SCIENCE, LAW, AND THE ENVIRONMENT: THE MAKING OF A MODERN DISCIPLINE

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In the environmental arena, law and science are like uneasy partners in an arranged marriage. They bicker over definitions and standards. They have different interpretations of uncertainty and acceptable levels of truth. Scholars and practitioners call for bridging the gap while recognizing the separation of the disciplines, believing that this will improve environmental decisions. But this approach does not work because it fails to recognize the reality that science and law are intertwined. Using examples from the Endangered Species Act and recent advances in modern science, this Article illustrates how science and law influence each others thinking, direction, and advances. This Article explores what happens when science and law converge illustrating that 1) policy-driven science is an outcome, 2) the definitions of science and law, and the roles of scientists and lawyers become blurred, 3) discrepancies in standards of uncertainty alter the outcome of decision making and judicial rulings, and 4) differences of opinion between the disciplines on what constitutes science impact policy decisions and the application of science to law.

When science and law intersect, scientists, lawyers, policy makers, and judges all step into each others domain. Despite our best intentions this is unavoidable. This Article calls for the recognition that science and law are intertwined. It advocates the development of a new modern discipline that trains students to be fluent in science, law, and policy in order to better meet today's environmental needs. It offers a few suggestions on how to go about this and invites and challenges others to contribute their own ideas.

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I. INTRODUCTION

All sides are calling for greater integration of science, law, and policy.[1] Those who attempt it recognize the path is a challenging one. There are often misconceptions as to the nature of science and policy, and about what does or should happen when the disciplines intersect. This Article examines some of these issues and suggests ways to deal with them.

The principles and practices of science and law have evolved over centuries, each in relation to their specific roles and interests. Scientists seek knowledge though a formal process known as the scientific method. Science seeks to expand our understanding of the world, and scientific "truth" is subject to revision. Law also conducts an open-ended search for

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[1] *See, e.g.*, Dan J. Rohlf, *Science, Law, and Policy in Managing Natural Resources: Toward a Sound Mix Rather than a Sound Bite*, *in* FOREST FUTURES 127, 129 (Karen Arabas & Joe Bowersox eds., 2004) (arguing that "successful management strategies must rest on . . . policy decisions informed . . . by science"); Deborah M. Brosnan & Martha J. Groom, *The Integration of Conservation Science and Policy: The Pursuit of Knowledge Meets the Use of Knowledge*, *in* 3 PRINCIPLES OF CONSERVATION BIOLOGY 625, 625 (Martha J. Groom, Gary K. Meffe & C. Ronald Carroll eds., 2006) (discussing the need to "make conservation science a central component of environmental decisions, policies, and laws"); David E. Blockstein, *How to Lose Your Political Virginity While Keeping your Scientific Credibility*, 52 BIOSCIENCE 91 (2002) (discussing why scientists should become involved in politics); *Scientific Peer-Review in the Endangered Species Act: Hearing Before the S. Subcomm. on Fisheries, Wildlife, and Water of the S. Comm. on Env't and Pub. Works*, 107th Cong. (2001) [hereinafter *ESA Hearing*] (statement of Deborah M. Brosnan, Founder and President of SEI), *available at* http://www.sei.org/downloads/dbtest050901/db_testimony.pdf; SEI, EXAMPLES OF CALLS FOR PEER REVIEW UNDER THE ENDANGERED SPECIES ACT, *available at* http://www.sei.org/downloads/dbtest050901/pr_calls.pdf; WILLIAM. G. WELLS JR., WORKING WITH CONGRESS: A PRACTICAL GUIDE FOR SCIENTISTS AND ENGINEERS 2 (1996). In addition, organizations such as the American Association for the Advancement of Science maintain programs devoted to the intersection of science, government, and society. *See* Am. Assoc. for the Advancement of Science, Programs, *Science and Policy*, http://www.aaas.org/programs/science_policy/ (last visited Nov. 18, 2007). Other professional organizations, including the Ecological Society of America, have highlighted or taken policy stances on the need for science and policy integration. *See, e.g.*, ECOLOGICAL SOCIETY OF AMERICA, ET. AL., SCIENTIFIC SOCIETIES' STATEMENT ON THE ENDANGERED SPECIES ACT 3 (2006), *available at* http://www.esa.org/pao/policyStatements/pdfDocuments/2-2006_finalStatement_Scientific%20Societies%20ESA.pdf (stating that "decisions made under the [Endangered Species Act] must be made on the basis of the best scientific data available").

understanding but demands a definite finding of facts at a given point in time. Law is built on the idea that the best way to find the truth is for advocates on each side to argue it vigorously in front of an impartial judge or jury. Courtroom law in particular is characterized by an adversarial approach. Science, by contrast, involves a cooperative sharing of information so that others can test and refine hypotheses and theories. As noted by the National Academy of Sciences, in science and law "even the search for truth does not serve the same aims" and is not always governed by the same constraints and requirements.[2] Science seeks to understand and predict the natural world, while law seeks current truth about science and other facts in order to serve justice between parties and other societal goals.[3] Environmental policy is defined as a "broad category and includes all the ways that society tries to address environmental problems, including laws and regulations."[4] Policy is based on values and biases. We expect it to be fair and reasonable but not necessarily objective. Thus the distinctions seem clear. Scientists objectively carry out science and produce research results, while lawyers and policy makers use that information to help formulate fair and reasonable policies.

For the most part we believe the closer the integration of these disciplines, in ways that still preserve their distinctiveness, the better the decisions and policies will be for the environment and people. Practitioners in the different disciplines may vary in the specific imbalances that they seek to redress by bringing science and policy together. Scientists, for instance, may feel that science is poorly treated in the courtroom, or that it is abused by agencies, and seek a greater role for science. They may be driven by a desire to have laws and policies that are more reflective of current scientific thinking and even seek to have scientific standards be legal ones. At the same time, lawyers are often frustrated by what they perceive as fuzzy standards and uncertainties that do not contribute to the fact finding necessary for good law. Indeed, lawyers often view the scientific community as one which believes its methods and procedures are above legal scrutiny and questioning.

Thus it appears that all we have to do is bring the sides together in ways that maintain the boundaries and uphold the respective roles of scientist, lawyer, and policy maker. But in the rough and tumble of environmental decision making this is naïve. Despite the many calls for better integration and hundreds of discussions, we are still no closer to the goal. This is largely because we have failed to recognize that when science and law intersect, definitions and roles change. In the way that eggs and milk make batter when mixed, so too science and law create something new when put together. While it is crucial to recognize the discreteness of each, their integration presents opportunities that are largely ignored because we are compelled to focus only on maintaining the differences. This Article supports the call for better integration between science and law, but argues that we need a stronger model than simply "bridging the gap." Our societal and environmental needs would be better met by recognizing that science and

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2 NAT'L ACAD. OF SCI., A CONVERGENCE OF SCIENCE AND LAW 1 (2000).

3 *Id.* at 2.

4 Brosnan & Groom, *supra* note 1, at 630.

law not only overlap, but at times blend.[5] We would benefit from the creation of an integrated discipline of modern trained professionals who are fluent in their understanding of science and law, and who can adequately address the full complexity of issues we face today. There is not only a practical need for professionals in this arena, but the convergence of law and science itself leads to many questions that are worthy of scholarly pursuit. Individual lawyers and scientists are beginning to publish on these topics.[6] To date their work is largely limited to journals in their own professions and rarely seen by colleagues outside. Academic journals and other systems are needed to encourage those individuals who today straddle the worlds of science and law, and who often find themselves with few opportunities for publishing or discourse among like-minded professionals. Universities, law schools, and other institutions should respond to this need that is both scholarly and vocational (many who work in ecological and natural resources science find themselves dealing with policy and legal mandates that are new to them).

A closer examination of the science-law interface illustrates how they impact each other, and why we may fail to recognize how deeply they are embedded in each other's domain. The juxtaposition of science and law in the Endangered Species Act (ESA)[7] offers a good illustration, and this Article uses several examples from the ESA.

A. The Endangered Species Act: Intertwining Science and Law

Enacted in 1973, the federal ESA is a powerful piece of legislation that protects species and their habitats.[8] It has been called the pitbull of

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5 David H. Guston, *Boundary Organizations in Environmental Policy and Science: An Introduction*, 26 SCI., TECH. & HUMAN VALUES 399, 399 (2001) (describing how "the blurring of boundaries between science and politics, rather than the intentional separation often advocated and practiced, can lead to more productive policy making").

6 *See, e.g.*, Robert T. Lackey, *Science, Scientists and Policy Advocacy*, 21 CONSERVATION BIOLOGY 12 (2007); Dennis D. Murphy & Barry R. Noon, *The Role of Scientists in Conservation Planning on Private Lands*, 21 CONSERVATION BIOLOGY 25 (2007); Thomas M. Franklin, *Putting Wildlife Science to Work: Influencing Public Policy*, 23 WILDLIFE SOC'Y BULL. 322 (1995); Holly Doremus, *The Purposes, Effects, and Future of the Endangered Species Act's Best Available Science Mandate*, 34 ENVTL. L. 397 (2006); Holly Doremus & A. Dan Tarlock, *Science, Judgment, and Controversy in Natural Resource Regulation*, 26 PUB. LAND & RESOURCES L. REV. 1 (2005); Allan Kanner & Mary E. Ziegler, *Understanding and Protecting Natural Resources*, 17 DUKE ENVTL. L. & POL'Y F. 119 (2006); Robert B. Keiter, *The Law of Fire: Reshaping Public Land Policy in an Era of Ecology and Litigation*, 36 ENVTL. L. 301 (2006). Not surprisingly, a review of citations in scientific journals shows that, with few notable exceptions, scientists rarely cite relevant references from law and policy journals. Similarly, environmental law publications infrequently cite relevant peer-reviewed scientific articles.

7 *See, e.g.*, NAT'L RESEARCH COUNCIL, SCIENCE AND THE ENDANGERED SPECIES ACT 159 (1995); J.B. Ruhl, *The Battle Over Endangered Species Act Methodology*, 34 ENVTL. L. 555, 603 (2004). For an excellent discussion of the nature of science-policy interaction, see Professor Ruhl's presentation at the Law, Science, and the Environment forum. J.B. Ruhl, Professor, Florida State University College of Law, Presentation at the Lewis and Clark Law School Law, Science, and the Environment Forum (Apr. 2007).

8 Endangered Species Act of 1973, 16 U.S.C. § 1531(b) (2000).

environmental legislation.[9] The ESA is administered by two agencies: the Fish and Wildlife Service (FWS or The Service) and the National Marine Fisheries Service (NMFS).[10] Section 4 of the ESA requires these agencies to list species that are "in danger of extinction, or likely to become so within the foreseeable future."[11] The listing decision must be made "solely on the basis of the best scientific and commercial data available."[12] Potential economic or social consequences that may result from granting a species federal protection must be ignored.[13] In theory, a law based explicitly on objective science should be the poster-child for how science and law can remain separate but work side-by-side. But more often than not it seems to illustrate the opposite.

Not long after the ESA was enacted, lawyers, politicians, and interest groups, who beforehand had little interest in the species concept, suddenly developed strong opinions on what constitutes a species and indeed what constitutes science itself.[14] A couple of decades later, many scientists were

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9 Eric Fisher, *Habitat Conservation Planning Under the Endangered Species Act: No Surprises & The Quest for Certainty*, 67 U. COLO. L. REV. 371, 371 (1996).

10 Ruhl, *supra* note 7, at 557 (noting that NMFS is also known as NOAA Fisheries Service). *See also* 50 C.F.R. § 424.10(i) (2000) (referring interchangeably to the two names of the agency, which is the convention used in this Article).

11 16 U.S.C. § 1533(b)(1)(B)(ii) (2000).

12 *Id.* § 1533(b)(1)(A) (2000).

13 *Id.* Other decisions made under the ESA, such as those regarding critical habitat, may consider factors other than science. *Id.* § 1533(b)(2) (2000).

14 Since the passage of the ESA a wide range of individuals and organizations have expressed a broad range of opinions on the nature and protection of species. To illustrate with just a few examples: Former Interior Secretary Manuel Lujan sparked controversy when he said, "Do we have to save every subspecies? The red squirrel is the best example. Nobody's told me the difference between a red squirrel, a black one or a brown one." Warren E. Leary, *Interior Secretary Questions Law on Endangered Species*, N.Y. TIMES, May 12, 1990, *available at* http://query.nytimes.com/gst/fullpage.html?res=9C0CE1D91639F931A25756C0A966958260. More recently, the Colorado Homebuilders Association noted in their newsletter that many have questioned the 1998 listing of the Preble's meadow jumping mouse. In two articles the group further notes that Coloradans for Water Conservation and Development (CWCD) believes that the mouse was erroneously listed as threatened under the ESA in 1998. Kent Holsinger, *Preble's Mouse One Step Closer to De-listing*, COLO. ASS'N OF HOMEBUILDERS, Apr. 20, 2004, http://hbacolorado.com/gov_affairs/endangered.aspx (last visited Nov. 18, 2007). In other words, they believe that it did not meet the criteria for species or subspecies. Similarly, the Wyoming delegation expressed much the same opinion and argument in a letter to Secretary Norton calling for delisting of the mouse. *See* Letter from Michael B. Enzi et al., U.S. Senator–WY, to Gale Norton, Sec'y, Dep't of the Interior (Jan. 27, 2005), *available at* http://www.senate.gov/~enzi/mousedelist.htm. Patrick Crank, Wyoming's attorney general, compared the mouse to the mythical Wyoming jackalope, saying that "'[t]hey both do not exist' . . . . (The Preble's mouse) 'exists only in the minds of some folks in the US Fish and Wildlife Service and some environmental groups.'" Rebecca Boyle, *Endangered Mouse Creates Political Divide*, GREELEY TRIB., Sept. 19, 2006, *available at* http://www.greeleytrib.com/article/20060919/NEWS/109190089. On the other hand, non-scientific groups including religious organizations have defended the species concept and the ESA. The Evangelical Environmental Network (representing over 1000 local churches and an arm of the Evangelicals for Social Action which has affiliates that include a group of 88 evangelical colleges) expressed their opinion that the Endangered Species Act is "the Noah's ark of our day," arguing that "Congress and special interests are trying to sink it." Peter Steinfels, *Evangelical Group Defends Laws*

shocked to discover the science and scientific standards they considered their private domain were being debated and decided by judges and lawyers in the courtroom. It was only with the emergence of "conservation biology" in the early 1990s[15] that academic scientists began to engage more formally in the policies and decisions that affect the fate of studied organisms and habitats. Despite this, many scientists remain ill-equipped and untrained in the regulations and rules that govern legal decisions and how these in turn impact science. For instance, the majority of academic scientists are unaware of the conventional rules of judicial review which tilt the balance in favor of agency decisions in litigation that challenges the substantive merit of the decision.[16] Because agencies base many natural resources decisions (in addition to listing decisions) on science, this convention plays a major role on what constitutes science and what standards are set and accepted. Conventions like these are rarely if ever discussed in conservation biology classes. Consequently, many scientists enter the policy arena or courtroom believing the normal rules and standards of the science process apply and are shocked to find they do not.

Integrating science and law in the ESA and broader environmental policies means more than simply doing what we have always done but with different colleagues. The ramifications extend to the ways we think about scientific questions and standards as well as legal ones. This Article discusses four main topics to illustrate why treating science and law as if they are entirely separate rarely works—and why that may be remedied by a new discipline and more formal training. Section II argues that policy-driven science is a reality when science and law converge. Section III discusses how the definitions of science and law, and the roles of scientists and lawyers, blur when science and law intersect. Unless we are willing to deal with these consequences as realities rather than things we can absolutely avoid, we will spend longer calling for integration and may fail to get there. Finally, this Article discusses how differences in the standards of uncertainty and what constitutes science impact policy decisions and the application of science to law.[17]

Protecting Endangered Species as a Modern 'Noah's Ark', N.Y. TIMES, Jan. 21, 1996, *available at* http://query.nytimes.com/gst/fullpage.html?res=9B01EFDF1739F932A05752C0A960958260. One of their spokesmen, Mr. Benzel, said that the evangelicals were not scientists but that they could make the case for the ESA on biblical and theological grounds. *Id.* The group had several meetings with congressional representatives urging support of species and the ESA. *Id.*; *see generally* Brosnan, *supra* note 1.

[15] The publication of *Conservation Biology: The Science of Scarcity and Diversity* in 1986, the launching of the Society of Conservation Biology, and the first publication of its journal, Conservation Biology, in 1987 heralded in the era of Conservation Biology that advanced rapidly in the early 1990s. *See* MARTHA J. GROOM, GARY K. MEFFE & C. RONALD CARROLL, PRINCIPLES OF CONSERVATION BIOLOGY 12, 15 (3d ed. 2006) (referring to works by Michael E. Soulé).

[16] *See generally* Chevron U.S.A. Inc. v. Natural Res. Def. Council, 467 U.S. 837, 843 (1984) (holding that if a statute is ambiguous, the court must defer to an agency's reasonable interpretation of the statute in question).

[17] I have drawn many of the examples discussed in these four sections from the work of the organization I head, Sustainable Ecosystems Institute. SEI is dedicated to impartial but policy-relevant conservation biology. Our work has led us to understand the critical need for a broad

II. THE CONVERGENCE OF SCIENCE AND LAW I: SCIENCE-DRIVEN LAW AND POLICY-DRIVEN SCIENCE

The Endangered Species Act was drafted using population biology that was current in the early 1970s, influenced by the work of scientists like Robert May and others.[18] From a scientific perspective this represents one of the great strengths of the Act (although the science has since moved on). But the most obvious outcome of a law that requires decisions to be made solely on science is that it continually requires science to support it.[19] Thus, from the outset, science had a role in law, and law became embedded in science.

When the ESA was enacted, the biological species concept[20] was, and still is, regarded as central and robust. The scientific community had a broad understanding of what constituted a population, and moreover the concept of population was recognized as a valid scientific organizing principle. Thus the species concept originated in science, but from the moment it was incorporated into the ESA, what constituted a species or subspecies became more than simply an academic discussion.[21] The definition of a species (let alone subspecies) evolved into a policy fracas that had severe political fall out, threatened scientific reputations, and carried a significant price tag. The controversy surrounding the Preble's Meadow Jumping Mouse is a prime example. It is not just governments, developers, and environmentalists who are battling in the media, but the scientists themselves.[22]

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training in all relevant disciplines.

[18] *See, e.g.*, ROBERT M. MAY, STABILITY AND COMPLEXITY IN MODEL ECOSYSTEMS (2d ed. 1974) (addressing questions such as what makes populations stabilize, fluctuate, or become extinct); *see also* 16 U.S.C. § 1533 (2000) (addressing how determinations of endangered and threatened species are made).

[19] *See, e.g.*, 16 U.S.C. §§ 1533, 1536 (2000) (provisions using the best science available standard); *see also* Holly Deremus, *The Purposes, Effects, and Future of the Endangered Species Act's Best Available Science Mandate*, 34 ENVTL. L. 397, 405–07 (2004) (analyzing the best available science mandate).

[20] The biological species concept states that organisms are classified as being in the same species if they are potentially capable of breeding and producing fertile offspring. *See* Understanding Evolution, *Evolution 101*, http://evolution.berkeley.edu/evosite/evo101/VA1BioSpeciesConcept.shtml (last visited Nov. 18, 2007).

[21] *See* 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, 619–23 (1994) [hereinafter Rohlf, *Something Fishy*] (discussing the history of the definition of "species" by the NMFS and the FWS); *see also* Daniel J. Rohlf, *Six Biological Reasons Why the Endangered Species Act Doesn't Work—And What to Do About It*, 5 CONSERVATION BIOLOGY 273, 280–81 (1991) (discussing the need for conservation biologists to understand the legal implications of their findings and to effectively communicate with lawmakers).

[22] The question is whether the Preble's mouse is a distinct subspecies. News media have feasted on disputes between dueling scientists who differ in their conclusions in addition to debates between governments, environmentalists, and developers. *See, e.g.*, Kirk Johnson, *Debate Swirls Around the Status of a Protected Mouse*, N.Y. TIMES, June 27, 2004, at 16; Sean Paige, *Mystery Mouse Takes Centerstage in Endangered Species Drama*, THE GAZETTE COLO. SPRINGS, Apr. 17, 2006; ROB ROY RAMEY II ET AL., DOES SCIENCE SUPPORT THE PREBLE'S MEADOW JUMPING MOUSE AS A DISTINCT SUBSPECIES?, DENVER MUSEUM OF NATURE & SCIENCE, DEC. 18, 2003, http://www.dmns.org/main/en/Professionals/Press/Press+Release+Archives/Press+Releases/Museum+News/Prebles+Jumping+Mouse+Release.htm (last visited Nov. 18, 2007); ASSOCIATE

Scientists consider a scientific question to be one that is driven by a series of observations about the natural world that lead to a set of testable hypotheses. However, as the ESA illustrates, scientific questions can be driven and framed by law and policy. Whether those questions are deemed of greater interest to the scientific community or whether they truly advance our understanding of the natural world can be debated. Thus, policy driven science may derive not from a series of observations of nature but rather in response to a judge's ruling. Research itself can be initiated by a politician's need for an answer, or by a lawsuit filed by a developer. The desired outcome is not knowledge but simply resolution of a dispute favoring one viewpoint over another. By contrast, in more traditional science, there is no need for a winner or loser—opposing views are equally accepted if the underlying methodology is deemed adequate. Indeed, competing theories are often welcomed and widely published in science.

Several examples illustrate the concept of policy-driven science. Early on, the ESA allowed protection of groupings that were below the species category.[23] In 1978 Congress ratified listings below the species level by broadening the ESA's definition to include subspecies and Distinct Population Segments (DPS) of vertebrate animals.[24] While scientists had studied and used subspecies definitions, they had never, in the scientific literature, employed the term DPS. Certainly, it is doubtful that any academic scientist could have offered a definition at that time or would have agreed that, for instance, a population of vertebrate fish was more worthy of protection than a population of invertebrate butterflies. Is a DPS a scientific or a policy grouping? Available scientific information provides little to enlighten us when interpreting the phrase.

The result of the DPS policy was a flurry of activity to develop a scientific understanding of a DPS,[25] an effort that was driven purely by lawmakers' decisions. In 1996, the Fish and Wildlife Service and National

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PRESS, *Tiny Mouse Stands in Way of U.S. Government*, Fox News, Jan. 30, 2006, http://www.foxnews.com/story/0,2933,182892,00.html (last visited Nov. 18, 2007).

23 DANIEL J. ROHLF, THE ENDANGERED SPECIES ACT: A GUIDE TO ITS PROTECTIONS AND IMPLEMENTATION 26 (1989); Rohlf, *Something Fishy*, *supra* note 21, at 619.

24 16 U.S.C. § 1532 (2000).

25 *See* Craig Moritz, *Defining 'Evolutionary Significant Units' for Conservation*, 9 TRENDS IN ECOLOGY & EVOLUTION 373, 373 (1994) (discussing various definitions of the term evolutionary significant units); Robin S. Waples, *Evolutionarily Significant Units and the Conservation of Biological Diversity under the Endangered Species Act*, *in* EVOLUTION AND THE AQUATIC ECOSYSTEM: DEFINING UNIQUE UNITS IN POPULATION CONSERVATION 8 (Jennifer L. Nielsen ed., 1995) (reviewing the legislative, legal, and case histories of the ESA to examine the source of the ESU concept and discuss critiques of its application); David S. Pennock & Walter W. Dimmick, *Critique of the Evolutionary Significant Unit as a Definition for "Distinct Population Segments" Under the U.S. Endangered Species Act*, 11 CONSERVATION BIOLOGY 611, 617 (1997) (claiming that the new definition of "evolutionary significant units" is less protective than the older concept of "distinct population segments"); Walter W. Dimmick et al., *The Importance of Systematic Biology in Defining Units of Conservation*, 13 CONSERVATION BIOLOGY 653, 659 (1999) (criticizing the focus on adaptation created by categorization of species as evolutionary significant units); Alfried P. Volger & Rob Desalle, *Diagnosing Units of Conservation Management*, 8 CONSERVATION BIOLOGY 354, 356–57 (1994) (favoring a definition for evolutionary significant units based on patterns of variation).

Marine Fisheries Service furnished an answer: a group of vertebrate animals constitutes a DPS if that group is discrete from other populations of the same species and significant to the species as a whole.[26] Since then many hundreds of scientists have been engaged in analyzing population trends, distribution data, DNA, mtDNA, and a host of other attributes in order to develop a workable model of what constitutes a DPS.[27] The term has spawned a suite of lawsuits and scientific reviews concerning the listing of the Spotted Owl, the Southern Resident Orca, Pacific Salmon, the Marbled Murrelet, and many others.[28] Today, the fate of biological diversity, many livelihoods, and millions of dollars in development revenues rest on a "science" concept that was codified by lawyers and enacted by politicians.[29] Has tinkering with the definition of species always been to provide a deeper scientific understanding of our world or because agencies need to deal with the enormous political and social costs of the ESA?

Note that the two regulatory agencies have developed subtly different approaches for dealing with the DPS issue. The FWS has persisted in using the concept as originally formulated, in essence agreeing with the law that there are taxonomic units below the subspecies level.[30] By contrast, NOAA Fisheries has advocated the use of the concept of the Evolutionary Species Unit (ESU) which recognizes that there is a continuum of distinctiveness of populations below the species level.[31] The latter approach more closely resembles current thinking in population biology and taxonomy.[32] Genetic

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[26] Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act, 61 Fed. Reg. 4722, 4722 (Feb. 7, 1996).

[27] A steady stream of scientific papers and species status reviews continue to address this topic. *See, e.g.*, Jody Hey et al., *Understanding and Confronting Uncertainty in Biology and Conservation*, 18 TRENDS IN ECOLOGY AND EVOLUTION 597, 597 (2003) (presenting a theory synthesis in which individual taxonomic species are used as hypotheses of evolutionary entities); Dylan J. Fraser & Louis Bernatchez, *Adaptive Evolutionary Conservation: Towards a Unified Concept for Defining Conservation Units*, 10 MOLECULAR ECOLOGY 2741 (2001) (providing a framework for defining evolutionarily significant units of species); Stephen A. Karl & Brian W. Bowen, *Evolutionary Significant Units Versus Geopolitical Taxonomy: Molecular Systematics of an Endangered Sea Turtle (genus* Chelonia*)*, 13 CONSERVATION BIOLOGY 990 (1999) (discussing taxonomic rank as an important criterion in assessing the conservation priority of an endangered organism); R.G. GUSTAFSON ET AL., U.S. DEP'T OF COMMERCE, NOAA TECH. MEMORANDUM NMFS-NWFSC-76, STATUS REVIEW OF CHERRY POINT PACIFIC HERRING (*CLUPEA PALLASII*) 68 (2006) (concluding that spawning populations of Pacific herring from Puget Sound and the Strait of Georgia constituted the Georgia Basin Pacific herring DPS).

[28] *See, e.g.*, N. Spotted Owl v. Hodel, 716 F. Supp. 479 (W.D. Wash. 1988); Ctr. for Biological Diversity v. Lohn, 483 F.3d 984 (9th Cir. 2007); Alsea Valley Alliance v. Lautenbacher, No. 06-6093-HO, slip op. at 1 (D. Or. Aug. 14, 2007); Coos County Bd. of County Comm'rs v. Norton, No. 06-6010-HO, slip op. at 1 (D. Or. June 19, 2006).

[29] Similar situations exist for terms such as "critical habitat" and "significant portion of [a species'] range." 16 U.S.C. §§ 1532(5)(A), 1532(6) (2000).

[30] *See* Rohlf, *Something Fishy*, *supra* note 21, at 656–58; Daniel J. Rohlf, *Section 4 of the Endangered Species Act: Top Ten Issues for the Next Thirty Years*, 34 ENVTL. L. 483, 517 (2004); Derek O. Teaney, *The Insignificant Killer Whale: A Case Study of Inherent Flaws in the Wildlife Service's Distinct Population Segment Policy and a Proposed Solution*, 34 ENVTL. L. 647, 653 (2004).

[31] Rohlf, *Something Fishy*, *supra* note 21, at 620–21.

[32] New Techniques and approaches have shifted the emphasis from discreteness towards

and other tools are now so powerful that it is possible to recognize increasingly fine distinctions among groupings of animals, down to family level.[33] In such circumstances there is a complete continuum of distinctiveness, and recognizing any particular level as distinct may seem to at least some biologists as arbitrary. Modern day evolutionary biologists have for the most part abandoned naming any group lower than a full species, even avoiding the recognition of subspecies.[34] Practically, the differences between the agencies' policies and the developing science are not necessarily major,[35] but they have served to focus attention on the subsidiary terms "discrete" and "significant," and whether they are creatures of scientific or policy terminology.[36]

An interesting example was uncovered by SEI's analysis of the status of the Spotted Owl.[37] That report showed that there was genetic interchange between the Northern subspecies (protected under the ESA) and the Californian subspecies (not listed under the ESA).[38] In essence, there are some Northern birds with Californian genes and vice versa. Biologically this is no surprise—we expect such genetic exchange between adjacent members of the same species. But, from a policy perspective it raises an interesting question: Are owls with mixed genetic lineage protected? In this case SEI's scientific review panel determined that the two populations were discrete[39]—

continuum. For example, results of molecular genetic analyses resulted in a species of a tropical reef-building coral (*Montastraea annularis*) being split into a "species complex." *See, e.g.*, Hironobu Fukami et al., *Geographic Differences in Species Boundaries Among Members of the Montastraea Annularis Complex Based on Molecular and Morphological Markers*, 58 EVOLUTION 324, 325 (2004); Jose V. Lopez et al., *Molecular Determination of Species Boundaries in Corals: Genetic Analysis of the Montastraea Annularis Complex Using Amplified Fragment Length Polymorphisms and a Microsatellite Marker*, 196 BIOLOGICAL BULL. 80, 80 (1999). As early as 1996, Bronlow predicted that new scientific techniques and thinking would impact conservation. C. Alexander Brownlow, *Molecular Taxonomy and the Conservation of the Red Wolf and Other Endangered Carnivores*, 10 CONSERVATION BIOLOGY 390, 390 (1996) ("[I]t is likely that broader consequences will be felt throughout the conservation community as species come under the scrutiny of a more powerful means of taxonomic identification.").

33 Keith A. Crandall et al., *Considering Evolutionary Processes in Conservation Biology*, 15 TRENDS IN ECOLOGY & EVOLUTION 290, 290 (2000); Sylvia M. Fallon, *Genetic Data and the Listing of Species Under the U.S. Endangered Species Act*, 21 CONSERVATION BIOLOGY 1186, 1187 (2007); S. T. Williams et al., *The Marine Indo-West Pacific Break: Contrasting the Resolving Power of Mitochondrial and Nuclear Genes*, 42 INTEGRATIVE & COMPARATIVE BIOLOGY 941, 941 (2002).

34 Interview with Steven Courtney, Dep't of Biology, Univ. of Or., in Portland, Or. (Apr. 10, 2007).

35 *But see* ROHLF, THE ENDANGERED SPECIES ACT: A GUIDE TO ITS PROTECTIONS AND IMPLEMENTATION, *supra* note 23, at 37.

36 This example illustrates how the evolution of science itself impacts its ability to interface with the law; while we may think of science as evolving at a leisurely pace, it frequently changes faster than applicable law. While scientists move away from the subspecies concept in favor of other approaches, the ESA still depends on the category as a basis for science based decisions and protection.

37 SEI, SCIENTIFIC EVALUATION OF THE STATUS OF THE NORTHERN SPOTTED OWL (2004), *available at* http://www.sei.org/owl/finalreport/finalreport.htm (last visited Nov. 18, 2007) [hereinafter SEI REPORT].

38 *Id.* at 3-14 to 3-15.

39 *Id.* at 3-27.

and therefore met currently accepted definitions of subspecies—thus providing the FWS with a straightforward mechanism for its decision to protect all Northern Spotted Owls. However, it is easy to envision situations where the picture will be less clear and where scientists will be unable to provide such clear answers to policy-driven questions. Moreover, scientists and policy makers will wrestle over whether their decision should be based on science or policy, and who should make that determination.

Policy-driven science is not always bad for science.[40] Indeed, it leads to new thinking, new methods, and new discoveries. For instance, Population Viability Analysis made great strides during the 1990s, in part because of the ESA and the development of global lists of endangered species, such as the International Union for the Conservation of Nature and Natural Resources' (IUCN) Red List.[41] The work of scientists like Barry Noon,[42] much of which has been in response to legal rulings and policy needs, shows that top rate science that advances our knowledge of the world can be carried out in a policy-driven framework. Similarly, the fields of genetic pedigree analysis and practical brood stock management, developed for use in endangered species programs, have advanced our understanding of population genetics.[43]

Policy needs are also beginning to shape the very structure of the scientific process itself. Peer review, integral to the maintenance of scientific quality control, was originally developed in academic contexts.[44] SEI is at the

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[40] Policy-driven science is very different from the disturbing trend of politicized science where data and results are manipulated to support a political stance. CHRIS MOONEY, THE REPUBLICAN WAR ON SCIENCE 17 (2005) ("political science 'abuse'" is an "attempt to inappropriately undermine, alter, or otherwise interfere with the scientific process, or scientific conclusions, for political or ideological reasons").

[41] *See generally* Mark L. Shaffer, *Population Viability Analysis*, 4 CONSERVATION BIOLOGY 39, 39 (1990); M.S. Boyce, *Population Viability Analysis*, 23 ANN. REV. OF ECOLOGY AND SYSTEMATICS 481 (1992) (discussing the pros and cons of population viability analysis in modeling population dynamics); Dennis D. Murphy et al., *An Environment-metapopulation Approach to Population Viability Analysis for a Threatened Invertebrate*, 4 CONSERVATION BIOLOGY 41 (1990) (discussing the application of population viability analysis to invertebrates through metapopulation approach); H. Resit Akcakaya et al., *Linking Landscape Data with Population Viability Analysis: Management Options for the Helmeted Honeyeater Lichenostomus melanops cassidix*, 73 BIOLOGICAL CONSERVATION 169 (1995) (presenting a new approach to analyzing a species' population variability that links special data directly to a metapopulation model); Barbara L. Taylor, *The Reliability of Using Population Viability Analysis for Risk Classification of Species*, 9 CONSERVATION BIOLOGY 551 (1995) (discussing the reliability of population viability analysis for listing species on the IUCN list).

[42] *See, e.g.*, Barry R. Noon & Charles M. Biles, *Mathematical Demography of Spotted Owls in the Pacific Northwest*, 54 J. WILDLIFE MGMT. 18 (1990); Dennis D. Murphy & Barry R. Noon, *Integrating Scientific Methods with Habitat Conservation Planning: Reserve Design for Northern Spotted Owls*, 2 ECOLOGICAL APPLICATIONS 3 (1992); Bruce B. Bingham & Barry R. Noon, *Mitigation of Habitat "Take": Application to Habitat Conservation Planning*, 11 CONSERVATION BIOLOGY 127 (1997).

[43] Recently the author served on an expert panel to consider conservation of endangered Atlantic Salmon and saw firsthand the significant advances made in these fields. *See* LEE BLANKENSHIP ET AL., REVIEW OF ATLANTIC SALMON HATCHERY PROTOCOLS, PRODUCTION, AND PRODUCT ASSESSMENT (2007), *available at* http://www.maine.gov/asc/pdf/SEI%20Final%20 report.pdf.

[44] *See* Deborah M. Brosnan, *Can Peer Review Help Resolve Natural Resource Conflicts?*, 16

forefront of re-defining peer review to make it practicable in regulatory contexts—where, for example, anonymity cannot be maintained—while preserving the fundamental scientific integrity that is essential. SEI's review processes are organized to ensure a full and transparent debate, where opposing scientific viewpoints are expressed and evaluated *in public*, with an explanation for the final evaluation reached by the science panel. This innovative process has proven useful for reaching scientific conclusions on several major environmental issues, such as management of large river systems, such as the Missouri and Columbia, wetlands, such as the Everglades, as well as with controversial ESA decisions, such as those surrounding the Northern Spotted Owl, Preble's Meadow Jumping Mouse, and Atlantic Salmon.[45]

Less studied—at least among scientists—is the influential role of science in driving major policy actions and laws. Can scientists' findings lead to the same flurry among policy makers and Congress that the DPS policy did among scientists? For instance, as academic scientists focus more on DNA analyses to define populations and species, it remains to be seen whether their results will simply affect listing and delisting decisions, recovery plans, etc., or whether they may even generate changes to the law itself. Certainly, they are forcing policy makers to seek clarity and to attempt to understand the biology underpinning the DPS/ESU concept. Policy and legal changes that may potentially arise from scientific findings in climate change research may offer some good clues and lessons for the future of environmental policy at national and international levels. The core issue is that as scientists we need to recognize that policy-driven science is a common and important way that science is carried out.[46] Additionally, as scientists in the policy arena, we need to be vigilant that a scientific theory or organizing principle is not discredited or ignored simply because it is "unworkable" in policy.

III. CONVERGENCE OF SCIENCE AND LAW II: BLURRING THE LINES AND ROLES OF SCIENCE AND LAW

Although we may be keen to distinguish between science and policy, the lines between them are becoming less and less distinct. Scientists blur them as much as policy makers, lawyers, and judges. Which profession, for instance, is most qualified to define endangered? Who determines whether an issue is a policy or a science call? In the courtroom, different judges have ruled differently on whether standards set by agencies are scientific or policy. For

ISSUES SCI. & TECH. 32, 34 (2000); *ESA Hearing*, *supra* note 1, at 23–25.

45 SEI, *Newsletters, Books, Reports, Articles*, http://www.sei.org/pub.html (last visited Nov. 18, 2007) (showing a complete list of publications that have contributed to discussions about major environmental issues.) *See, e.g.*, SEI, INDEPENDENT SCIENCE REVIEW OF THE PALLID STURGEON ASSESSMENT PROGRAM: FINAL REPORT (2004), *available at* http://sei.org/sturgeon/PASTISRFinalReport.pdf; SEI REPORT, *supra* note 37; BRIAN S. ARBOGAST ET AL., EVALUATION OF SCIENTIFIC INFORMATION REGARDING PREBLE'S MEADOW JUMPING MOUSE (2006), *available at* http://www.fws.gov/mountain-prairie/species/mammals/preble/Prebles_SEI_report.pdf.

46 MOONEY, *supra* note 40, at 16.

instance, while a district court ruled that an ESA no-jeopardy standard constituted a reasonable agency policy call, the appeals court reviewing the same standard called it expert scientific judgment that does not belong in a courtroom.[47] The roles and pronouncements of scientists and lawyers are equally debated.

Recently, conservation scientist Dr. Stuart Pimm argued that the loss of a population of an endangered species would put that species in jeopardy, noting that he fully understood the legal implications of his statement.[48] Lawyers may see this as trespassing into policy, or roll their eyes at what they consider another naïve scientist practicing law without a license. Yet, many scientists, such as Pimm, who have rigorously studied the relevant populations for years may feel that they are indeed the person with the best professional knowledge to judge when a species is or is not in jeopardy. In the same vein, scientists listening to attorneys argue over whether a species should be listed under the ESA may feel that they are listening to lawyers practicing advanced science without a Ph.D. Yet those lawyers may believe that it is they who have the better understanding of standards and practices and are thus more qualified to make those decisions. Despite our best intentions all are challenged to maintain the boundaries between science and law. We would do better to recognize that there are aspects of science and law that are embedded in environmental decisions and they simply cannot be easily separated out.

Science and law have different definitions and standards even when applying terms from each others disciplines. What constitutes scientific uncertainty and what constitutes science, including scientific standards, are two topics that are particularly challenging. These areas are a foundation of science and scientists would likely argue the issues belong in their domain. The courts, however, see things differently.

IV. UNCERTAINTY AND SCIENCE

"Doubt is ubiquitous in science."[49] There are many sources of uncertainty:

- Natural variation and inherent stochasticity of ecological systems . . .
- Inaccurate measurement of the state of ecological systems . . .
- [Use of] [a]bstract and simplified models to predict the response of managed systems to management actions . . .

[47] Daniel J. Rohlf, *Jeopardy Under the Endangered Species Act: Playing a Game that Protected Species Can't Win*, 41 WASHBURN L.J. 114 (2001); Am. Rivers v. Nat'l Marine Fisheries Serv., No. 96-384-MA, 1997 WL 33797790, at *10 (D. Or. Apr. 3, 1997); Am. Rivers v. Nat'l Marine Fisheries Serv., No. 98-35141, 1999 WL 68644, at *1 (D. Or. Feb. 11, 1999).

[48] Dr. Stuart Pimm, Duke Univ., Speech at SEI Public Panel Process as a Presentation to South Florida Avian Ecology Science Review Forum: Cape Sable Seaside Sparrow (Aug. 13–15, 2007) (audio recording available at http://www.sei.org/everglades/presentations.htm). Pimm's presentation was pre-recorded, played at the forum and entered in the record.

[49] Brosnan & Groom, *supra* note 1, at 634.

- Fundamental misunderstanding of variables . . .
- . . . interpretation of incomplete data . . .
- Uncertainty [in predicting the future, including] . . . future stressors to the system[50]

Uncertainty drives scientific questions. Scientists use the scientific method to reduce uncertainty; the goal of science is to approach the truth by subjecting alternative hypotheses to rigorous tests. Thus, scientists do not construct conclusions from data, they construct hypotheses that are tested with further data. They cannot prove the truth of an assertion, rather they fail to disprove it and thus support provisional truths or hypotheses that have withstood challenges. Scientific dissent that arises from uncertainty is often regarded as a positive aspect of science—but not so in policy or the public arena.

A key area for developing better integration of science and law concerns the interpretation and use of uncertainty. How much uncertainty is acceptable? How does uncertainty affect the burden of proof applied to listing or other environmental decisions? How do scientists and non-scientists alike use or misuse the concept?

Over the past several years we have witnessed scientific uncertainty invoked as the reason to maintain the status quo, to take no action in favor of species or habitats, or as evidence of perpetrating false information on the public.[51] Certainly expressions of uncertainty are part of the scientific process—we are trained to be cautious about our conclusions, and to always recognize the provisional nature of our conclusions. Yet such caution is open to exploitation by any party who seek to use such uncertainty to foster their own goals. In an adversarial courtroom, caution may be seen as a weakness, rather than a fundamental strength. At the same time, uncertainty is a key component of the information that must be used by any responsible decision maker. The Global Climate Change debate finally appears to be approaching resolution, despite years of political obfuscation (largely exploiting scientific caution and minority opinion).[52] Scientists have

[50] *Id.* at 634–37.

[51] Exploiting scientific uncertainty and doubt has long been a strategy of politicians, industry groups, and others. As far back as 1969 a now infamous tobacco document by Brown and Williamson read "Doubt is our product, since it is the best means of competing with the 'body of fact' that exists in the mind of the general public. It is also a means of establishing controversy." Alan D. Attie, *Book Review: The Republican War on Science by Chris Mooney*, 116 J. CLINICAL INVESTIGATION 552 (Mar. 2006). *See also* J.B. Ruhl, *Reconstructing the Wall of Virtue: Maxims for the Co-Evolution of Environmental Law and Environmental Science*, 37 ENVTL. L. 1063 (2007) [hereinafter Ruhl, *Reconstructing the Wall of Virtue*]; J.B. Ruhl & Tom McGarity, Regulatory Tools for Interdisciplinary Problems, Presentation at the Law, Science, and Environment Forum at the Lewis and Clark Law School (Aug. 19, 2007) (audio recording available at http://lawlib.lclark.edu/podcast/?p=270).

[52] Senator James Inhofe (R-OK), a skeptic on human-induced climate change, argues that scientists vigorously disagree over whether human activities are causing global warming. Senator James Inhofe, Chairman, Senate Env't and Pub. Works Comm., Senate Floor Speech, Hot & Cold Media Spin Cycle: A Challenge to Journalists Who Cover Global Warming 2–4 (Sept. 25, 2006). He has used scientific uncertainty to challenge the science and conclusions regarding

responded to the debate not by making changes to their predictions—or even to the fact that there remain some uncertainties—but by increasing their levels of certainty and unanimity about their predictions—to the point that these can no longer be ignored.

Scientists often apply a 95% confidence level as an acceptable standard of certainty (engineers have higher standards for building construction).[53] In courtroom law, "beyond a reasonable doubt" may be sufficient, although genetic testing typically requires very high levels of certainty.[54] For decision makers, "best available" science may constitute support in 51% of scenarios.[55] These various standards are clearly not interchangeable across disciplines. Some understanding of how to merge them is needed if we are to better integrate science and law. Recently, scientists who work at the interface of law, science, and policy are beginning to present formal definitions of uncertainty. For instance, the IPCC panel and SEI reviews now include explicit definitions and statements on uncertainty.[56] Additionally,

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global climate change. Calling the idea that humans are warming the planet a hoax in Congressional speeches, he notes that the "greatest climate threat we face may be coming from alarmist computer models." *Id.* Republican Party political consultant Frank Luntz recommended using scientific doubt to undermine public environmental concerns. Jennifer Washburn, *Science's Worst Enemy: Corporate Funding*, DISCOVER 73, Oct. 11, 2007, *available at* http://discovermagazine.com/2007/oct/sciences-worst-enemy-private-funding/?searchterm=science's%20worst%20enemy. Luntz explained that "[v]oters believe that there is no consensus about global warming within the scientific community. . . . Should the public come to believe the scientific issues are settled, their views about global warming will change accordingly. Therefore, you need to make the lack of scientific certainty a primary issue in the debate." *Id.*

[53] Steven Rotman, *Don't Know Much About Epidemiology?*, 43 TRIAL 30, 34 (2007).

[54] *See* BLACK'S LAWS DICTIONARY 1265 (6th ed. 1990).

[55] This is the case in the absence of adequate data or clearly defined standards.

[56] The panel of expert scientists reviewing the status of the Northern Spotted Owl was asked to evaluate the quality of the information and the certainty of the conclusions. The results were presented in a matrix illustrating both the degree of unanimity and uncertainty on different topics, as well as which data were considered most reliable and why panelists reached their individual conclusions. *See* SEI REPORT, *supra* note 37, at 10–1 to 11–17 (providing an example of the questions and answers received). The Intergovernmental Panel on Climate Change (IPCC) uses the following criteria which it applies to its conclusions:

Virtually certain: > 99% probability of occurrence
Very likely: 90–99% probability
Likely: 66–90% probability
About as likely as not: 33–66% probability
Unlikely: 10–33% probability
Very unlikely: 1–10% probability
Exceptionally unlikely: < 1% probability

IPCC, CLIMATE CHANGE 2001: THE SCIENTIFIC BASIS 2 n.7 (J.T. Houghton et al. eds., 2001), *available at* www.grida.no/climate/ipcc_tar/wg1/pdf/WG1_TAR-FRONT.PDF. For example, an IPCC report states that "[m]ost of the observed increase in globally averaged temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas concentrations. This is an advance from the TAR's conclusion that 'most of the observed warming over the last 50 years is *likely* to have been due to the increase in greenhouse gas concentrations.'" INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS; SUMMARY FOR POLICYMAKERS 8 (IPCC 2007), *available at* http://ipcc-wg1.ucar.edu/wg1/docs/WG1AR4_SPM_PlenaryApproved.pdf?loc=interstitialskip. The U.S.

SEI uses questionnaires to determine unanimity among scientists on its review panels. Specific presentation on the levels of uncertainty and unanimity is much valued by policy makers, but not as much by the scientists themselves. These techniques were not developed for scientists or for science but rather to communicate with policy makers, to minimize the potential for abuse of scientific findings, and as a way to apply the same standards across science, law, and policy.

A. What is Science and What are Scientific Standards?

The Endangered Species Act calls for decisions to be made on the "best scientific . . . data available."[57] In academia there is a widespread understanding on what constitutes good science; peer review is science's primary tool in maintaining and evaluating scientific quality. It is the gold standard of science. However, in policy and the courtroom the very definition of science can be open to debate. The term "best scientific . . . data" in the ESA is not accompanied by any guidance in the Act's definition section.[58] Thus, scientists, lawyers, policy makers, and judges, all of whom have a stake in the outcome, have taken roles in attempting a definition.

Academic science has the luxury of moving ahead at a leisurely pace, including time for the peer review process. This is not the case, however, in policy considerations or in the courtroom, where decisions must be made "here and now." In policy and law there is no guarantee that the best available science will be sufficient to inform decisions. Indeed, available science may not always meet the standards set forward by academic peer review. Sometimes the only information available is gray literature which has no defined standard in science.[59] At times the courts themselves have issued conflicting rulings on what constitutes best available science.[60] A scientist, particularly one unschooled in the workings of law or policy, is apt to use a strict scientific standard in the courtroom, when judges and regulators may be using a legal or policy one. Indeed, this occurred in a recent case concerning the Hawaiian monk seal when a scientist noted that her results had not yet been peer-reviewed and thus should be considered preliminary.[61] Based on her submission the judge ruled the science

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Climate Change Science Program has quoted the IPCC's statements based on the criteria. *E.g.*, CLIMATE CHANGE SCI. PROGRAM & SUBCOMM. ON GLOBAL CHANGE RESEARCH, STRATEGIC PLAN FOR THE U.S. CLIMATE CHANGE SCIENCE PROGRAM 39, 189 (2003).

57 16 U.S.C. § 1533 (2000).

58 *See id.* § 1532 (2000).

59 Gray literature refers to reports or publications that have not had a formal, independent peer review. P.J. SULLIVAN ET AL., DEFINING AND IMPLEMENTING BEST AVAILABLE SCIENCE FOR FISHERIES AND ENVIRONMENTAL SCIENCE, POLICY, AND MANAGEMENT 12–13 (2006), *available at* www.fisheries.org/afs/publicpolicy/science.pdf.

60 Gustavo A. Bisbal, *The Best Available Science for the Management of Anadromous Salmonids in the Columbia River Basin*, 59 CANADIAN J. FISHERIES & AQUATIC SCI. 1952, 1958 (2002).

61 Greenpeace Found. v. Mineta, 122 F. Supp. 2d. 1123, 1133–34 (D. Haw. 2000). Since evidence exists that lobsters are important prey items for the endangered monk seal, the

inadmissible.[62] This does not mean that any science is better than no science, rather it illustrates the need for a clear understanding of how science can be applied across all sectors.

B. Imposing Standards: The Data Quality Act

In 2000, the government stepped in to partially address the issue of scientific quality with the Data Quality Act (DQA), which was enacted as a two-sentence rider in a spending bill.[63] The Data Quality Act has fanned the flames about what constitutes science and who determines its quality.[64] DQA has been called by many names including "A science abusers dream come true,"[65] "A revolution in the role of science in policy making or a can of worms?,"[66] and the "nemesis of regulation."[67]

Under the Data Quality Act, OMB's guidelines direct federal agencies "to develop information resources management procedures for reviewing and substantiating (by documentation or other means selected by the agency) the quality (including the objectivity, utility, and integrity) of information before it is disseminated."[68] The guidelines define "'quality' as the encompassing term, of which 'utility,' 'objectivity,' and 'integrity' are the constituents."[69] If the agency disseminates information from research that it has initiated or sponsored, the information must adhere to the agency's information quality guidelines.[70] OMB has weighed in with opinions on the quality and reliability of scientific information. For instance, OMB guidelines state that in general, scientific and research information that has "been subjected to formal, independent, external peer review" is regarded as presumptively objective.[71] The review process utilized by scientific journals is an example of a formal, independent, external peer review; however, the guidelines specifically note that "[a]lthough journal peer review is clearly valuable, there are cases where

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plaintiffs argued that by reducing prey availability the lobster fishery was "taking" monk seals (i.e. harming, harassing, or killing them) from their critical habitat. *Id.* at 1133. Part of their scientific evidence included a report by a scientist investigating the seals' diet. *Id.* Her work on fatty acids indicated that lobsters comprise a high percentage of monk seals diet. *Id.* However, the scientist emphasized that based on scientific standards, her research was preliminary and had not been peer reviewed. *Id.* at 1134.

62 *Id.* at 1134 (finding that these preliminary findings are not a basis for conclusive determination, although this standard has not been applied to other scientific information).

63 Act of Dec. 21, 2000, Pub. L. No. 106-554 app. C, § 515, 114 Stat. 2763A, 2763A-153 to 2763A-154.

64 *See generally* Rick Weiss, *'Data Quality' Law is Nemesis Of Regulation*, WASH. POST, Aug. 16, 2004 (discussing the reprieve from regulation of atrazine gained under the Data Quality Act).

65 MOONEY, *supra* note 40, at 103.

66 *The Data Quality Act: A Revolution in the Role of Science in Policy Making or a Can of Worms*, WATER RES. INST. NEWS OF THE UNIV. OF N.C., May/June, 2003, at 6.

67 Weiss, *supra* note 64.

68 Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies, 67 Fed. Reg. 8452, 8453 (Feb. 22, 2002).

69 *Id.*

70 *Id.* at 8453–54.

71 *Id.* at 8454.

flawed science has been published in respected journals."[72] Consequently, the guidelines provide that the presumption of objectivity "is rebuttable based on a persuasive showing by the petitioner in a particular instance."[73] This led many to fear frivolous challenges to science and scientists themselves. A quick perusal of the list of challenges shows that many parties have already filed legal challenges to agency sponsored research for an array of reasons.[74] DQA raises many questions about who has oversight over scientific information and review. For instance, in 2003, Fjord Seafood filed a petition with the FWS and NMFS challenging the listing of Maine's wild Atlantic Salmon under the ESA.[75] Fjord claimed that federal agencies relied on a 1999 study by a U.S. Geological Survey (USGS) geneticist and withheld raw data from the public.[76] Fjord argues that this data was critical to the listing[77] and that it prevented them from undertaking their own independent review of the study.[78]

[72] *Id.* at 8454–55.

[73] *Id.* at 8459.

[74] Challenges under the Data Quality Act have been filed against several departments including the Departments of Agriculture, Commerce, Defense, Education, Energy, Health and Human Services, Interior, Labor, State, Transportation, as well as executive agencies such as the Environmental Protection Agency (EPA). OMB Watch, *Docket of Data Quality Petitions*, http://www.ombwatch.org/article/articleview/2668/1/231?TopicID=7 (last visited Nov. 18, 2007). Issues have ranged from the science behind the listing and protection of Endangered Species to data used to determine risks to human health. In 2003, Public Employees for Environmental Responsibility (PEER) filed a DQA challenge against the U.S. Army Corps of Engineers arguing that the proprietary scientific models being used in feasibility studies concerning navigation—and thus having environmental impacts—of the upper Mississippi River must be considered inaccurate and biased because they had not undergone peer review. OMB Watch, *Another Lawsuit Filed Under the Data Quality Act*, http://www.ombwatch.org/article/articleview/1979/1/252?TopicID=1 (last visited Nov. 18, 2007). In another challenge dating back to May 2004, the U.S. Chamber of Commerce has argued the variation in information across sixteen DPA databases on the characteristics of chemicals should be resolved because use of the varying information may lead to unreliable predications or estimations of human health risk impacts. Letter from William L. Kovacs, Vice President for Env't, Tech. & Regulatory Affairs, U.S. Chamber of Commerce, to Info. Quality Guidelines Staff, U.S. EPA (May 26, 2004), *available at* http://www.epa.gov/quality/informationguidelines/documents/04019.pdf. The EPA rejected the U.S. Chamber of Commerce's DQA challenge and appeal of supposed inconsistencies across several EPA databases. Letter from Kimberly T. Nelson, Assistant Admin. and Chief Info. Officer, U.S. EPA, to William L. Kovacs, U.S. Chamber of Commerce (Jan. 12, 2005), *available at* http://www.epa.gov/quality/informationguidelines/documents/04019-response.pdf. The EPA did however agree to make several small changes. *Id.*; *see also* OMB Watch, *EPA Holds off Industry Attack on Health, Safety and Environmental Data*, *available at* http://www.ombwatch.org/article/articleview/3904/1/231?Top:ID=1 (discussing the U.S. Chamber of Commerce's challenge). However, the recent dismissal of the Salt Institute's challenge under the Data Quality Act for the correction of underlying data on a scientific study by the National Heart, Lung, and Blood Institute on the effects of sodium on blood pressure was likely more heartening to independent researchers and institutions fearing frivolous challenges to sound science. Salt Inst. v. Leavitt, 440 F.3d 156, 157 (4th Cir. 2006). The Fourth Circuit affirmed the district court's dismissal of the suit, finding that the Act did not create a legal right to correct information and consequently the plaintiffs lacked standing. *Id.* at 159.

[75] Aaron Porter, *Fjord Challenges Federal Salmon Genetics Data*, http://www.thecre.com/abstracts-reviews/20030428_fws.html (last visited Nov. 18, 2007).

[76] *Id.*

[77] *Id.*

[78] Several environmental groups filed oppositions to this petition making it the first time

V. CONCLUSIONS AND RECOMMENDATIONS

Clearly, it is not sufficient to throw scientists, lawyers, and policy makers into the mix and see which standard wins out. This is a poor way to conserve species and manage our environment, yet it is precisely what we do most of the time. Guidance and practical training for those who work at the cusp of environmental science and policy would go far to resolving these disputes.

A scientist views science as a way of learning. A policy maker or lawyer may see science as the justification for a decision, a requirement of the law, a tool or impediment, or something that opposes or supports their viewpoint.[79] On the other hand, a courtroom lawyer may demand that scientific statements be held to standards that are more consistent with courtroom practices than academic ones. Regardless of profession, when anyone enters into the messy realm of science, law, and policy they will, at some point, address topics and make judgments beyond their expertise. While we may all strive to minimize our forays into the territories of other professionals, it is naïve to imagine that we can totally avoid them. A scientist who has spent thirty years studying the trends in a population of birds or whales will have a valid professional opinion on when that population is at risk of extinction. They are more likely to see this as a science question and are not likely to hand the decision readily to a lawyer who may never have set foot in the field.

Instead of asking for integration of science, policy, and law while still maintaining the separation of each discipline, perhaps it is time to look at what a multi-disciplinary profession might offer. Rather than patching the cracks and bridging the gaps, we would be better served to consider a discipline that includes the essential elements of science, law, and policy that will provide the skills we need today and enable us to make better decisions for our planet. Such a new discipline is more likely to result in better integration and also more effective use of science and law. It is also more likely to reduce abuses of science in the legal or political arena.[80]

How might we approach this? The following list offers a few suggestions.

1. The most obvious approach is to advance a discipline of professionals who have rigorous training in science, policy, and law.[81] These professionals would be trained to know the scientific and legal history of an issue and to understand and be able to navigate differences between scientific and legal burdens of proof.

that the DQA had been formally opposed by third parties. *Id.*

79 *Cf.* Ruhl, *Reconstructing the Wall of Virtue*, *supra* note 51 (discussing scenarios where scientists present data in a way to achieve their predetermined objectives over competing policy objectives).

80 *See* Guston, *supra* note 5, at 399 ("[T]he blurring of boundaries between science and politics . . . can lead to more productive policy making.").

81 This does not mean a graduate in science who has taken a policy class.

2. Immersion Courses. There are courses available to scientists, lawyers, and policy makers by academic institutions and in training centers.[82] These efforts are commendable and greatly improve knowledge of the science-policy interface. However, these courses often fail to bring many disciplines together and rarely provide the sufficient levels of immersion necessary. Ideally courses would bring together scientists, lawyers, and policymakers and fully immerse them in the training and practicalities needed in today's world.

3. Requirement of Standards. Today, policy courses are seen as elective rather than requirements for most conservation scientists. Science students, especially graduate students who are judged on their academic performance alone, often ignore policy courses completely even if they plan on a career in conservation biology. However, any scientists hoping to enter the field of conservation and policy should at least be aware of the existence and the basic tenets of the main environmental laws, as well as have an understanding of how policy and legal standards operate.

4. Additional gatherings, such as the law, science, and environment forum, where participants move beyond identifying challenges and begin to define what elements would constitute such a discipline.

5. Opportunities to publish and present findings in a scholarly forum that will reach a multi-disciplinary audience.

It is no longer useful to argue over who can use the "jeopardy" word. Far more useful is to have people who can understand the scientific, legal, and policy ingredients that go into the definitions and decisions. This can only be done by rigorously training professionals and making that training a job requirement.

Integrating science and law is a multi-disciplinary venture. No single view point or discipline has all the answers. As we move forward, I encourage and challenge others to offer their opinions on what would constitute such a discipline: What elements should be included? Do the social sciences have a role and, if so, what is it? What training should be given to students and professionals? My hope is that the Law, Science, and the Environment Forum and any follow up will spark more discussion on how we might move forward in a more innovative way that meets the needs of today's society.

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[82] Lawyers attend CLE (Continuing Legal Education) classes, biologists do their own classes or go to centers like the National Center for Ecological Analysis and Synthesis (NCEAS), places such as the U.C. Santa Barbara Bren School offers science-policy courses, decision makers frequent courses at the FWS' National Training Center or Lewis and Clark Law School. The American Association for the Advancement of Science (AAAS) science and policy fellowships or Aldo Leopold fellowships for scientists come closest to immersion efforts. *See* Ruhl, *Reconstructing the Wall of Virtue*, *supra* note 51, at 1080–82 (listing additional courses and venues).