THE LIZARD, THE SCIENTIST, & THE LAWMAKER: AN ANALYSIS OF THE TRENDING FIGHT OVER THE USE OF SCIENCE UNDER THE ENDANGERED SPECIES ACT AND HOW TO ADDRESS IT

By
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Recently in Texas, the dunes sagebrush lizard—a tiny, little-known reptile living in the sparse brush and dunes of the oil and gas fields—sparked a heated discussion and criticism over the listing process under the Endangered Species Act (ESA). This six-year battle ended with the withdrawal of a proposed rule to list the lizard and resulted in numerous criticisms about the role and use of scientific data throughout the process. Under the ESA, the United States Fish & Wildlife Service (FWS) is required to consider the best available scientific data when deciding whether to list a species. However, there is no direct legislative history explaining this standard. Because existing scientific data on "stressors" in the environment is typically limited and inadequate, this data gap leads to uncertainty, which unquestionably leads to difficult decision making by the regulatory agencies. Although a review of past listing designations confirms that FWS is not only utilizing sound science, but more often than not, is making sound decisions based on that science, many policy makers are still criticizing the use of science in decision-making processes and are pitting science against economics. This Article advocates for a more systematic, transparent application of science in the decision-making process: a well-defined "weight of evidence" approach that will foster structured deliberations, hypothesis testing, and the necessary clarity and transparency that will benefit all parties involved.

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I. INTRODUCTION

For many years, the scientific community operated without a defined and transparent process for integrating qualitatively different types of data when reaching conclusions or answers to a specific hypothesis or phenomenon.[1] Regulatory agencies and various scientific disciplines have since adopted methods for developing, compiling, and analyzing scientific data when determining risk to the environment and human health. Some agencies assessing ecological risk have loosely used a "weight of evidence" (WoE) approach. Recently, the Environmental Protection Agency (EPA) has used a WoE approach in screening various contaminants, including endocrine disrupting chemicals (EDCs)—that is, those having the potential to interact with estrogen, androgen, and thyroid hormones.[2] Although EDCs are ubiquitous and cause a vast array of nondescript symptoms, the EPA's intention in creating a guidance document that utilizes a WoE approach was "to provide a transparent scientific approach for broadly evaluating . . . data . . . ."[3] The purpose of this analytical structure was

[1] Igor Linkov et al., *Weight-of-Evidence Evaluation in Environmental Assessment: Review of Qualitative and Quantitative Approaches*, 407 Sci. Total Env. 5199, 5199 (2009).

[2] Christopher J. Borgert et al., *Hypothesis-Driven Weight of Evidence Framework for Evaluating Data within the US EPA's Endocrine Disruptor Screening Program*, 61 Reg. Toxicology & Pharmacology 185, 185 (2011).

[3] *Id.* (internal quotations omitted).

to provide a clear statement of how the agency intended to evaluate the data so its methodology would be transparent to all stakeholders.[4]

The process of synthesizing heterogeneous information occurs just as often in the scientific world.[5] Scientists utilize data quality assessment, peer review, and scientific literature review to form conclusions and formulate decisions used to advise regulatory agencies.[6] Although there is a structure in place, this process of synthesizing information still requires judgment in light of complex problems that often pit environmental health against economic development.[7]

The United States (U.S.) Fish & Wildlife Service (FWS) regularly encounters this complexity when it makes decisions regarding wildlife and habitat designations, often with incomplete data and competing interests. Under the Endangered Species Act (ESA), FWS's decision to list a species must be based solely on "the best scientific and commercial data available."[8] In making this determination, the agency must base its decision on any of the following factors: (1) "the present or threatened destruction, modification, or curtailment of its habitat or range";[9] (2) "overutilization for commercial, recreational, scientific, or educational purposes";[10] (3) "disease or predation";[11] (4) "the inadequacy of existing regulatory mechanisms";[12] or (5) "other natural or manmade factors affecting its continued existence."[13] These five factors were recently put through the proverbial gauntlet when FWS proposed a rule to list the dunes sagebrush lizard (DSL) as endangered.[14] Lawmakers, policy makers, and private stakeholders were successful not only in delaying the process, but also in achieving the eventual withdrawal of the proposed rule by FWS.[15] The fight largely hinged upon the adequacy and interpretation of the scientific data in determining the risk posed by particular stressors (e.g., habitat destruction/modification, chemical exposures).[16]

Determining the status of a species such as the DSL is closely aligned with ecological risk assessment measures. Much like jurors or judges weighing the evidence to decide the fate of a defendant in court,

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[4] *Id.*

[5] Linkov et al., *supra* n. 1, at 5199.

[6] *Id.*

[7] *Id.*

[8] 16 U.S.C. § 1533(b)(1)(A) (2012).

[9] *Id*. at § 1533(a)(1)(A).

[10] *Id*. at § 1533(a)(1)(B).

[11] *Id*. at § 1533(a)(1)(C).

[12] *Id*. at § 1533(a)(1)(D).

[13] *Id*. at § 1533(a)(1)(E).

[14] Endangered Status for Dunes Sagebrush Lizard, 75 Fed. Reg. 77801, 77804 (proposed Dec. 14, 2010).

[15] Withdrawal of the Proposed Rule to List Dunes Sagebrush Lizard, 77 Fed. Reg. 36872, 36872 (June 19, 2012).

[16] Taylor Kilroy, *"Reptile Dysfunction": How Can a Three-Inch Lizard Threaten to Shut Down the Oil and Gas Industry in the Permian Basin?*, 7 Envtl. & Energy L. & Policy J. 87, 91 (2012).

scientists, in conjunction with regulatory agencies, must make determinations of risk or probabilities of future risk. In employing ecological risk assessment measures, scientists recognize that both consistency and transparency in analytical methods used in decision making are important in strengthening conclusions about risk and resulting decisions.[17] This recognition has resulted in a call for using new approaches in analyzing lines of evidence, both qualitatively and quantitatively.[18] Regulatory agencies also face pressure from state officials who are unhappy with the scientific review process, arguing that the science needed to support the designation is lacking.[19]

Essentially, all parties seem to be calling for additional measures to ensure that the scientific data is analyzed with clarity, consistency, and transparency. This Article proposes analyzing the data with a formalized weighted approach that is consistent with using the best scientific and commercial evidence available to assess endangered or threatened species habitat designations under the ESA. Utilizing a modified WoE approach, it is possible to create a systematic and more transparent solution that allows regulatory agencies to carefully measure or weigh each line of evidence with some precision, regardless of the relative lack of scientific evidence. This weighing process does not attempt to change the current standard set forth in the ESA. Rather, it provides specific guidance as to how to weigh the evidence available to decision makers who must make determinations about the status of a species and its habitat.

Therefore, this Article will review the recent decision by FWS not to list the DSL as endangered, and will use this example as a platform for discussing different perceptions of science and the continual need for clarification and communication of these concepts to the public. Further, this Article will analyze past decisions based on the best scientific and commercial evidence available. Finally, this Article will propose a methodology based on the WoE standard that will allow for a more consistent and transparent analysis of scientific data in determining the status of species.

II. THE DUNES SAGEBRUSH LIZARD

The dunes sagebrush lizard (DSL) (*Sceloporus arenicolus*) has arguably been one of the most controversial species involved in the recent battles over listing species under the Endangered Species Act (ESA).[20] This little lizard, native to the High Plains of New Mexico and Texas, has been of particular conservation concern because it is ex-

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[17] Linkov et al., *supra* n. 1, at 5200.

[18] *Id.*

[19] Melissa Gaskill, Nature, *Lizard's Future Hinges on Voluntary Measures*, http://www.nature.com/news/lizard-s-future-hinges-on-voluntary-measures-1.10860 [http://perma.cc/Y5KZ-5KQD] (June 21, 2012) (accessed Apr. 12, 2014).

[20] Laura Peterson et al., *Natural Resource "Conflicts" in the U.S. Southwest: A Story of Hype over Substance*, 12 Sust. Dev. L. & Policy 32, 33 (2011).

tremely particular about its habitat in the Permian Basin, which also happens to be in the same area where approximately one million barrels of oil and nearly four billion cubic feet of natural gas are produced each day.[21] The habitat of the DSL occupies approximately 749,000 acres, or less than 2% of the 39.6 million acre Permian Basin. Why the concern? From the perspective of the state of Texas, it is because the lizards' distribution is juxtaposed with one of the largest oil and gas production areas in Texas.[22] However, from a conservation perspective, it is because these lizards do not have a home outside of this relatively small area of fragmented, sand dune structures.[23]

In other words, these little creatures are "habitat specialists" because they can thrive only within a narrow range of conditions that exist within the shinnery oak dunes.[24] This particularized habitat has an interesting dynamic because the cover and occurrence of two- to three-foot tall shinnery oak trees stabilizes the fragmented sand dune fields. However, these trees are interspersed with developing oil and gas wells and access roads that are carved out for purposes of accessing the sites.[25] Without the small shrub-like trees providing stability, the dune fields would essentially flatten, vastly changing the landscape.[26] The undisturbed regions of the landscape are a spatially dynamic system where flat areas called shinnery oak flats separate the large dune systems.[27] Within the system, the lizards reside in deep, wind-hollowed depressions in the sand called blowouts.[28] The lizards choose the blowout sites because of a predominance of medium-sized sand grains, as opposed to finer sands. The U.S. Fish & Wildlife Service (FWS) believes that the finer sand grains interfere with the lizards' ability to breathe when burying themselves, for example, to avoid

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[21] U. of Tex. Permian Basin, Ctr. for Energy & Econ. Diversification, *Permian Basin Statistics*, http://www.utpb.edu/ceed/energy-resources/petroleum-library/permian-basin-statistics [http://perma.cc/SLV3-LXS9] (2012) (accessed Apr. 12, 2014). The Permian Basin is the name given both to a 250-mile wide, 300-mile long buried petroleum-rich geological feature under portions of west Texas and eastern New Mexico, and the surface area above the petroleum deposits. Charles D. Vertrees, *The Handbook of Texas Online, Permian Basin*, https://www.tshaonline.org/handbook/online/articles/ryp02 [http://perma.cc/3S6H-VRT6] (June 15, 2010) (accessed Apr. 12, 2014).

[22] *See* Vertrees, *Permian Basin*, *supra* n. 21 ("[The Permian Basin is] the largest inland petrochemical complex in the United States."); Independent Petroleum Assn. of America, *Declaration of Independents: America's Oil & Gas Producers, The Imperishable Permian Basin*, http://oilindependents.org/the-imperishable-permian-basin [http://perma.cc/YR39-WZTC] (accessed Apr. 12, 2014) ("The Permian accounts for about two-thirds of crude oil production in Texas and nearly 15 percent of that of the entire U.S.").

[23] 75 Fed. Reg. at 77803.

[24] *Id.*

[25] *Id.* at 77803–06.

[26] *Id.* at 77803.

[27] U.S. Fish & Wildlife Serv., *Species Profile for the Dunes Sagebrush Lizard (*Sceloporus arenicolus*)*, http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=C03J [http://perma.cc/5EVQ-HXCT] (updated Feb. 22, 2014) (accessed Apr. 12, 2014) [hereinafter *Dunes Sagebrush Lizard Profile*].

[28] 77 Fed. Reg. at 36873.

predators or to thermoregulate.[29] It is feasible to also find the lizards in the shinnery oak flats that are adjacent to the dunes, as female lizards use these areas to find nesting sites.[30]

The greatest threat to the lizard is the loss of this specialized habitat, due to a variety of factors, including activities associated with oil and gas development and herbicide use on the shinnery oak for range improvements.[31] Because of these concerns, in 2010, FWS proposed listing the lizard, outlining scientific evidence supporting "immediate and significant threats due to oil and gas activities, and herbicide treatments" throughout its range.[32] This proposal set off an interesting chain of events with an all-out "Texas style" showdown, pitting economic interests against what some referred to as "inadequate science."[33]

A. The Chronology of Events

Scientific literature first described the presence of the DSL in eastern New Mexico and western Texas in 1960, and officially recognized the DSL as a species in 1992.[34] It was not until 2002, when the Center for Biological Diversity petitioned FWS to list the species as endangered, followed by a lawsuit in 2004, that this lizard started getting increased attention from both scientists and policy makers.[35] Following the district court's ruling, FWS found that the listing of the lizard was warranted but not crucial enough to be prioritized.[36]

Eight years later, in 2010, FWS proposed a new rule for listing the lizard.[37] FWS was very clear that the primary purpose of its review was to determine whether or not to list the lizard as endangered, and not a decision on whether to designate its home as critical habitat.[38] The proposed rule referred to a relatively new population survey conducted in 2008, which indicated that lizards were absent from 20% of

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[29] *Id.*

[30] *Dunes Sagebrush Lizard Profile*, *supra* n. 27.

[31] 77 Fed. Reg. at 36887–88.

[32] 75 Fed. Reg. at 77813.

[33] *See e.g.* Susan Combs, *Interagency Task Force on Economic Growth and Endangered Species Update 2013*, at 1, 7, 22 (Texas Comptroller of Public Accounts, Jan. 2013) (available at http://texasahead.org/texasfirst/esa/downloads/96-1735%20EndangeSpecies_011113.pdf [http://perma.cc/46HJ-BWUS] (accessed Apr. 12, 2014)) (using the DSL as a case study arguing that "[u]nfounded burdensome regulations from the federal Endangered Species Act (ESA) . . . can sometimes proceed with grossly inadequate research").

[34] *Id.* at 77802.

[35] 77 Fed. Reg. at 36872; 12-Month Findings on Resubmitted Petitions to List the Southern Idaho Ground Squirrel, Sand Dune Lizard, and Tahoe Yellow Cress, 69 Fed. Reg. 77167, 77168–73 (Dec. 27, 2004).

[36] 69 Fed. Reg. at 77167.

[37] 75 Fed. Reg. at 77801.

[38] Press Release, U.S. Fish & Wildlife Serv., *Fish and Wildlife Service Proposes Endangered Status for Dunes Sagebrush Lizard* (Dec. 13, 2010) (available at http://www.fws.gov/southwest/es/Documents/NRDunessagebrushlizardlistingFinal12-13-10.pdf [http://perma.cc/T4JL-JX5Z] (accessed Apr. 12, 2014)).

fifty-four sand dune sites that the agency initially surveyed in 1997.[39] Additional surveys in 2010 supported this proposition, showing that 24% of the historic sites that FWS surveyed in 1997 no longer had lizards.[40] FWS voiced additional concern over the spraying of tebuthiuron[41] and the removal of shinnery oak habitat on some of the sites.[42]

FWS submitted this study and other scientific findings through an external peer review process, which began in December of 2010.[43] Meanwhile, in Texas, legislative action affected how the state handles endangered species issues. In 2011, soon after the proposed rule for the DSL was published in the Federal Register and late into a special session, state Representative Warren Chisum added an amendment into a "fiscal matters" bill that put the Texas state comptroller (the state's chief financial officer) in charge of endangered species in Texas instead of the Texas Parks and Wildlife Department.[44] Since this was not an independent bill, there was no hearing on the rationale behind the move,[45] although Chisum later commented that the oil and gas association pushed his amendment.[46] "'There was a group of us, the people from [the Texas Oil & Gas Association (TXOGA)], and we said we need to get this done,' Chisum told The Texas Tribune. 'That's how it got started. Of course, we brought the comptroller in.'"[47]

On November 30, 2011, Senators John Cornyn (R-Texas) and James M. Inhofe (R-Oklahoma, and Ranking Member of the Committee on Environment and Public Works) wrote a letter to the Secretary of the Interior, asking him to delay a final listing decision for six months due to a "significant level of dispute" between New Mexico State University's and Texas Tech University's scientific data relating to the biological health of the species.[48]

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[39] 75 Fed. Reg. at 77804. Only fifty-four of the seventy-two historic sites were surveyed in 2008 due to poor weather conditions or access issues. Dunes sagebrush lizards were absent from eleven of the fifty-four sites surveyed. *Id.*

[40] *Id.* Lizards were absent from seventeen of the seventy-two historic sites surveyed in 1997. *Id.*

[41] Tebuthiuron is an herbicide used to remove shinnery oak for rangeland purposes. *Id.* at 77804, 77809.

[42] *Id.* at 77804.

[43] U.S. Fish & Wildlife Serv., *Proposed Rule to List the Dunes Sagebrush Lizard (*Sceloporus arenicolus*) As Endangered throughout Its Range* (Feb. 14, 2011) (available at http://www.fws.gov/southwest/science/pdfs/dslpeerreviewplan2.14.2011.pdf [http://perma.cc/R4HE-MQ5Y] (accessed Apr. 12, 2014)) [hereinafter *Proposed Rule to List DSL*].

[44] David Barer, State Impact Texas, *Comptroller's Endangered Species Duties Could Go to Wildlife Department*, http://stateimpact.npr.org/texas/2013/05/01/comptrollers-endangered-species-duties-could-go-to-wildlife-department [http://perma.cc/5VMW-UQB7] (May 1, 2013) (accessed Apr. 12, 2014).

[45] *Id.*

[46] Jay Root, Texas Tribune, *Oil Lobbyists Oversee Protection of Threatened Lizard*, http://www.texastribune.org/2013/04/24/oil-lobbyists-oversee-threatened-lizard-protection [http://perma.cc/3GY5-J24G] (Apr. 24, 2013) (accessed Apr. 12, 2014).

[47] *Id*.

[48] Ltr. from U.S. Sen. John Cornyn & U.S. Sen. James M. Inhofe, Ranking Member, Comm. on Env. & Pub. Works, to the Hon. Ken Salazar, Sec. of the Int., *Proposed List-*

In December of 2011, FWS announced a six-month extension for the DSL listing decision and reopened the comment period.[49] The agency based its decision on "substantial disagreement regarding the sufficiency or accuracy of the available data relevant to the proposed listing rule, making it necessary to solicit additional information by reopening the comment period for 45 days."[50] During this time period, the comptroller's office assisted in developing a draft Texas Conservation Plan (TCP), which includes a Candidate Conservation Agreement with Assurances.[51] The purpose of the voluntary agreement was to allow participants (e.g., oil and gas interests, ranchers, private landowners) "to enroll their property in the plan and through a recovery award program offset any disturbance to the species."[52]

Six months later, in June 2012, FWS announced the following:

> *As a result of unprecedented commitments to voluntary conservation agreements* now in place in New Mexico and Texas that provide for the long-term conservation of the dunes sagebrush lizard, the U.S. Fish and Wildlife Service has determined that the species does not need to be listed under the Endangered Species Act.[53]

Opponents of the decision not to list the DSL charge that the Obama Administration, anxious to avoid threats from both Congress and the oil industry during an election year, made a politically motivated decision.[54] Further, their criticisms extended to voluntary conservation agreements: "The difference between the ESA and voluntary conservation is the difference between a very good chance of recovery and a roll

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ing of the Dunes Sagebrush Lizard 1 (Nov. 30, 2011) (available at http://www.cornyn.senate.gov/public/index.cfm?p=NewsReleases&ContentRecord_id=13d0c8bc-932e-42d9-8887-34ab5dbc2681 [http://perma.cc/XYC8-NLEV] (accessed Apr. 12, 2014)). Specifically, the letter cited to the August 10, 2011 peer review by New Mexico State University, which noted that among other conclusions: (1) The statement of a 40% loss of lizard habitat was not scientifically defensible due to the methodology; and (2) specific habitat requirements for the DSL had not been quantified in the published scientific literature or agency reports. *Id.* The letter also cited to an October 21, 2011 review by Texas Tech University scientists, including among other items, that the lizard population research conducted in 2007 and 2009 demonstrates that the DSL was not showing characteristics of an endangered species. *Id.* at 2.

[49] 6-Month Extension of Final Determination for the Proposed Listing of the Dunes Sagebrush Lizard As Endangered, 76 Fed. Reg. 75858, 75858 (Dec. 5, 2011).

[50] *Id.*

[51] *Texas Conservation Plan for the Dunes Sagebrush Lizard (*Sceloporus arenicolus*)* 1, 4 (Sept. 27, 2011) (available at http://www.fws.gov/southwest/es/documents/r2es/tx_cons_plan_dsl_20110927.pdf [http://perma.cc/V74K-N4S4] (accessed Apr. 12, 2014)).

[52] Tex. A&M U., Inst. of Renewable Nat. Resources, *Implementing the Texas Conservation Plan for the Dunes Sagebrush Lizard* (available at http://irnr.tamu.edu/media/392711/dsl.pdf [http://perma.cc/ZRM6-8NHV] (accessed Apr. 12, 2014)).

[53] Press Release, U.S. Dept. of the Int., *Landmark Conservation Agreements Keep Dunes Sagebrush Lizard off the Endangered Species List in NM, TX* (June 13, 2012) (available at http://www.fws.gov/southwest/es/DSL.html [http://perma.cc/LAE2-FJRU] (accessed Apr. 12, 2014)) (emphasis added) [hereinafter *Conservation Agreements Press Release*].

[54] Gaskill, *supra* n. 19.

of the dice."[55] The Texas comptroller contracted with Texas A&M University to craft the TCP, but efforts stalled when A&M needed additional help contacting landowners and oil companies.[56] TXOGA then approached the comptroller about temporarily setting up a nonprofit foundation to implement and manage the TCP.[57] Formed in February 2012, the Texas Habitat Conservation Foundation consisted of three registered TXOGA lobbyists, who functioned as board members and hired a wildlife biologist to oversee operations.[58] The reassignment of endangered species issues to the comptroller's control, and TXOGA's key role in creating and managing the TCP, have not, however, been universally hailed. Texas State Senator Kel Seliger (R-SD 31, which includes the Permian Basin) voices concern that TXOGA will use the TCP to set mitigation costs at levels which benefit large petroleum companies, while raising competitive barriers to smaller, independent oil companies.[59]

Currently, the Texas Habitat Conservation Foundation's board is in transition. The new board will consist of a biochemist, a representative from Texas Agricultural Land Trust, and Warren Chisum—who as a state representative was responsible for transferring Texas state endangered species responsibility to the comptroller, and is now an oil and gas lobbyist.[60] State Senator Seliger recently introduced legislation that seeks to return endangered species oversight power to the Texas Parks and Wildlife Department, create an interdepartmental State Endangered Species Response Committee, and create a fund for endangered species research.[61]

New Mexico had already instituted the types of conservation measures Texas was now pushing. As early as 1995, New Mexico afforded the DSL protection from takings, not habitat destruction, under the state's Wildlife Conservation Act. In 2008, the state implemented voluntary conservation agreements with private landowners.[62] As of 2010, six private landowners and four oil companies were enrolled in the agreement.[63]

Despite the existence of these conservation measures, on November 22, 2011, Representative Steve Pearce (R-NM), as part of a biparti-

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[55] *Id.* (quoting Taylor McKinnon, Public-Lands Campaigns Director at the Center for Biological Diversity in Flagstaff, Arizona).

[56] Root, *supra* n. 46.

[57] *Id.* TXOGA represents multiple companies including Exxon and Chevron. *Id.*

[58] *Id.*

[59] *Id.*

[60] *Id.*

[61] Barer, *supra* n. 44. Ben Shepperd, President of the Permian Basin Petroleum Association, testified in support of the bill. *Id.*

[62] 75 Fed. Reg. at 77811. New Mexico implemented both a Candidate Conservation Agreement and Candidate Conservation Agreement with Assurances, which would allow private landowners and operators such as oil and gas companies and ranchers, to participate in conservation measures while maintaining economic interests. *Id.*

[63] *Id.* The Federal Register also notes that land interests of the owners and operators total approximately 200,000 acres. *Id.*

san group—seventeen Republicans and one Democrat—wrote to Ken Salazar, Secretary of the Interior, asking FWS not to list the DSL, and in the alternative, to delay its final decision by at least six months.[64] Citing to the "growing body of evidence" and voluntary cooperative programs already in place in New Mexico, the group stated that a listing of the lizard would "kill these voluntary, cooperative programs that w[ould] save tax dollars in a time of budget cuts."[65] Further, the letter highlighted their primary concern that there was not enough available scientific information to support the premise that the species was declining.[66]

FWS has commented that "[t]he efficacy of the[se] agreements depends *on sustained future participation by all entities with controlling interests* on properties with suitable and occupied habitat for the dunes sagebrush lizard."[67] FWS knows there are hundreds of oil and gas operators in these ranges and acknowledges that "participation throughout the majority of the dunes sagebrush lizard habitat would be necessary for the conservation of the species."[68] Currently, there are no local or state regulatory mechanisms to ensure conservation; rather, the only mechanism for the preservation of the lizard is once again, through voluntary enrollment in the conservation agreements.[69]

The story here does not end with the conservation agreements or FWS's decision not to list the DSL. As of June 2013, the Center for Biological Diversity and Defenders of Wildlife have filed suit against FWS for relying on confidential voluntary habitat conservation agreements concerning the DSL.[70] These agreements were signed by property owners in Texas, but are confidential—even from the government.[71]

B. The Science & The Rhetoric

Misuse and misunderstanding of science seems to be the basis of a trending fight against listing endangered species, particularly in the case of the dunes sagebrush lizard. When FWS first proposed listing the DSL as endangered, state policy makers voiced opposition, stating that the science was lacking and, therefore, could not support such a

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64 Ltr. from Rep. Steve Pearce et al., to the Hon. Ken Salazar, Sec. of the Int., *Proposed Listing of the Dunes Sagebrush Lizard* 1 (Nov. 22, 2011) (available at http://www.nmoga.org/wp-content/uploads/2011/11/Signed-DSL-Extension-Letter-to-Salazar.pdf [http://perma.cc/Q26F-5QPZ] (accessed Apr. 12, 2014)).

65 *Id.*

66 *Id.*

67 75 Fed. Reg. at 77811 (emphasis added).

68 *Id.*

69 *Id.*

70 Compl. for Declaratory & Injunctive Relief at ¶¶ 1, 4, *Defenders of Wildlife v. Jewell*, http://esawatch.org/wp-content/uploads/2013/07/130618-Defenders-CBD-v-Ashe-Complaint-re-DunesSagebrushLizard.pdf [http://perma.cc/DV56-P64Y] (D.D.C. June 19, 2013) (No. 1:13-cv-00919) (accessed Apr. 12, 2014).

71 *Id.* at ¶¶ 44, 47–49.

designation.[72] Scientists approach this issue of scientific uncertainty with a different perspective. In the case of the DSL, Dr. Lee Fitzgerald, a prominent Texas A&M University researcher who has studied the DSL for over nineteen years, stated that "more is known about this species than many that are listed."[73] In fact, Dr. Fitzgerald received funding from Texas and the oil and gas industry to gather additional information on DSL locations, updating a 2007 survey he had conducted.[74] This population survey included twenty-eight new, undocumented lizard locations that were on private land and had been inaccessible during his initial survey.[75] Texas officials and Dr. Fitzgerald differed in their comments on the discovery of lizards in the private land locations. Dr. Fitzgerald commented: "We weren't surprised where we found or didn't find the lizard. . . . We identified suitable habitat, and if you go to those places, there's a good chance you'll find one."[76] The problem, Dr. Fitzgerald noted, is that human activity segments and causes the loss of DSL habitat.[77] Texas officials, on the other hand, lauded the discovery of lizards on private lands as an "important step in developing their conservation plans."[78] The oil and gas industry seized on the findings, "dr[iving] home the point" that the lizard was not threatened by oil and gas production in the area.[79]

However, decision making under the ESA does not rest on the opinion of one or even a few individuals. And so, in accordance with the Act, FWS called for an independent, third-party review of the DSL listing proposal, including "a discussion of the scientific information reviewed."[80] As in many other endangered species cases, the challenge in the DSL case centered on finding a consensus as to what the science showed. There is considerable variation in the interpretation of "best available science," as well as how agencies and policy makers communicate this standard to the public.[81] In fact, the Texas comptroller echoed a familiar sentiment about this standard currently held by many policy makers in Texas in her February 2013 op-ed piece in the Washington Times:

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[72] Gaskill, *supra* n. 19.

[73] *Id.* (internal quotations omitted).

[74] *Id.* (citing Nicole L. Smolensky & Lee A. Fitzgerald, *Distance Sampling Underestimates Population Densities of Dune-Dwelling Lizards*, 44 J. Herpetology 372 (2010)).

[75] *Id.* (citing Lee A. Fitzgerald et al., *Final Report: The Range and Distribution of* Sceloporus arenicolus *in Texas: Results of Surveys Conducted 8–15 June 2011* (2011) (available at http://irnr.tamu.edu/media/285120/tx_dsl_final.pdf [http://perma.cc/PT9P-CTAJ] (accessed Apr. 12, 2014))).

[76] *Id.* (internal quotations omitted).

[77] *Id.*

[78] Gaskill, *supra* n. 19.

[79] *Id.* (internal quotations omitted).

[80] *Proposed Rule to List DSL*, *supra* n. 43.

[81] *See* Kristin Carden, *Bridging the Divide: The Role of Science in Species Conservation Law*, 30 Harv. Envtl. L. Rev. 165, 234–35 (2006) (proposing a framework for applying the "best available science" by "integrat[ing] that scientific knowledge into our cultural framework, invit[ing] public participation in the planning process, and ultimately overcom[ing] public distrust of ecosystem management").

> For communities and private landowners, the Endangered Species Act can be the toughest environmental law to challenge successfully. For example, the act requires listing decisions to be based on "the best scientific and commercial data available." Not adequate or even accurate data, mind you, just "the best available"—and listing supporters often are the only ones offering any data. Thus, the burden of doing research and collecting relevant data falls on those affected by a potential listing.[82]

Therein lies the rub. Considerable disagreement exists among policy makers, agency officials, and scientists as to what scientific data falls under this standard and, more importantly, how it should be reviewed. An examination of the scientific review, economic arguments, and the resulting listing determination of the DSL illustrates this disagreement.

1. The Peer Review

In December 2010, FWS announced that, according to its joint policy with the National Marine Fisheries Service, it would seek the expert opinions of at least three independent scientists to "peer review" the science behind the DSL proposal.[83] The purpose of the review was "to ensure that [the] determination of status for this species [was] based on scientifically sound data, assumptions, and analyses."[84] Scientists from Auburn University, University of New Mexico, Duke University, Pennsylvania State University, and Texas A&M University provided reviews of the scientific literature on the DSL population during the public comment period.[85] Below is a summary of the findings of the invited reviewers:[86]

Reviewer	Affiliation	Adequate Science?	Sound Science?	Conclusion
Troy L. Best, Ph.D. Professor and Curator of Mammals[87]	Auburn University	Yes	Yes	DSL should be listed

[82] Susan Combs, *Preserving Endangered Species the Texas Way*, Wash. Times (Feb. 28, 2013) (available at http://www.washingtontimes.com/news/2013/feb/28/preserving-endangered-species-the-texas-way/ [http://perma.cc/CV62-QZ8D] (accessed Apr. 12, 2014)).

[83] 75 Fed. Reg. at 77816. The scientists are typically specialists in the area of concern. For example, a reviewing scientist in this case had expertise in lizard ecology/conservation biology. U.S. Fish & Wildlife Serv., *Dunes Sagebrush Lizard: Peer Review*, http://www.fws.gov/southwest/es/DSL.html#peerreview [http://perma.cc/Q5G-5ZGG] (updated Nov. 13, 2013) (accessed Apr. 12, 2014) [hereinafter *DSL Peer Review*].

[84] 75 Fed. Reg. at 77816.

[85] *DSL Peer Review*, *supra* n. 83.

[86] *Id.*

[87] Ltr. from Troy L. Best, Ph.D., Auburn U., to Debra Hill, U.S. Fish & Wildlife Serv., *Proposed Rule to List Dunes Sagebrush Lizard (*Sceloporus arenicolus*) As Endangered throughout Its Range* (Jan. 27, 2011) (available at http://www.fws.gov/southwest/es/Documents/R2ES/PeerReview/DSL_Listing_Review_by_Best.pdf [http://perma.cc/6BGC-XCQA] (accessed Apr. 12, 2014)) ("I believe the assumptions and

Reviewer	Affiliation	Adequate Science?	Sound Science?	Conclusion
Lauren Chan, Ph.D.[88]	Department of Biology, Duke University	No Comment	No Comment	No Comment
Toby J. Hibbitts, Ph.D. Curator of Amphibians and Reptiles[89]	Texas A&M University	Did not disagree, but specific critiques	Did not disagree, but specific critiques	No Comment
Travis R. Robbins, Ph.D.[90]	Department of Biology, Pennsylvania State University	Yes	Yes	DSL should be listed

conclusions in the proposed rule are well supported. They are based upon reasonable interpretations and representations of the information produced by excellent scientific research. In my opinion, the dunes sagebrush lizard should be listed as endangered based upon the evidence presented in the proposed rule.").

[88] Email from Lauren Chan, Ph.D., Dept. of Biology, Duke U., to Debra Hill, U.S. Fish & Wildlife Serv., *DSL* (Feb. 14, 2011, 9:03 a.m.) (available at http://www.fws.gov/southwest/es/Documents/R2ES/PeerReview/DSL_Listing_Review_by_Chan.pdf [http://perma.cc/5B4D-72RT] (accessed Apr. 12, 2014)). Dr. Chan noted in her email response that she had only one minor comment regarding the time of divergence between *S. arencolus* and *S. graciosus*. *Id.*

[89] Peer Review from Toby J. Hibbitts, Ph.D., Curator of Amphibians & Reptiles, Tex. A&M U., to U.S. Fish & Wildlife Serv., *Toby J. Hibbitts Edits to Federal Register / Vol. 75, No. 239* (2011) (available at http://www.fws.gov/southwest/es/Documents/R2ES/PeerReview/DSL_Listing_Review_by_Hibbitts.pdf [http://perma.cc/LPS3-QTBM] (accessed Apr. 12, 2014)). Dr. Hibbitts gave very specific critiques regarding some of the characterizations and the population sampling techniques in a few of the studies (e.g. timing of one population survey). *Id.* A follow-up email from FWS to Dr. Hibbitts on January 31, 2011 asked if he disagreed with the overall conclusion of listing. He responded, "Nothing says that it shouldn't be listed. Just some clarifications on some things. I think a bunch of the things I suggest would strengthen the listing package." Email from Toby Hibbitts, Ph.D., Curator of Amphibians & Reptiles, Tex. A&M U., to U.S. Fish & Wildlife Serv., *Re: Review* (Jan. 31, 2011) (copy on file with *Animal Law*).

[90] Peer Review from Travis R. Robbins, Ph.D., Dept. of Biology, Pa. St. U., to U.S. Fish & Wildlife Serv., *Re: Peer Review for the U.S. Fish and Wildlife Service's Proposed Rule to List the Dunes Sagebrush Lizard (*Sceloporus arenicolus*) As Endangered throughout Its Range* (available at http://www.fws.gov/southwest/es/Documents/R2ES/PeerReview/DSL_Listing_Review_by_Robbins.pdf [http://perma.cc/B4YJ-EU9B] (accessed Apr. 12, 2014)). In his report, Dr. Robbins stated: "The studies examining how habitat alteration affected Dunes Sagebrush Lizard densities were also based on sound scientific methodology and statistical analyses." *Id.* at 2. Additionally, he commented that "[t]hose factors regarded as threats—habitat alteration (Factor A), inadequate regulation (Factor D), and pollution (Factor E)—were supported by high quality data with minimal scientific uncertainty." *Id.* at 6.

Reviewer	Affiliation	Adequate Science?	Sound Science?	Conclusion
Howard Snell, Ph.D. Professor & Curator[91]	Department of Biology & Museum of Southwestern Biology University of New Mexico	Yes	Yes	DSL should be listed

The level of expertise among the reviewers and the consistency in their evaluations is noteworthy, as is that most of the reviewers agreed that the science warranted the proposed listing.

2. More Scientific Data & Review

While FWS solicited peer reviews and extended the public commenting period, stakeholders and policy makers in Texas and New Mexico were conducting or commissioning additional scientific studies. This work was arguably part of an admirable effort to collect additional scientific data in order to fully assess the DSL population and potential stressors. In 2011, Dr. Fitzgerald's lab conducted another Texas population distribution survey of DSL.[92]

The authors of the report noted that, historically, the DSL has a very limited range, "among the smallest of any North American lizard."[93] The researchers surveyed additional lands, and as a result, added twenty-eight localities to the contiguous habitat in Texas.[94] Additionally, the researchers put forth multiple recommendations, which included: (1) better integration of population distribution data between Texas and New Mexico; (2) additional surveys in northern Winkler and western Andrews counties if access to private lands becomes available; (3) "refinement of habitat occupancy maps as more information becomes available"; (4) selection of study sites with vary-

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[91] Ltr. from Howard L. Snell, Ph.D., Prof. & Curator, Dept. of Biology & Museum of S.W. Biology, U. of N.M., to Debra M. Hill, U.S. Fish &Wildlife Serv., *Review of the Proposed Rule to List the Dunes Sagebrush Lizard (*Sceloporus arenicolus*) As Endangered throughout Its Range* (available at http://www.fws.gov/southwest/es/Documents/R2ES/PeerReview/DSL_Listing_Review_by_Snell.pdf [http://perma.cc/T4KD-NLQW] (accessed Apr. 12, 2014)). Dr. Snell's summary was as follows: "[T]he proposed rule presents a scientifically supported conclusion that *Sceloporus arenicolus* is in danger of extinction, that a number of anthropogenic actions exacerbates the situation, and that existing regulatory mechanisms and actions have failed to reverse a pattern of declining populations. Listing this species as endangered is a necessary step that can improve the chances this species will persist." *Id.* at 2.

[92] Lee A. Fitzgerald et al., *Final Report: The Range and Distribution of* Sceloporus arenicolus *in Texas: Results of Surveys Conducted 8–15 June 2011* (2011) (available at http://irnr.tamu.edu/media/285120/tx_dsl_final.pdf [http://perma.cc/N73V-YNVK] (accessed Apr. 12, 2014)).

[93] *Id.* at 1.

[94] *Id.* at 13.

ing landscape distributions; and (5) additional surveys to test persistence of, and connectivity among, populations.[95]

During this time, Texas Tech University was also commissioned to study the effects of particular stressors on the DSL, including potential exposure to hydrogen sulfide; sand pH and sulfate content; sand grain size; and the presence of chemical residues, in particular, total petroleum hydrocarbons and tebuthiuron, in the environmental media.[96] Overall, the study "found limited evidence for risks to DSL" and stressed the need for additional sampling and "data covering a more extensive temporal and spatial scale."[97] Texas Tech University researchers were also commissioned to conduct an independent review of the current literature mentioned in FWS's proposed rule.[98] The report concluded:

> While the available data does not convincingly point to listing the DSL at this time, more information and better data could meet the criteria for listing the species in the future. Additionally, a more robust understanding of the species would facilitate and focus management efforts. Given that a primary concern regarding listing the DSL is the potential adverse economic impacts on energy and food production, a more comprehensive data set would allow fine tuning spatially-explicit management plans that could greatly reduce economic impacts.[99]

Meanwhile, in New Mexico, the Bureau of Land Management (BLM), the agency that controls 71% of the minerals within the New Mexico DSL range,[100] released its DSL survey report for the field season of 2011.[101] According to the report, the BLM captured a total of fifty-three DSLs during the survey.[102] The New Mexico BLM also ob-

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[95] *Id.* at 14–16.

[96] Christopher J. Salice & Todd A. Anderson, *Report: Summary of Research Findings Regarding Potential Risks to the Dunes Sagebrush Lizard* (unpublished rpt., Tex. Tech U. 2011) (available at http://texasahead.org/texasfirst/esa/task_force/priority/reference_docs/dsl/DSLReport_to_PBPA090111.pdf [http://perma.cc/XN4P-QYAF] (accessed Apr. 12, 2014)).

[97] *Id.* at 1.

[98] Christopher J. Salice et al., *Review of the Relevant Factors That Are the Basis for the Proposed Listing of the Dunes Sagebrush Lizard As an Endangered Species* 1–8 (unpublished rpt., Tex. Tech U. Oct. 21, 2011) (available at http://texasahead.org/texasfirst/esa/task_force/priority/reference_docs/dsl/TTUScienceReviewofDSLListingFinal_102411.pdf [http://perma.cc/6Z8Y-XPTY] (accessed Apr. 12, 2014)).

[99] *Id.* at 6.

[100] Carol Leach, *U.S. Fish & Wildlife Proposal to List the Dunes Sagebrush Lizard As an Endangered Species Threatens Energy Development in Southeast New Mexico* (newsltr., Beatty & Wozniak, P.C. Jan. 2011) (available at http://www.bwenergylaw.com/News/documents/USFishandWildlifeProposaltoListtheDunesSagebrushLizardasanEndangeredSpeciesThreatensEnergyDe.pdf [http://perma.cc/4BA-BWDN] (accessed Apr. 12, 2014)).

[101] Bureau of Land Mgt. Pecos Dist., *Dunes Sagebrush Lizard (*Sceloporus arenicolus*) Survey Report Field Season 2011* (2011) (available at http://www.blm.gov/pgdata/etc/medialib/blm/nm/field_offices/roswell/docs.Par.7953.File.dat/2011%20BLM%20DSL%20Report%20Final%20web.pdf [http://perma.cc/7JJ6-89Y5] (accessed Apr. 12, 2014)).

[102] *Id.* at 10.

served that DSLs were present in the following areas: (1) in reclaimed areas (post oil and gas production); (2) in dunes areas experiencing a high level of oil and gas development; (3) in areas outside of the Texas A&M survey area; and (4) within the boundaries of units of shinnery oak and mesquite areas that were once treated with tebuthiuron.[103]

Although there was value in the additional collection of scientific data and review, the overall effect fueled dire predictions of economic disaster and a renewed sense of scientific uncertainty in the accuracy and completeness of DSL population counts.[104] FWS was then left with the complicated task of properly weighing the new data in conjunction with the initial peer-reviewed data. The most recent information tended to overshadow the entire body of evidence.[105] The new information forced the agency to consider whether there was a change in the level of uncertainty associated with the body of evidence. Additionally, with the DSL, FWS likely faced an unprecedented amount of interest and political pressure to properly adjudicate these varying scientific opinions.

BLM's presentation of additional information raised questions regarding what the agency should consider when making determinations of whether to list a species. Should the agency consider dire predictions of economic consequences? Should the agency base its determination on new science backed by parties with economic interests? The ESA lays out a seemingly simple directive; however, review and decision making during a listing process is complex and potentially more complicated than what lawmakers likely anticipated when drafting the ESA.

C. Endangered Economy?

Congress amended the ESA in 1982 to specifically make the listing process an impartial and objective inquiry, free of any economic considerations and instead focusing on biological or scientific evidence.[106] In doing this, Congress created what is now known as the

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[103] *Id.* at 9–10.

[104] *See e.g.* Susan Combs, *Endangered Economy: A Case Study of the Dunes Sagebrush Lizard and the West Texas Oil and Gas Industry* 2–4 (Publication No. 96-1709, Tex. Comptroller of Pub. Accounts Oct. 2012) (available at http://texasahead.org/texasfirst/species/pdf/96-1709_DSL.pdf [http://perma.cc/5RTW-FB3T] (accessed Apr. 12, 2014)) (noting that "when the DSL was being considered for listing, the entire Texas economy was placed at risk," and that the DSL was not listed, due in part to "the effort of the oil and gas industry to obtain valid scientific data on the DSL").

[105] *See Conservation Agreements Press Release*, *supra* n. 53 (noting that "[n]ew information provided by the BLM and Texas A&M University has enabled the Service to refine" and identify additional DSL habitat, and that Service biologists, after "careful analysis of the scientific data," have determined that the DSL is no longer in danger of extinction).

[106] Michael J. Bean & Melanie J. Rowland, *The Evolution of National Wildlife Law* 206 (3d ed., Praeger Publishers 1997).

"strictly science" mandate, noting that "economic considerations have no relevance to determinations regarding the status of species."[107]

After the announcement of the proposed DSL rule, opponents began voicing concerns that the listing would greatly impact the economy of the Southwest.[108] In fact, the Texas comptroller, the current state guardian of endangered species, published an online study titled *Endangered Economy: A Case Study of the Dunes Sagebrush Lizard and the West Texas Oil and Gas Industry*.[109] Under the heading "Are Texas Jobs the Endangered Species?," the publication stated that the DSL listing placed the entire Texas economy at risk—despite most of the state being hundreds of miles from the Permian Basin.[110] Further, the publication estimated that $8 billion in annual investment would be lost, along with over 31,000 jobs.[111]

Proponents of the listing disagreed with this dire economic forecast. In 2011, the Center for Biological Diversity (CBD) issued a report on the impact of a potential DSL listing on oil and gas activity and the economy in Texas.[112] CBD argued that the listing would have little effect on the industry. Based on its mapping of the area, the DSL's habitat exists on less than 2% of the 39.6 million acre Permian Basin.[113] In the six west Texas counties included in this region, DSL habitat exists on 4.7% of private lands and 5% of state lands.[114] In other words, only a small fraction of the land in question supported the DSL's specialized habitat.[115] Based on CBD's analysis of Fitzgerald's 2011 location and distribution data, the report concluded that "[e]ven if drilling were to cease everywhere in lizard habitat following an endangered listing, which is not likely, fossil fuel extraction would continue unabated on 95 percent of state lands and nearly 99 percent of all lands in the analysis area."[116]

Although the ESA is quite clear in its "strictly science" mandate, the DSL issue quickly declined into an economy versus environment debate with hundreds of media outlets publishing alarming forecasts

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107 H.R. Rpt. 97-567 at 20 (May 17, 1982) (reprinted in 1982 U.S.C.C.A.N. 2807, 2820); *see also* Holly Doremus, *Listing Decisions under the Endangered Species Act: Why Better Science Isn't Always Better Policy*, 75 Wash. U. L.Q. 1029, 1051 (1997) (reviewing federal agencies' duty to limit listing evaluations to only scientific measures).

108 *See* Peterson et al., *supra* n. 20, at 33–34 (explaining opponents' economics-based arguments against listing of the DSL).

109 Combs, *supra* n. 104.

110 *Id.* at 2.

111 *Id.*

112 Jay C. Lininger et al., *Impact of Dunes Sagebrush Lizard Protection on Oil and Gas Activity in West Texas* (Ctr. for Biological Diversity Dec. 2011) (available at http://www.biologicaldiversity.org/species/reptiles/dunes_sagebrush_lizard/pdfs/Texas_DSL_habitat_report.pdf [http://perma.cc/3JGC-84JH] (accessed Apr. 12, 2014)).

113 *Id.* at 3.

114 *Id.* at 4.

115 *See id.* at 4–6 (noting that while the habitat considered was overinclusive,"[t]he limited area of dunes sagebrush lizard habitat makes ESA regulation unlikely to affect more than a small portion of oil and gas activity in west Texas").

116 *Id*. at 6.

to the public.[117] Somehow, the law and the science got lost, or at the very least muddled, as the media presented articles to the public that captured the hype, but not the substance of the issue. This example is indicative of future public debates in which the issue will likely be framed as economy versus environment. Moving beyond this political argument, the fundamental disagreement still lies in the parties' interpretation of the scientific basis for the listing decision. Although much of the disagreement can be attributed to the economic argument, misconception about the science underlying the decision presents the biggest hurdle.

III. DIFFERING INTERPRETATIONS OF SCIENCE

Often, federal agencies cannot wait for consistent scientific conclusions or scientific certainty before making decisions. This urgency creates the tension between law and science. Science is fundamentally different from the law. In the legal field, there is always an endpoint or finale associated with a court's action.[118] In contrast, scientists are not expected to come up with a definitive answer within a particular time frame.[119] The scientific process is focused on an incremental truth-seeking process rather than an end result.[120] In other words, science is cumulative and progressive, continuously building on past experiments and results.[121]

The fundamental part of this progressive process is the formulation of a question.[122] In addressing a question, scientists develop a hypothesis or a prediction about the outcome of what they expect to observe.[123] Observations and data generated from an experiment are tested against the hypothesis, either proving or disproving the hypothesis.[124] This process leads the scientific community to test and retest the hypothesis, challenging the "soundness" of the scientific theory.[125] This quest represents the ongoing search for failure of the hypothe-

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117 *See* Peterson et al., *supra* n. 20, at 32, 34 (describing how the oil and gas industry inundated local media with claims that environmentalists were determined to shut down the industry); *but see* Lininger et al., *supra* n. 112, at 1–2 (concluding that DSL listing would likely have little real effect on economic activity).

118 Victoria Sutton, *Law and Science: Cases and Materials* 35 (Carolina Academic Press 2001) (excerpting D. Allan Bromley, Keynote Address, *1998 Annual Meeting of the American Bar Association* (Toronto, Can. Aug. 2, 1998)).

119 *Id.* at 35–36.

120 *Id.* at 36.

121 *Id.*

122 *See id.* (describing the goal of science as seeking "truth," and therefore, when faced with a question, "scientists make observations or measurements, and on that basis develop an hypothesis that explains what they observe").

123 *Id.*

124 Sutton, *supra* n. 118, at 26.

125 Kenneth R. Foster & Peter W. Huber, *Judging Science: Scientific Knowledge and the Federal Courts* 138 (1st paperback ed., MIT Press 1999).

sis.[126] What gradually emerges from unsuccessful attempts is reliability and validity of the science, all of which takes time.[127]

A. Decision Science

What is science? A scientist would likely answer that "science is a process, a way of examining the natural world and discovering important truths about it."[128] The Supreme Court has acknowledged the concept that science is "a *process* for proposing and refining theoretical explanations about the world that are subject to further testing and refinement."[129] The scientific method best illustrates this process.[130] While the scientific method is not easily explained, various views of scientists and philosophers have shaped its definition.[131] While the scientific method emphasizes replication through careful experimental design and execution to both test hypotheses and assess causality, many regulatory agencies must make decisions based on methods that favor expediency.[132]

Taking a scientific approach to prioritizing management strategies is known as "decision science" and is distinct from the "scientific method."[133] Regulatory agencies employ both processes as they ask scientists to not only collect and analyze data, but also to assist agencies and stakeholders in developing and implementing conservation plans.[134] The process of decision science emphasizes correlative responses (whether B is positively responding to A), as opposed to a hypothesis driven cause-and-effect approach as observed through the

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[126] *Id.* (explaining that this process is also known as "falsification" in Karl Popper's philosophy of science).

[127] *Id.* at 138–39. Popper, in essence, provided a checklist, outlining how scientists evaluate other scientists' theories for reliability and validity by: (1) comparing various conclusions deducted from a theory against each other to check for internal consistency; (2) investigating the logical form of a theory to determine whether it is "tautological" or has the character of a scientific theory; (3) comparing the theory against others to determine whether it would constitute a scientific advancement should it survive the test; and (4) empirically applying the conclusions derived from the theory. *Id.*

[128] David Goodstein, *How Science Works*, in *Reference Manual on Scientific Evidence* 67, 69 (2d ed., Fed. Jud. Ctr. 2000) (available at http://www.fjc.gov/public/pdf.nsf/lookup/sciman0d.pdf/$file/sciman0d.pdf [http://perma.cc/3ZM5-SRUP] (accessed Apr. 12, 2014)).

[129] *Daubert v. Merrell Dow Pharms., Inc.*, 509 U.S. 579, 590 (1993) (quoting the Amici Curiae Br. of the Am. Assn. for the Advancement of Sci. et al.) (emphasis in original, internal quotations omitted).

[130] Goodstein, *supra* n. 128, at 69.

[131] *Id.* at 70. Sir Francis Bacon believed "that science proceeds through the collection of observations without prejudice," while Karl Popper, as a "skeptical theorist," understood the scientific method to be a process, known as falsification, by which a good scientist would come up with a hypothesis, then proceed to attack or disprove it. *Id.*

[132] Mark W. Schwartz et al., *Perspectives on the Open Standards for the Practice of Conservation*, 155 Biological Conserv. 169, 175 (2012) (citing G.F. Wilhere, *Adaptive Management in Habitat Conservation Plans*, 16 Conserv. Biology 20 (2002)).

[133] *Id.*

[134] *Id.*

scientific method.[135] This approach in implementing conservation management is understandable, as hypothesis testing at an early stage is difficult due to relatively low sample sizes, lack of ability to replicate, and the potential for multiple causal influences on the results.[136] This, of course, can lead to some amount of uncertainty, the perception of which can fuel disagreement about the extent to which agencies should employ conservation measures.

B. Scientific Uncertainty

From a scientist's point of view, "science never *proves* anything—in the manner that mathematics or other formal logical systems prove things—because science is fundamentally based on observations."[137] More importantly, uncertainties in the scientific world are not all the same.[138] And even when conclusions and theories are regarded as "settled facts," the basis of these settled facts still contains a likelihood of potential disproval, even if that likelihood is "vanishingly small."[139]

Congress, agencies, and courts have acknowledged the unavoidable nature of scientific uncertainty. "In the conservation context . . . it makes more sense to rely upon professional judgments of scientists[,]" as opposed to opinions of policy makers, when it comes to the evaluation of available scientific data.[140] Congress implicitly acknowledged this uncertainty by mandating reliance on "the best scientific and commercial data available."[141] Further, the U.S. Fish & Wildlife Service (FWS) and the National Oceanic and Atmospheric Administration, along with multiple courts, have recognized that scientific evidence supporting the Endangered Species Act (ESA) listing determinations does not have to be conclusive.[142]

While quantification of uncertainty in terms of probabilities and confidence intervals is ideal, those involved in decision science recognize that quantification is not always possible when the problem is complex, new, or unique.[143] That leaves scientists with the familiar and comfortable task of estimating uncertainty ranges in data with error bars or estimating the likelihood that the result was attributable

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135 *Id.*

136 *Id.*

137 America's Climate Choices: Panel on Advancing the Sci. of Climate Change et al., *Advancing the Science of Climate Change* 21 (Natl. Academies Press 2010) (emphasis in original).

138 *Id.*

139 *Id.* at 21–22.

140 Carden, *supra* n. 81, at 175.

141 16 U.S.C. § 1533(b)(1)(A).

142 Doremus, *supra* n. 107, at 1075; *see* Carden, *supra* n. 81, at 190–91 ("Most importantly, the courts have held that this standard requires the wildlife agencies to use the best scientific data *available*, not the best scientific data *possible*." (emphasis in original)).

143 *See e.g. Advancing the Science of Climate Change*, *supra* n. 137, at 22 (discussing climate change research and noting that "precise quantification of uncertainty is not always possible due to the complexity or uniqueness of the system being studied").

to chance or due to the theory being tested.[144] Scientific studies that refer to error or contemplate uncertainty generally have a different effect on nonscientists.[145]

The use of the word *uncertainty* in scientific studies leaves the public with an uneasy feeling "because for many people, 'uncertainty' means that little or nothing is known."[146] In contrast, to scientists, this term characterizes the precision or confidence behind the results.[147] Although policy makers have historically voiced concerns about agency reliance on uncertain data, the agencies are quite accustomed to making determinations based on uncertain data and are given express deference by the Supreme Court to do so.[148]

Since the ESA mandates the use of what some might consider uncertain scientific data, stakeholders and policy makers often voice concerns about the regulatory agency possibly giving more weight to the data than it deserves or using the mere possibility of a threat to overprotect a species.[149]

C. Science & Policy Makers

Scientific evidence in terms of the law is typically categorized as either legitimate evidence or "junk science."[150] While scientists find comfort through employing the scientific method, judges, policy makers, and the general public often do not have this same experience. The purity of the process is often lost through the reporting of results, statistical calculations, and the resulting legal and policy decisions.[151] In

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144 *Id.* at 20–22.

145 U. Cal. Museum of Paleontology, *Understanding Science, Misconceptions about Science*, http://undsci.berkeley.edu/teaching/misconceptions.php [http://perma.cc/6XK4-UAHE] (accessed Apr. 12, 2014).

146 *Advancing the Science of Climate Change*, *supra* n. 137, at 22.

147 *Id.*

148 *See e.g. Nat. Resources Def. Council v. EPA*, 16 F.3d 1395, 1400 (4th Cir. 1993) (applying a "highly deferential standard [of review,] which presumes the validity of the agency's action"); *Ethyl Corp. v. EPA*, 541 F.2d 1, 34 (D.C. Cir. 1976) (employing a "highly deferential" standard of review in evaluating agency actions (citing *Citizens to Preserve Overton Park v. Volpe*, 401 U.S. 402, 415 (1971))); *S.W. Ctr. for Biological Diversity v. Norton*, 2002 WL 1733618 at *9 (D.D.C. 2002) ("Another implication of [the] 'best scientific data available' requirement is that FWS must rely on even inconclusive or uncertain information if that is the best available at the time of the listing decision."); *Defenders of Wildlife v. Babbitt*, 958 F. Supp. 670, 680 (D.D.C. 1997) ("Judicial and administrative interpretations of the ESA have consistently construed the statute's 'best available data' standard as requiring far less than 'conclusive evidence.'"); *Carlton v. Babbitt*, 900 F. Supp. 526, 529 (D.D.C. 1995) (acknowledging the agency decision must be based on available data, not all possible data).

149 *See* Carden, *supra* n. 81, at 201–02 (noting the ESA's emphasis on science encourages "all sides in the . . . environmental debate" to manipulate the concept of science in order to advance their agendas).

150 Foster & Huber, *supra* n. 125, at 17.

151 *See e.g.* Fred Pearce, Yale Env. 360, *Climategate: Anatomy of a Public Relations Disaster*, http://e360.yale.edu/feature/climategate_anatomy_of_a_public_relations_disaster/2221/ [http://perma.cc/K4SS-PGLC] (Dec. 10, 2009) (accessed Apr. 12, 2014) (describing how standard scientific terms and techniques used in climate studies were

fact, interpretations of scientific findings by the nonscientific audience vary drastically because of frames of reference, personal ideas, and beliefs.[152] Further, policy makers often believe that science provides the truth, equating that truth with an absolute, constant result, which does not exist.[153] The basic nature of science is that there will always be uncertainty and the nature of the scientific method brings us closer to discovering the truth by falsifying some hypotheses.[154]

Policy makers must deal with uncertainty in a different way than scientists.[155] Since science plays a primary role in environmental policy making, environmental scientists often advise policy makers and regulatory agencies because scientists' expertise and presumed objectivity make them trustworthy advisors.[156] Moreover, public officials often feel an obligation to their constituents to balance what science suggests in terms of human and environmental protection with the needs of the economy.[157] Continuing disagreement over the degree of economic risk associated with environmental problems often pits the public against scientific experts.[158] From this sensitive and often contentious negotiation, the policy maker should ideally draft environmental policies that strike a balance between conservation and realistic implementation. However, with the mounting pressures of pleasing constituencies, this difficult task leaves policy makers to de-

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read in such a way as to undermine confidence in the scientific process underlying the studies); Robert Socolow, Bull. of the Atomic Scientists, *Yes, Science Is Being Distorted. But, Much More Dangerous, It Is Being Rejected*, http://thebulletin.org/when-politicians-distort-science/yes-science-being-distorted-much-more-dangerous-it-being-rejected [http://perma.cc/RF68-TD3S] (Oct. 20, 2011) (accessed Apr. 12, 2014) (describing the erosion of the scientific method "as a privileged way of knowing" in the face of political, cultural, and litigation concerns).

152 P.J. Sullivan et al., *Defining and Implementing Best Available Science for Fisheries and Environmental Science, Policy, and Management*, 31 Fisheries 460, 460–61 (2006); James R. Weber & Charlotte Schell Word, *The Communication Process As Evaluative Context: What Do Nonscientists Hear When Scientists Speak?*, 51 BioScience 487, 488 (2001).

153 *See* Sullivan et al., *supra* n. 152, at 460–61 ("Unfortunately, many policymakers, regulators, and judges have unrealistic expectations of science. They expect science to produce uncontested, value-free, universally applicable knowledge . . . .").

154 *See* Goodstein, *supra* n. 128, at 70 (describing falsification, the process of attacking the weakest point in a hypothesis).

155 *See generally* Robert Costanza & Laura Cornwell, *The 4P Approach to Dealing with Scientific Uncertainty*, 34 Env. 12, 12–14 (Nov. 1992) (noting that scientists and policy makers hold "radically different expectations and modes of operation" vis-à-vis uncertainty: scientists tend to "uncover[ ] more uncertainty rather than . . . absolute precision," while policy makers seek "unambiguous, defensible decisions").

156 Walter A. Rosenbaum, *Environmental Politics and Policy* 58 (7th ed., CQ Press 2008).

157 Didier Schmitt, *The Great Divide*, The Scientist (Dec. 1, 2013) (available at http://www.the-scientist.com/?articles.view/articleNo/38364/title/The-Great-Divide/ [http://perma.cc/XLD5-D9UY] (accessed Apr. 12, 2014)).

158 Rosenbaum, *supra* n. 156, at 60.

cide between a result that may be either environmentally or politically risky.[159]

Additionally, science and politics operate on different time scales.[160] Policy makers must contend with an election cycle, while scientists must contend with the pace of the experiments, with the timeline of the experiment dependent on the hypothesis under investigation.[161] Scientists are often more methodical and measured than policy makers, as they often have the luxury of time and funding for research without the pressure of public opinion.

On a grander scale, scientific progress can also be measured in terms of major paradigm shifts.[162] Thomas Kuhn observed that within a given paradigm, scientists move forward, making steady, incremental progress doing "normal science."[163] As time passes and contradictions accumulate, a "scientific revolution" occurs that shatters the old paradigm and replaces it with a new one.[164] However, a much more exciting and dramatic theory, better known as a "crucial experiment," provides an opposing philosophy about the progression of science.[165] For example, the germ theory of disease and the conclusion that light bends in a gravitational field both arose from crucial experiments that changed the course of science and history.[166] The iconic nature and notoriety of such experiments support a contrasting view that a paradigm shift can occur based on a single experiment.[167]

Whether or not the idea of a crucial experiment actually exists in environmental science remains to be seen. A single experiment in environmental toxicology typically does not provide the causal link between toxic exposure and disease nor does it answer crucial ecological risk assessment questions.[168] From a causation perspective, the courts, lawmakers, and administrative agencies typically require or depend on a number of experiments with statistical force when making decisions.[169] The resulting conundrum deals with the question of how this evidence should be weighted and considered.

Often, lawmakers are left with the responsibility of managing a delicate balance between overregulating and underregulating based on

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159 *Id.*

160 *Id.* at 59; *see e.g.* Richard V. Pouyat & Margaret A. McGlinch, Student Author, *A Legislative Solution to Acid Deposition*, 1 Envtl. Sci. & Policy 249 (1998) (discussing the differences in advances in science and policy with regard to the 1990 Clean Air Act Amendments and the monitoring of sulfur dioxide and nitrogen oxides).

161 Rosenbaum, *supra* n. 156, at 59; Pouyat & McGlinch, *supra* n. 160, at 251–52.

162 Goodstein, *supra* n. 128, at 72.

163 *Id.*

164 *Id.*

165 Sheldon Krimsky, *The Weight of Scientific Evidence in Policy and Law*, 95 Am. J. Pub. Health S129, S129 (2005). A "crucial experiment," also known as a determinative experiment, is one that crystallizes a new scientific consensus. *Id.*

166 *Id.*

167 *Id.*

168 *Id.*

169 *Id.*

ecological threats. These threats are identifiable regardless of the state of scientific support for the threats.[170] Therefore, whether a paradigm shift occurs and science rapidly advances or relatively new science identifies a possible risk, policy makers are forced to make decisions despite the disparate paths created by temporal dynamics.[171]

D. Science & Society

The public lacks an understanding of scientific knowledge, and often has difficulty distinguishing the legitimate skepticism inherent in all sciences from the radical skepticism that refuses to acknowledge any evidence tending to disprove a hypothesis.[172] As a result of this flawed perception, it is difficult for policy makers to sustain broad public support for issues involving complex scientific concepts, and easier for a vocal partisan minority to create fear, sow confusion, and delay decision making by focusing on the uncertainty.[173] Social science research shows that experts and laypeople often interpret risk differently, with perceptions depending on "how they value the outcomes at stake."[174]

How one regards science and scientific uncertainty depends greatly on exposure to, and knowledge about, a particular subject matter, and on how the information is communicated.[175] For example, a doctor may consider using a test to screen for cancer even though there is no convincing statistical evidence to support its use. Perhaps the doctor is taking conservative measures to treat a patient in the face of uncertain evidence. Likewise, public officials must create environmental policies in the face of scientific uncertainty or continuing disagreement among experts and the public over the actual degree of risk associated with environmental stressors.[176] Rosenbaum provides several illustrations of the differences in risk perception between an expert and the general public. For example, the public may assign the highest possible risk rating to a chemical waste disposal facility, whereas an expert may rank it much lower.[177] In contrast, an expert could rate both "stratospheric ozone depletion and indoor radon" at a

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170 Richard J. Lazarus, *The Making of Environmental Law* 16–17 (U. of Chi. Press 2004). "For instance, industrial dischargers of water pollutants often complain that the federal Clean Water Act disproportionately targets their discharges for control, especially in light of the increasingly high percentage of water quality problems caused by contaminated runoff from agricultural activities, which are much less regulated." *Id.* at 17.

171 *See e.g.* Pouyat & McGlinch, *supra* n. 160, at 254 (arguing for the need to adopt new legislation to further reduce sulfur dioxide in response to emerging scientific studies).

172 Nick Pidgeon & Baruch Fischhoff, *The Role of Social and Decision Sciences in Communicating Uncertain Climate Risks*, 1 Nat. Climate Change 35, 35 (2011).

173 *Id.*

174 *Id.* at 37.

175 *Id.* at 36–37.

176 Rosenbaum, *supra* n. 156, at 60.

177 *Id.*

higher risk level than the public would.[178] These comparisons illustrate differing perceptions of scientific uncertainty and degrees of risk between regulatory agencies and the public.[179] These perceptions lead to "disparate views of ecological risk" and differing agendas or priorities when it comes to environmental regulation.[180]

Policy makers ultimately must make decisions, and therefore must choose between scientifically and politically risky decisions.[181] Regardless of how scientists and policy makers decide these issues, both communities should strive to work together not only to communicate a clear, simplified version of the science to the public, but also to discount those on the fringe who seek to distort science in order to promote a political agenda.

E. Science & Agency Discretion

Courts afford considerable deference to agency decision making because agencies are charged with implementing regulations with scientific or technical expertise.[182] This deference is evident when an agency is reviewing scientific data through expert peer review.[183] Moreover, even when credible opposing opinions exist on the nature of the scientific data, courts still defer to the agency. The Fifth Circuit has stated this much: "[W]here . . . the agency presents scientifically respectable conclusions which appellants are able to dispute with rival evidence of presumably equal dignity, we will not displace the administrative choice."[184]

In 1984, when the Supreme Court first solidified the principle of deference to agency interpretations of statutory schemes, it commented:

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178 *Id.*

179 *Id.*

180 *Id.*

181 *Id.* at 60–61. Consider "the decision in September 1997 by officials of the National Institute of Environmental Health Sciences (NIEHS) and the Minnesota Pollution Control Agency (MPCA) to announce to the public that samples of Minnesota surface water and groundwater had produced severe abnormalities in native frogs." This hurried announcement provoked fierce criticism from scientific colleagues, particularly in the face of conflicting scientific evidence from the state's own EPA research laboratory. Although officials explained they had no intention of "going public" until they had further interpreted the data, the media seized on the agency's offer to provide bottled water to the public, making a public announcement unavoidable. Rosenbaum, *supra* n. 156, at 60–61.

182 *See e.g.* Julie Lurman Joly et al., *Recognizing When the "Best Scientific Data Available" Isn't*, 29 Stan. Envtl. L.J. 247, 258 (2010) (discussing judicial review of administrative decisions under the Administrative Procedures Act and how a court's deference to the agency is greatest when reviewing technical expertise).

183 *Id.* at 258, 281; *see e.g. Louisiana ex rel. Guste v. Verity*, 853 F.2d 322, 329 (5th Cir. 1988) (stating that the court will defer to the administrative decision supporting regulations on the shrimp industry designed to reduce sea turtle mortality).

184 *Louisiana ex rel. Guste*, 853 F.2d at 329.

> If Congress has explicitly left a gap for the agency to fill, there is an express delegation of authority to the agency . . . . Such legislative regulations are given controlling weight unless they are arbitrary, capricious, or manifestly contrary to the statute. . . . In such a case, a court may not substitute its own construction of a statutory provision for a reasonable interpretation made by the administrator of the agency.[185]

For over twenty-five years, courts have examined the "arbitrary and capricious standard" in the context of FWS actions under the ESA. In *Bennett v. Spear*, the Supreme Court specifically addressed the "best available scientific and commercial data" directive,[186] determining that "[t]he obvious purpose of the requirement . . . is to ensure that the ESA not be implemented haphazardly, on the basis of speculation or surmise."[187]

Finally, disagreement with FWS's "ultimate findings or the studies underlying them does not automatically render its decision arbitrary and capricious."[188] In 2000, a Florida district court held that FWS did not act arbitrarily and capriciously in issuing and failing to revoke an incidental take permit allowing a limited amount of beach driving and artificial lighting that arguably disturbed the nesting season of loggerhead turtles.[189] The court commented that FWS did, in fact, rely on the best available scientific and commercial data, which included a vast array of scientific data, literature, and public comments.[190]

IV. AGENCY USE OF SCIENCE UNDER THE ENDANGERED SPECIES ACT

The Endangered Species Act (ESA) is the primary federal law that protects endangered and threatened animal and plant species.[191] The regulatory structure of the ESA provides a comprehensive system that allows for protection of the ecosystems upon which endangered and threatened species depend.[192] Through the ESA, the Secretary of the Interior has the power to promulgate regulations for listing species

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185 *Chevron U.S.A. Inc. v. Nat. Resources Def. Council, Inc.*, 467 U.S. 837, 843–44 (1984) (internal footnotes omitted).

186 *Bennett v. Spear*, 520 U.S. 154, 176 (1997).

187 *Id.*

188 *Loggerhead Turtle v. Co. Council of Volusia Co.*, 120 F. Supp. 2d 1005, 1023 (M.D. Fla. 2000).

189 *Id.* at 1026.

190 *Id.* at 1022–23.

191 16 U.S.C. §§ 1531–1544; *see* Davina Kari Kaile, Student Author, *Evolution of Wildlife Legislation in the United States: An Analysis of the Legal Efforts to Protect Endangered Species and the Prospects for the Future*, 5 Geo. Intl. Envtl. L. Rev. 441, 441 (1993) (describing Congress's enactment of the ESA as the "landmark event" and "catalyst of the movement to protect endangered species").

192 *See* 16 U.S.C. § 1531(b) (communicating the purpose of the ESA); *see also Gibbs v. Babbitt*, 214 F.3d 483, 486–87 (4th Cir. 2000) (applying the purpose and regulatory scheme established in the ESA to affirm regulatory protections for endangered red wolves).

that have become either endangered or threatened.[193] A species is considered endangered when it is in "danger of extinction throughout all or a significant portion of its range," while a species is threatened when it is "likely to become an endangered species within the foreseeable future."[194]

Section 4 of the ESA authorizes two agencies, the U.S. Fish & Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS), to identify and list these species,[195] as well as to designate a critical habitat and develop a recovery plan for each species.[196] After a species is listed, FWS and NMFS are required to ensure that no future actions they take will jeopardize the continued existence of the species.[197] Additionally, the agency must take specific steps to protect the species and its habitat, including creating and implementing a recovery plan for each listed species.[198]

Congress's intent was somewhat obvious in the "language, history, and structure" of the ESA in that the balance tips in favor of an endangered species, affording it "the highest of priorities."[199] While this intent seems to indicate a favorable outcome for species that are threatened by human activities, the ESA requires that an agency's listing decisions be made "solely on the best scientific and commercial data available."[200] Congress first incorporated this phrase into the 1982 ESA amendments.[201] Similarly, National Standard 2 of the Magnuson–Stevens Fishery Conservation and Management Act directs that both "[c]onservation and management measures shall be based upon the best scientific information available."[202] The Environmental Protection Agency also utilizes "the best available science" when implementing the Clean Water Act.[203] So why did Congress find it necessary to limit the criteria upon which a regulatory agency makes its listing determination? According to Congress, the phrase was meant to prevent nonscientific considerations from significantly influencing listing decisions.[204]

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193 *See* 16 U.S.C. § 1533(a)(1) (listing the factors the Secretary will consider when determining whether a species is endangered or threatened); *see also id.* at § 1532(15) (vesting program responsibilities with the Secretary of Interior or the Secretary of Commerce); *id.* at § 1533(c) (describing the publication of a list in the Federal Register of species that the Secretary has identified as endangered or threatened).

194 *Id.* at § 1532(6), (20).

195 *Id.* at § 1533(a)(1), (c).

196 *Id.* at § 1533(a)(3), (f).

197 16 U.S.C. § 1536(a)(2).

198 *Id.* at § 1533(f).

199 *Tenn. Valley Auth. v. Hill*, 437 U.S. 153, 174 (1978).

200 16 U.S.C. § 1533(b)(1)(A).

201 Doremus, *supra* n. 107, at 1055.

202 50 C.F.R. § 600.315(a) (2012).

203 Sullivan et al., *supra* n. 152, at 460.

204 H.R. Rpt. 97-567 at 20; *see* Doremus, *supra* n. 107, at 1051 (reviewing federal agencies' duty to limit listing evaluations to only scientific measures).

Unfortunately, when Congress amended the ESA in 1982, it provided no guidance, either through a statutory definition or legislative history, as to what "best available scientific and commercial data" means.[205] Central to the debate over the dunes sagebrush lizard (DSL) is whether the scientific uncertainty necessitated additional studies to merit a listing decision by FWS. However, the "best available science" standard does not require or obligate FWS to conduct additional "studies to obtain missing data."[206] The best science, to many, means high quality science where scientists conduct studies using the scientific process.[207] In an ideal world, the scientists would have both time and funding to perform these experiments, which in turn would strengthen the amount of scientific evidence available for agency review. However, both Congress and the courts have recognized that, more often than not, an agency will be faced with making a decision based on weak or inconclusive scientific data.[208]

Professor Holly Doremus notes two concerns that often arise when decision makers must rely on what can be considered incomplete or shaky data. First, decision makers may be fooled into giving more weight to the scientific data than they should.[209] Second, "overzealous"

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[205] Olivia Odom Green & Ahjond S. Garmestani, *Adaptive Management to Protect Biodiversity: Best Available Science and the Endangered Species Act*, 4 Diversity 164, 167–68 (2012); *see also Defenders of Wildlife*, 958 F. Supp. at 680 (noting that judicial and administrative interpretations of the ESA have relied on Congress's intent to preventively protect species in construing the phrase "best available data"). As the court recognized, the legislative history "contains ample expressions of Congressional intent that preventive action to protect species be taken sooner rather than later." *Id.*; *see e.g.* H.R. Rpt. 93-412 at 5 (July 27, 1973) ("Sheer self-interest impels us to be cautious. The institutionalization of that caution lies at the heart of [the ESA]."); 119 Cong. Rec. 30167 (daily ed. Sept. 18, 1973) (Representative Don. H. Clausen remarked: "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."); *id.* (Representative Gilman remarked: "In approving this legislation, we will be giving authority for the inclusion of those species which . . . might be threatened by extinction in the near future. Such foresight will help avoid the regrettable plight of repairing damages already incurred. By heeding the warnings of possible extinction today, we will prevent tomorrow's crisis.").

[206] U.S. Gen. Acctg. Off., Rpt. to Cong. Requesters, *Endangered Species: Fish and Wildlife Service Uses Best Available Science to Make Listing Decisions, But Additional Guidance Needed for Critical Habitat Designations*, GAO-03-803, 9 (Aug. 2003) (available at http://www.gao.gov/assets/240/239459.pdf [http://perma.cc/45L9-S3HQ] (accessed Apr. 12, 2014)) [hereinafter GAO Rpt.].

[207] Sullivan et al., *supra* n. 152, at 461. The authors note that the scientific process "typically includes the following elements": (1) "[a] clear statement of objectives"; (2) a conceptual model used to characterize systems, state assumptions, make predictions, and test hypotheses; (3) "[a] good experimental design and a standardized method for collecting data"; (4) analysis and interpretation supported by "statistical rigor and sound logic"; (5) clear recordkeeping and documentation of the experiment; and (6) scientific peer review. *Id.*

[208] Doremus, *supra* n. 107, at 1075; *see e.g. Defenders of Wildlife*, 958 F. Supp. at 679 ("The statute contains no requirement that the evidence be conclusive in order for a species to be listed.").

[209] Doremus, *supra* n. 107, at 1075.

regulators may use less than sound science to justify listing a species[210] and, as a result, unnecessarily harm the economy.[211] However, as Doremus notes, there are systematic safeguards that protect society from government run amok. Inherent in the judicial review of agency decision making is an acknowledgment of, and deference to, agency expertise in the ESA context because the agency is the group of scientific experts charged with making these decisions.[212]

By qualifying the best science as "available," rather than the "best science possible," the ESA substantially reduces the burden on agencies.[213] As such, this standard can be interpreted as one that requires far less than "conclusive evidence." The Ninth Circuit has expanded on this definition, stating that by requiring the listing of species based on the best available data, Congress intended to "give the benefit of the doubt to the species."[214] In fact, "requiring that agency decisions be made on the 'best scientific and commercial data available,' rather than absolute scientific certainty, is in keeping with congressional intent in crafting the ESA."[215]

According to some courts, FWS maintains "that it need not, and must not, wait for conclusive evidence in order to list a species."[216] In *Defenders of Wildlife v. Babbitt*, the court provided several examples of FWS's position. In the decision to list the northern spotted owl, the agency explained that because it had "used the best data available to prepare the proposed rule," it was "not obligated to have data on all aspects of a species' biology prior to reaching a determination on listings."[217] In this case, FWS concluded that "[t]o withdraw the proposal

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210 *Id.*

211 "Overzealous" regulation could lead to an increase in the already high costs of listing and protecting endangered and threatened species, and therefore result in a negative impact on the economy. *See generally* Randy T. Simmons & Kimberly Frost, *Accounting for Species: The True Costs of the Endangered Species Act* (Prop. & Env. Research Ctr. 2004) (available at http://perc.org/sites/default/files/esa_costs.pdf [http://perma.cc/Y5JY-AVK9] (accessed Apr. 12, 2014)) (critiquing the reporting of federal expenditures for endangered species).

212 Doremus, *supra* n. 107, at 1075–76; *see U.S. v. Guthrie*, 50 F.3d 936, 946 (11th Cir. 1995) (stating that the court is "'highly deferential' to an agency's consideration of the factors relevant to its decision").

213 *See S.W. Ctr. for Biological Diversity v. Norton*, 2002 WL 1733618 at *8 (citing *Bldg. Indus. Assn. of Super. Cal. v. Norton*, 247 F.3d 1241, 1246 (D.C. Cir. 2001)) ("In recognizing that scientific studies are often incomplete and open to challenge, the D.C. Circuit emphasized that § 1533(b)(1) requires FWS to utilize the 'best scientific . . . data *available*,' not the best scientific data *possible*." (emphasis in original)); Doremus, *supra* n. 107, at 1075 ("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. Both the listing agencies and courts have recognized that the evidence supporting ESA listing determinations need not be conclusive.").

214 *Defenders of Wildlife*, 958 F. Supp. at 680 (quoting *Conner v. Burford*, 848 F.2d 1441, 1454 (9th Cir. 1988)).

215 *Id.* at 679–80.

216 *Id.* at 680.

217 *Id.* (quoting 55 Fed. Reg. 26114, 26128 (June 26, 1990)).

and conduct additional research would not improve the status of the [species] and would not be in keeping with the mandates of the Endangered Species Act."[218] "More recently, the FWS decided to list the California red-legged frog, even though many aspects of the species' status were 'not completely understood.'"[219] It reasoned that the listing was important because "a significant delay in listing a species due to large, long-term biological or ecological research efforts could compromise the survival of the [species]."[220] Both of these cases illustrate that it is not always feasible for FWS to take a wait-and-see approach when everything is not perfectly understood because doing so could easily jeopardize a species arguably already at risk.

V. CATEGORIZING BEST AVAILABLE SCIENCE ISSUES SURROUNDING LISTING DECISIONS

Seeking to avoid significant delay in listing species, the U.S. Fish & Wildlife Service (FWS) often faces scientific uncertainty, which can stem not only from inconclusive science, but also from experts with conflicting opinions. Much of the disagreement in the dunes sagebrush lizard (DSL) case hinges upon adequate characterization of the current lizard population, its defined habitat, and whether man-made activities such as oil and gas development and vehicular use within the habitat are actual stressors.[221] The overall theme echoed by critics is that listing decisions are made when the science does not support the decision.[222]

The U.S. General Accounting Office (GAO)'s review of the Federal Register notices of species listings revealed that the most common sources of disagreements could be categorized into three distinct groups: "(1) whether the plants or animals under consideration qualified as a 'species' as defined by the [Endangered Species Act (ESA)], (2) the [population] status of the species, or (3) the degree of threat that the species [actually] faces."[223] Additionally, the GAO surveyed external expert peer reviewers enlisted to review the best available science and found that most of FWS's listing decisions were scientifically supported and that "few listing decisions on the basis of inadequate science" were overturned through judicial review.[224] The numbers are quite telling. In conducting this review, the GAO noted that FWS received 143 peer-review responses for fifty-four of sixty-three listing decisions finalized between 1999 and 2002.[225] In forty-eight of these decisions, the reviewers who "provid[ed] comments unanimously

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[218] *Id.* (quoting 55 Fed. Reg. 26114, 26129 (June 26, 1990)).

[219] *Id.* (citing 61 Fed. Reg. 25813, 25817 (May 23, 1996)).

[220] 61 Fed. Reg. 25813, 25817 (May 23, 1996).

[221] *See supra* pt. II (discussing the controversy surrounding listing of the DSL).

[222] *See supra* pt. II(B) (discussing the arguments in opposition to the listing of the DSL).

[223] GAO Rpt., *supra* n. 206, at 58.

[224] *Id.* at 19.

[225] *Id.* at 21.

agreed with the [FWS's] scientific conclusions or otherwise indicated support for the decision to list the species."[226] These replies indicate that many of the comments regarding the inadequacy of the best available science are misplaced, according to a majority of external experts.[227] Rather, the focus could and should be placed on improving the analysis of the science during the decision-making process and possible policy changes. The following examples illustrate some of the challenges faced by FWS when making listing decisions.

A. The Flat-Tailed Horned Lizard—The Need for Qualitative Assessment

In *Defenders of Wildlife v. Norton*, an environmental group successfully challenged FWS's decision not to list the flat-tailed horned lizard in 2001.[228] Initially, FWS had concluded that regardless of the threat to the lizard on private lands, the lizard was already protected by a conservation agreement that covered public lands.[229] Commenting that the ESA defines "endangered species" as being "in danger of extinction throughout all or a significant portion of its range," the court criticized the Secretary's assumption that a species was in danger of extinction in "a significant portion of its range" only if it was in danger of extinction everywhere.[230] The court also criticized Defenders of Wildlife's quantitative approach to the phrase where it argued that a "projected loss of 82% of the lizard's habitat" constituted a "significant portion of its range."[231] Equating the suggested quantitative approach with the Secretary's faulty interpretation,[232] the court commented that the legislative history indicated that Congress meant to broaden protection for species to include danger of extinction in "*any* portion of its range."[233]

The court's implicit acknowledgement of a need for a case-by-case determination by FWS further justifies a qualitative versus quantitative assessment. Therefore, the issue remains as to whether a transparent, fluid, and consistent qualitative assessment mechanism can and should be used by FWS.

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226 *Id.*

227 *See id.* at 19 ("Experts and others we spoke to generally agreed that most listed species probably deserved being listed under the current standard for best available scientific information.").

228 *Defenders of Wildlife v. Norton*, 258 F.3d 1136, 1140 (9th Cir. 2001). The flat-tailed horned lizard inhabits parts of southern California, southwestern Arizona, and northwestern Mexico. *Id.* at 1138.

229 *Id.*

230 *Id.* at 1141–42.

231 *Id.* at 1143.

232 *Id.*

233 *Id.* at 1144 (emphasis in original).

B. The Queen Charlotte Goshawk—Decision Making & Future Actions

In 1994, the Southwest Center for Biological Diversity filed a petition asking that the Queen Charlotte goshawk, a large but rarely seen subspecies of hawk, be listed as threatened or endangered under the ESA.[234] In this case, FWS found that based on the best available scientific evidence, a listing was not warranted because it was expecting that the U.S. Forest Service would provide land management options in the future to address conservation.[235] Initially, the district court ruled that the Secretary could not rely on possible future actions as an excuse for not deciding whether the listing should occur.[236] However, the primary dispute in the case was what to make of the best available scientific data, not over whether such data existed.[237] Upon remand, the district court ruled that the data "simply was not good enough," issuing an order to FWS to conduct an additional population study.[238] On appeal, the D.C. Circuit ruled that the ESA's statutory language required that the Secretary "list a species as endangered or threatened . . . based solely on the best available data," and that the Secretary had no obligation to conduct additional studies.[239] The court further commented that "[e]ven if the available scientific and commercial data were quite inconclusive, [the Secretary] may—indeed must—still rely on it at that stage."[240]

With a mandate by lawmakers and the judiciary to make a decision based on the best available scientific data,[241] FWS must then take a fluid, somewhat qualitative approach to decision making, weighing and analyzing the scientific evidence. Surveyed expert panels do not dispute FWS's use of the scientific evidence or even its decision making.[242] However, the lack of clarity as to the deliberation process for the final decision leaves open the possibility that rhetoric and political spin will create irrational, fear-based public opposition. A possible solution is an extension of the weight of evidence (WoE) approach already used by scientists in ecological risk management and adopted by a variety of agencies for decision making involving risk assessment.[243]

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234 *S.W. Ctr. for Biological Diversity v. Babbitt*, 939 F. Supp. 49, 50 (D.D.C. 1996).

235 *Id.* at 51.

236 *S.W. Ctr. for Biological Diversity v. Babbitt*, 215 F.3d 58, 60 (D.C. Cir. 2000).

237 *Id.* at 59.

238 *Id.*

239 *Id.* at 60.

240 *Id.*

241 16 U.S.C. § 1533(b)(1)(A); *see e.g. Trout Unlimited v. Lohn*, 559 F.3d 946, 949 (9th Cir. 2009) ("The ultimate listing determinations must be based 'solely on . . . the best scientific and commercial data available after conducting a review of the status of the species.'" (quoting 16 U.S.C. § 1533(b)(1)(A)).

242 GAO Rpt., *supra* n. 206, at 19.

243 Ruth N. Hull & Stella Swanson, *Sequential Analysis of Lines of Evidence—An Advanced Weight-of-Evidence Approach for Ecological Risk Assessment*, 2 Integrated Envtl. Assessment & Mgt. 302, 302 (2006); *see e.g. Officials Call for Research Agenda to*

Most recently, the WoE approach has also been used in the litigation context when scientific uncertainty clouds causation.[244] Additionally, agencies can employ this approach to communicate the risks and allay the public's fears.

C. The Northern Spotted Owl—Habitat Protection & Economic Fears

One of the challenges that ecologists often face when studying species populations is the lack of access to private lands.[245] Like the DSL, many imperiled species occupy habitats that span both private and public lands. One such species, the northern spotted owl, caused a considerable amount of controversy in 1991 when a federal judge stepped in and issued an injunction, banning new timber sales on 24 million acres of forest in Northern California, Oregon, and Washington.[246] This owl, like the DSL, is somewhat of a habitat specialist, preferring to reside in old-growth forests that consist of large Douglas fir trees.[247] Prior to 1978, logging had eliminated the majority of old-growth forests on private lands, so it was clear that any potential owl conservation would occur on federal timberlands.[248] In 1981, FWS concluded that the owl population was robust enough that it did not warrant protection under the ESA.[249] Afterwards, "the White House, congressional leaders and forest managers" more than doubled timber production in Washington and western Oregon up until the mid-1980s, raising logging quotas and ensuring that they were met.[250] In fact, there was even evidence of clear-cutting of trees on private land "in order to avoid logging restrictions designed to protect the northern spotted owl."[251] FWS finally listed the owl as a threatened species in

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Examine Weight-of-Evidence, 13 Risk Policy Rpt. Newsltr. (Dec. 12, 2006) (available at http://insideepa.com/Risk-Policy-Report/Risk-Policy-Report-12/12/2006/officials-call-for-research-agenda-to-examine-weight-of-evidence/menu-id-1098.html [http://perma.cc/CCL-8XH3] (accessed Apr. 12, 2014)) (discussing a government-mandated push for agencies to improve their use of a "weight-of-evidence" approach in decision making) [hereinafter Risk Policy Rpt.].

244 *See Milward v. Acuity Specialty Prods. Group*, Inc., 639 F.3d 11, 17 (1st Cir. 2011) ("This 'weight of the evidence' approach to making causal determinations involves a mode of logical reasoning often described as 'inference to the best explanation,' in which the conclusion is not guaranteed by the premises." (internal footnote omitted)).

245 Jodi Hilty & Adina M. Merenlender, *Studying Biodiversity on Private Lands*, 17 Conserv. Biology 132, 132–33 (Feb. 2003).

246 Peterson et al., *supra* n. 20, at 35; Ernie Niemi et al., *The Sky Did NOT Fall: The Pacific Northwest's Response to Logging Reductions* (ECONorthwest Apr. 1999) (available at http://pages.uoregon.edu/whitelaw/432/articles/SkyDidNotFallFull.pdf [http://perma.cc/8FSL-Z2SH] (accessed Apr. 12, 2014)).

247 Niemi et al., *supra* n. 246, at 6.

248 *Id.*

249 *Id.* Although, FWS did note that the owl's dependence on the old growth forest made it extremely vulnerable. *Id.* at 6–7.

250 *Id.* at 7.

251 Jeffrey A. Michael, *The Endangered Species Act and Private Landowner Incentives*, Human Conflicts with Wildlife: Econ. Considerations 29, 32 (Aug. 1, 2000) (USDA

1990.[252] However, it failed to designate critical habitat, which led to the eventual judicial injunction.[253]

Some predicted that as a result of the ruling, as many as 150,000 people would lose their jobs as a consequence of the owl's protection.[254] According to one report, some local restaurants had even started advertising "spotted owl soup" in support of the timber industry.[255] And, although employment in the timber industry dropped 22%, overall employment in the area rose 27%.[256] The dire prediction did not materialize and further investigation revealed that the decline in the timber industry was due to a steady decrease in employment in the industry that started well before the listing.[257]

As recent as 2008, a nonpartisan panel of scientific experts convened to reassess current threats and evaluate a draft recovery plan.[258] The panel concluded that the previously identified major threats, including loss of habitat to harvest and fire, as well as competition from the Barred Owl, still existed.[259] Citing to the weight of the evidence espoused in this draft recovery plan, FWS supported the continued listing of the owl.[260]

On one of its associated websites, *Texas First*, the Texas comptroller refers to the listing of the northern spotted owl as "one of the most controversial issues in the history of the Endangered Species Act."[261] Further, the comptroller states: "The sacrifices made by the logging industry, however, did not stop the decline in the northern spotted owl population."[262] While it is true that the Northwest experienced a decline in the logging industry, FWS, in its *Revised Recovery Plan*, still

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Natl. Wildlife Research Ctr. Symposia) (available at http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1002&context=nwrchumanconflicts [http://perma.cc/EM5Q-TBAL] (accessed Apr. 12, 2014)); *see also* Albert Gidari, *The Endangered Species Act: Impact of Section 9 on Private Landowners*, 24 Envtl. L. 419, 439 (1994) (recounting how a tree farmer in Washington state, to avoid coming under the purview of the ESA, preemptively cut down trees to avoid creating "old-growth forest characteristics" that would attract northern spotted owls).

252 55 Fed. Reg. 26114 (June 26, 1990).

253 Niemi et al., *supra* n. 246, at 8.

254 *Id.* at i.

255 Susan Combs, Tex. Comptroller Pub. Accounts, *Keeping Texas First: Tracking the Economic Impact of Federal Action on Endangered Species*, *Case History: The Northern Spotted Owl*, http://www.texasahead.org/texasfirst/news_impact/case_studies.php [http://perma.cc/7VDF-KM9A] (accessed Apr. 12, 2014) [hereinafter *Northern Spotted Owl Case History*].

256 Niemi et al., *supra* n. 246, at i.

257 *Id.* at iii.

258 Steven P. Courtney et al., *Scientific Review of the Draft Northern Spotted Owl Recovery Plan and Reviewer Comments* i (Sustainable Ecosystems Inst. Apr. 2008) (available at http://www.fws.gov/pacific/ecoservices/endangered/recovery/documents/NSODPR_Final_Report_April-2.pdf [http://perma.cc/EH3Q-477V] (accessed Apr. 12, 2014)).

259 *Id.*

260 *Id.* at 10.

261 *Northern Spotted Owl Case History*, *supra* n. 255.

262 *Id.*

refers to the previous decline in habitat as one of the ongoing threats.[263] Often, a threat to a species is not one-dimensional and is rarely attributable to one particular factor. The collective consideration of ongoing threats and the implementation of a weighted approach could provide further transparency and clarity of the evaluation process.

VI. THE WEIGHT OF SCIENTIFIC EVIDENCE— THE NEXT STEP

The Endangered Species Act (ESA)'s best available science standard has been subject to many reviews and critiques since its passage. Although the U.S. General Accounting Office (GAO) has reported that peer reviewers were satisfied with the implementation of the standard,[264] a review of the case law suggests consistent public dissatisfaction over the regulatory agencies' use of science in their decision making.[265] The focus should shift from the best science standard to creating a more defined decision-making process for weighing and implementing the best available science.

Regulatory science has used the weight of evidence (WoE) approach in both regulatory rules and decisions.[266] The WoE approach is a method that weighs and considers all the scientific evidence relevant to the evaluation of a causal hypothesis.[267] It is often used in ecological risk assessment when the lack of quantitative evidence (e.g., numerical data with statistical significance) forces the focus on qualitative evidence.[268]

Unlike the best available science standard, however, very little time has been spent on interpreting the meaning of the WoE stan-

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263 *See* U.S. Fish & Wildlife Serv., *Revised Recovery Plan for the Northern Spotted Owl (*Strix occidentalis caurina*)* vi, 15 (June 28, 2011) (available at http://www.fws.gov/arcata/es/birds/nso/documents/USFWS2011RevisedRecoveryPlanNorthernSpottedOwl.pdf. [http://perma.cc/T2SN-5D3N] (accessed Apr. 12, 2014)) (explaining that historical timber management practices used in the Pacific Northwest—including clearcuts, shelterwoods, and heavy commercial thinning—"converted spotted owl habitat to non-habitat").

264 GAO Rpt., *supra* n. 206, at 3.

265 *See e.g. Ecology Ctr., Inc. v. U.S. Forest Serv.*, 451 F.3d 1183, 1188 (10th Cir. 2006) (evaluating the plaintiff's contention that the Forest Service failed to rely on the *Reynolds Report*, which met the best available science standard); *San Luis & Delta-Mendota Water Auth. v. Salazar*, 760 F. Supp. 2d. 855, 881 (E.D. Cal. 2010) (addressing plaintiff's claim that FWS violated the ESA's best available science requirement by failing to employ a quantitative life-cycle model).

266 Krimsky, *supra* n. 165, at S129.

267 *Id.*; *see also* Charles Menzie et al., *Special Report of the Massachusetts Weight-of-Evidence Workgroup: A Weight-of-Evidence Approach for Evaluating Ecological Risks*, 2 Human & Ecological Risk Assessment 277, 278 (1996) (describing "a weight-of-evidence evaluation procedure for integrating the results of multiple measurements in ecological risk assessments").

268 Linkov et al., *supra* n. 1, at 5199.

dard.[269] Yet this standard is emerging as a workable standard not only in the regulatory field, but also in litigation where scientific experts, legal professionals, and juries are left to grapple with incomplete science.[270] As previously discussed, science rarely provides definitive answers regarding the threat of extinction, which necessitates an ecological risk assessment based on the available studies. In other words, the idea of one determinative experiment that results in an answer to causation essentially functions as an urban legend both in the scientific and legal fields—it simply does not exist.[271]

Civil and criminal courts have recognized this concept in considering the facts presented and weighing the evidence according to a particular standard of proof.[272] Therefore, the weight of the evidence in favor of the proposition must be "more probably true than false."[273] Whether the standard of proof is by a "preponderance of the evidence" or "beyond a reasonable doubt," many legal, scientific, and mathematical theorists have pondered the standard in terms of probabilities.[274] In a civil case, probabilities are expressed in mathematical terms as 50% or .5 (the preponderance threshold).[275] In the context of toxic tort litigation, probabilities are sometimes evaluated by causation factors,[276] or even in terms of the numbers and types of scientific studies required to quantify risk and prove causation.[277] Although these probabilities are meant to guide decision makers in assessing various types of evidence in a court of law, imposing hyper-specific requirements of statistical proof in science can be burdensome and unrealistic. The First Circuit recently acknowledged this concept in upholding an expert's WoE approach in a benzene exposure case where the expert testified that multiple lines of evidence supported causation.[278]

The WoE approach, when employed in a risk assessment analysis, can be subject to a number of interpretations and methods, often leading to a muddled or rather opaque outcome that can create more ques-

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269 Katherine Renshaw, *Leaving the Fox to Guard the Henhouse: Bringing Accountability to Consultation under the Endangered Species Act*, 32 Colum. J. Envtl. L. 161, 167 (2007); *see generally Milward*, 639 F.3d at 23 (upholding a WoE approach for the first time in a toxic tort litigation context in 2011 and demonstrating the lower court's "mistake in its understanding of the weight of the evidence").

270 *See id.* at 17–18 ("The fact that the role of judgment in the weight of the evidence approach is more readily apparent than it is in other methodologies does not mean that the approach is any less scientific.").

271 Linkov et al., *supra* n. 1, at 5203.

272 Vern R. Walker, *Preponderance, Probability and Warranted Factfinding*, 62 Brook. L. Rev. 1075, 1080 (1996).

273 *Id.* at 1076; *see e.g. McCormick on Evidence* 574–75 (John William Strong et al. eds., 4th ed., West 1992) (explaining the burden of persuasion in civil cases generally).

274 Walker, *supra* n. 272, at 1076.

275 *Id.*

276 *Merrell Dow Pharms., Inc. v. Havner*, 953 S.W.2d 706, 714–16 (Tex. 1997).

277 *See id.* at 716 (discussing different quantitative risk of injury standards in toxic tort cases).

278 *Milward*, 639 F.3d at 19, 23.

tions than answers.[279] Although all WoE methods include both qualitative and quantitative considerations, they differ with respect to the amount of qualitative data available.[280]

A. The Use of WoE by Regulatory Agencies

In 2010, the Environmental Protection Agency (EPA) released its draft *Weight-of-Evidence Guidance Document: Evaluating Results of EDSP Tier 1 Screening to Identify Candidate Chemicals for Tier 2 Testing*, which the agency would use to determine whether certain chemicals had the potential to interact with hormonal components of the endocrine system.[281] So why use this approach when evaluating a critical component of human health? The EPA stated that the intent behind the guidance was "to provide a transparent scientific approach for broadly evaluating Tier 1 screening data to determine if additional Tier 2 testing is necessary."[282] The guidance was a step in the right direction towards clarifying a complex, multi-tiered process, providing experts with a base for additional suggestions to the WoE approach.[283]

There has also been a call for other regulatory agencies, such as the Food and Drug Administration (FDA), to implement a similar approach when determining the sufficiency of scientific data.[284] Similarly, the FDA also uses "the weight of evidence concept when communicating issues of causation" with regard to a health claim about a food or the toxicity of a regulated product.[285] This approach to evaluating causation issues associated with human health has also recently transitioned into a litigation context where a typical *Daubert*

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[279] Linkov et al., *supra* n. 1, at 5203.

[280] *Id.* at 5201. Linkov lists the WoE methods in order of increasing quantification: (1) Listing Evidence (the presentation of individual lines of evidence without an attempt to integrate them); (2) Best Professional Judgment (the qualitative integration of these lines of evidence); (3) Causal Criteria (a criteria-based methodology for determining cause and effect relationships); (4) Logic (the use of qualitative logic models to evaluate individual lines of evidence that "either refute, discount, or corroborate one or more possible causes"); (5) Scoring (a simple quantitative method of "weighting or ranking" the multiple lines of evidence); (6) Indexing (integrating multiple lines of evidence into a single determinative measure with the use of empirical models); and (7) Quantification (the use of formal analysis and statistical models to integrate multiple lines of evidence). *Id.*

[281] Borgert et al., *supra* n. 2, at 185.

[282] *Id.* (internal quotations omitted).

[283] *See id.* (stating that some may view the guidance as "providing a desired degree of flexibility for accommodating expert judgments within the effluvium of regulatory analyses and decision-making under uncertainty").

[284] *See* Joseph W. Cormier, *Advancing FDA's Regulatory Science through Weight of Evidence Evaluations*, 28 J. Contemp. Health L. & Policy 1, 1–3 (2011) (noting that the FDA is "striving to be more '*science-led*'" (emphasis in original)).

[285] *Id.* at 13; *see also* U.S. Food & Drug Administration, Ctr. for Veterinary Med., *Veterinary Medicine Advisory Committee Briefing Packet: AquAdvantage Salmon* (Sept. 10, 2010) (available at http://www.fda.gov/downloads/AdvisoryCommittees/CommitteesMeetingMaterials/VeterinaryMedicineAdvisoryCommittee/UCM224762.pdf [http://perma.cc/F2VS-BMTY] (accessed Apr. 12, 2014)) (detailing the order of deference the FDA gives to sources in WoE evaluations).

evaluation was untenable due to the lack of available epidemiological evidence.[286]

B. WoE in Toxic Tort Litigation

Recently, the regulatory trend of adopting a WoE approach in decision making found its way into litigation. In 2011, the First Circuit became the first court to use this approach when assessing causality in the toxic tort litigation context.[287] Prior to *Milward*, plaintiffs often faced the daunting task of proving causation in cases lacking particularized studies concretely concluding that causation existed, even though the weight of the evidence suggested otherwise.[288]

In *Milward*, the plaintiff and his wife brought a negligence claim against chemical companies, alleging that his workplace exposure to benzene-containing chemicals was the cause of his rare form of leukemia.[289] The district court ruled that the testimony on general causation, offered by plaintiff's expert witness, was inadmissible under Federal Rule of Evidence 702 because it lacked "sufficient demonstrated scientific reliability."[290] The First Circuit reversed the district court decision, holding that the expert's testimony was admissible.[291] The expert based his opinion "on a 'weight of the evidence' methodology in which he considered five lines of evidence drawn from the peer-reviewed scientific literature on leukemia and benzene."[292] The First Circuit agreed with this approach, stating that this methodology was both sound and reliable under *Daubert*.[293] The court further commented that a trial court cannot treat lack of statistical significance as a crucial flaw in the unique situation where there is a lack of epidemiological evidence due to the rarity of the type of leukemia and the difficulties of data collection.[294]

Thus, the judiciary has observed that the presence of scientific uncertainty due to the lack of a specific type of data or even conflicting opinions does not discount the body or the weight of evidence observed in the literature.[295] Federal agencies also recognize this general con-

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[286] *See Milward*, 639 F.3d at 24–26 (holding that the district court erred in finding the "lack of statistical significance as a crucial flaw").

[287] *See id.* at 17–18 (finding that expert's use of a weight of the evidence approach was valid).

[288] *See id.* at 24–26 (explaining the district court's holding that plaintiffs' expert failed to prove causation due to a lack of particularized studies, even though the weight of the evidence was in the expert's favor).

[289] *Id.* at 13.

[290] *Id.*

[291] *Id.* at 14.

[292] *Milward*, 639 F.3d at 16.

[293] *Id.* at 20.

[294] *Id.* at 24.

[295] *See id*. at 25 (noting how "Dr. Smith explained that his citation to epidemiological data was meant to challenge the theory that benzene exposure could not cause [leukemia], and to highlight that the limited data available was consistent with the conclusions that he had reached on the basis of other bodies of evidence"; the lower court "not

cept,[296] however there are still difficulties with the nature of the WoE methodology, particularly in instituting a structured methodology and with communicating to lawmakers and the general public.

C. WoE in Climate Science

Since the early 1990s, scientists have faced the major challenge of explaining the risks and uncertainties of climate science to nonscientists.[297] Over the past two decades, climate science has slowly moved toward more directly confronting uncertainty and adopting risk-based evaluations of potential impacts largely through a WoE approach.[298] Over the years, the language in the reports on climate science has become more refined. Facing significant public criticism, the Intergovernmental Panel on Climate Change (IPCC) has recognized that communicating scientific uncertainty to the public is very much tied to the descriptive terms used in its assessment reports.[299] The IPCC sequence of key findings reported over the past thirteen years illustrates this concept.[300]

Rather than using formal expressions of uncertainty, the first three IPCC assessments instead used future-based predictions.[301] The first assessment report, completed in 1990, was the IPCC's initial attempt at categorizing and communicating its findings, providing a broad overview of the uncertainties and evidence for global warming.[302] Five years later, the second assessment report continued to refine uncertainty, concluding that "the *balance of evidence* suggests . . . a discernible human influence on global climate."[303] In 2001, the third assessment further refined these findings, concluding that "[i]n the light of new evidence and taking into account the remaining uncertain-

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only misconstrued the concept of biological plausibility . . . but also . . . the concept's role in Dr. Smith's analysis").

296 Risk Policy Rpt., *supra* n. 243.

297 Pidgeon & Fischhoff, *supra* n. 172, at 35.

298 *Id.* at 37.

299 *See id.* (noting that "lay observers can get an exaggerated sense of scientific uncertainty" and that the "first three IPCC assessments avoided formal expressions of uncertainty").

300 *See e.g.* Intergovernmental Panel on Climate Change, *Publications and Data*, https://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml#1 [http://perma.cc/QVM8-TYBS] (accessed Apr. 12, 2014) (online repository of IPCC climate change reports from 1990 to the most recent report from 2013).

301 Pidgeon & Fischhoff, *supra* n. 172, at 37.

302 Intergovernmental Panel on Climate Change, *Climate Change*: *The IPCC Scientific Assessment* (J.T. Houghton et al. eds., Cambridge U. Press 1990) (available at http://www.ipcc.ch/ipccreports/far/wg_I/ipcc_far_wg_I_full_report.pdf [http://perma.cc/7NC9-ZBJQ] (accessed Apr. 12, 2014)).

303 Intergovernmental Panel on Climate Change, *IPCC Second Assessment: Climate Change 1995* 22 (IPCC 1995) (available at http://www.ipcc.ch/pdf/climate-changes-1995/ipcc-2nd-assessment/2nd-assessment-en.pdf [http://perma.cc/9CXA-3JM2] (accessed Apr. 12, 2014)) (emphasis added).

ties, most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations."[304]

The approach of the IPCC changed with the fourth report. Building on the growing scientific consensus on global warming, the fourth assessment, issued in 2007, strengthened both the specificity and certainty of its language.[305] The fourth report finds that the existence of climate change is unequivocal:

> The observed widespread warming of the atmosphere and ocean, together with ice mass loss, support the conclusion that it is *extremely unlikely* that global climate change of the past 50 years can be explained without external forcing and *very likely* that it is not due to known natural causes alone.[306]

This assessment differs from earlier assessments in that it specifically assigned likelihoods while utilizing a weight of evidence approach.[307]

The IPCC used verbal qualifiers as a communication tool to convey the conclusions of the consensus based on the weight of the evidence.[308] In other words, the scientists of the IPCC focused on how to better communicate science to nonscientists. Although there is arguably some progress made here with the concrete and descriptive nature of the language, the question of whether the IPCC was successful in its message is still largely unanswered.[309]

D. Creating a Workable WoE Methodology for Decision Making under the ESA

Although the term *weight of evidence* has been used in ecological risk assessment by scientists, "there is no consensus on its definition or how it should be applied."[310] And when agencies apply this concept in utilizing scientific evidence to make regulatory decisions, it is even more necessary to create a workable structure that would provide transparency and consistency.[311] Since regulatory agencies are often

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304 Intergovernmental Panel on Climate Change, *Climate Change 2001: Synthesis Report* 51 (Robert T. Watson et al. eds., Cambridge U. Press 2001) (available at http://www.grida.no/publications/other/ipcc_tar/?src=/climate/ipcc_tar/ [http://perma.cc/ZE92-5ZRG] (accessed Apr. 12, 2014)).

305 Intergovernmental Panel on Climate Change, *Climate Change 2007: Synthesis Report* 72 (Rajendra K. Pachauri et al. eds., IPCC 2008) (available at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf [http://perma.cc/P8LF-S54T] (accessed Apr. 12, 2014)).

306 *Id.* at 39 (emphasis in original).

307 Pidgeon & Fischhoff, *supra* n. 172, at 37.

308 *Id.*

309 *See id.* (suggesting that empirical research is needed to determine whether the IPCC has successfully communicated its message).

310 Krimsky, *supra* n. 165, at S131.

311 *See e.g.* Borgert et al., *supra* n. 2, at 186 (advocating for a hypothesis-driven weight of evidence framework that incorporates documentation and transparency); Risk Policy Rpt., *supra* n. 243 (detailing calls from government officials for a new research agenda to clarify how federal agencies use scientific data under the weight of evidence approach in making regulatory decisions).

dealing with inconclusive science—such as less than perfect dunes sagebrush lizard (DSL) population studies—this approach seems ideal, particularly because it is often applied when there is no single study that "is conclusive in demonstrating a cause–effect relationship."[312] While the WoE approach is mentioned often in regulatory literature, a defined methodology is rarely explained, leaving open an inference of subjectivity and bias.[313] The EPA has noted in using this approach that "no single 'weighing factor' determines the overall weight" and that "factors are not scored numerically";[314] however, the implementation of WoE could be enhanced if criteria for weighing the evidence were established at the outset of the process.[315]

Thus, there is a need not only to define the WoE terminology, but also to develop a categorical framework that will establish step-by-step clarity and transparency in the decision-making process.[316] Scientists recently introduced one such method as a "hypothesis-driven weight of evidence" framework for evaluating scientific data within the EPA's Endocrine Disruptor Screening Program.[317] The proposed method includes seven steps or categories for implementing the WoE methodology, including quantitative measurement based on each endpoint.[318] This approach can be modified to adjust for lack of quantitative data and better accommodate FWS's best available science evaluation process. This modification would include the following steps: (1) "define a specific hypothesis to be evaluated"; (2) "systemically search, review and select data relevant to each hypothesis"; (3) "evaluate the primary validity and reliability of each study"; (4) develop weightings for each type of endpoint or factor "with respect to its sensitivity and specificity for testing the hypothesis"; and (5) "develop an overall WoE determination as to whether each hypothesis is supported or rejected," and the strength of each, "based on the overall WoE weightings."[319] This process hinges upon the development of a hypothesis, a traditional method used in the scientific process, which is arguably essential to a deliberative process that involves risk assessment. Evidence of a risk or potential stressor in the context of a particular species has little to no significance unless agencies form and evaluate a hypothesis against the data or evidence.[320] This explicit structure could afford FWS an

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312 Krimsky, *supra* n. 165, at S131.

313 *See id.* (noting that "[w]ithout an explication of how evidence is 'weighed,'" the scientific reasoning supporting a WoE claim escapes scrutiny, casting doubt on the results).

314 *Id.* at S133.

315 *Id.* at S132.

316 Borgert et al., *supra* n. 2, at 186.

317 *Id.* at 185.

318 *See id.* at 186 (proposing a seven step, hypothesis-driven weight of evidence framework that is used as a precursor to the modified five step framework above).

319 *Id.*

320 Patrick Donnelly et al., PowerPoint, *Application of the Endangered Species Act's Best Available Standard* slide 5 (242d ACS Natl. Meeting & Exposition Aug. 28–Sept. 1, 2011) (available at http://www.agrodiv.org/documents/denver11/Endangered%20Spe

opportunity to provide more substance to its application of the best available science, and allow for proper consideration of contradictory data, improving accountability and consistency.[321]

For example, in the case of the DSL—as in the case of many endangered species—FWS has reiterated that habitat modification or destruction is one of the primary threats in its consideration of a possible listing.[322] Therefore, it would make sense to weigh this particular factor accordingly against each hypothesis and then examine what the weight of evidence suggests. For example, even if there is a lack of definitive evidence to suggest that habitat modification is responsible for the decline in the DSL population, decision makers should ask what the weight of evidence suggests, seeking to determine if there are various studies or lines of evidence that support the decision for the listing. Further, the evaluation process mentioned above could be published in the Federal Register.

Much like a preponderance of evidence standard used in the courtroom, this weighing allows for decision making when faced with a lack of evidence or conflicting expert opinions. This particular application of the best available scientific evidence could lead to a more solid conclusion even in the face of uncertainty. And, in cases like the DSL, the WoE methodology provides additional transparency and clarity in the process when agencies like FWS are faced with accusations of making decisions based on unsound science. By adopting the WoE approach in its decision-making process, regulatory agencies can continue to bridge the gap between the science, law, and policy.

VII. CONCLUSION

In the face of scientific uncertainty, federal agencies such as the U.S. Fish & Wildlife Service (FWS) are facing increasing challenges to decisions made in species listings under the Endangered Species Act (ESA) where population data is either absent or incomplete. Courts have reiterated that statutory interpretation of the ESA dictates that decisions be made "solely on the best scientific and commercial data available."[323] New competing views, pitting economics against "shaky science" supporting the listing of endangered species, such as the dunes sagebrush lizard, have pressured agencies to allow for outside interests to shape the evaluation process. In order to calm the chaos and better communicate the scientific process to both policy makers and the public, the implementation of a categorical weight of evidence

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cies%20Act%20and%20Regulation/AGRO153_Donnelly.Patrick.pdf [http://perma.cc/VG5M-E3KY] (accessed Apr. 12, 2014)).

321 *Id.* at slide 9.

322 *See* Peterson et al., *supra* n. 20, at 33 (discussing destruction of habitat as a factor leading to the ESA listing of the lesser prairie chicken and the proposed listing of the dunes sagebrush lizard).

323 *See e.g. Trout Unlimited*, 559 F.3d at 949 ("The ultimate listing determinations must be based 'solely on . . . the best scientific and commercial data available after conducting a review of the status of the species.'" (quoting 16 U.S.C. § 1533(b)(1)(A))).

process in analyzing the scientific data will allow FWS to battle the semantics of "scientific uncertainty" and allow the focus to remain on an appropriate weighted analysis of the available scientific data.