainty."); *see also* Effie J. Chan, Note, *The "Brave New World" of Daubert: True Peer Review, Editorial Peer Review, and Scientific Validity*, 70 N.Y.U. L. REV. 100, 113-23 (1995) (distinguishing "true peer review" in the form of replication of experiments from "editorial peer review").

599. CHUBIN & HACKETT, *supra* note 193, at 88-89.

600. The Ecological Society of America shares this view. *See* Carroll et al., *supra* note 463, at 4 ("Adding independent peer review . . . to the listing process would unnecessarily lengthen the time to make a listing decision without providing any substantial benefits.").

601. Any agency conclusion so unsupported by the data as to fail editorial peer review would likely fail judicial review under the arbitrary and capricious standard. *See supra* text accompanying notes 240-57.

reassuring non-scientists "that impartial expertise has entered into a decision."[602] Peer review might also help identify uncertainty the agency has not acknowledged, facilitating public oversight of the decision and thereby improving public acceptance.[603] In the context of ESA listing decisions, however, peer review seems a crude and ineffective tool for performing these functions. If the agencies are, as the statutory scheme assumes, functioning as neutral arbiters, peer review will be unnecessary. The agencies' review of the data should already provide the impartial screening mechanism peer review generally offers. If, on the other hand, the agencies' neutrality cannot be trusted, peer review will not help. After all, if the shared biases of biologists lead to unreliable listing decisions, submitting proposals to additional biologists for review is not likely to improve them.[604] Moreover, the agency is likely to have substantial latitude in choosing peer reviewers who share its viewpoint, and reviewing courts will be hard pressed to overturn decisions in which even a single reviewer concurs.

If the legislature feels that peer review is essential, a more appropriate model might be one developed in the context of other highly technical regulatory decisions, that of review by a standing panel of experts. The Environmental Protection Agency uses such panels to advise it on a variety of matters, including the determination of air quality standards under the Clean Air Act.[605] Although the use of such panels has generated delay and criticism,[606] at least a panel would provide some degree of consistency, a trait conspicuously absent from current agency implementation of the ESA.

c. The Role of Public Scrutiny

Ruthless public scrutiny may provide a more effective check on agency listing determinations than formal peer review. Scrutiny by the lay public is not an element of the scientific process, but is an appropriate step in ESA listing determinations. Those determinations have impacts well beyond the scientific community; they should therefore be justified in a manner that is accessible to the interested public, not just to members of the relevant scientific community. Furthermore, the limited availability of robust data means that listing decisions often rely heavily on hunches. While the use of

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602. CHUBIN & HACKETT, *supra* note 193, at 122.

603. *See* Alyson C. Flournoy, *Coping with Complexity*, 27 LOYOLA (L.A.) L. REV. 809, 823 (1994).

604. It is hardly surprising that the peer reviews solicited under the 1994 policy appear uniformly positive. *See supra* note 282.

605. *See* 42 U.S.C. § 7417 (1994).

606. *See* JASANOFF, *supra* note 29.

hunches is an unobjectionable, and indeed essential, step in the ordinary scientific process,[607] it carries some special risks in this context. Incorrect hunches may result in the unnecessary loss either of species or of economic benefits. Under the circumstances, policymakers must pay special attention to the risks of intuitive decisionmaking. Some of those risks can be minimized by effective public scrutiny.

The most serious shortcoming of decisions based on hunches is that they may be skewed by the personal biases of the scientists involved. Traditional scientific norms, which require scientists to minimize the role their subjective preferences play in their professional opinions, and to maintain political neutrality on the issues they study, should tend to counteract the effect of bias.[608] These norms may not completely solve the problem, however, for two reasons. First, the professional norm of objectivity is enforced by the same mechanisms that eventually winnow good science from bad—replication and extension of research results, accompanied by direct and indirect harm to the professional reputations of those whose intuitions turn out to be wrong. This process will not be effective if data are extremely hard to come by. In those circumstances, an incorrect hunch is likely to go undetected for some time, limiting its impact on the careers of its champions.

Second, the norm of political neutrality may not constrain these decisions because it has eroded significantly over the last 30 years. This erosion has been particularly obvious in the context of several environmental problems, prominent among them the conservation of biological resources. One of the earliest examples of public political advocacy by a scientist, Rachel Carson's *Silent Spring*,[609] originated in concerns about the future of songbird species. The image of scientist-advocate, once considered strange, has become familiar in fields like ecology. Indeed, political advocacy is now an accepted role of the major professional society in ecology.[610] The relatively new discipline of conservation biology is even more openly political. Reed Noss,

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607. *See supra* notes 183-89 and accompanying text.

608. *See supra* notes 229-31 and accompanying text.

609. Carson worked as an FWS biologist for many years. *See* PAUL BROOKS, THE HOUSE OF LIFE: RACHEL CARSON AT WORK 7-8 (1972).

610. The Ecological Society of America created an ad hoc Committee on Endangered Species a few years ago; that committee submitted a report to Congress advocating strengthening amendments to the ESA and adoption of additional legislation for the protection of representative ecosystems. *See* 75 BULL. ECOLOGICAL SOC'Y AM. 247 (1994). The Society's Code of Ethics exhorts its members to "use their knowledge, skills, and training . . . to find ways to harmonize society's needs . . . with the maintenance and enhancement of natural and managed ecosystems" and to volunteer their skills "for the benefit of society and the environment." The Ecological Society of America, Code of Ethics (copy on file with author). Nonetheless, the Society continues to acknowledge the norm of scientific objectivity. Members are expected to "convey their findings objectively," at least to the extent that they do not "fabricate or falsify results or commit scientific fraud." *Id.*

a leading practitioner, writes that "conservation biology is more value-laden than most sciences because it is not concerned with knowledge for its own sake but rather is directed toward particular goals. Maintaining biodiversity is an unquestioned goal of conservation biologists."[611] The journal Conservation Biology recently ran as an editorial an open letter to Congress in which academic scientists joined with environmental activists in defense of the ESA, writing that "[t]he vast majority of biological scientists agrees fundamentally about the importance of conserving the diversity of life on Earth."[612]

This open advocacy of highly preservationist policies is understandably troubling to conservation skeptics. Nonetheless, the apparent bias of many in the conservation field in favor of strong protective measures need not preclude reliance on their professional hunches. Scientist-advocates remain scientists, and their desire for credibility and respect in scientific circles will often significantly constrain their advocacy.[613] Furthermore, many of these scientist-advocates understand that credible science will support their advocacy in ways that unfounded claims will not.[614] The adversary norms of the scientific community will also help. Scientists are "trained to attempt to falsify current ideas;"[615] the more controversial the theory, the more strongly it will attract challenges,[616] even from other scientists who share the

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611. Reed F. Noss, *Some Principles of Conservation Biology, as They Apply to Environmental Law*, 69 CHI.-KENT L. REV. 893, 895 (1994). The new discipline was born at a meeting called by biologist Michael E. Soulé to convince academics to join forces to save disappearing plants and animals. Ann Gibbons, *Conservation Biology in the Fast Lane*, 255 SCI. 20 (1992).

612. *On Reauthorization of the Endangered Species Act*, 8 CONSERVATION BIOLOGY 1 (1994). Signatories included Jane Lubchenco, Professor of Marine Biology at Oregon State University, Dennis Murphy, Director of the Center for Conservation Biology at Stanford University, Victor Sher, President of the Sierra Club Legal Defense Fund, and Michael Bean, Senior Counsel for the Environmental Defense Fund.

613. Stephen H. Schneider, a Stanford biology professor who encourages his colleagues to take on the role of "scientist-advocate," explains that the norms of scientific objectivity and truthfulness continue to apply. He believes that scientists have an obligation to reveal the uncertainties of their results, and to acknowledge that policy choices entail value judgments. *See* Stephen H. Schneider, *Is the "Scientist-Advocate" an Oxymoron?*, paper presented at the American Association for the Advancement of Science Annual Meeting, Feb. 12, 1993; *see also* Sabatier & Zafonte, *supra* note 532, at 140-41 (although university and agency scientists tended to share environmentalist views, their interpretation of data was constrained by professional standards).

614. *See, e.g.*, Dennis D. Murphy, *Conservation Biology and Scientific Method*, 4 CONSERVATION BIOLOGY 203, 204 (1990) ("If the science of conservation biology is to be precise, respected, and well-defined, our findings must be the results of rigorous hypothesis testing. Only then can we bring our findings to the public policy arena and advocate their use without questions of propriety."); Boyce, *supra* note 463, at 482 (inadequately supported predictions of minimum viable populations "risk[] damaging the credibility of conservation biologists"); Murphy and Noon, *supra* note 161, at 774 (exhorting wildlife biologists to produce credible science in order to withstand legal challenges).

615. Schneider, *supra* note 613, at 8.

616. *See supra* note 180.

underlying preservationist view.

In the end, however, public scrutiny is the most effective weapon against careless or biased decisionmaking. As it should be, the ESA listing process is considerably more accessible to the public than the ordinary scientific process. Listing proposals must be made available for public review and comment before they are finalized, and a public hearing must be held if one is requested.[617] This public review period provides the opportunity for informal but intensely adversarial scrutiny of the decision. Scientists with a professional interest in the species are drawn to these proceedings, as are persons threatened with economic harm by the proposal. The proceedings afford an opportunity for more complete evaluation of the data and interpretations than is typical of formal peer review, permitting attacks not only on the reliability of the methods and the plausibility of the interpretation, but also on the motives and honesty of those who supply the data.

This stringent public review can force the agencies to limit their reliance on hunches to those justified by scientific expertise rather than personal bias. Because the agency must publicly defend any hunches on which it relies, scientific adversaries can challenge those hunches. Furthermore, anti-protection interests have both the opportunity and the incentive to present their perspective. Industries and large landowners can and do hire experts who vigorously contest the data and opinions offered by listing proponents.[618]

Public review will only serve as an effective check if the listing agencies make their data fully available to opponents of the decision. They should be required to support listing determinations with full public presentation of the relevant data, and explicit acknowledgement of any uncertainty in that data. On the other hand, landowners should not be able to block listings by withholding information within their control.[619] If a landowner's refusal to share data or permit access leaves the agencies unable to determine whether a species has fallen below the viability threshold, the agencies should be permitted to add that species to the protected list.

The listing agencies may legitimately cringe at this "make it all public" rule in cases where they fear vandalism by listing opponents.[620] This

617. *See* 16 U.S.C. § 1533(b)(5) (1994).

618. *See, e.g.*, *Industry-Sponsored Population Report on Bull Trout Catches Heat from Fish Researchers*, SEATTLE TIMES, June 25, 1995, at B3 (describing population study sponsored by Intermountain Forestry Association); Fairy Shrimp Rule, *supra* note 284 (describing studies undertaken by industry consultants).

619. *See supra* note 478-81 and accompanying text.

620. *See* Fairy Shrimp Rule, *supra* note 284, at 48,149 (alleging that landowners had destroyed

problem, however, can be addressed by making listings immediately effective, as FWS did with the Central Valley fairy shrimp species.[621] Sensitive areas can then be monitored, and listing opponents can be permitted to gather data subject to the full sanctions of the ESA if they commit acts of destruction. Should monitoring prove too heavy a burden, or if the species is so reduced that it could be wiped out with a single event, FWS could perhaps be permitted to release the sensitive information only to certified surveyors,[622] subject to a bonding requirement if necessary. If information gathered in such surveys showed the listing to have been unjustified, listing opponents could seek, and would be entitled to, delisting.

VI. CONCLUSION

The ESA requires a scientific foundation to achieve its goals. In light of that clear need for science and the historic scientific underpinnings of conservation policy, it is not surprising that so many commentators tout more and better science as the solution to the current controversy dogging the ESA.

Better science, however, does not automatically produce better policy decisions. Rather than genuflecting ritually before the altar of science, we should ask whether science can solve the difficult policy questions we face. Close examination of the ESA shows that many of the most troubling issues are not truly scientific. For that reason, excessive reliance on science has not improved policy decisions under the ESA. In fact, the impossible legislative demand that ESA listing determinations rest solely on scientific information has produced a number of undesirable effects. It has encouraged the agencies to conceal the true bases for their decisions; led them to ignore several of the values Congress intended to protect through the ESA; caused them to miss significant opportunities to educate and inform the general public; made their decisions appear deceptively certain and objective; and ultimately

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vernal pool habitat to avoid the impact of listing); NRDC v. United States Dept. of the Interior, 113 F.3d 1121, 1128 (9th Cir. 1997) (O'Scannlain, J., dissenting) ("When it decided not to designate critical habitat for the gnatcatcher the Service found that on at least 11 occasions, private landowners had destroyed gnatcatcher habitat"). Conservation opponents have brought this type of suspicion on themselves with repeated talk of the incentives the ESA creates to "shoot, shovel, and shut up." *See, e.g.*, Kosova, *supra* note 478 (quoting Rep. Tauzin as saying "We've got incredibly horrible stories about people who shoot and shovel and shut up—kill the animal and get rid of it.").

621. Fairy Shrimp Rule, *supra* note 284, at 48,149.

622. The Army Corps of Engineers has been considering requiring certification of wetlands delineators. *See* 60 Fed. Reg. 13,654 (1995); Margaret N. Strand, *Recent Developments in Federal Wetlands Law: Part I*, 26 ENVTL. L. REP. (BNA) 10,283, 10,287 (1996). Certification, while it may be useful, is clearly not a complete protection against falsification of data. *See* Marbled Murrelet v. Pacific Lumber Co., 880 F. Supp. 1343, 1354 (N.D. Cal. 1995).

undermined both political support for the protection of dwindling species and the credibility of science as a foundation for policy decisions.

The strictly science mandate is responsible for much of the current controversy concerning the ESA. That controversy reflects an accurate sense among interest groups on both sides that their views have not been considered in the listing process. The futile search for scientific answers has supplanted, even stifled, a full societal debate on the purposes and importance of conserving biological resources. Such a debate is essential to the long-term resolution of disagreements over the appropriate form of conservation policy.

Accordingly, reform of the strictly science mandate, rather than its further enlargement, should be a high priority as Congress considers ESA reauthorization. The legislature should separate the scientific aspects of listing determinations from the value judgments, including which groups should be considered for protection, what level of extinction risk is tolerable, and what the time line for evaluating extinction risks should be. It should either make these judgments itself or delegate them to the agencies free of the strictures of the strictly science directive.

With respect to the scientific elements of these decisions, the agencies should remain free to rely on the best available data even if those data are relatively weak. They should not be required to submit their determinations for formal peer review, because the same effect can be achieved through the existing public review and comment procedures. The listing agencies should follow the scientific process more closely in evaluating the data which support listing determinations, and particularly in communicating that data to the public. Listing procedures should facilitate review of the decision by the general public as well as by skeptical scientists.

Only through these changes can ESA listing determinations gain both political and scientific credibility. And only with credibility in both those realms can conservation policy be effective over a biologically significant period of time.