

# JUDICIAL REVIEW OF SCIENTIFIC UNCERTAINTY IN CLIMATE CHANGE LAWSUITS: DEFERENTIAL AND NONDEFERENTIAL EVALUATION OF AGENCY FACTUAL AND POLICY DETERMINATIONS

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*Scientific determinations are often at the heart of environmental disputes. When those disputes take the form of litigation, the courts may be called on to determine whether an administrative agency's treatment of the science warrants deference. For several reasons, judges are inclined to apply deferential review to agency factual and science-based policy determinations. Most judges are not trained in the language and methods of science. They may be reluctant to intervene on matters on which their lack of expertise risks producing uninformed judgments. If a statute delegates to an agency the responsibility of making those determinations, courts may be loath to usurp that authority by substituting their judgment for the agency's. If the statutory delegations authorize agencies to premise their decisions on the best available information, courts may regard that authorization as a signal not to take agencies to task for failing to do the impossible. Those mandates reflect a congressional judgment that agency determinations should pass judicial muster even if they fall short of conclusiveness, which may be impossible to achieve. Finally, when technical issues arise in the context of uncertainty at "the frontiers of scientific knowledge," the Supreme Court has warned judges that highly deferential review is required.*

*This Article describes a study analyzing cases decided by the federal courts over a period of thirty years that presented issues involving scientific uncertainty tied to climate change that arose under two key environmental statutes, the National Environmental Policy Act and the Endangered Species Act. The Article provides both quantitative and qualitative analyses of those cases, focusing on ascertaining the factors that drove courts to apply either deferential or non-deferential review. We found, as might be expected, that the courts applied deferential review in the majority of climate change cases arising under these two laws that presented disputes in which litigants challenged agency resolution of factual or policy matters characterized by scientific uncertainty. In the remaining cases, however, the courts, applying the arbitrary and capricious standard of judicial review, refused to defer, engaging instead in relatively rigorous review of agency science. They did so for any one of several reasons, including irrationality in agency reasoning, incomplete analysis of record science, evidentiary shortcomings, and end result-oriented reasoning. These practices induced courts to reject rote acceptance of agency pleas for deference to their scientific expertise. The Article concludes by suggesting further studies that may be useful in understanding how courts can be expected to strike the balance between deferential review and insistence that agencies provide adequate reasons for their actions in contexts of scientific uncertainty.*

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## INTRODUCTION

Science plays a critical role in identifying how to address important social problems,<sup>1</sup> as the COVID-19 pandemic vividly demonstrated. The development of governmental policies to solve social problems often relies on law as a

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1. Dale Jamieson, *Scientific Uncertainty and the Political Process*, 545 ANNALS AM. ACAD. POL. & SOC. SCI. 35, 36 (1996) (“Some of the most controversial public policy decisions in American society involve risks that are primarily understood through scientific processes and institutions.”).

“problem-solving tool.”<sup>2</sup> The fora in which that process of problem solving occurs include litigation, for “when existing law [in the form of statutes, for example] is clearly not adequate to resolve the dispute, the court confronts an opportunity to solve the underlying social problem self-consciously, on its own authority, by making law.”<sup>3</sup>

But the disciplines of science and law do not necessarily see eye to eye on matters such as what scientific knowledge is or the proper use of the information it provides. One salient example of the different lenses used by scientists and lawyers concerns scientific uncertainty.<sup>4</sup> As one sociologist has noted, “[b]ecause science involves producing knowledge about what was previously unknown, uncertainty is a normal and necessary characteristic of scientific work.”<sup>5</sup> When scientific issues arise in litigation, however, judges may expect “that science and scientists will simply present objective truth. On this expectation, judges find it hard to understand that established scientists can hold opposing views on quite basic questions.”<sup>6</sup>

Judge James Skelly Wright, in an early Clean Air Act case, explored the differing perceptions of fact and uncertainty in the contexts of scientific research and civil litigation. He explained that a scientist typically will not regard evidence as establishing certainty:

[U]nless the probability of error, by standard statistical measurement, is less than 5%. That is, scientific fact is at least 95% certain. Such certainty has never characterized the judicial or the administrative process. . . . [T]he standard of ordinary civil litigation, a preponderance of the evidence, demands only 51% certainty. A jury may weigh

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2. J.B. Ruhl & Harold J. Ruhl, Jr., *The Arrow of the Law in Modern Administrative States: Using Complexity Theory to Reveal the Diminishing Returns and Increasing Risks the Burgeoning of Law Poses to Society*, 30 U.C. DAVIS L. REV. 405, 475 (1997).
  3. James A. Henderson, Jr., *Contract's Constitutive Core: Solving Problems by Making Deals*, 2012 U. ILL. L. REV. 89, 116 (2012).
  4. See Deborah M. Hussey Freeland, *Speaking Science to Law*, 25 GEO. INT'L ENV'T L. REV. 289, 334 (2013) (“Key terms that are superficially identical in the languages of science and law are actually terms of art with distinctive meanings in each. Fundamental misunderstandings ensue when a lawyer is unaware that crucial terms relating to truth and professional judgment . . . are superficially identical but actually homonymous.”).
  5. Stephen C. Zehr, *Scientists' Representations of Uncertainty*, in COMMUNICATING UNCERTAINTY: MEDIA COVERAGE OF NEW AND CONTROVERSIAL SCIENCE 3 (Sharon M. Friedman, Sharon Dunwoody & Carol L. Rogers eds., 1999); cf. Freeland, *supra* note 4, at 299 (stating that for scientists, “research results are always provisional. However, scientists still, provisionally, deem some propositions more worthy of belief than others”); *id.* at 303 (“Science is understood to be provisional; this provisionality motivates more and more scientific study, and is thus vital to the scientific enterprise.”).
  6. Pauline Newman, *Law and Science: The Testing of Justice*, 57 N.Y.U. ANN. SURV. AM. L. 419, 425 (2000).

conflicting evidence and certify as adjudicative (although not scientific) fact that which it believes is more likely than not.<sup>7</sup>

Stephanie Tai has elaborated further on “the divergence in judicial and scientific uses of the term” scientific uncertainty<sup>8</sup>: she points out that scientists engaged in tasks such as risk assessment focus more on “knowledge uncertainty” than on conflicting interpretations of that knowledge among scientists. In contrast, when courts discuss “uncertainty” they may be referring to disagreements on particular scientific findings, or what one may call “controversy uncertainty.”<sup>9</sup> Thus, according to one observer, scientific uncertainty straddles the line between scientific knowledge and public policy formulation,<sup>10</sup> and both scientists and policymakers fashion their definitions of the term to serve their own discrete purposes.<sup>11</sup> As a result, “[t]he use of science to inform law requires careful, multifaceted translation. We cannot just paste scientific language into legal processes and expect lawyers to hear what scientists are saying.”<sup>12</sup>

The ways in which scientists and lawyers (including judges) characterize scientific uncertainty affect the formulation and application of environmental law. Holly Doremus recognized as much in describing uncertainty as “the unifying hallmark of environmental and natural resource regulation.”<sup>13</sup> If anything,

7. *Ethyl Corp. v. EPA*, 541 F.2d 1, 28 n.58 (D.C. Cir. 1976).

8. Stephanie Tai, *Uncertainty About Uncertainty: The Impact of Judicial Decisions on Assessing Scientific Uncertainty*, 11 U. PA. J. CONST. L. 671, 676 (2009).

9. *Id.* at 676–77.

10. Jamieson, *supra* note 1, at 40–41; *see also* Jane Maienschein, James P. Collins & Daniel S. Strouse, *Biology and Law: Challenges of Adjudicating Competing Claims in a Democracy*, 38 JURIMETRICS J. 151, 152 (1998) (“[T]he interface of science and law requires adjudicating many competing claims to knowledge,” and that because disciplines such as law and science “have different conceptions of evidence and different approaches to addressing questions, it is difficult to integrate their research findings.”); Elizabeth Mertz, *Undervaluing Indeterminacy: Translating Social Science into Law*, 60 DEPAUL L. REV. 397, 397 (2011) (“Among the biggest challenges facing attempts to translate between social science and law is the problem of indeterminacy. . . . [S]cholars from law and social science approach the issue with very different frameworks. This can lead to inaccurate or distorted interdisciplinary translations.”).

11. Jamieson, *supra* note 1, at 43.

12. Deborah M. Hussey Freeland, *Law & Science: Toward a Unified Field*, 47 CONN. L. REV. 529, 544 (2014).

13. Holly Doremus, *Precaution, Science, and Learning While Doing in Natural Resource Management*, 82 WASH. L. REV. 547, 548 (2007); *see also* John S. Applegate & Robert L. Fischman, Foreword, *Missing Information: The Scientific Data Gap in Conservation and Chemical Regulation*, 83 IND. L.J. 399, 400 (2008) (“The intractable form of scientific uncertainty—‘knowledge uncertainty,’ as Professor Howard Latin put it—is most frequently what the environmental law texts refer to, because intractability establishes uncertainty as a central, inherent characteristic of environmental regulation, which environmental law and policy must somehow manage.” (citations omitted)); Melanie E. Kleiss, *NEPA and Scientific Uncertainty: Using the Precautionary Principle to Bridge the Gap*, 87 MINN. L. REV. 1215, 1216 (2003) (“Predicting environmental impacts always involves uncertainty . . .”). For discussion

the contexts in which the science is uncertain have expanded over time, despite the ongoing accumulation of knowledge.<sup>14</sup>

Among the environmental problems characterized by significant and persistent uncertainty is climate change. Certain aspects of climate change science are beyond dispute among the vast majority of reputable climate scientists. These include the existence of a warming planet and the acknowledgment that human activity—greenhouse gas (“GHG”) emissions and deforestation in particular—is a contributing factor. The National Oceanic and Atmospheric Administration (“NOAA”) has pointed out that “[m]ultiple studies published in peer-reviewed scientific journals show that 97 percent or more of actively publishing climate scientists agree: Climate-warming trends over the past century are extremely likely due to human activities.”<sup>15</sup> As the Intergovernmental Panel on Climate Change (“IPCC”) stated in its most recent assessment report, human activities are unequivocally responsible for observed increases in GHG concentrations since around 1750.<sup>16</sup> Attribution science<sup>17</sup> is even making it pos-

of some of the sources of this uncertainty, see Daniel A. Farber, *Probabilities Behaving Badly: Complexity Theory and Environmental Uncertainty*, 37 U.C. DAVIS L. REV. 145, 149–52 (2003).

14. See Zehr, *supra* note 5, at 18:

We should expect uncertainty to remain salient in public science, given the expanding number and scope of issues that elicit scientific uncertainty. For example, the key environmental problems of the 1960s and 1970s were largely local, while the environmental issues of today have not only increased in number, but also are national and international in scale. As the scope of these problems increased, so has the amount of scientific uncertainty.

One definition of science is that it “is the body of knowledge accumulated through the discoveries about all the things in the universe.” Alina Bradford & Ashley Hamer, *Science and the Scientific Method: Definitions and Examples*, LIVE SCI. (Aug. 4, 2017), <https://perma.cc/5S7A-85QY>.

15. *Scientific Consensus: Earth’s Climate Is Warming*, NASA, <https://perma.cc/X5GF-AAWK> (citing, among other studies, John Cook et al., *Consensus on Consensus: A Synthesis of Consensus Estimates on Human-Caused Global Warming*, 11 ENV’T RSCH. LETTERS 048002, at 1 (2016), <https://perma.cc/6DFC-7QWC> (“Climate scientists overwhelmingly agree that humans are causing recent global warming.”)); see also Michael Burger, Jessica Wentz & Radley Horton, *The Law and Science of Climate Change Attribution*, 45 COLUM. J. ENV’T L. 57, 60 (2020) (“There is overwhelming scientific agreement that human activities are changing the global climate system and these changes are already affecting human and natural systems.”).
16. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS: WORKING GROUP I CONTRIBUTION TO THE SIXTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, at SPM-5 (Valérie Masson-Delmotte et al. eds., 2021) [hereinafter IPCC, AR6 CLIMATE SCIENCE CHANGE 2021], [https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC\\_AR6\\_WGI\\_Full\\_Report.pdf](https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf).
17. “Attribution of climate change has been defined as ‘the process of evaluating the relative contributions of multiple causal factors to a change or event with an assignment of statistical

sible to draw correlations between climate change and specific extreme weather events.<sup>18</sup> For example, scientists from the United States, Canada, and several European countries concluded that the scorching heat wave that afflicted the Pacific Northwest in the summer of 2021 “was virtually impossible without human-caused climate change.”<sup>19</sup>

Nevertheless, considerable uncertainty surrounds other aspects of climate change.<sup>20</sup> Scientists are unable to predict the magnitude of the physical effects of climate change or exactly how those effects will differ by location with any assurance. Partly, these uncertainties are due to the yet-to-be-determined nature of the human response to warnings about climate risks—will GHG emis-

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confidence.” Peter A. Stott et al., *Attribution of Extreme Weather and Climate-Related Events*, 7 WIREs CLIMATE CHANGE 23, 24 (2016) (citation omitted), <https://perma.cc/L6XN-TG8C>; see also Phillippe Naveau, Alexis Hannart & Aurélien Ribes, *Statistical Methods for Extreme Event Attribution in Climate Science*, 7 ANN. REV. STAT. & ITS APPLICATION 89 (2020) (discussing the science of “extreme event attribution”).

18. See Burger, Wentz & Horton, *supra* note 15, at 61–62 (“Significant advances in climate change detection and attribution science—the branch of science which seeks to isolate the effect of human influence on the climate and related earth systems—have continued to clarify the extent to which anthropogenic climate change causes both slow onset changes and extreme events.”); see also Renee Cho, *Attribution Science: Linking Climate Change to Extreme Weather*, COLUM. CLIMATE SCHOOL: STATE OF THE PLANET (Oct. 4, 2021), <https://perma.cc/Q7VZ-ZXP8> (“[A] new type of research called *attribution science* can determine, not if climate change caused an event, but if climate change made some extreme events more severe and more likely to occur, and if so, by how much.”). Litigants are likely to rely on advances in attribution science in their efforts to hold defendants responsible for damages resulting from extreme weather events. See Burger, Wentz & Horton, *supra* note 15, at 63 (“Recently, researchers have been developing methodologies to link harmful impacts that were caused or exacerbated by climate change to specific emitters, with an eye towards holding emitters and other responsible parties accountable in court for their contribution to the harms. As the science evolves, so too will its role in the courtroom and in policymaking.” (citation omitted)).
19. *Western North American Extreme Heat Virtually Impossible Without Human-Caused Climate Change*, WORLD WEATHER ATTRIBUTION (July 7, 2021), <https://perma.cc/699F-SYCD>. The study’s authors added, however, that “because the temperature records of June 2021 were very far outside all historical observations, determining the likelihood of this event in today’s climate is highly uncertain.” *Id.*
20. See Andrew Taylor, *Why the Social Cost of Carbon Is a Red Herring*, 31 TUL. ENV’T L.J. 345, 363 (2018) (“[W]hile climate science has been developing rapidly, it is necessarily and admittedly subject to a great degree of uncertainty across multiple aspects. This is to be expected as climate change is so massive in scale and potential impact, occurs somewhat unpredictably over long periods of time, and is not conducive to regular laboratory trials.” (citation omitted)); Wendy S. Parker & James S. Risbey, *False Precision, Surprise and Improved Uncertainty Assessment*, 373 PHIL. TRANSACTIONS ROYAL SOC’Y 1, 2 (2015), <https://perma.cc/59J2-34N5> (“But for many empirical questions of interest to decision-makers, answers have non-negligible uncertainty. In the climate context, this is the case for many questions.”).

sions continue unabated, for example, or be curtailed?<sup>21</sup> In addition, scientists engaged in assessing the future of climate change and its effects rely on global climate models that generate simulations of future climate scenarios. Unfortunately, according to some observers, “the limitations of these probabilistic approaches to the physical aspects of climate change are becoming increasingly apparent. Climate models have structural errors, many of which are shared, which challenges a probabilistic interpretation of multi-model ensembles.”<sup>22</sup> These errors may stem, for example, from aggregation of multiple real-world processes into one modeling process or simplification that results from averaging multiple data inputs.<sup>23</sup> Feedback loops, such as the release of frozen carbon that will result when Arctic permafrost melts, exacerbate the uncertainty of predicting the impacts of a given level of warming.<sup>24</sup>

The uncertainties surrounding climate change have drawn the attention of both the scientific and legal communities. The IPCC, created in 1988 by the World Meteorological Organization and the United Nations Environment Programme “to provide government at all levels with scientific information that they can use to develop climate policies,”<sup>25</sup> has provided the most widely publicized scientific analyses of the causes and effects of climate change. In a series

21. Cf. Fred K. Morrison, Craig Manson & Matthew C. Wickersham, *Climate Change Science and the Daubert Standard*, 44 WM. & MARY ENV'T L. & POL'Y REV. 391, 410 (2020) (referring to three main sources of uncertainty in the climate models used to predict future climate change: (1) “natural internal variability which is intrinsic to the climate system”; (2) “uncertainty concerning past, present and future forcing on the climate system by anthropogenic forcing agents”; and (3) “uncertainty related to the response of the climate system to the specified forcing agents” (citations omitted)).

22. Theodore G. Shepherd et al., *Storylines: An Alternative Approach to Representing Uncertainty in Physical Aspects of Climate Change*, 151 CLIMATIC CHANGE 555, 557 (2018). The authors add:

Effective bias correction of multivariate relationships, such as those involved in compound events, requires vast amounts of data that may not exist. In any case, it is not known how to correct model biases in simulating climate *changes* (as opposed to simulations of the present climate state). Estimates of uncertainties at the regional scale can quickly accumulate to a point where this knowledge hinders rather than supports scenario-led climate adaptation decision-making.

*Id.* (citations omitted).

23. See Alvaro Hasani, *Forecasting the End of Climate Change Litigation: Why Expert Testimony Based on Climate Models Should Not Be Admissible*, 32 MISS. COLL. L. REV. 83, 100 (2013).

24. See Leah A. Dundon, *Climate Science for Lawyers*, BEVERIDGE & DIAMOND (2017), <https://perma.cc/KUJ5-QYMG> (“Despite broad agreement that feedbacks are likely to amplify human-caused warming, there is still uncertainty as to the degree of amplification.”); cf. *How Feedback Loops Are Making the Climate Crisis Worse*, CLIMATE REALITY PROJECT (Jan. 7, 2020), <https://perma.cc/3HA5-6CGH>; Monique Brouillette, News Feature, *How Microbes in Permafrost Could Trigger a Massive Carbon Bomb*, NATURE (Mar. 17, 2021), <https://perma.cc/AVN8-4Z4E>.

25. *About the IPCC*, IPCC, <https://perma.cc/9AYV-BTXF>.

of assessment reports, the IPCC has addressed various aspects of climate change, including physical science, mitigation, and adaptation.<sup>26</sup>

The IPCC has issued five series of assessment reports and portions of a sixth that was published in 2021.<sup>27</sup> In conjunction with the preparation of these reports, the IPCC has published Guidance Notes to assist the lead authors of the various reports “in the consistent treatment of uncertainties.”<sup>28</sup> The Note published to assist in the preparation of the Fifth Assessment Reports “define[d] a common approach and calibrated language that can be used broadly for developing expert judgments and for evaluating and communicating the degree of certainty in findings of the assessment process.”<sup>29</sup> The Note explained that the Fifth Assessment Reports would “rely on two metrics for communicating the degree of certainty in key findings: (1) confidence in the validity of a finding based on the type, amount, quality, and consistency of evidence; and (2) quantified measures of uncertainty in a finding expressed probabilistically (based on statistical analysis or expert judgment).”<sup>30</sup> Levels of confidence were expressed using qualifying language.<sup>31</sup> A finding that a fact is “virtually certain” has a 99–100% probability. The other qualifiers reflect lower levels of confidence: very likely (90–100%), likely (66–100%), about as likely as not

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26. The IPCC has explained that:

For the assessment reports, experts volunteer their time as IPCC authors to assess the thousands of scientific papers published each year to provide a comprehensive summary of what is known about the drivers of climate change, its impacts and future risks, and how adaptation and mitigation can reduce those risks. . . . Through its assessments, the IPCC identifies the strength of scientific agreement in different areas and indicates where further research is needed.

*Id.*

27. IPCC, AR6 CLIMATE SCIENCE CHANGE 2021, *supra* note 16. In addition to the assessment reports, there are many special issue reports. *See Reports*, IPCC, <https://perma.cc/749N-BPP7>.

28. IPCC, GUIDANCE NOTES FOR LEAD AUTHORS OF THE IPCC FIFTH ASSESSMENT REPORT ON CONSISTENT TREATMENT OF UNCERTAINTIES 1 (2010) [hereinafter GUIDANCE NOTES]; *see also* Michael D. Mastrandrea et al., *The IPCC AR5 Guidance Note on Consistent Treatment of Uncertainties: A Common Approach Across the Working Groups*, 108 CLIMATIC CHANGE 675, 676 (2011) (“Starting with the Third Assessment Report (TAR), guidance outlining a common approach for treatment of uncertainties across the Working Groups has been provided to all authors in each assessment cycle,” whose purpose “has been to encourage, across the [IPCC’s] Working Groups, consistent characterization of the degree of certainty in key findings based on the strength of and uncertainties in the underlying knowledge base.”).

29. GUIDANCE NOTES, *supra* note 28, at 1.

30. *Id.* The sixth report “follows the approach developed for [the fifth assessment report].” IPCC, AR6 CLIMATE SCIENCE CHANGE 2021, *supra* note 16, at 1-30 box 1.1.

31. *See* GUIDANCE NOTES, *supra* note 28, at 3.



(33–66%), unlikely (0–33%), very unlikely (1–10%), and exceptionally unlikely (0–1%).<sup>32</sup>

The IPCC Guidance Notes provide perhaps the preeminent example of how scientists can systematically describe scientific uncertainty relating to climate science in policy documentation.<sup>33</sup> The IPCC’s system for communicating scientific uncertainty has been widely emulated by other scientific organizations. The U.S. Global Change Research Program (“USGCRP”), for example, which Congress ordered the President to establish in 1990,<sup>34</sup> has drawn on the IPCC Guidance Notes in describing the reliability of its conclusions concerning climate science.<sup>35</sup>

Scientific uncertainty surrounding climate change is relevant to legal discourse as well as to communication among scientists (and communication by scientists to policymakers and the public). But translating scientific uncertainty into legal concepts can be problematic, both generally and as relevant to climate change. As noted above, scientists and lawyers may not view uncertainty from a common vantage point.<sup>36</sup> As a result, “the law’s use of science is uncertain and uneven.”<sup>37</sup> The problem is particularly acute in the context of litigation, where differences in the training of scientists and lawyers,<sup>38</sup> and in the languages they use, “cause[] a question of legitimacy in the evidence that is presented in court,”<sup>39</sup> or that is relied on by government officials in making decisions that are challenged in court.<sup>40</sup>

32. *Id.* at 3 tbl.1.

33. For descriptions of other systems for communicating these uncertainties, see Michael Traynor, *Communicating Scientific Uncertainty: A Lawyer’s Perspective*, 45 ENV’T L. REP. 10,159, 10,160–62 (2015).

34. Global Change Research Act of 1990, Pub. L. No. 101-606, § 103, 104 Stat. 3096, 3098 (codified at 15 U.S.C. § 2933). The Act requires the preparation at least once every four years of an assessment that discusses the scientific uncertainties associated with its climate science findings, analyzes the effects of climate change on the natural environment and various human activity, and analyzes current trends and projects future trends in climate change. 15 U.S.C. § 2936.

35. U.S. GLOB. CHANGE RSCH. PROGRAM, *FOURTH NATIONAL CLIMATE ASSESSMENT, VOLUME II: IMPACTS, RISKS, AND ADAPTATION IN THE UNITED STATES 7* (David Reidmiller et al. eds., 2018, revised 2021).

36. *See supra* notes 4–11 and accompanying text.

37. John C. Holmes, Book Review, 48 FED. LAW. 68, 68 (2001) (reviewing DAVID L. FAIGMAN, *LEGAL ALCHEMY: THE USE AND MISUSE OF SCIENCE IN THE LAW* (1999)).

38. *See* David L. Faigman, *Judges as “Amateur Scientists”*, 86 B.U. L. REV. 1207, 1211 (2006) (“Lawyers, of which judges are merely a subset, generally lack good training in the methods of science. Most lawyers do not speak the language of science. Lawyers and scientists come from different worlds of education and experience.”).

39. Clifford Fisher, *The Role of Causation in Science as Law and Proposed Changes in the Current Common Law Toxic Tort System*, 9 BUFF. ENV’T L.J. 35, 51–52 (2001).

40. In addition, “it can be difficult for non-scientists, such as judges, to separate out science and policy judgment without additional assistance. When these get conflated, courts will not be

Moreover, science communication in the context of litigation typically has a different purpose than discourse among scientists. Whereas the scientific community discusses science for the purpose of advancing human knowledge, litigants in lawsuits such as those that implicate climate change introduce science into the proceedings for the purpose of supporting their overall position in litigation.<sup>41</sup> Acknowledging what remains unknown in scientific studies sustains credibility in the scientific community because, as Karl Popper famously argued, “the hallmark of scientific theory is its falsifiability.”<sup>42</sup> In the litigation context, the acknowledgment of scientific uncertainty between a plaintiff’s claim of a causal link between the defendant’s conduct and the plaintiff’s harm, or between a challenged agency action and the environmental harm it will allegedly generate, may be fatal to the litigant’s prospects of convincing a judge or jury to rule in its favor.

There is no shortage of commentary on the treatment of scientific uncertainty in courts.<sup>43</sup> Some of these works focus on judicial treatment of scientific uncertainty in climate litigation in particular.<sup>44</sup> Most of these studies provide

able to determine when a management decision is rationally supported by scientific evidence.” Sara A. Clark, *Taking a Hard Look at Agency Science: Can the Courts Ever Succeed?*, 36 *ECOLOGY L.Q.* 317, 343 (2009).

41. Litigation, however, is often described as a process whose goal is the search for truth. See *Carroll v. Jacques Admiralty Law Firm, P.C.*, 110 F.3d 290, 294 (5th Cir. 1997) (describing “the search for truth” as being “at the heart of the litigation process”); see also Michael Moore, *Tobacco Litigation*, 41 *N.Y.L. SCH. L. REV.* 365, 368 (1997). But see David H. Taylor, *Should It Take a Thief?: Rethinking the Admission of Illegally Obtained Evidence in Civil Cases*, 22 *REV. LITIG.* 625, 630 (2003) (“[C]ivil litigation is not as much a search for the truth as it is a means of reaching an acceptable resolution of a dispute.”).
42. See *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 593 (1993) (“[T]he criterion of the scientific status of a theory is its falsifiability, or refutability, or testability.” (quoting KARL POPPER, *CONJECTURES AND REFUTATIONS: THE GROWTH OF SCIENTIFIC KNOWLEDGE* 37 (5th ed. 1989))); see also Barbara Pfeffer Billauer, *Admissibility of Scientific Evidence Under Daubert: The Fatal Flaws of ‘Falsifiability’ and ‘Falsification’*, 22 *B.U. J. SCI. & TECH. L.* 21, 36 (2016) (“Popper constantly reiterates that ‘falsifiability’ is the *sine qua non* of science . . .”).
43. See, e.g., Kenneth S. Abraham & Richard A. Merrill, *Scientific Uncertainty in the Courts*, 2 *ISSUES IN SCI. & TECH.* 93 (1986); Troyen A. Brennan, *Helping Courts with Toxic Torts: Some Proposals Regarding Alternative Methods for Presenting and Assessing Scientific Evidence in Common Law Courts*, 51 *U. PITT. L. REV.* 1 (1989); Carla Mattix & Kathleen Becker, *Scientific Uncertainty Under the National Environmental Policy Act*, 54 *ADMIN. L. REV.* 1125 (2002); Emily Hammond Meazell, *Deference and Dialogue in Administrative Law*, 111 *COLUM. L. REV.* 1722, 1726–31 (2011); Susan R. Poulter, *Daubert and Scientific Evidence: Assessing Evidentiary Reliability in Toxic Tort Litigation*, 1993 *UTAH L. REV.* 1307 (1993); Tai, *supra* note 8; Wendy E. Wagner, *Choosing Ignorance in the Manufacture of Toxic Products*, 82 *CORNELL L. REV.* 773, 792 (1997).
44. See, e.g., Kirsten Engel & Jonathan Overpeck, *Adaptation and the Courtroom: Judging Climate Science*, 3 *MICH. J. ENV’T & ADMIN. L.* 1 (2013); Petra Minnerop & Friederike Otto, *Climate Change and Causation: Joining Law and Climate Science on the Basis of Formal Logic*, 27 *BUFF. ENV’T L.J.* 49 (2019–20); Hari M. Osofsky, *The Intersection of Scale, Science, and*

recommendations for how judges should conceptualize scientific uncertainty in resolving cases before them. What is missing, however, is empirical research systematically assessing how courts actually address scientific uncertainty in briefs and other documents submitted by litigants. Additional such research could also shed light on how courts address uncertainty that agencies express in making decisions that allegedly would have adverse impacts on climate change (such as a decision to authorize extraction of fossil fuels on federal lands) or that would be adversely affected by climate change (such as a decision to build a sewage treatment plant or an airport in an area at risk of coastal flooding).<sup>45</sup>

This Article presents such an empirical evaluation. It explores how federal courts addressed uncertainty in climate science—how the judges framed scientific uncertainty in climate litigation—in the context of lawsuits challenging agency decisions based on alleged noncompliance with two important federal environmental statutes: the National Environmental Policy Act (“NEPA”)<sup>46</sup> and the Endangered Species Act (“ESA”).<sup>47</sup> Both statutes impose analytical obligations on federal agencies.<sup>48</sup> Both are important centerpieces of U.S. environmental law and litigation as a general matter.<sup>49</sup> Both have already been the subject of a considerable amount of litigation relating to the climate impacts of

*Law in Massachusetts v. EPA*, 9 OR. REV. INT’L L. 233 (2007); Natasha Geiling, *City of Oakland v. BP: Testing the Limits of Climate Science in Climate Litigation*, 46 *ECOLOGY L.Q.* 683, 684 (2019); Jill Jaffe, *Scientific Uncertainty and the Regulation of Greenhouse Gases Under the Clean Air Act*, 37 *ECOLOGY L.Q.* 765 (2010); Leah Vasarhelyi, Note, *Political Accountability and Judicial Review in the Context of Climate Change Regulation*, 32 *COLO. NAT. RES. ENERGY & ENV’T L. REV.* 159 (2021).

45. David Markell & J.B. Ruhl, *An Empirical Assessment of Climate Change in the Courts: A New Jurisprudence or Business as Usual?*, 64 *FLA. L. REV.* 15 (2012) [hereinafter Markell & Ruhl, *Assessment*], provides an early empirical evaluation of climate litigation, but it does not focus on scientific uncertainty or judicial treatment of it. The same is true of David Markell & J.B. Ruhl, *An Empirical Survey of Climate Change Litigation in the United States*, 40 *ENV’T L. REP. NEWS & ANALYSIS* 10,644 (2010) [hereinafter Markell & Ruhl, *Survey*].

46. Pub. L. No. 91-190, 83 Stat. 852 (1970) (codified as amended in scattered sections of 42 U.S.C.).

47. 16 U.S.C. §§ 1531–1544.

48. See *infra* Part I.

49. David E. Adelman & Robert L. Glicksman, *Judicial Ideology as a Check on Executive Power*, 81 *OHIO ST. L.J.* 175, 196 (2020) (“NEPA and the ESA are among the most important and most heavily litigated federal environmental statutes.”). Based on the Sabin Center Database of U.S. Climate Change Litigation, which we used to generate the cases we studied, as of December 16, 2021, the statute which had generated the most domestic climate litigation was NEPA (308 cases). The ESA and other wildlife protection statutes gave rise to 163 cases. Only the Clean Air Act (“CAA”) spurred more cases (179) than the ESA. No other federal environmental statute came close. *U.S. Climate Change Litigation*, SABIN CTR. FOR CLIMATE CHANGE & ARNOLD & PORTER, <https://perma.cc/F8KE-PBJP>. We chose not to include cases decided under the federal CAA because only seven met the criteria for inclusion in our database. See *infra* Appendix 2, Figure 7.

agency action.<sup>50</sup> Therefore, they present an important testing ground for the willingness and ability of the courts to scrutinize factual information characterized by uncertainty in climate science.<sup>51</sup> The question at issue is whether judges are able to rise to the challenge of fashioning meaningful responses to the characterizations of such uncertainty by scientists, in and outside agencies. The answer may go a long way toward determining whether the judicial branch is capable of playing an important role in government efforts to minimize climate change's potentially destructive clout.<sup>52</sup>

We analyzed fifty-one lawsuits involving NEPA and the ESA in which federal judges confronted scientific uncertainty in ruling on the validity of agency decisions with climate-related implications.<sup>53</sup> Although courts are strongly inclined to defer to agency resolution of complex scientific issues, and they did exactly that in a majority of the cases we surveyed, they declared agency reasoning in the treatment of scientific uncertainty to be arbitrary and capricious in a considerable number of cases.

The Article proceeds as follows. Part I provides a brief summary of the methodology we used in identifying and analyzing the cases.<sup>54</sup> Part II reviews the provisions of NEPA and the ESA, focusing on those that are most likely to be implicated when agencies performing their duties under the two statutes encounter issues on which the science is unresolved.

Part III describes both our quantitative and qualitative findings. Part III.A covers the quantitative analysis, answering a series of questions concerning the characteristics of the cases in our database and the manner in which the courts resolved them. Part III.B provides qualitative analysis of judicial review of agency treatment of scientific uncertainty under the arbitrary and capricious standard of judicial review. It both discerns patterns in the cases that turned aside litigants' challenges to agency scientific determination and identifies factors that triggered what was, in some cases, surprisingly rigorous judicial scru-

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50. See *infra* Part III.B.3(b)(3).

51. Marilyn Averill, *Climate Litigation: Ethical Implications and Societal Impacts*, 85 DENV. U. L. REV. 899, 902 (2008) ("Climate litigation allows study of the role of U.S. courts in the co-production of knowledge, in shaping ethical debates, and in the relationship between law and ethics in general.")

52. More than a decade ago, Professors Markell and Ruhl noted that "[s]ome commentators have suggested that the courts are already significant drivers of climate change policy, and their role is likely to increase." Markell & Ruhl, *Survey*, *supra* note 45, at 10,646; cf. Benjamin Ewing & Douglas A. Kysar, *Prods and Pleas: Limited Government in an Era of Unlimited Harm*, 12 YALE L.J. 350, 370–71 (2011) (taking issue with those who minimize the judicial role in climate-related tort litigation). Others have studied the role that courts have played in the formulation of climate policy in other parts of the world. See Meredith Wilensky, *Climate Change in the Courts: An Assessment of Non-U.S. Climate Litigation*, 26 DUKE ENV'T L. & POL'Y F. 131, 134 (2015).

53. For a list of the fifty-one cases, see Appendix 1.

54. We describe that methodology more thoroughly in Appendix 2.

tiny of agency approaches to decision-making in contexts of scientific uncertainty.

Finally, the Conclusion discusses the implications of the cases we reviewed for the future of agency treatment of climate science and litigation in which it is challenged. It also points to possible future research endeavors to further illuminate how courts are likely to preserve the delicate balance between deferential review of technical determinations by expert agencies and judicial intervention when agency reasoning in making those determinations is deficient.

## I. AGENCY DECISION-MAKING UNDER CONDITIONS OF SCIENTIFIC UNCERTAINTY UNDER THE NATIONAL ENVIRONMENTAL POLICY ACT AND THE ENDANGERED SPECIES ACT

Both NEPA and the ESA require agencies to steep themselves in scientific determinations concerning the environmental impacts of their actions. Both statutes require agencies to make predictive judgments, and both envision and require decision-making when the available science is unable to justify definitive conclusions in making those judgments. This Part briefly summarizes the requirements imposed on agencies by NEPA and the ESA, focusing on the statutory and regulatory provisions (or judicial interpretations of those provisions) that are most relevant to decision-making under conditions of scientific uncertainty. It is the agencies' compliance or noncompliance with those provisions that is most likely to be determinative in judicial review of agency actions in climate cases that involve scientific uncertainty.

### *A. Scientific Uncertainty and NEPA*

Kicking off the environmental decade of the 1970s, the adoption of NEPA codified a national policy of “encourag[ing] productive and enjoyable harmony between man and his environment” and “promot[ing] efforts which will prevent or eliminate damage to the environment and biosphere.”<sup>55</sup> NEPA declared that the federal government has a continuing responsibility to “attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences.”<sup>56</sup>

NEPA's most important provision directs all federal agencies to prepare an environmental impact statement (“EIS”) in connection with proposals for “major Federal actions significantly affecting the quality of the human environment.”<sup>57</sup> An EIS must describe, among other things, the environmental impact

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55. 42 U.S.C. § 4321.

56. *Id.* § 4331(b)(3).

57. *Id.* § 4332(2)(C). The CEQ regulations define a major federal action as “an activity or decision subject to Federal control and responsibility” that “may include new and continuing activities, including projects and programs entirely or partly financed, assisted, conducted,

of the proposed action, any adverse environmental effects which cannot be avoided if the proposed action is implemented, alternatives to the proposed action, and any irreversible and irretrievable resource commitments that would result if a proposal were implemented.<sup>58</sup> Agencies can avoid preparing an EIS if a particular action falls within a category of actions that the agency has previously determined “normally do not have a significant effect on the human environment” and there are no extraordinary circumstances indicating that “a normally excluded action may have a significant effect.”<sup>59</sup> Even if a proposed action does not qualify for such a “categorical exclusion,” the agency proposing it may avoid the duty to prepare an EIS by preparing an environmental assessment (“EA”) that includes a “finding of no significant impact” (“FONSI”) supported by “sufficient evidence and analysis.”<sup>60</sup> Figure 1 provides a flow chart indicating how agencies determine whether a proposed action is categorically excluded, the proper subject of an EA, or one that requires preparation of an EIS.

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regulated, or approved by federal agencies; new or revised agency rules, regulations, plans, policies, or procedures; and legislative proposals.” 40 C.F.R. § 1508.1(q) (2021). The regulations provide that a major federal action tends to fall into one of several categories, including adoption of (i) official policy such as regulations; (ii) formal plans which prescribe alternative uses of federal resources upon which future actions will be based; (iii) programs such as groups of actions to implement a plan or policy, or systematic and connected agency actions allocating resources; and (iv) approval of specific projects in a defined geographic area, including actions approved by permit or other regulatory decision. *Id.* § 1508.1(q)(3).

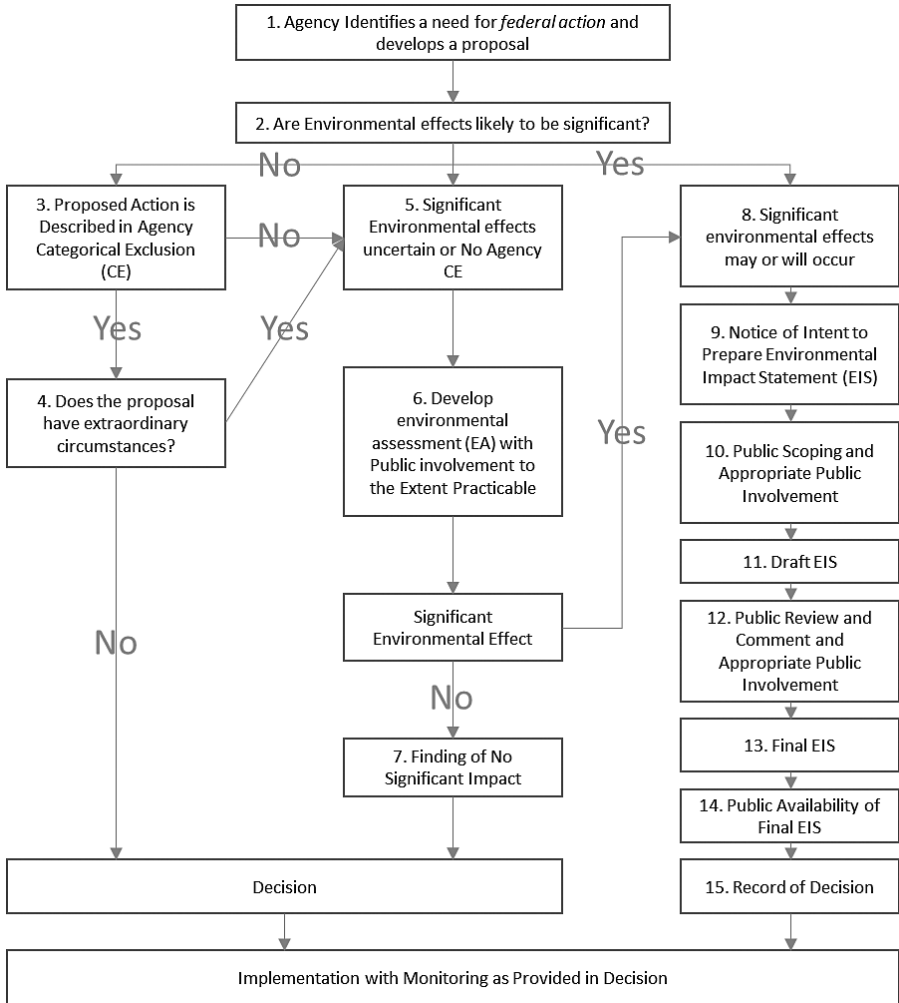
58. 42 U.S.C. § 4332(2)(C).

59. 40 C.F.R. § 1501.4 (2021). Federal agencies may escape NEPA compliance obligations for several other reasons. *See id.* § 1501.1(a) (listing circumstances in which NEPA or its EIS preparation requirement may not apply).

60. *Id.* § 1501.5(a), (c)(1). NEPA created the Council on Environmental Quality (“CEQ”) within the Executive Office of the President. 42 U.S.C. § 4342. CEQ has issued regulations which provide that they are “applicable to and binding on all Federal agencies for implementing the procedural provisions of [NEPA].” 40 C.F.R. § 1500.3(a) (2021); *see also id.* § 1500.1(b) (“The regulations in this subchapter implement section 102(2) of NEPA. They provide direction to Federal agencies to determine what actions are subject to NEPA’s procedural requirements and the level of NEPA review where applicable.”); *id.* § 1507.1 (“All agencies of the Federal Government shall comply with these regulations.”).

The CEQ regulations define a FONSI as “a document by a Federal agency briefly presenting the reasons why an action, not otherwise categorically excluded (§ 1501.4 of this chapter), will not have a significant effect on the human environment and for which an environmental impact statement therefore will not be prepared.” *Id.* § 1508.1(l). The regulations define an environmental assessment to mean a “concise public document prepared by a Federal agency to aid an agency’s compliance with the Act and support its determination of whether to prepare an environmental impact statement or a finding of no significant impact.” *Id.* § 1508.1(h).

FIGURE 1. THE NEPA PROCESS<sup>61</sup>



NEPA is designed to ensure that federal agencies “stop and think” about the potential impacts of their decisions on the natural environment and to publicly disclose the results of those deliberations.<sup>62</sup> As one of us has explained elsewhere, however:

61. COUNCIL ON ENV'T QUALITY, A CITIZEN'S GUIDE TO NEPA: HAVING YOUR VOICE HEARD 8 (2021), <https://perma.cc/CX2X-KVZS>.  
 62. See Robert L. Glicksman & Alejandro E. Camacho, *The Trump Card: Tarnishing Planning, Democracy, and the Environment*, 50 ENV'T L. REP. NEWS & ANALYSIS 10,281, 10,283 (2020); see also 40 C.F.R. § 1500.1(a) (2021) (“The purpose and function of NEPA is satisfied if Federal agencies have considered relevant environmental information, and the public

The NEPA documentation process . . . does not always square with the nature of a dynamic natural system in a state of disequilibrium. Particularly when an agency is considering a long-term project, a project covering expansive tracts of land, or an action likely to affect (or be affected by) climate change, it may have great difficulty predicting the course of events or foreseeing how its proposed action will affect a resource or ecosystem it is charged with protecting.<sup>63</sup>

How, then, can agencies comply with their environmental evaluation and reporting responsibilities if the potential effects of a proposed major federal action are shrouded in uncertainty?

NEPA itself does not answer this conundrum, specifying that an EIS must describe a proposed action's environmental effects, alternatives to the proposed action, and irreversible resource commitments that would occur if the action were implemented.<sup>64</sup> The CEQ regulations, however, provide some guidance on how agencies should function in a context of scientific uncertainty. The regulations require that agencies "[i]dentify environmental effects and values in adequate detail so the decision maker can appropriately consider such effects and values alongside economic and technical analyses."<sup>65</sup> Agencies must prepare EISs "using an inter-disciplinary approach that will insure the integrated use of the natural and social sciences and the environmental design arts."<sup>66</sup> Agencies must "ensure the professional integrity, including scientific integrity, of the discussions and analyses in environmental documents. Agencies shall make use of reliable existing data and resources. Agencies may make use of any reliable data sources, such as remotely gathered information or statistical models."<sup>67</sup> CEQ's position, however, is that "[a]gencies are not required to undertake new scientific and technical research to inform their analyses."<sup>68</sup>

The CEQ regulations directly address the possibility that the consequences of a proposed action will be unknown or even unknowable. An EIS must describe the environment to be affected by the proposed action, "includ-

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has been informed regarding the decision-making process."); *id.* § 1502.1 ("The primary purpose of an environmental impact statement prepared pursuant to section 102(2)(C) of NEPA is to ensure agencies consider the environmental impacts of their actions in decision making. It shall provide full and fair discussion of significant environmental impacts and shall inform decision makers and the public of reasonable alternatives that would avoid or minimize adverse impacts or enhance the quality of the human environment.").

63. Robert L. Glicksman & Jarryd Page, *Adaptive Management and NEPA: How to Reconcile Predictive Assessment in the Face of Uncertainty with Natural Resource Management Flexibility and Success*, 46 HARV. ENVTL. L. REV. 121, 124 (2022).

64. 42 U.S.C. § 4332(2)(C).

65. 40 C.F.R. § 1501.2(b)(2) (2021).

66. *Id.* § 1502.6.

67. *Id.* § 1502.23.

68. *Id.*



ing the reasonably foreseeable environmental trends and planned actions in the area(s).”<sup>69</sup> The regulations also provide that “[w]hen an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement, and there is incomplete or unavailable information, the agency shall make clear that such information is lacking.”<sup>70</sup> The regulations add that “[i]f the incomplete but available information relevant to reasonably foreseeable significant adverse impacts is essential to a reasoned choice among alternatives, and the overall costs of obtaining it are not unreasonable, the agency shall include the information in the environmental impact statement.”<sup>71</sup> If, however, an agency cannot obtain the information relevant to reasonably foreseeable significant adverse impacts because the costs of doing so are unreasonable or the means to obtain it are unknown, the EIS must state that the information is incomplete or unavailable, describe the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable adverse environmental impacts, summarize existing credible evidence relevant to evaluating those impacts, and base its evaluation on theoretical approaches or research methods that are generally accepted in the scientific community.<sup>72</sup>

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69. *Id.* § 1502.15.

70. *Id.* § 1502.21(a). For these purposes, “reasonably foreseeable” impacts include those “that have catastrophic consequences, even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason.” *Id.* § 1502.21(d). See generally Mark Reeve, *Scientific Uncertainty and the National Environmental Policy Act—The Council on Environmental Quality’s Regulation 40 C.F.R. Section 1502.22*, 60 WASH. L. REV. 101 (1984) (discussing the version of the regulation that was in effect before it was amended in 2020). For a discussion of the 2020 revisions, see Steph Tai, *Scientific Uncertainty and the Council on Environmental Quality’s Proposed Changes to Its National Environmental Policy Act Regulations*, 51 TRENDS 11 (2020).

71. 40 C.F.R. § 1502.21(b) (2021); cf. *Birckhead v. FERC*, 925 F.3d 510, 517–18 (D.C. Cir. 2019) (deferring to the agency’s assertion that information necessary to establish a causal relationship between approval of a natural gas pipeline and the environmental effects of upstream gas production was unavailable).

72. 40 C.F.R. § 1502.21(c) (2021). Before the adoption of the 2020 amendments, which occurred after the close of our survey period, the regulation dealing with incomplete or unavailable information appeared at 40 C.F.R. § 1502.22 (2019). Surprisingly, this regulation was not cited by courts in their review of agency treatment of scientific uncertainty in the vast majority of the cases in our survey, even though it would seem to be directly relevant. One case in which a court did address § 1502.22 is *WildEarth Guardians v. U.S. Forest Service*, 828 F. Supp. 1223 (D. Colo. 2011). Environmental public interest groups brought a NEPA challenge to the Forest Service’s approval of coal mining operations in a national forest. *Id.* The plaintiffs argued that the agency’s EIS failed to adequately analyze the cumulative impacts of methane venting on climate change. *Id.* at 1239–40. The Forest Service responded that it could not estimate the effect of the project on climate change because of the lack of appropriate models and research. *Id.* at 1240. The court rejected the claim that the agency acted arbitrarily, finding that it complied with § 1502.22 by providing a statement that information concerning the precise impact of flaring on climate change was unavailable and

Regulatory definitions further flesh out the meaning of these requirements. CEQ defines “effects or impacts” as:

[C]hanges to the human environment from the proposed action or alternatives that are reasonably foreseeable and have a reasonably close causal relationship to the proposed action or alternatives, including those effects that occur at the same time and place as the proposed action or alternatives and may include effects that are later in time or farther removed in distance from the proposed action or alternatives.<sup>73</sup>

The regulations direct agencies generally not to consider effects “if they are remote in time, geographically remote, or the product of a lengthy causal chain.”<sup>74</sup> They also define “reasonably foreseeable” as “sufficiently likely to occur such that a person of ordinary prudence would take it into account in reaching a decision.”<sup>75</sup>

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could not be credibly calculated. *Id.* The plaintiffs failed to identify any method that would have filled that knowledge gap. *Id.* at 1239–40; *see also* High Country Conservation Advocs. v. U.S. Forest Serv., 333 F. Supp. 3d 1107, 1130–31 (D. Colo. 2018), *vacated and remanded on other grounds*, 951 F.3d 1217 (10th Cir. 2020) (finding that the Forest Service complied with § 1502.22 by disclosing reasonably foreseeable effects on climate change of proposed exploration and coal mining activities).

These two cases were part of our original database of 838 lawsuits but do not appear in our final list of fifty-one cases. These cases were excluded by the NVivo software that searched for cases based on the list of codes that appears in Appendix 2 indicating any discussion of scientific uncertainty.

73. 40 C.F.R. § 1508.1(g) (2021). Before 2020, the CEQ regulations required agencies to consider “cumulative effects,” which they defined as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency . . . undertakes such other actions.” *See* *Bark v. U.S. Forest Serv.*, 958 F.3d 865, 872 (9th Cir. 2020) (citing 40 C.F.R. § 1508.7 (2019)). The 2020 regulations replaced regulations initially adopted in 1978. *See* Update to the Regulations Implementing the Procedural Provisions of the National Environmental Policy Act, 85 Fed. Reg. 43,304, 43,304 (July 16, 2020) (to be codified in scattered parts of 40 C.F.R.). The pre-2020 regulations also defined “effects” to include “indirect effects,” which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable.” 40 C.F.R. § 1508.8 (2019). CEQ’s 2021 proposed revisions to the 2020 regulations would largely restore the pre-2020 definition of “effects,” including within the term “direct,” “indirect,” and “cumulative effects.” National Environmental Policy Act Implementing Regulations Revisions, 86 Fed. Reg. 55,757, 55,759, 55,768–69 (proposed Oct. 7, 2021) (to be codified at 40 C.F.R. § 1508.1(g)).

74. 40 C.F.R. § 1508.1(g)(2) (2021).

75. *Id.* § 1508.1(aa). Before the adoption of the 2020 regulations, individual agencies could adopt their own, supplemental NEPA implementation regulations that went beyond CEQ’s. The Interior Department, for example, issued NEPA regulations that define “reasonably foreseeable future actions” as “those federal and non-federal activities not yet undertaken, but sufficiently likely to occur, that a Responsible Official of ordinary prudence would take such activities into account in reaching a decision,” but excluding “actions that are highly specula-

Thus, the CEQ regulations seek to reconcile agency obligations to assess and disclose the potential environmental effects of their proposed actions with the possibility that those effects may be uncertain at the time the agency prepares its NEPA documentation. They require agencies to assess the effects of future actions only if they are reasonably foreseeable and of effects themselves only if they are reasonably foreseeable. Remoteness in time or distance may justify exclusion of effects from an EA or an EIS, and agency obligations to perform research to minimize or eliminate uncertainty are limited by cost considerations. Nevertheless, agencies must comply with NEPA in a manner consistent with scientific integrity and make use of reliable existing data and resources. Further, as the courts have recognized, they must provide “a reasonable, good faith objective presentation of the topics [NEPA] requires an [EIS] to cover,” including analysis of reasonably foreseeable actions and impacts.<sup>76</sup>

### B. *Scientific Uncertainty and the ESA*

The ESA, like NEPA, requires agencies whose actions may result in adverse environmental impacts to predict and evaluate those impacts—in this case, on species listed by one of two federal agencies, the U.S. Fish and Wildlife Service (“FWS”) within the Department of the Interior or the National Marine Fisheries Service (“NMFS”) within the Department of Commerce,<sup>77</sup> (together,

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tive or indefinite.” 43 C.F.R. § 46.30 (2021). The 2020 regulations provide that, with limited exceptions, “agency NEPA procedures shall not impose additional procedures or requirements beyond those set forth in [CEQ’s] regulations.” 40 C.F.R. § 1507.3(b) (2021). In 2021, CEQ proposed amendments to its NEPA regulations that would eliminate that provision. National Environmental Policy Act Implementing Regulations Revisions, 86 Fed. Reg. at 55,759, 55,761–62. The proposal is designed to clarify that “agencies have the discretion and flexibility to develop procedures beyond the CEQ regulatory requirements, enabling agencies to address their specific programs and the contexts in which they operate.” *Id.* at 55,761.

76. *Utahns for Better Transp. v. U.S. Dep’t of Transp.*, 305 F.3d 1152, 1174 (10th Cir. 2002) (quoting *Colo. Env’t Coal. v. Dombeck*, 185 F.3d 1162, 1172 (10th Cir. 1999)), *modified on reh’g*, 319 F.3d 1207 (10th Cir. 2003) (note that these decisions were handed down before issuance of the 2020 regulations); *see also* *W. Watersheds Project v. Christiansen*, 348 F. Supp. 3d 1204, 1208 (D. Wyo. 2018) (“An agency need not include every possible alternative, nor analyze consequences of alternatives it has in good faith rejected ‘as too remote, speculative, or . . . impractical or ineffective.’” (quoting *WildEarth Guardians v. Nat’l Park Serv.*, 703 F.3d 1178, 1183 (10th Cir. 2013))); *Surfrider Found. v. Dalton*, 989 F. Supp. 1309, 1324 (S.D. Cal. 1998) (“The term ‘reasonably’ suggests that the agency must make a good faith effort to consider likely cumulative effects.”), *aff’d*, 196 F.3d 1057 (9th Cir. 1999).

77. FWS has primary responsibility for terrestrial and freshwater organisms, and NMFS is responsible for marine mammals, reptiles, fish, and plants. *See* *Defs. of Wildlife v. U.S. Navy*, 733 F.3d 1106, 1111 (11th Cir. 2013); *Nat’l Wildlife Fed’n v. FEMA*, 345 F. Supp. 2d 1151, 1167 (W.D. Wash. 2004) (citing 50 C.F.R. § 402.01(b) (1986)).

“the Services”) as threatened<sup>78</sup> or endangered.<sup>79</sup> Thus, the ESA, like NEPA, often places agencies in the position of evaluating and describing impacts that cannot yet be fully ascertained.

The ESA’s purposes “are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved [and] to provide a program for the conservation” of those species.<sup>80</sup> In adopting the ESA, Congress declared a policy that all federal agencies “shall seek to conserve endangered species and threatened species and shall utilize their authorities” to promote the ESA’s purposes.<sup>81</sup> The ESA provisions most relevant to this Article are section 4, which governs the listing and delisting of species and the designation of their critical habitat;<sup>82</sup> section 7, which imposes an affirmative duty on all federal agencies to carry out programs for the conservation of listed species<sup>83</sup> and a duty to ensure that their actions are not likely to jeopardize listed species or result in the destruction or adverse modification of their critical habitat;<sup>84</sup> and section 9, which makes it unlawful for any person to take any listed species within the United States.<sup>85</sup>

Scientific uncertainty concerning climate change and other matters can affect (and has affected) the application of these provisions. When deciding whether to list a species, the Services must consider several factors that necessarily require predictive judgments about the future of a species’ fate.<sup>86</sup> These include the present *or threatened* destruction, modification, or curtailment of its habitat or range; overutilization for commercial or other purposes; disease or predation; the inadequacy of existing regulatory mechanisms; and other natural or man-made factors affecting *the continued existence* of the species.<sup>87</sup> The ESA

78. A threatened species is one “which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.” 16 U.S.C. § 1532(20).

79. An endangered species is one “which is in danger of extinction throughout all or a significant portion of its range.” *Id.* § 1532(6).

80. *Id.* § 1531(b).

81. *Id.* § 1531(c)(1).

82. *Id.* § 1533. Section 4 also requires FWS and NMFS to develop and implement recovery plans for the conservation and survival of listed species. *Id.* § 1533(f)(1). The weight of judicial opinion is that recovery plans are not binding on the agencies that develop them. *See, e.g.,* Friends of Blackwater v. Salazar, 691 F.3d 428, 432–34 (D.C. Cir. 2012); *see also* Conservation Cong. v. Finley, 774 F.3d 611, 614 (9th Cir. 2014) (“[W]hile they provide guidance for the conservation of those species, they are not binding authorities.” (citing *Friends of Blackwater*, 691 F.3d at 432–34)).

83. 16 U.S.C. § 1536(a)(1).

84. *Id.* § 1536(a)(2).

85. *Id.* § 1538(a)(1)(B).

86. *Id.* § 1533(a)(1).

87. *Id.*; *see, e.g.,* *In re Polar Bear Endangered Species Act Listing & 4(d) Rule Litig.*, 794 F. Supp. 2d 65, 69 (D.D.C. 2011) (upholding FWS’s listing of the polar bear as threatened despite the claim that “climate science is too uncertain to support any reliable predictions about the future of polar bears”), *aff’d*, 709 F.3d 1 (D.C. Cir. 2013).

requires that the Services make listing determinations “solely on the basis of the best scientific and commercial data available . . . after conducting a review of the status of the species” and taking into account efforts being made by other governmental entities to protect the species.<sup>88</sup> Neither the ESA nor the joint FWS-NMFS implementing regulations define the term “best scientific and commercial data available,” affording the agencies the discretion to define it contextually and leaving little guidance for courts assessing whether the agencies have complied with the statutory mandate to base their decisions on such evidence.<sup>89</sup>

The jointly issued FWS-NMFS regulations provide that in determining whether a species is threatened:

[T]he Services must analyze whether the species is likely to become an endangered species within the foreseeable future. The term foreseeable future extends only so far into the future as the Services can reasonably determine that both the future threats and the species’ responses to those threats are likely. The Services will describe the foreseeable future on a case-by-case basis, using the best available data and taking into account considerations such as the species’ life-history characteristics, threat-projection timeframes, and environmental variability. The Services need not identify the foreseeable future in terms of a specific period of time.<sup>90</sup>

By definition, determining whether a species is threatened requires a projection of the future condition of the species, whose status could well be affected by climate change and other events and circumstances that are not known at the time of the designation decision.

The ESA requires the Services to designate critical habitat for a species concurrently with listing it “to the maximum extent prudent and determinable.”<sup>91</sup> Critical habitat designations must be made “on the basis of the best scientific data available” after taking into account economic and other factors.<sup>92</sup> The Services may exclude an area from critical habitat upon a determination that the benefits of the exclusion outweigh the benefits of inclusion, unless the agency determines, “based on the best scientific and commercial data available,”

88. 16 U.S.C. § 1533(b)(1)(A); *see also* 50 C.F.R. § 424.11(b) (2021).

89. *But cf.* Endangered and Threatened Wildlife and Plants: Notice of Interagency Cooperative Policy on Information Standards Under the Endangered Species Act, 59 Fed. Reg. 16,022 (July 1, 1994) (announcing interagency policy to provide criteria, establish procedures, and provide guidance to ensure that decisions made by the Services under the ESA represent the best scientific and commercial data available).

90. 50 C.F.R. § 424.11(d) (2021).

91. 16 U.S.C. § 1533(a)(3)(A).

92. *Id.* § 1533(b)(2); *see also* 50 C.F.R. § 424.12(a) (2021).

that exclusion will result in species extinction.<sup>93</sup> The joint regulations allow the Services to forego critical habitat designation if it is not prudent or determinable, and provide that designation is not determinable when either data sufficient to perform required analyses are lacking or the biological needs of the species are not sufficiently well known to identify an area that qualifies as critical habitat.<sup>94</sup> The repeated references to reliance on the best *available* data reflect a recognition that listing and critical habitat designation determinations must often be made despite uncertainty about the present and future status of the species under consideration.<sup>95</sup>

As noted above, section 7 of the ESA requires each federal agency to ensure that any action it authorizes, funds, or carries out not be likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the species' habitat.<sup>96</sup> Agencies must do so based on "the best scientific and commercial data available."<sup>97</sup> Further, they must do so in consultation with either one of the Services.<sup>98</sup> Figure 2 provides a flow chart of the ESA section 7 consultation process.

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93. 16 U.S.C. § 1533(b)(2); *see also* 50 C.F.R. § 424.19(c) (2021).

94. 50 C.F.R. § 424.12(a)(2) (2021). The ESA defines critical habitat as (i) the areas occupied by the species at the time of listing on which are found "physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection"; and (ii) areas outside the area occupied by the species at the time of listing upon a determination that the areas are essential for the conservation of the species. 16 U.S.C. § 1532(5)(A). For interpretation of these provisions, *see Weyerhaeuser Co. v. U.S. Fish and Wildlife Service*, 139 S. Ct. 361 (2018).

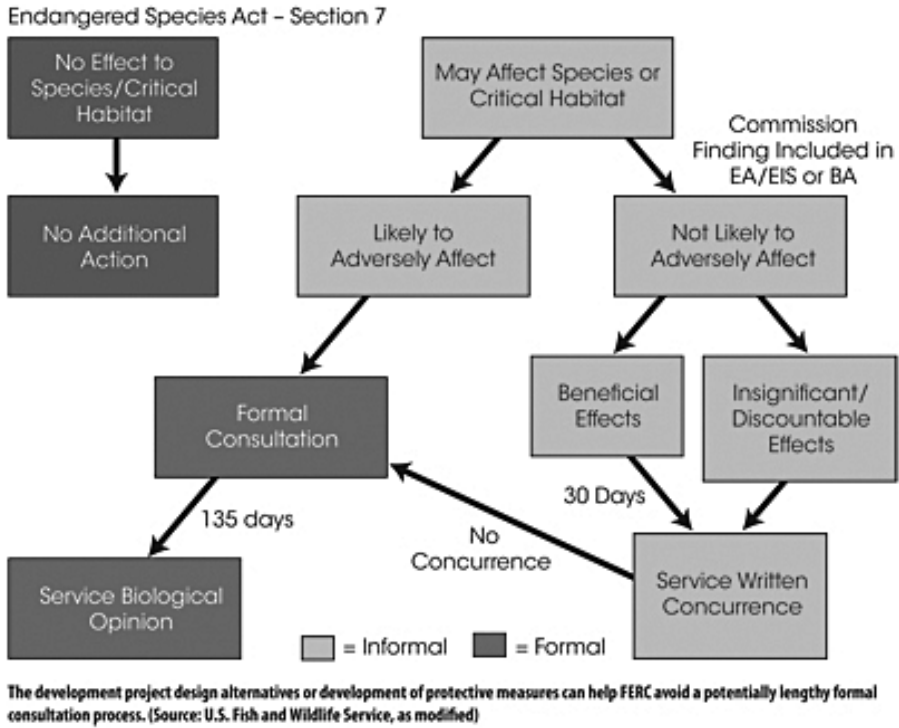
95. *See, e.g., Oceana, Inc. v. Evans*, 384 F. Supp. 2d 203, 219 (D.D.C. 2005) ("Time and again courts have upheld agency action based on the 'best available' science, recognizing that some degree of speculation and uncertainty is inherent in agency decisionmaking, even in the precautionary context of the ESA."), *order clarified*, 389 F. Supp. 2d 4 (D.D.C. 2005), *appeal dismissed*, 179 F. App'x 703 (D.C. Cir. 2006).

96. 16 U.S.C. § 1536(a)(2). The joint FWS-NMFS regulations define "jeopardize the continued existence" to mean "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species." 50 C.F.R. § 402.02 (2021). They define "destruction or adverse modification" as "a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species." *Id.*

97. 16 U.S.C. § 1536(a)(2).

98. *Id.*; 50 C.F.R. § 402.10(a) (2021).

FIGURE 2. ENDANGERED SPECIES CONSULTATION PROCESS (SECTION 7)<sup>99</sup>



The ESA section 7 consultation process is analogous in some respects to the NEPA compliance process in that the joint implementing regulations require different procedures and the preparation of different documents based on the likelihood and severity of an action’s impact on listed species.<sup>100</sup> Each

99. Alan D. Mitchnick, *Endangered Species Consultation: Why Does It Take So Long?*, RENEWABLE ENERGY WORLD (Apr. 23, 2014), <https://perma.cc/7PMQ-JMKR>.

100. See, e.g., *Sierra Club v. U.S. Army Corps of Eng’rs*, 990 F. Supp. 2d 9, 30 (D.D.C. 2013) (“The statute pursuant to which the FWS issued its opinion and take statement (Section 7 of the ESA, 16 U.S.C. § 1536(b)) establishes a ‘consultation’ process whereby other federal agencies considering whether or not to exercise their own permitting authority engage with the FWS—a process that differs significantly from the kind of agency activity that ordinarily counts as major federal action for NEPA purposes.”); *Fund for Animals v. Hall*, 448 F. Supp. 2d 127, 136 (D.D.C. 2006) (describing some of the “important ways” in which “the ESA’s Section 7 consultation process differs from the cumulative impacts analysis required by NEPA”); Jody Freeman & Jim Rossi, *Agency Coordination in Shared Regulatory Space*, 125 HARV. L. REV. 1131, 1184 (2012) (“Interagency consultation requirements such as those embodied in the ESA and NEPA similarly provide vehicles for pooling expertise and data from different sources.”); Brian J. Gatchel, *Informational and Procedural Standing After Lujan v. Defenders of Wildlife*, 11 J. LAND USE & ENV’T L. 75, 104 (1995) (comparing the ESA consultation and NEPA documentation processes); Oliver A. Houck & Michael Rolland,

agency must confer with the appropriate Service on any action which is likely to violate section 7(a)(2).<sup>101</sup> Any agency may prepare a biological assessment in cooperation with the appropriate Service.<sup>102</sup> The assessment evaluates the potential effects of a proposed action on listed species and designated and proposed critical habitat for the purpose of determining whether any listed species or habitat are likely to be adversely affected and whether formal consultation with one of the Services is necessary.<sup>103</sup>

If the action agency determines that its action may affect listed species or critical habitat, formal consultation is required, unless, after informal consultation or preparation of a biological assessment, the agency determines, with the Service's written concurrence, that the proposed action is not likely to adversely affect any listed species or critical habitat.<sup>104</sup> Any federal agency requesting formal consultation must provide the Service with the best scientific and commercial data available or which can be obtained during the consultation for an adequate review of the effects the action may have on listed species or critical habitat.<sup>105</sup>

During formal consultation, the Service must, among other things, evaluate the effects of the action and the cumulative effects on listed species or critical habitat.<sup>106</sup> The regulations define "effects" as consequences to listed species or critical habitat that:

[A]re caused by the proposed action . . . . A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action.<sup>107</sup>

The regulations further provide that "[a] conclusion of reasonably certain to occur must be based on clear and substantial information, using the best

*Federalism in Wetlands Regulation: A Consideration of Delegation of Clean Water Act Section 404 and Related Programs to the States*, 54 MD. L. REV. 1242, 1258–59, 1299–1300 (1995) (referring to the differences between ESA consultations and the NEPA process).

101. 50 C.F.R. § 402.10(a) (2021).

102. *Id.* § 402.12(b)(1). If the Service advises that no listed species or critical habitat may be affected, the action agency need not prepare a biological assessment and further consultation is unnecessary. *Id.* § 402.12(d)(1); *see also* 16 U.S.C. § 1536(c).

103. 50 C.F.R. § 402.12(k)(1) (2021). The regulations provide for optional informal consultation between the Service and the action agency to assist the action agency in determining whether formal consultation is required. *Id.* § 402.13(a). If the action agency decides, with the Service's concurrence, after informal consultation that its action is not likely to adversely affect listed species or critical habitat, formal consultation is not required. *Id.* § 402.13(c).

104. *Id.* § 402.14(a)–(b)(1).

105. *Id.* § 402.14(d).

106. *Id.* § 402.14(g)(3).

107. *Id.* § 402.02.



scientific and commercial data available.”<sup>108</sup> An effect may be deemed to not have been caused by an action based on temporal or geographic remoteness or the presence of “a lengthy causal chain that involves so many steps as to make the consequence not reasonably certain to occur.”<sup>109</sup>

The Services’ definition of cumulative effects is evocative of the NEPA regulations that call for evaluation of reasonably foreseeable actions and impacts. The ESA regulations define “cumulative effects” as those “that are reasonably certain to occur within” the area of the action subject to consultation.<sup>110</sup> The regulations again specify that a conclusion of “reasonably certain to occur must be based on clear and substantial information, using the best scientific and commercial data available.”<sup>111</sup> These provisions all require predictive judgments whose accuracy and reliability may be affected by scientific uncertainty.

At the end of the consultation process, the Service must prepare a biological opinion.<sup>112</sup> The opinion must specify whether the Service has determined that the action is or is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of its critical habitat, a determination that often occurs in a context of scientific uncertainty about the fate of a species or its habitat.<sup>113</sup> If the Service issues a jeopardy opinion, it must include reasonable and prudent alternatives,<sup>114</sup> which are alternatives that can be implemented in a manner consistent with the intended purpose of the action, that are within the action agency’s legal authority, that are economically and technologically feasible, and that the Service “believes would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat.”<sup>115</sup> Formal consultation ends upon issuance of a biological opinion.<sup>116</sup>

If the Service concludes that an action and the resultant incidental take of listed species will not violate section 7(a)(2), it must include in a biological opinion an incidental take statement (“ITS”).<sup>117</sup> Incidental takes are those “that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant.”<sup>118</sup> An ITS describes the impact of the incidental take on the species, reasonable and prudent measures to mini-

108. *Id.* § 402.17(b).

109. *Id.*

110. *Id.* § 402.02.

111. *Id.* § 402.17(a).

112. *Id.* § 402.14(e)(3).

113. *Id.* § 402.14(h)(1)(iv). The former finding results in a “jeopardy biological opinion,” while the later results in a “no jeopardy biological opinion.” *Id.*

114. *Id.* § 402.14(h)(2); *see also* 16 U.S.C. § 1536(b)(3)(A).

115. 50 C.F.R. § 402.02 (2021).

116. *Id.* § 402.14(m)(1).

117. *Id.* § 402.14(i)(1); 16 U.S.C. § 1536(b)(4).

118. 50 C.F.R. § 402.02 (2021).

mize the impact, and terms and conditions to implement those measures.<sup>119</sup> If the amount or extent of incidental take allowed by the ITS is exceeded during the course of the action, the action agency must reinitiate consultation.<sup>120</sup> Any take that complies with an ITS does not qualify as a taking prohibited by section 9 of the ESA.<sup>121</sup>

The final provision that is potentially relevant to our study is the section 9 take prohibition.<sup>122</sup> Any person, including a private individual or business or a federal agency, may violate the take prohibition.<sup>123</sup> The take prohibition does not implicate scientific uncertainty as obviously as the ESA's listing and consultation provisions do. But even here, predictive judgments are relevant and may be affected by that uncertainty. The ESA, for example, defines "take" to include "harass."<sup>124</sup> The joint FWS-NMFS regulations define "harass" as "an intentional or negligent act or omission which creates the *likelihood* of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering."<sup>125</sup>

Various permitting provisions also may be affected by uncertainty. ESA regulations provide for the issuance of permits authorizing otherwise prohibited takes for scientific purposes, enhancement of species propagation or survival, or incidental takes.<sup>126</sup> In ruling on a permit for scientific purposes or enhancement of survival, the Service must consider the probable direct and indirect effects which permit issuance would have on affected wild populations, and whether the permit's purpose would be likely to reduce the threat of extinction facing the species of affected wildlife.<sup>127</sup> The Service may not issue an incidental take permit unless it concludes that the taking to be authorized "will not appreciably reduce the likelihood of the survival and recovery of the species in the wild."<sup>128</sup> Further, the regulations authorize imposition of additional conservation and mitigation requirements on permit holders if it deems them necessary to respond to unforeseen circumstances.<sup>129</sup>

119. 16 U.S.C. § 1536(b)(4); 50 C.F.R. § 402.14(i)(1) (2021).

120. 50 C.F.R. § 402.14(i)(4) (2021).

121. *Id.* § 402.14(i)(5).

122. 16 U.S.C. § 1538(a)(1).

123. *See id.* § 1532(13) (defining person).

124. *Id.* § 1532(19).

125. 50 C.F.R. § 17.3(c) (2021) (emphasis added).

126. *Id.* § 17.22.

127. *Id.* § 17.22(a)(2)(ii), (iv).

128. *Id.* § 17.22(b)(2)(D); 16 U.S.C. § 1539(a)(2)(B)(iv).

129. 50 C.F.R. § 17.22(b)(5)(iii)(B) (2021). Unforeseen circumstances are those that could not reasonably have been anticipated at the time a habitat conservation plan was negotiated. *Id.* § 17.3.

The ESA's mandates that FWS and NMFS premise their regulatory decisions on the best available scientific evidence available implicitly recognize that the agencies must necessarily operate at times without access to definitive scientific answers. The regulatory provisions requiring the Services to consider effects that are reasonably certain to occur likewise recognize the need for predictive judgments. Climate change presents a host of scientific questions for which answers are not currently available, and climate science turns on modeling and other predictive judgments.<sup>130</sup> Our study sought to determine how the federal courts evaluated agency efforts to respond to these kinds of challenges.

## II. A METHODOLOGICAL SUMMARY

To assemble the data for this Article, we began with a database of 838 cases initially compiled for another empirical evaluation of climate litigation, *Strategies in and Outcomes of Climate Change Litigation in the United States* ("Strategies and Outcomes") in which two of us participated.<sup>131</sup> That database included all lawsuits involving climate change<sup>132</sup> filed in federal or state courts in the United States between 1990 and 2016 that were identified by the Columbia University Law School Sabin Center for Climate Change Litigation Chart.<sup>133</sup> The Sabin Center database includes the date each lawsuit was filed, its current status, a short description of the lawsuit, and the identities of the plaintiffs and defendants. The Chart also provides links to documents such as complaints and judicial decisions.

The team for the *Strategies and Outcomes* research effort coded each lawsuit in the Sabin Center database according to the level of science (either climate- or non-climate-related) discussed in the documents in that case file (e.g., court opinion, settlement order, brief). The team defined the *level of science used* as the number of words, terminology, or phrases mentioned in any court document that indicated any reference to or discussion of scientific information re-

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130. See *supra* notes 15–24 and accompanying text.

131. Sabrina McCormick et al., *Strategies in and Outcomes of Climate Change Litigation in the United States*, 8 NATURE CLIMATE CHANGE 829 (2018), <https://perma.cc/N5ME-GZRD>.

132. Sabin Center staff compile their charts by searching Westlaw's databases for cases that have some substantive nexus with GHG mitigation, climate change impacts, or climate adaptation, and through daily review of news articles in publications that cover environmental and energy law and policy that have a particular climate focus. Markell & Ruhl, *Assessment*, *supra* note 45, built their analysis from the Sabin Center database. E-mails from Margaret Barry to Daniel Kim (July 27 & 29, 2017) (on file with authors); see also Markell & Ruhl, *Assessment*, *supra* note 45, at 27 ("We decided to define climate change litigation as any piece of federal, state, tribal, or local administrative or judicial litigation in which the party filings or tribunal decisions directly and expressly raise an issue of fact or law regarding the substance or policy of climate change causes and impacts.").

133. For a current version of the chart, see *U.S. Climate Change Litigation*, COLUM. L. SCH. SABIN CTR. FOR CLIMATE CHANGE & ARNOLD & PORTER, <https://perma.cc/F8KE-PBJP>.

lating to a legal issue in the case.<sup>134</sup> The team then manually checked each document that contained a flagged term to determine whether the flagged terms were actually indicative of discussion of scientific information. If flagged terms appeared in a part of the document discussing climate science (e.g., climatology) and qualified as *climate-related scientific evidence*, it counted as one instance of climate science evidence being discussed in the case. If the relevant words were in a part of the document discussing any other science (e.g., non-climate science, economics), it qualified as *non-climate scientific evidence* and was counted as one instance of non-climate science evidence being discussed in the case. Depending on the number of instances of references in a document to climate or non-climate scientific evidence, the team coded the document as “no science discussed,” “court engaged in scientific discussion,” “science important, but not central,” or “science central.”

For this Article, we modified the database of 838 lawsuits that emerged from the earlier study in four ways. First, we retained only cases that were filed in a federal administrative or judicial forum. Second, we excluded cases coded as “no science discussed.” Third, we updated the database by adding federal lawsuits identified in the Sabin Center Chart in which scientific evidence was discussed and filed between 2016 and 2018.<sup>135</sup> Fourth, we merged cases decided at different levels (e.g., a district court case that was later reviewed by a circuit court of appeals) into a single case, using the decision handed down at the highest level.<sup>136</sup> The final database included 222 climate-related federal lawsuits filed from 1990 to 2018 in which scientific evidence is discussed.

For each of the remaining 222 cases, we collected all publicly available documents from each lawsuit (i.e., 5,695 documents in total).<sup>137</sup> We then sorted those documents into one of six author groups: plaintiff, defendant, plaintiff’s amici, defendant’s amici, court, and other. We created a folder for each case, using the NVivo qualitative data analysis software package,<sup>138</sup> with subfolders

134. We used the following list of search terms to highlight areas where the court may be discussing scientific evidence to determine the impact of the evidence on the court’s decisions: *science, scientific, greenhouse gas, GHG, emission, emit, air, quality, qualitative, quantify, quantitative, global warming, climate, climate change, data, evidence, research, expert, report, comment, study, witness, testimony, testify, IPCC, health, public health, -ology, -logic, -logical.*

135. We coded every lawsuit based on the year filed and the year decided. The cutoff date for inclusion in our database for this Article for the “year filed” was December 31, 2018. The cutoff date for the “year decided” was June 30, 2020. We coded lawsuits filed before December 31, 2018, but decided after June 30, 2020, as “pending.”

136. For cases decided at the district court and appellate court levels, we analyzed both decisions, but coded the cases as deference or no deference cases based on the appellate court decision.

137. Most documents were downloaded from the Westlaw database. If a case was not available from Westlaw, we returned to the Sabin Center Chart and downloaded the documents available on the page for that case. For cases appearing in neither Westlaw nor the Sabin Center database, we searched the web using Google for case materials.

138. NVivo is “a software package that allows [one] to categorize key words and phrases according to topics and interrelated themes, while also ensuring that the coded data are organized in a meaningful and user-friendly manner.” Mellisa Holtzman, *Family Definitions and Chil-*

for each author group. Any additional documents were included in the case's general file but outside of any of the author group subfolders.

In an attempt to select the group of climate lawsuits in which judges engaged in discussion of scientific uncertainty, we took a two-step approach with the database of 222 court opinions: text coding using NVivo and manual qualitative analysis.<sup>139</sup> Through this two-step approach, we compiled a final database of fifty-one cases brought under NEPA and the ESA against federal agencies in which scientific uncertainty figured prominently in the courts' opinions. We then analyzed the sample and divided the cases into two groups: cases in which the court granted deference to agencies' use of science and cases in which the court did not. As the Conclusion explains, we found that there are recurring themes among the cases falling under each type regarding how judges reflect on scientific uncertainty in their rulings.

### III. QUANTITATIVE AND QUALITATIVE ANALYSIS OF SCIENTIFIC UNCERTAINTY IN CLIMATE LITIGATION

To determine how the federal courts have responded to the challenge of applying legal doctrines to uncertainty in climate science, as presented to the courts in litigation brought under NEPA and the ESA, we engaged in both quantitative and qualitative analysis of the fifty-one cases in our database. In Part III.A, we present a general overview of the fifty-one cases using univariate and bivariate descriptive statistical analysis,<sup>140</sup> which provide answers to several key questions about the nature of the litigated climate cases that involve scientific uncertainty. Part III.B presents the qualitative research methods that we used to analyze the textual data mined from the court opinions. Based on that analysis of the NEPA and ESA cases, we are able to identify situations in which the courts applied deferential or non-deferential review of agency efforts to address scientific uncertainty in carrying out their statutory duties.

#### A. *Quantitative Analysis of the Case Results*

Among the questions that interested us was what kinds of litigants brought suits in which the courts were most likely to engage on issues that prompted discussion of scientific uncertainty. We found that the main plaintiffs for these lawsuits were environmental nongovernmental organizations ("ENGOs"). Out of the fifty-one climate cases in our database in which courts discussed scientific uncertainty, forty cases were filed by ENGOs (Table 1). The

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*dren's Rights in Custody Decision Making: The Importance of a Changing Litigant Context*, 49 FAM. CT. REV. 591, 594 (2011); see NVivo: *Qualitative Data Analysis Software*, QSR INT'L, <https://perma.cc/BM5N-SHAA>.

139. For further discussion, see Appendix 2.

140. Univariate analysis is the analysis of one variable. Bivariate analysis is the analysis of two variables. Descriptive statistical analysis describes the basic statistical features of the data.

NGOs that frequently initiated lawsuits that triggered discussion of scientific uncertainty include the Center for Biological Diversity (“CBD”), Sierra Club, Defenders of Wildlife, and Natural Resources Defense Council (“NRDC”).

TABLE 1. TYPE OF PLAINTIFFS AND DEFENDANTS AND THE NUMBER OF CASES FOR EACH PLAINTIFF V. DEFENDANT

Agency (defendant)	NGO (plaintiff)	Industry (plaintiff)	Local Gov (plaintiff)	Individual (plaintiff)	Total
Army Corps	3	0	0	0	3
Bureau of Land Management	4	0	0	2	6
Bureau of Ocean Energy Management	0	0	1	0	1
Department of the Interior – other	1	0	0	0	1
Federal Energy Regulatory Commission	2	0	0	0	2
Federal Highway Administration	1	0	0	0	1
Forest Service	5	0	0	0	5
Fish and Wildlife Service	9	2	1	1	13
National Highway Traffic Safety Administration	1	0	1	0	2
National Oceanic and Atmospheric Administration	4	2	0	0	6
State Department	1	0	0	0	1
Surface Transportation Board	1	0	0	1	2
Multiple Agency	8	0	0	0	8
Total	40	4	3	4	51

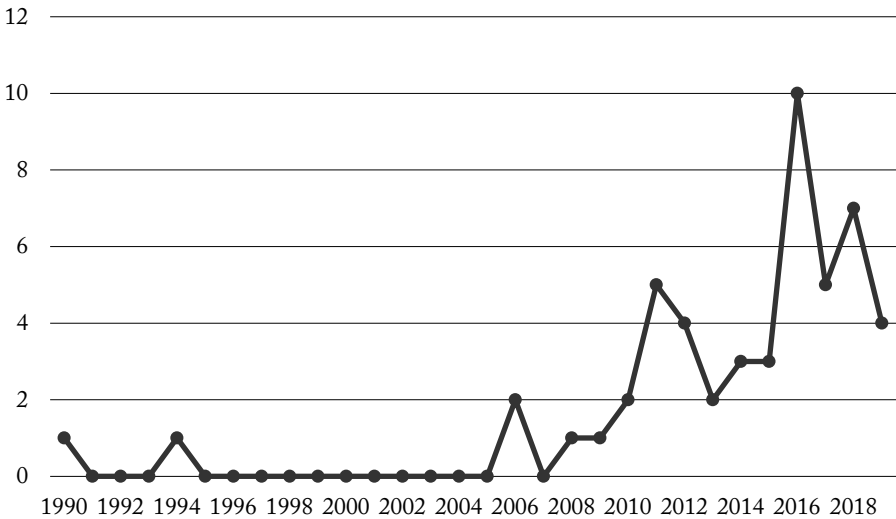
Another question was which agencies were defendants in lawsuits in which the courts addressed scientific uncertainty relating to climate change. The federal agencies frequently sued included FWS, the U.S. Forest Service (“USFS”), the Bureau of Land Management (“BLM”), and NOAA (see Table 1). Most of the disputes in our database involved challenges by ENGOs to federal agencies that had approved development projects with potential adverse environmental effects.

We were also interested in ascertaining whether judicial scrutiny of scientific uncertainty in climate litigation became more or less intrusive over time. On the one hand, as climate issues become more familiar, courts might become more comfortable addressing the science brought to their attention by litigants. On the other hand, if continuing scientific research (such as research involving

attribution science) sheds new light on the mechanisms and impacts of climate change, there might be less uncertainty for the agencies and courts to discuss.

Figure 3 shows how many cases in our database were decided each year in the time period covered by our search. It shows that the number of opinions that discussed scientific uncertainty generally *increased* over time, first gradually and then more sharply, although there was a drop-off in later years. In 2016, there was a peak, with ten cases in which the judges discussed scientific uncertainty. The total number of cases shown in this graph represents fifty cases. One remaining case of the fifty-one in our database had not been decided as of June 30, 2020, which was the final date for the decisions of the cases to be included in this research.<sup>141</sup>

FIGURE 3. CASES DECIDED BY YEAR



141. *Crow Indian Tribe v. United States*, 343 F. Supp. 3d 999 (D. Mont. 2018), was decided before our cutoff date for decided cases, but the Ninth Circuit's decision affirming in part and remanding in part the district court's decision was issued after that cutoff date. *Crow Indian Tribe v. United States*, 965 F.3d 662 (9th Cir. 2020). We therefore coded the case as pending as of our June 30, 2020 cutoff date. The Ninth Circuit agreed with the district court that FWS's decision to delist the grizzly bear population in the Greater Yellowstone Ecosystem under the ESA was arbitrary and capricious because the agency failed to adequately analyze the effect of delisting on the remnant grizzly population and acted contrary to the best available science in determining that the Yellowstone grizzly was no longer threatened in the long term by a lack of genetic diversity. *Id.* at 677–80.

*Natural Resources Defense Council v. Bernhardt*, No. 1:05-cv-02107, 2020 WL 364098 (E.D. Cal. Jan. 22, 2020), was a case in which ENGOs alleged that long-term priority water contracts with the Bureau of Reclamation violated section 9 of the ESA, 16 U.S.C. § 1538, which prohibits the taking of listed species. The decision, which was issued after our cutoff date, involved disposition of motions to stay and dismiss that did not end the litigation.

Our next question was what kinds of environmental problems triggered judicial discussion of scientific uncertainty in climate cases.<sup>142</sup> Among the climate change lawsuits in which the judges engaged in a discussion about scientific uncertainty, biodiversity and air pollution were the two environmental impacts linked to climate change that the courts discussed most frequently (see Figure 4). Most of the biodiversity cases, not surprisingly, were among the twenty-one lawsuits filed under the ESA. The thirty NEPA cases included all five topics shown in Figure 4: air, water, biodiversity, energy, and other.<sup>143</sup> The air pollution cases usually disputed the likelihood of a development project (e.g., industrial plants or factories) emitting harmful pollutants and causing damage to the environment, especially with regard to cumulative effects on and from climate change. The biodiversity topics revolved around federal actions that were likely to affect endangered species and/or their habitats based on climate change models that forecast the well-being of those species.

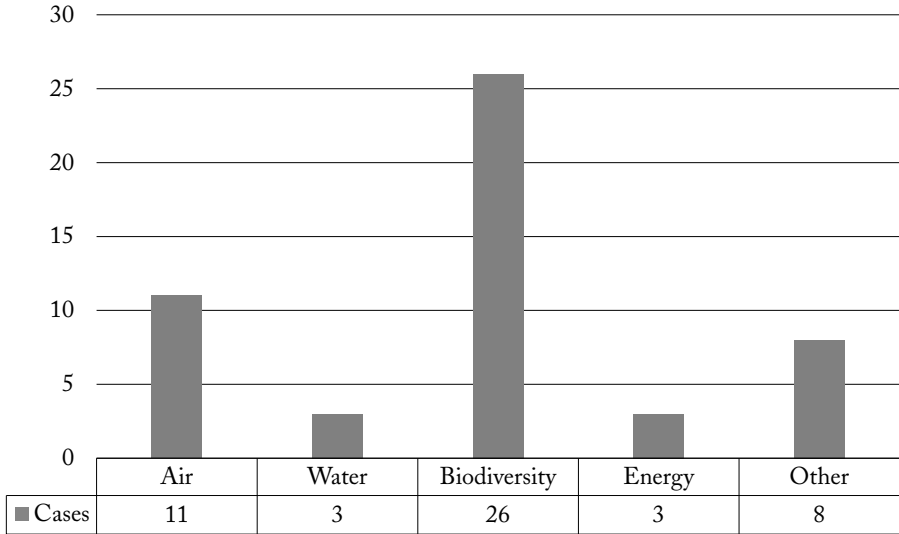
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142. The cases in our database are derived from the Sabin Center's climate litigation database. *See supra* notes 133–37 and accompanying text. A case is included in the Sabin database only if “climate change law, policy, or science [is] a material issue of law or fact in the case. Cases that make only a passing reference to climate change, but do not address climate-relevant laws, policies, or actions in a meaningful way are not included.” *About*, CLIMATE CHANGE LITIG. DATABASES, <https://perma.cc/FT9J-ZY6K>. Climate change, however, affects the natural environment in many different ways. For example, it can exacerbate the formation of ozone pollution by raising surface temperatures. *See Air Quality and Climate Change Research*, EPA, <https://perma.cc/VX97-28Z9> (“Atmospheric warming associated with climate change has the potential to increase ground-level ozone in many regions, which may present challenges for compliance with the ozone standards in the future.”). Climate change can alter habitat in ways that displace species or threaten their viability. *See Habitats*, NAT'L WILDLIFE FED'N, <https://perma.cc/U3F9-DGAU> (“Climate change is altering key habitat elements that are critical to wildlife's survival and putting natural resources in jeopardy.”). As a result, a case that qualifies as a climate litigation case in the Sabin database almost invariably implicates resources associated with other environmental regulatory programs, such as those intended to protect clean air, clean water, or endangered or threatened species.

143. “Other” covered topics that do not fit squarely into the other four topics. These are mostly multi-topical lawsuits that dispute various environmental impacts without necessarily pinpointing one as the primary issue. For example, *Center for Biological Diversity v. Bureau of Land Management*, No. 2:14-cv-00226, 2017 WL 3667700 (D. Nev. Aug. 23, 2017), *appeal dismissed*, No. 17-17152, 2017 WL 7036679 (9th Cir. Dec. 17, 2017), involved issues concerning air, water, and biodiversity (in terms of species habitat) without plaintiffs having focused on any one primary topic.



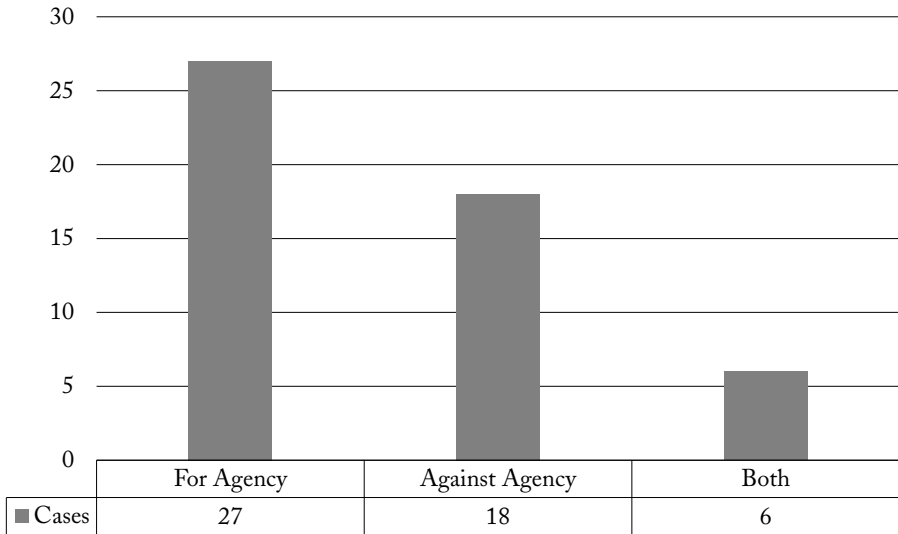
FIGURE 4. AREAS OF ENVIRONMENTAL IMPACT IN NEPA AND ESA LITIGATION



Finally, as Part III.B indicates, we were interested in the degree of deference (if any) that the courts afforded to the defendant agencies on the agencies’ determinations involving scientific uncertainty. As Figure 5 indicates, the courts elected not to defer to the agency regarding scientific uncertainty and ruled against the agency in eighteen cases. In another twenty-seven cases, the courts decided that the agencies were entitled to deference in disposing of challenges to agency action. There were six cases in which the courts deferred to an agency’s scientific reasoning on some claims but not on others.<sup>144</sup> Part III.B explores the reasons why the courts deferred to agency responses to scientific uncertainty in some cases but not others.

144. For example, in *Oceana, Inc. v. Pritzker*, 75 F. Supp. 3d 469 (D.D.C. 2014), the court decided that NMFS sufficiently considered the potential climate change impact on loggerhead turtles of operation of the Atlantic Sea Scallop Fishery in a biological opinion (“BiOp”) it prepared under the ESA, despite the uncertainties surrounding these topics. *Id.* at 491–93. The court refused to defer, however, to the agency’s selection of a monitoring surrogate to serve as a proxy for the numerical take limit specified in an ITS that accompanied the BiOp or to the agency’s perception of the effectiveness of its chosen monitoring mechanism. *Id.* at 494–99. On remand, the court again deferred to part but not all of NMFS’s analysis of its revised BiOp. *See Oceana, Inc v. Ross*, 321 F. Supp. 3d 128 (D.D.C. 2018).

FIGURE 5. PRESENCE OR ABSENCE OF JUDICIAL DEFERENCE TO AGENCY SCIENCE



*B. Qualitative Textual Analysis of Judicial Treatment of Scientific Uncertainty*

As Part III.A reveals, the courts afforded deference to the manner in which agencies addressed scientific uncertainty in some NEPA and ESA cases but not others. Our principal aim in conducting this study was to determine what accounts for judicial willingness (or unwillingness) to defer to agencies on questions for which, by definition, there is no clear answer but for which agencies generally tend to have more expertise than federal judges. This section identifies factors that may explain when courts are likely to defer to agency resolution of questions on which climate science is unsettled.

*1. The Applicability and Significance of the Standard of Review*

The degree of deference that courts afford administrative agency determinations depends on several factors. One factor is the nature of the legal issue presented to the court. The courts may address review of questions of fact, law, and policy differently. The federal Administrative Procedure Act (“APA”), for example, mandates the application of different standards of review for agency determinations on questions of fact,<sup>145</sup> law,<sup>146</sup> and policy.<sup>147</sup> Another potentially

145. 5 U.S.C. § 706(2)(A), (E).

146. *Id.* § 706(2)(C) (governing judicial review of agency statutory interpretations).

147. *Id.* § 706(2)(A) (requiring application of the arbitrary and capricious test); *see also* ROBERT L. GLICKSMAN & RICHARD E. LEVY, ADMINISTRATIVE LAW: AGENCY ACTION IN LE-

relevant factor is the procedure the agency used in reaching its decision. Under the APA, judicial review of factual determinations reached in formal rulemaking or adjudication is subject to review under the substantial evidence test,<sup>148</sup> while the arbitrary and capricious test applies to factual determinations reached in informal rulemaking or adjudication.<sup>149</sup> In addition, the willingness of courts to defer to challenged agency determinations may turn on “factors such as the relative expertise of the agency and the courts, the agency’s familiarity with the record, and the extent to which review may interfere with agency operations or be necessary to protect the rights of parties.”<sup>150</sup>

The applicability of one standard of review rather than another matters: “[a]t bottom, the scope and standard of review determine the allocation of power among Congress, agencies, and the courts. Deference to agencies allows them to control policy choices, while aggressive review means that courts control policy choices.”<sup>151</sup> Review of agency factual determinations tends to be relatively deferential because Congress has delegated fact-finding responsibility to the agency whose decision is being reviewed, the agency has (comparatively greater) expertise in the field, and the agency is more familiar with the record.<sup>152</sup>

The arbitrary and capricious standard of review applied to most of the determinations relating to scientific uncertainty in the cases in our database. Because NEPA does not include a provision authorizing judicial review, NEPA challenges must be brought based on a cause of action derived from the APA.<sup>153</sup> The ESA includes a citizen suit provision but, with limited exceptions,<sup>154</sup> it only authorizes suits against FWS or NMFS in which the plaintiff alleges a failure to perform a nondiscretionary duty under the statutory listing provi-

GAL CONTEXT 189 (3d ed. 2020) (stating that courts strike the balance between giving agencies the discretion needed to implement statutory mandates and protecting the rights of parties and preserving the rule of law “depending on whether the question for review is one of fact, law, or policy”).

148. 5 U.S.C. § 706(2)(E); GLICKSMAN & LEVY, *supra* note 147, at 246.

149. GLICKSMAN & LEVY, *supra* note 147, at 247.

150. *Id.* at 189.

151. *Id.*

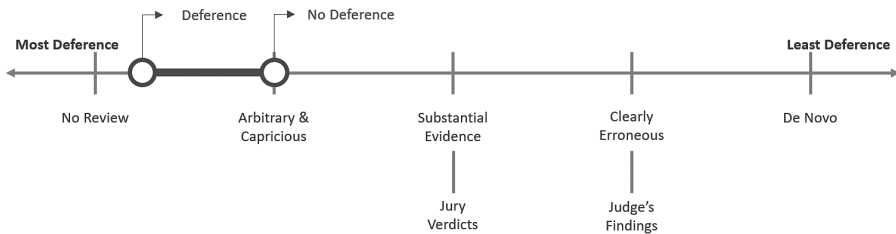
152. *Id.* at 222.

153. *Wild Va. v. Council on Env’t Quality*, 544 F. Supp. 3d 620, 632 (W.D. Va. 2021). Section 702 of the APA provides that “[a] person suffering legal wrong because of agency action, or adversely affected or aggrieved by agency action within the meaning of a relevant statute, is entitled to judicial review thereof.” 5 U.S.C. § 702. The APA also provides that “final agency action for which there is no other adequate remedy in a court [is] subject to judicial review.” *Id.* § 704. These provisions create a cause of action for review of final agency action. *See* *Block v. Cmty. Nutrition Inst.*, 467 U.S. 340, 345 (1984) (“The APA confers a general cause of action upon persons ‘adversely affected or aggrieved by agency action within the meaning of a relevant statute.’” (quoting 5 U.S.C. § 702)).

154. *See* 16 U.S.C. § 1540(g)(1)(B) (authorizing suits to compel the Secretary of the Interior or Agriculture to apply the statutory prohibitions on taking endangered or threatened species in the event of an emergency that poses a significant risk to the well-being of a listed species).

sions.<sup>155</sup> Thus, many ESA cases are also brought under the APA, which governs judicial review of agency actions under both statutes.<sup>156</sup> In any event, because the ESA's citizen suit provision does not enunciate its own standard of review, "[i]rrespective of whether an ESA claim is brought under the APA or the citizen-suit provision, the APA's 'arbitrary and capricious' standard applies."<sup>157</sup> Neither NEPA nor the ESA require formal rulemaking or adjudication.<sup>158</sup> The determinations at issue, in the portions of the cases in which we were interested, were either factual determinations concerning the scientific evidence before the court or policy determinations concerning how the agency should proceed in the face of scientific uncertainty. Both kinds of determinations are subject to arbitrary and capricious review under the APA.<sup>159</sup> Thus, the courts in the cases we analyzed, in applying the arbitrary and capricious standard, had to choose the degree of deference that was appropriate in the circled portion of Figure 6, ranging from deference to little or no deference.

FIGURE 6. SPECTRUM OF DEFERENCE<sup>160</sup>



Within that range, a court could determine that the agency's determinations were entitled to deference or that they were not entitled to deference and

155. *Id.* § 1540(g)(1)(C).

156. *Ariz. Cattle Growers' Ass'n v. U.S. Fish & Wildlife Serv.*, 273 F.3d 1229, 1235–36 (9th Cir. 2001) (“Judicial review of administrative decisions involving the ESA is governed by section 706 of the APA.”); *cf.* *WildEarth Guardians v. Steele*, 545 F. Supp. 3d 855, 863 (D. Mont. 2021) (“The Administrative Procedures [sic] Act . . . governs judicial review of agency actions under NEPA and the ESA.”).

157. *W. Watersheds Project v. Kraayenbrink*, 632 F.3d 472, 481 (9th Cir. 2011).

158. The one context in which formal adjudication is required under the ESA is when the Endangered Species Committee considers an application for an exemption from the ESA's no jeopardy provision, 16 U.S.C. § 1536(a)(2). *See id.* § 1536(g)(4) (requiring a hearing in accordance with the APA's formal adjudication procedures, 5 U.S.C. §§ 554–556). None of the cases in our database involved such an exemption request.

159. *See* 5 U.S.C. § 706(2)(A); ROBERT GLICKSMAN ET AL., *STAY AHEAD OF THE PACK: YOUR COMPREHENSIVE GUIDE TO THE UPPER LEVEL CURRICULUM* 33–34 (2018); *see also* DANIEL R. MANDELKER ET AL., *NEPA LAW AND LITIGATION* 108 (2021 ed.) (“[J]udicial review of factual questions is carried out under the deferential ‘arbitrary and capricious’ standard of review.” (citing *Marsh v. Or. Nat. Res. Council*, 490 U.S. 360 (1989))).

160. GLICKSMAN & LEVY, *supra* note 147, at 222.

therefore, reflected arbitrary and capricious decision-making (as reflected in the right side of Figure 6). Deferential review would tend to be characterized by a court's disinclination to second-guess the agency's approach to factual or policy matters where the science is uncertain, even if the party challenging the agency's decision took issue with that approach.<sup>161</sup> Non-deferential review would tend to reflect judicial dissatisfaction with the agency's failure to consider scientific uncertainty or the agency's inadequate explanation of how it treated the uncertainty.<sup>162</sup>

## 2. *The Meaning of Arbitrary and Capricious Review*

How does a court decide whether to defer to agency factual or policy determinations? Several Supreme Court cases exploring the meaning and application of the arbitrary and capricious test provide the starting points in answering that question. *Citizens to Preserve Overton Park, Inc. v. Volpe*<sup>163</sup> sent mixed signals in an early environmental case about the appropriate degree of deference owed to agencies by courts applying the arbitrary and capricious test. The key question, the Court explained, is:

Whether the decision was based on a consideration of the relevant factors and whether there has been a clear error of judgment. Although this inquiry into the facts is to be searching and careful, the ultimate standard of review is a narrow one. The court is not empowered to substitute its judgment for that of the agency.<sup>164</sup>

As Peter Strauss has pointed out, *Overton Park* provided the “foundation stone for contemporary ‘hard look’ judicial review,” which has reflected the Court's insistence that even though arbitrary and capricious review is “narrow,” it must at the same time be “searching” and “thorough,” which often triggers an “extensive . . . inquiry” into the merits of agency reasoning.<sup>165</sup>

A dozen years later, the Court carved out a category of cases in which particularly deferential review is called for in *Baltimore Gas & Electric v. Natural*

161. See, e.g., *WildEarth Guardians v. U.S. Army Corps of Eng'rs*, 429 F. Supp. 3d 1224, 1270 (D.N.M. 2019) (“A ‘careful, searching review’ in this case reveals highly technical determinations by scientists that, while [they] may be disputable in the eyes of [the plaintiff], earn deference in the eyes of the Court . . .”).

162. See, e.g., *Ctr. for Biological Diversity v. Bureau of Land Mgmt.*, 937 F. Supp. 2d 1140, 1157 (N.D. Cal. 2013) (“[W]e must reject any attempt by agencies to shirk their responsibilities under NEPA by labeling any and all discussion of future environmental effects as ‘crystal ball inquiry.’” (quoting *City of Davis v. Coleman*, 521 F.2d 661, 676 (9th Cir. 1975))).

163. 401 U.S. 402 (1971).

164. *Id.* at 416 (citations omitted).

165. Peter L. Strauss, *Revisiting Overton Park: Political and Judicial Controls over Administrative Actions Affecting the Community*, 39 UCLA L. REV. 1251, 1263 (1992).

*Resources Defense Council*.<sup>166</sup> That case involved a NEPA challenge to the Nuclear Regulatory Commission's ("NRC" or "Commission") approach to the licensing of nuclear power plants.<sup>167</sup> The issue before the agency was how to factor into the decision-making process the environmental risks posed by the "back-end" of the fuel cycle, including the storage and disposal of nuclear waste, whose nature and magnitude were uncertain. The NRC acknowledged that the risks from long-term onsite storage pending the development of a safe method of permanent disposal were uncertain, but it took the position that research would likely resolve most of those uncertainties in the near future.<sup>168</sup> It issued a rule to govern the licensing process, concluding that these risks would not be relevant to licensing determinations at all and that it would not consider them in NEPA analysis in subsequent individual licensing proceedings.<sup>169</sup> Further, the Commission refused to allow licensing boards to further consider the uncertainties associated with waste storage and disposal.<sup>170</sup> The Supreme Court deferred to the NRC's approach and upheld the rule. Emily Hammond has encapsulated the approach reflected in this case as "super deference," which "is supported by basic notions of institutional competence and plays into a natural judicial tendency to avoid any deep confrontations with science."<sup>171</sup> Explaining its deferential posture, the Court characterized the rule's zero-risk assumption as "a policy judgment" that was "within the bounds of reasoned decision-making. It is not our task to determine what decision we, as Commissioners, would have reached. Our only task is to determine whether the Commission has considered the relevant factors and articulated a rational connection between the

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166. 462 U.S. 87 (1983).

167. *Id.*

168. *Id.* at 93.

169. *Id.* at 93–94; *see also id.* at 98 ("In its Table S–3 Rule here, the Commission has determined that the probabilities favor the zero-release assumption, because the Nation is likely to develop methods to store the wastes with no leakage to the environment.").

170. *Id.* at 94.

171. Emily Hammond Meazell, *Super Deference, the Science Obsession, and Judicial Review as Translation of Agency Science*, 109 MICH. L. REV. 733, 734 (2011). Hammond adds that supporters of super deference argue that "if agency science is mostly about policy, and the politically accountable executive controls agencies, then agencies are the more legitimate institution with respect to science." *Id.* at 734–35. She takes issue with super deference, however, asserting that:

Super deference is not grounded in realistic notions of agency science; it may contribute to ossification and the science charade; and it appears to have a disparate impact on environmental law. Measured against broader administrative-law values, super deference also inhibits transparency; undermines deliberation; fails to accord with political accountability; and generally abdicates the courts' role in the constitutional scheme by encouraging outcome-oriented review. For these and many other reasons, I contend that super deference has very little utility.

*Id.* at 737–38 (citation omitted).

facts found and the choice made.”<sup>172</sup> It added that “a reviewing court must remember that the Commission is making predictions, within its area of special expertise, at the frontiers of science. When examining this kind of scientific determination, as opposed to simple findings of fact, a reviewing court must generally be at its most deferential.”<sup>173</sup>

The same year that the Court decided *Baltimore Gas & Electric*, it issued another decision that provided additional guidance to reviewing courts applying the arbitrary and capricious test. In *Motor Vehicle Manufacturers Association v. State Farm Mutual Automobile Insurance Company*,<sup>174</sup> the Court reviewed the Reagan Administration’s rescission of a rule adopted by the Department of Transportation’s National Highway Traffic Safety Administration (“NHTSA”) that required auto manufacturers to include either passive restraints or air bags in newly manufactured vehicles.<sup>175</sup> A threshold question was whether rescission of a rule should be subject to the APA § 706(2)(A)’s arbitrary and capricious test or should instead be judged by an even more deferential standard—the one a court would use in assessing an agency’s refusal to issue a rule in the first place.<sup>176</sup> The Court concluded that the arbitrary and capricious standard applies to rule rescissions. It reasoned that “the revocation of an extant regulation is substantially different than a failure to act. Revocation constitutes a reversal of the agency’s former views as to the proper course.”<sup>177</sup> In light of the policy reversal, “an agency changing its course by rescinding a rule is obligated to supply a reasoned analysis for the change beyond that which may be required when an agency does not act in the first instance.”<sup>178</sup> Thus, the Court signaled that inconsistency over time (in rulemaking and elsewhere) may call for application of a relatively rigorous version of the arbitrary and capricious test. The Court would reinforce that message in later cases.<sup>179</sup>

The Court in *State Farm* then identified four situations that are indicative of arbitrary and capricious agency decision-making:

Normally, an agency rule would be arbitrary and capricious if the agency has [1] relied on factors which Congress has not intended it to consider, [2] entirely failed to consider an important aspect of the problem, [3] offered an explanation for its decision that runs counter to the evidence before the agency, or [4] is so implausible that it could not be ascribed to a difference in view or the product of agency

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172. *Balt. Gas & Elec.*, 462 U.S. at 105.

173. *Id.* at 103.

174. 463 U.S. 29 (1983).

175. *Id.* at 38–39.

176. *Id.* at 40–41.

177. *Id.* at 41.

178. *Id.* at 42.

179. *See infra* notes 187–88 and accompanying text.

expertise. The reviewing court should not attempt itself to make up for such deficiencies . . . .<sup>180</sup>

The Court thus created a template for litigants seeking to challenge agency decisions as arbitrary and capricious. The case qualifies as a “giant[ ] . . . of the modern administrative law canon,”<sup>181</sup> which is “perhaps the best known case concerning judicial review of agencies policy choices”<sup>182</sup> and reflects “a fairly intrusive review of agency decision making.”<sup>183</sup>

Another piece of the standard-of-review puzzle for our purposes is reflected in a series of decisions in which the Supreme Court addressed the application of the arbitrary and capricious test to agency policy reversals. As noted above, *State Farm* indicates that rescission of a rule may trigger more searching review than a decision not to adopt a rule in the first place.<sup>184</sup> In *FCC v. Fox Television Stations, Inc.*,<sup>185</sup> the Court provided a more extended discussion of when, if ever, agency shifts in position should trigger non-deferential review under the arbitrary and capricious test. The Court insisted that, to withstand a challenge under the arbitrary and capricious test, an agency’s change of policy must acknowledge that there has been a change and supply “good reasons for the new policy” that are permissible under the statute.<sup>186</sup> In addition, if the agency bases its new policy on factual findings that contradict those it relied on in fashioning its previous policy, or if that policy “engendered serious reliance interests,” the agency must provide a rational explanation for why it “disregard[ed] facts and circumstances that underlay or were engendered by the prior policy.”<sup>187</sup>

180. *State Farm*, 463 U.S. at 43 (bracketed numbers added).

181. Richard Murphy, *Chenery Unmasked: Reasonable Limits on the Duty to Give Reasons*, 80 U. CIN. L. REV. 817, 837 (2012).

182. Robert C. Dolehide, *A Comparative “Hard Look” at Chevron: What the United Kingdom and Australia Reveal About American Administrative Law*, 88 TEX. L. REV. 1381, 1387 (2010); cf. Kent Barnett & Christopher J. Walker, *Chevron Step Two’s Domain*, 93 NOTRE DAME L. REV. 1441, 1450 (2018) (calling *State Farm* “one of [the Court’s] most significant arbitrary-and-capricious decisions”).

183. Dolehide, *supra* note 182, at 1388; see also John C. Reitz, *Deference to the Administration in Judicial Review*, 66 AM. J. COMP. L. 269, 285 (2018) (“*State Farm* is an exhortation to the lower courts to make arbitrary-and-capricious review meaningful by taking a hard look at how the agency has exercised its de jure discretion . . . .”).

184. See *supra* notes 174–80 and accompanying text.

185. 556 U.S. 502 (2009).

186. *Id.* at 515.

187. *Id.* at 515–16; see also *Encino Motorcars, LLC v. Navarro*, 579 U.S. 211, 222 (2016) (finding that the Department of Labor’s explanation for altering its position on whether auto dealer service advisors are exempt from statutory minimum wage and overtime requirements “fell short of the agency’s duty to explain why it deemed it necessary to overrule its previous position”).



The Court subsequently “underscore[d]” that “the APA requires an agency to provide more substantial justification when ‘its new policy rests upon factual findings that contradict those which underlay its prior policy; or when its prior policy has engendered serious reliance interests that must be taken into account.’”<sup>188</sup> Thus, the Court indicated that courts should pay particular attention to an agency’s explanation for a decision reversing one of its own prior determinations or policies if the factual underpinnings of two inconsistent decisions are the same or if the initial decision gave rise to reliance interests that may be disrupted by a change in position.

Finally, the Court provided a summary of governing principles for courts conducting arbitrary and capricious review in *Department of Commerce v. New York*.<sup>189</sup> First among the “settled propositions” that the Court identified is the requirement that an agency “disclose the basis” of its action in order to permit meaningful judicial review.<sup>190</sup> Second, “a court is ordinarily limited to evaluating the agency’s contemporaneous explanation in light of the existing administrative record.”<sup>191</sup> Third, a court may not reject an agency’s stated reasons because it may have had additional unstated reasons for its action.<sup>192</sup> Fourth, although courts generally may not inquire into “the mental processes of administrative decisionmakers,” such an inquiry and extra-record discovery may be called for upon a showing of bad faith or improper behavior.<sup>193</sup> In *New York*, the Court remanded a decision by the Secretary of Commerce to add a question concerning citizenship status to the census because “the evidence tells a story that does not match the explanation the Secretary gave for his decision. [The Secretary’s] rationale—the sole stated reason—seems to have been contrived.”<sup>194</sup> The Court connected this justification for its non-deferential review of the Secretary’s decision to one of the core requirements of non-arbitrary agency action—reasoned decision-making:<sup>195</sup>

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188. *Perez v. Mortgage Bankers Ass’n*, 575 U.S. 92, 106 (2015).

189. 139 S. Ct. 2551 (2019).

190. *Id.* at 2573 (citing *Burlington Truck Lines, Inc. v. United States*, 371 U.S. 156, 167–69 (1962)).

191. *Id.* (citing *Vt. Yankee Nuclear Power Corp. v. Nat. Res. Def. Council, Inc.*, 435 U.S. 519, 549 (1978); *Camp v. Pitts*, 411 U.S. 138, 142–43 (1973)).

192. *Id.*

193. *Id.* at 2573–74 (citing *Citizens to Preserve Overton Park v. Volpe*, 401 U.S. 402, 420 (1971)).

194. *Id.* at 2575. “We are presented, in other words, with an explanation for agency action that is incongruent with what the record reveals about the agency’s priorities and decision-making process.” *Id.*

195. The Court had held in *State Farm* that “the agency’s explanation for rescission of the passive restraint requirement is not sufficient to enable us to conclude that the rescission was the product of reasoned decisionmaking.” *Motor Vehicles Mfrs. Ass’n v. State Farm Mut. Auto. Ins. Co.*, 463 U.S. 29, 52 (1983). Indeed, the lower court in *State Farm* had described reasoned decision-making as “the essence of lawful administrative action.” *State Farm Mut.*

The reasoned explanation requirement of administrative law, after all, is meant to ensure that agencies offer genuine justifications for important decisions, reasons that can be scrutinized by courts and the interested public. Accepting contrived reasons would defeat the purpose of the enterprise. If judicial review is to be more than an empty ritual, it must demand something better than the explanation offered for the action taken in this case.<sup>196</sup>

The reference to “reasoned decisionmaking” was not new. The Court had previously declared that “[f]ederal administrative agencies are required to engage in ‘reasoned decisionmaking,’”<sup>197</sup> and that the APA “establishes a scheme of ‘reasoned decisionmaking.’”<sup>198</sup> Likewise, scholars have posited that “the requirement that administrative agencies provide adequate reasons for their decisions has come to play a central role in judicial review of agency decisions.”<sup>199</sup>

Amidst this welter of decisions describing the judicial function in conducting arbitrary and capricious review, several points emerge that may be predictive of when courts will apply a relatively more or less deferential version of the standard. The test is generally located toward the deferential end of the standard of review spectrum reflected in Figure 6 above. Judicial review of agency factual determinations tends to be deferential because of the agency’s comparatively greater expertise and its familiarity with the administrative record. Courts are likely to be especially deferential when agencies make predictive determinations concerning technical or scientific matters. That point seems particularly salient in connection with judicial review of agency judgments about how to approach scientific uncertainty.

But courts will not defer to agency explanations that run counter to the evidence before the agency or are otherwise implausible.<sup>200</sup> They will not defer to agency policy reversals if the agency refuses to acknowledge its change of position or fails to explain why the change was appropriate notwithstanding the absence of a change in the factual underpinning for the reversed decision, and they may not defer if a change of position has significantly disrupted reliance

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Auto. Ins. Co. v. Dep’t of Transp., 680 F.2d 206, 209 (D.C. Cir. 1982), *vacated and remanded*, 463 U.S. 29 (1983). In *Baltimore Gas & Electric*, on the other hand, the Court found “the Commission’s zero-release assumption to be within the bounds of reasoned decisionmaking required by the APA.” *Balt. Gas & Elec. Co. v. Nat. Res. Def. Council, Inc.*, 462 U.S. 87, 104 (1983).

196. *New York*, 139 S. Ct. at 2575–76.

197. *Michigan v. EPA*, 576 U.S. 743, 750 (2015) (citation omitted).

198. *Allentown Mack Sales & Serv., Inc. v. NLRB*, 522 U.S. 359, 374 (1998) (citation omitted).

199. Sidney A. Shapiro & Richard E. Levy, *Heightened Scrutiny of the Fourth Branch: Separation of Powers and the Requirement of Adequate Reasons for Agency Decisions*, 1987 DUKE L.J. 387, 388 (1987).

200. *See State Farm*, 463 U.S. at 43.

interests.<sup>201</sup> Courts will not defer to agency decisions that are devoid of explanation (thereby thwarting the court's ability to carry out its assigned task of conducting arbitrary and capricious review) or that are supported by explanations that conflict with the evidence (i.e., that lack a rational connection between the facts found and the choice made)<sup>202</sup> or that appear contrived or pretextual.<sup>203</sup> Deferential review will not be appropriate if the agency relied on factors which Congress has not intended it to consider or entirely failed to consider an important aspect of the problem.<sup>204</sup> Any of these defects is likely to be regarded as indicative of a lack of reasoned decision-making which supports a determination of arbitrary and capricious action.

### 3. *Judicial Treatment of Agency Responses to Scientific Uncertainty Under NEPA and the ESA: Our Qualitative Findings*

Even though, under *Baltimore Gas & Electric*, deference is the default in reviewing technical and scientific findings of fact, we found a significant number of cases (twenty-two) in which courts refused to defer to agency treatment of scientific uncertainty, compared to thirty-two in which the courts deferred to agency resolution of science-related questions. We were able to identify a series of factors that prompted courts to afford deference to agency determinations in the face of scientific uncertainty and other factors that were indicative of arbitrariness justifying rejection of agency reasoning even in the core areas of an agency's technical expertise. We discuss these two clusters of cases in the following two sections. The cases discussed are illustrative, rather than all-inclusive, of the courts' deferential or non-deferential treatment of agency resolution of scientific uncertainty in the cases in our database.

#### a. *The Deference Cluster*

The first cluster of cases that emerged from our cohort of cases included those in which application of the arbitrary and capricious standard resulted in deference to an agency's treatment of scientific uncertainty in performing its NEPA or ESA responsibilities. Our analysis found twenty-seven cases in which courts deferred to agencies regarding a scientific matter (as found in the quantitative analysis shown in Figure 5). In rejecting attacks on the agency's handling of scientific uncertainty, the courts were unwilling to second-guess agency choices based on litigants' criticisms that were not accompanied by the challengers' presentation of more credible science. They also deferred when the

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201. See *supra* notes 185–88 and accompanying text.

202. See *supra* notes 177–80 and accompanying text.

203. See *supra* notes 192–97 and accompanying text.

204. See *supra* notes 179–80 and accompanying text.

agency's scientific analysis was thorough, with no obvious gaps in logic or overlooked and unaddressed problematic questions.

First, courts deferred to agencies when plaintiffs failed to identify more credible science than that used by the agency despite the allegedly poor quality of agency science.<sup>205</sup> If the plaintiffs could not provide any data that was arguably better than that used by the agency in order to compete with the agency's science, while at the same time suggesting that the agency's process was faulty because it failed to consider the best available science, the courts deferred to the agency's treatment of scientific uncertainty.<sup>206</sup>

These cases suggest that a challenge brought under NEPA or the ESA attacking the science used by the agency must proceed on two levels to have a reasonable chance of success. First, the plaintiff must demonstrate that the agency failed to use the best available science—such as by showing a gap in the agency's treatment of the available science. Second, the plaintiff must provide additional information not relied on or rejected by the agency that does represent the best available science. The first part of this showing requires proof that the agency's analysis of the science was insufficient because, for example, it was outdated or flawed. In cases in which plaintiffs argued that the methods or data used by an agency needed to be updated but failed to further demonstrate how the science fell short of what was required by law, the agency prevailed. Broadside attacks such as those alleging “analytical failings as a whole,” for example, did not suffice to convince courts that deference was inappropriate.<sup>207</sup> Courts were not impressed when litigants “call[ed] for more ‘analysis,’ but [did] not specify what they see as lacking or how ‘analysis’ could supply the want,”<sup>208</sup> or demanded further study without offering any reason “to question the accuracy or adequacy of the study that was conducted.”<sup>209</sup>

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205. A previous study in which one of us participated, which covered all federal appellate cases in which the federal Environmental Protection Agency (“EPA”) appeared as a party that were decided between January 1, 1991, and August 1, 1999, found that “[a]ttacks based on the nature of the evidence upon which EPA relied in making its scientific determinations were uniformly unsuccessful during the survey period.” Christopher H. Schroeder & Robert L. Glicksman, *Chevron, State Farm, and EPA in the Courts of Appeals During the 1990s*, 31 ENV'T L. REP. NEWS & ANALYSIS 10,371, 10,398 (2001). Analogous challenges in the cases covered by this Article also fared poorly.

206. *See, e.g.*, *Defs. of Wildlife v. U.S. Fish & Wildlife Serv.*, No. 16-CV-01993, 2016 WL 4382604, at \*22 (N.D. Cal. Aug. 17, 2016).

207. *E.g.*, *Earth Island Inst. v. U.S. Forest Serv.*, 697 F.3d 1010, 1023 (9th Cir. 2012) (unsuccessful NEPA challenge).

208. *City of Los Angeles v. Nat'l Highway Traffic Safety Admin.*, 912 F.2d 478, 488 (D.C. Cir. 1990) (unsuccessful NEPA challenge), *overruled on other grounds*, *Fla. Audubon Soc'y v. Bentsen*, 94 F.3d 658, 669 (D.C. Cir. 1996).

209. *Id.* at 490; *see also* *Ctr. for Biological Diversity v. Lubchenco*, 758 F. Supp. 2d 945, 969–71 (D. Alaska 2010) (deferring to FWS's treatment of risks to ribbon seals by ocean acidification due to climate change). *But cf.* *Ctr. for Biological Diversity v. Bureau of Land Mgmt.*, 937 F. Supp. 2d 1140, 1159 (N.D. Cal. 2013) (finding a NEPA violation due to BLM's

Moreover, even if the plaintiffs could pinpoint the allegedly inadequate scientific analysis and explain why it was inadequate, that demonstration alone tended to be insufficient in scientific uncertainty contexts to overcome judicial inclination to defer to agency expertise on factual or policy matters. Instead, those challenging the agency's use of science lost if they were unable to show that the science they presented to the court was more credible than the information on which the agency relied so that the agency should have replaced its scientific information with the litigants' alternative science.<sup>210</sup>

In one district court case, for example, ENGOs brought a suit challenging the U.S. Army Corps of Engineers' ("the Corps") approval of a solar facility in an ecologically sensitive area that included the habitat of several species listed under the ESA.<sup>211</sup> The plaintiffs claimed that FWS violated the ESA by failing to use the best available science in preparing its "no jeopardy" biological opinion on the project and that the Corps improperly relied on that opinion in issuing a dredge and fill permit for the project under the Clean Water Act.<sup>212</sup> They insisted that FWS rejected, without justification, the best available science and "instead relied on subpar data."<sup>213</sup> The court disagreed. The plaintiffs' assertion that FWS should have relied on a study prepared by the U.S. Geological Survey failed because that study was preliminary and the study FWS did rely on was published and peer-reviewed. The court emphasized that "the determination of what constitutes 'the *best* scientific data available' belongs to FWS's 'special expertise.'"<sup>214</sup> It concluded that "[p]laintiffs fail[ed] to present better scientific data on which FWS should have relied in concluding that harmful habitat fragmentation would not occur."<sup>215</sup> And it rejected the plaintiffs' claim that FWS relied on outdated data and should have used species density data from other studies.<sup>216</sup> FWS concluded that the study it relied on provided better site-specific information and explained why it rejected the plaintiff's preferred studies.<sup>217</sup> The court repeated a Ninth Circuit proposition that "[a]n agency complies with the best available science standard so long as it does not ignore

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failure to collect data about the effects of fracking that was particular to the region affected by oil and gas leases).

210. *See, e.g.*, *Alaska Oil & Gas Ass'n v. Jewell*, 815 F.3d 544 (9th Cir. 2016) (upholding designation of critical habitat for polar bears); *Idaho Rivers United v. U.S. Army Corps of Eng'rs*, No. C14-1800JLR, 2016 WL 498911, at \*17 (W.D. Wash. Feb. 9, 2016) (deferring to the Corps on its treatment of uncertainty relating to the local impacts of climate change in connection with proposed maintenance of the Snake River navigation channel).

211. *Def. of Wildlife*, 2016 WL 4382604.

212. *Id.* at \*19.

213. *Id.*

214. *Id.* at \*20 (quoting *San Luis & Delta-Mendota Water Auth. v. Jewell*, 747 F.3d 581, 602 (9th Cir. 2014)).

215. *Id.* at \*22.

216. *Id.* at \*22–24.

217. *Id.* at \*23.

available studies, even if it disagrees with or discredits them.”<sup>218</sup> It ultimately concluded that if the evidence is susceptible to more than one interpretation, the court is obliged to uphold the agency’s findings.<sup>219</sup>

In other cases, plaintiffs challenged an agency’s choice of scientific approach (including its forecast models and research methodology) rather than the accuracy of, currency of, or decision to rely on particular studies. Here, too, the courts tended to apply the arbitrary and capricious test deferentially.<sup>220</sup> For example, in one case, the plaintiffs brought an unsuccessful NEPA challenge to block BLM’s approval of a right-of-way across public lands for a utility-scale wind energy facility.<sup>221</sup> The plaintiffs claimed that BLM should have prepared a life-cycle assessment of the project’s GHG emissions, and in particular that it should have considered emissions not only from on-site construction and operation but also from off-site equipment manufacture and transportation.<sup>222</sup> The

218. *Id.* (quoting *San Luis & Delta Mendota Water Auth. v. Locke*, 776 F.3d 971, 995 (9th Cir. 2014)); *see also id.* (“The determination of what constitutes the ‘best scientific data available’ belongs to FWS’s ‘special expertise.’ . . . When examining this kind of scientific determination, as opposed to simple findings of fact, a reviewing court must generally be at its most deferential.” (quoting *San Luis*, 747 F.3d at 602)). The court also rejected the plaintiffs’ claim that FWS failed to consider relevant factors (the impact of drought on the distribution of the giant kangaroo rat population and the impact of kangaroo rat relocation on the San Joaquin kit fox). *Id.* at \*23–24. Even when the court regarded the plaintiffs’ concerns as “legitimate” in connection with FWS’s alleged failure to consider the impact of habitat loss caused by the project on the survival and recovery of the rat and fox, it refused to substitute its judgment for the agency’s, concluding that FWS had considered the relevant factors, and had not committed a clear error of judgment. *Id.* at \*24–25; *see also* *Ctr. for Biological Diversity v. Lubchenco*, 758 F. Supp. 2d 945, 961–62 (N.D. Cal. 2010) (concluding that FWS adequately considered differences in management of ribbon seals by Russia and the United States).

219. *Def. of Wildlife*, 2016 WL 4382604, at \*25.

220. *See, e.g., Ctr. for Biological Diversity*, 758 F. Supp. 2d at 964–65, 966–67 (deferring to FWS’s decision that climate models making projections beyond 2050 were unreliable). The courts have refused to find arbitrary action on these grounds on environmental issues that did not involve climate change. *See, e.g., Hillsdale Env’t Loss Prevention, Inc. v. U.S. Army Corps of Eng’rs*, 702 F.3d 1156, 1178 (10th Cir. 2012) (“Courts are not in a position to decide the propriety of competing methodologies . . . but instead, should determine simply whether the challenged method had a rational basis and took into consideration the relevant factor.’ . . . This is particularly true when the dispute involves a technical judgment within the agency’s area of expertise.” (quoting *Silverton Snowmobile Club v. U.S. Forest Serv.*, 433 F.3d 772, 782 (2006))).

221. *Protect Our Communities Found. v. Jewell*, No. 13CV575, 2014 WL 1364453, at \*1 (S.D. Cal. Mar. 25, 2014), *aff’d*, 825 F.3d 571 (9th Cir. 2016); *see also Idaho Rivers United v. U.S. Army Corps of Eng’rs*, No. C14-1800JLR, 2016 WL 498911, at \*16 (W.D. Wash. Feb. 9, 2016) (“NEPA does not require that we decide whether an environmental impact statement is based on the best scientific methodology available, nor does NEPA require us to resolve disagreements among various scientists as to methodology.” (quoting *Salmon River Concerned Citizens v. Robertson*, 32 F.3d 1346, 1359 (9th Cir. 1994))).

222. *Protect Our Communities*, 2014 WL 1364453, at \*49.

court rejected the claim, reasoning that “BLM was not obligated to engage in the ‘life-cycle’ assessment of GHG emissions that Plaintiffs demand . . . BLM’s choice of methodology in evaluating climate change impacts is grounded in legitimate concerns and is therefore entitled to respect from the Court.”<sup>223</sup>

In another case, the D.C. Circuit deferred to FWS’s reliance in listing polar bears as a threatened species under the ESA on U.S. Geological Survey models that projected the impacts of climate change on polar bear populations, even though the agency conceded the models’ limitations.<sup>224</sup> It distinguished cases in which an agency failed to explain how model shortcomings undercut the agency decisions: “FWS understood and explained the models’ limitations and carefully explained why its limited reliance on the models was justified.”<sup>225</sup>

The cases in the deference cluster indicate that courts are likely to defer to agency resolution of scientific disputes in the context of climate-related uncertainty unless plaintiffs are able to do more than identify alleged flaws in the agency’s interpretation of the science on which it relied.<sup>226</sup> Plaintiffs’ chances of success are likely to increase if they are able to present science that the court is convinced is stronger than what the agency relied upon. Challenges to agency methodologies and models also fared poorly. This result should not be surprising, for, as one of us has previously noted, “[s]ubstantive challenges to an agency’s use of modeling in environmental decision making typically face an uphill battle.”<sup>227</sup> That finding is significant, notwithstanding the structural er-

223. *Id.*

224. *In re Polar Bear Endangered Species Act Listing & Section 4(d) Rule Litig.*, MDL No. 1993, 709 F.3d 1, 13 (D.C. Cir. 2013); *see also* *San Luis & Delta-Mendota Water Auth. v. Jewell*, 747 F.3d 581, 620 (9th Cir. 2014) (“The fact that FWS chose one flawed model over another flawed model is the kind of judgment to which we must defer.”); Schroeder & Glicksman, *supra* note 205, at 10,401 (citing cases in which appellate courts deferred to EPA’s use of “admittedly imperfect scientific or statistical models”).

225. *In re Polar Bear*, 709 F.3d at 14.

226. *See, e.g.*, *League of Wilderness Defs./Blue Mountains Biodiversity Project v. Connaughton*, No. 3:12-CV-02271, 2013 WL 3776305, at \*14 (D. Or. July 17, 2013), *aff’d in part, rev’d in part, and remanded on other grounds*, 752 F.3d 755 (9th Cir. 2014) (rejecting claim that agency failed to adequately address impact of commercial logging project on carbon sequestration and climate change, even though the agency recognized that “it is not possible to determine the cumulative impact on global climate from emissions”); *see also* *Desert Survivors v. U.S. Dep’t of the Interior*, 321 F. Supp. 3d 1011, 1049–50 (N.D. Cal. 2018) (finding adequate discussion by FWS of cumulative effects of climate change and other species threats in refusing to list sage grouse as threatened).

227. Robert L. Glicksman, *Bridging Data Gaps Through Modeling and Evaluation of Surrogates: Use of the Best Available Science to Protect Biological Diversity Under the National Forest Management Act*, 83 *IND. L.J.* 465, 483 (2008); *see also id.* at 484 (“The courts typically have not been impressed by claims that an agency chose the wrong model from among competing alternative models, that deficiencies in the data the agency plugged into the model invalidated the results, that the model did not accurately predict or was not capable of actually predicting real world results, or that the agency should have deferred its decision until it

rors to which climate modeling may give rise,<sup>228</sup> given the ubiquity of scientists' (including agency scientists') reliance on models in conducting climate analysis.<sup>229</sup> Litigants challenging agency modeling are likely to have the best chance of succeeding if they are able to convince a court that the model used was mismatched to the scientific issue for which it is being used.<sup>230</sup>

*b. The No Deference Cluster*

The second cluster of cases that emerged from analysis included those in which application of the arbitrary and capricious standard resulted in a lack of deference to an agency's treatment of scientific uncertainty in performing its NEPA or ESA responsibilities, notwithstanding *Baltimore Gas & Electric's* strong default principle of deference to agency resolution of technical questions at the frontiers of scientific knowledge.<sup>231</sup> We found eighteen cases in this cluster.<sup>232</sup> In most of these cases, the courts identified flawed or otherwise inadequate reasoning in support of the agency's treatment of scientific uncertainty. These included cases in which courts concluded that the agency provided an explanation that lacked clarity<sup>233</sup> or that was tainted by internal inconsistencies,<sup>234</sup> relied on unsupported assumptions,<sup>235</sup> and failed to explain why the agency ignored or discounted scientific studies introduced into the record by

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could accumulate more information instead of relying on modeling results." (footnotes omitted)).

228. See *supra* notes 21–23 and accompanying text.

229. See Edward B. Rastetter, *Validating Models of Ecosystem Response to Global Change: How Can We Best Assess Models of Long-Term Global Change?*, 46 *BIO SCIENCE* 190, 196 (1996) (asserting that climate change models "surpass any other method of projecting responses to changes in climate"); cf. Daniel A. Farber, *Modeling Climate Change and Its Impacts: Law, Policy, and Science*, 86 *TEX. L. REV.* 1655, 1656–57 (2008) ("Given the complexities of climate change, such models are especially important in making information accessible to policy makers and members of the public.").

230. See Glicksman, *supra* note 227, at 485 ("The courts have invalidated agency decisions that relied on modeling or simulation exercises . . . in cases in which they have found that a particular model was ill-suited to the activities to which it applied or that the agency was unable to justify building the model on apparently arbitrary assumptions."); Schroeder & Glicksman, *supra* note 205, at 10,406–07.

231. See *supra* note 166 and accompanying text.

232. If a court deferred on some issues but not others, we included the case in both the deference and no deference clusters. That accounts for a total of 57 cases [(27 + 6) + (18 + 6)], even though our database comprised only 51 cases.

233. *E.g.*, *League of Wilderness Defs./Blue Mountains Biodiversity Project v. Connaughton*, 752 F.3d 755, 761 (9th Cir. 2014) (inadequate justification for failing to prepare a supplemental EIS under NEPA).

234. See, *e.g.*, *High Country Conservation Advocs. v. U.S. Forest Serv.*, 52 F. Supp. 3d 1174, 1195 (D. Colo. 2014) (faulting USFS and BLM for claiming that projecting GHG emissions from mining on public lands in Colorado would be too complex, while using data on methane emissions from three mines for other purposes); *id.* at 1196.



litigants.<sup>236</sup> These flaws qualified as reasons for deeming agency actions to be arbitrary based on an agency's failure to do one or more of the following: make a rational connection between the facts found and the choice made, consider an important aspect of the problem, or provide a plausible explanation for its action.

We divide these cases into four categories based on the nature of the defect the court identified. We devote more attention to these cases than to the cases in the deference cluster because of the expectation that courts will defer to, not take issue with, agency scientific determinations at the frontiers of knowledge.<sup>237</sup> The cases in this cluster are therefore more surprising than those in the deference cluster and are perhaps more revealing in predicting judicial receptions to those determinations.

(1) *Irrational Reasoning*

In some of the cases in the non-deference cluster, the courts declared agency actions to be arbitrary and capricious based on the overarching conclusion that an agency's treatment of scientific uncertainty reflected a failure to make a rational connection between the evidence in the record before it and the action it took. That flaw signified faulty reasoning. In one such case, the Ninth Circuit vacated FWS's decision to delist the Yellowstone grizzly bear as a threatened species under the ESA.<sup>238</sup> FWS based the delisting on its finding that a decline in whitebark pine production as a result of climate change was not likely to impact the species to the point at which it was likely to become

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235. *See, e.g.,* *WildEarth Guardians v. U.S. Bureau of Land Mgmt.*, 870 F.3d 1222, 1234–38 (10th Cir. 2017) (concluding that BLM's assumption that coal not extracted from federal lands would be available elsewhere at a comparable price was arbitrary); *Native Vill. of Point Hope v. Jewell*, 740 F.3d 489, 502–05 (9th Cir. 2014) (selection of an arbitrarily low estimate of the number of barrels of recoverable oil in assessing environmental impacts under NEPA of proposed leasing of oil and gas on public lands in Alaska); *Permian Basin Petrol. Ass'n v. Dep't of the Interior*, 127 F. Supp. 3d 700, 720 (W.D. Tex. 2015) (improper reliance in listing the lesser prairie chicken under the ESA on critical assumption that plan to create additional habitat and access to that habitat did not address the primary threat of drought and climate change); *High Country Conservation Advocs.*, 52 F. Supp. 3d at 1197–98 (finding it arbitrary for agencies to rely on unsupported assumptions that future GHG emission technologies will be adopted and that if coal were not mined on public lands in Colorado, consumers would “pay to have the same amount of coal pulled out of the ground somewhere else,” so that overall “emissions from coal combustion would be identical in either scenario”).

236. *See, e.g.,* *Buffalo Field Campaign v. Zinke*, 289 F. Supp. 103, 109–11 (D.D.C. 2018).

237. *See supra* notes 166–78 (describing *Baltimore Gas & Electric*); *see, e.g.,* *WildEarth Guardians v. U.S. Bureau of Land Mgmt.*, 870 F.3d 1222, 1236–37 (10th Cir. 2017) (distinguishing *Baltimore Gas & Electric* by concluding that although climate science will improve in the future, “it is not a scientific frontier as defined by the Supreme Court in *Baltimore Gas & Electric*, i.e., as barely emergent knowledge and technology”).

238. *Greater Yellowstone Coal., Inc. v. Servheen*, 665 F.3d 105 (9th Cir. 2011).

endangered in the foreseeable future. The court determined, however, that “it cannot reasonably be denied” that the loss of whitebark pines, which are an important food source for Yellowstone grizzlies, “presents at least a potential threat to the Yellowstone grizzly population.”<sup>239</sup> FWS protested that it simply did not know yet what the impact of whitebark pine loss would have on the species. The court “recognize[d] that scientific uncertainty generally calls for deference to agency expertise.”<sup>240</sup> In this case, however, FWS “did not articulate a rational connection between the data before it and its conclusion that whitebark pine declines were not likely to threaten the Yellowstone grizzly bear.”<sup>241</sup>

(2) *Incomplete Analysis*

In other cases, the courts refused to defer to agency treatment of science if agencies failed to consider an important aspect of the problem before them. In one case, for example, a district court vacated a FWS rule for evaluating conservation efforts when making listing decisions under the ESA because FWS failed to consider factors such as prior industry and landowner participation in other conservation efforts in the area or to project future funding, relying on a purported “high level of uncertainty” as a justification for its failure.<sup>242</sup> In another case, a district court found BLM’s failure to consider the downstream impacts on climate change of GHG emissions resulting from the consumption of oil and gas to be produced by oil and gas lease sales on federal lands to be arbitrary and capricious.<sup>243</sup>

(3) *Evidentiary Shortcomings*

The departure point for arbitrary and capricious review is a high degree of judicial deference to agency technical determinations, especially on issues implicating scientific uncertainty. Yet, in a significant number of cases in our cohort, courts concluded that the agency’s explanation ran counter to the evidence before it. For example, in one case, a district court remanded to FWS its exclu-

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239. *Id.* at 1024.

240. *Id.* at 1028.

241. *Id.* at 1030.

242. *Permian Basin Petroleum Ass’n v. Dep’t of the Interior*, 127 F. Supp. 3d 700, 714–15 (W.D. Tex. 2015); *see also id.* at 716–17 (failure to consider land enrolled by industry participants who might agree to restrict activity deemed detrimental to the lesser prairie chicken).

243. *San Juan Citizens All. v. U.S. Bureau of Land Mgmt.*, 326 F. Supp. 3d 1227, 1242–44 (D.N.M. 2018). *But cf. Appalachian Voices v. FERC*, No. 17-1271, 2019 WL 847199, at \*2 (D.C. Cir. Feb. 19, 2019) (holding that the Federal Energy Regulatory Commission (“FERC”) adequately considered climate impacts of downstream GHG emissions from combustion of natural gas that would be transported by proposed pipeline).

sion of Colorado from its designation of critical habitat for the Canada lynx.<sup>244</sup> FWS's failure to acknowledge that lynx reproduction likely signaled the presence of primary constituent elements in at least some parts of the state rendered the agency's exclusion of those areas from the lynx's critical habitat arbitrary and capricious.<sup>245</sup> In another case, the Ninth Circuit remanded corporate average fuel economy standards adopted by NHTSA because its FONSI was based on a conclusory assertion, which was contradicted by evidence in the record, that the standards would only result in a small increase in carbon emissions.<sup>246</sup> The court found that NHTSA provided no analysis or data to support its assertion.<sup>247</sup>

Relatedly, agencies were unable to take advantage of the deference normally due to their scientific determinations if they ignored evidence. In *High Country Advocates v. U.S. Forest Service*,<sup>248</sup> the court refused to accept the USFS and BLM's contention that it was impossible to disclose the foreseeable indirect effects on GHG emissions that would result from expanded mining operations on public lands.<sup>249</sup> The court pointed out that the social cost of carbon protocol was available to quantify a project's contribution to costs associated with climate change.<sup>250</sup> The agencies' EIS provided inaccurate information in an effort to justify omission of the social cost of carbon protocol, even though the draft EIS discussed it. Because the EIS's analysis conflicted with the evidence before the agency and was so implausible that the agencies' expertise could not salvage it, that analysis was arbitrary and capricious.<sup>251</sup> The court noted that the agencies "might have been able to offer non-arbitrary reasons why the protocol should

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244. *WildEarth Guardians v. U.S. Dep't of the Interior*, 205 F. Supp. 3d 1176, 1183–86 (D. Mont. 2016).

245. *Id.*; see also *WildEarth Guardians v. U.S. Bureau of Land Mgmt.*, 870 F.3d 1222, 1235 (10th Cir. 2017) (finding that BLM "provided no information" to support its analysis of the climate impacts of coal production on public lands).

246. *Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin.*, 538 F.3d 1172, 1220 (9th Cir. 2008).

247. *Id.* at 1223; see also *id.* at 1223–24 (finding that NHTSA made "vague and conclusory statements" that were unaccompanied by supporting data); *San Juan Citizens All.*, 326 F. Supp. 3d at 1242–48 (rejecting as inadequate BLM's "facile conclusion" that cumulative effects on climate oil and gas lease sales on public lands would be minor).

248. 52 F. Supp. 3d 1174 (D. Colo. 2014).

249. *Id.* at 1191–99.

250. *Id.* at 1190.

251. *Id.* at 1191 (quoting *New Mexico ex rel. Richardson v. Bureau of Land Mgmt.*, 565 F.3d 683, 704 (10th Cir. 2009)). Compare *EarthReports, Inc. v. FERC*, 828 F.3d 949, 956 (D.C. Cir. 2016) (deferring to FERC's refusal to use the social cost of carbon to analyze impacts of GHG emissions resulting from its approval of a natural gas export terminal), with *Appalachian Voices v. FERC*, No. 17-1271, 2019 WL 847199, at \*2 (D.C. Cir. Feb. 19, 2019).

not have been included in the EIS. They did not.”<sup>252</sup> In addition, courts in some cases took issue with agency explanations that litigants showed were based on obsolete information.<sup>253</sup>

In rare cases, the courts have even been willing to take issue with an agency’s interpretation of scientific studies bearing on climate change and its impacts. In yet another case involving the FWS’s effort to remove ESA protections for grizzly bears,<sup>254</sup> a district court held that FWS failed to make a reasoned determination when it removed Greater Yellowstone grizzly bears from the list of threatened species under the ESA.<sup>255</sup> The court’s starting point was the impropriety of allowing litigants to substitute their interpretation of the scientific data for the agency’s.<sup>256</sup> The tribal plaintiffs argued that although FWS relied on the best available science in making its delisting decision, it did not interpret that science rationally.<sup>257</sup> The court remarked that the APA sets “a high bar” for prevailing on such arguments, but that the tribes had cleared it.<sup>258</sup> In a previous conservation strategy, FWS had committed to translocating grizzlies from another population into the Yellowstone area to contribute to genetic diversity, but it abandoned that commitment in deciding to delist the bears.<sup>259</sup> Instead, it explained that genetic diversity was no longer a concern because a sufficiently large population already inhabited the area.<sup>260</sup> The court concluded that FWS “illogically cobbled together two studies” in the record to support its conclusion that adequate genetic diversity already existed.<sup>261</sup> In addition, the agency “ignored the clear concerns expressed by the studies’ authors about long-term viability of an isolated grizzly population; one of the studies had recommended measures to ensure cross-breeding between bear populations in two ecosystems, especially in light of the unpredictability of future climate and habitat changes.”<sup>262</sup> In short, “the studies cited by the Service do not squarely support the assertions for which they are cited.”<sup>263</sup> The court found the delisting

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252. *High Country Conservation Advocs.*, 52 F. Supp. 3d at 1191–92. The court also concluded that the agencies acted arbitrarily by failing to address or acknowledge an expert report on forecasting emissions submitted by the plaintiffs. *Id.* at 1198.

253. *See, e.g., Permian Basin Petroleum Ass’n v. Dep’t of the Interior*, 127 F. Supp. 3d 700, 716 (W.D. Tex. 2015).

254. *See supra* notes 238–41 and accompanying text for discussion of the Ninth Circuit’s earlier rejection of a delisting effort.

255. *Crow Indian Tribe v. United States*, 343 F. Supp. 3d 999, 1021 (D. Mont. 2018), *aff’d in part, remanded in part*, 965 F.3d 662 (9th Cir. 2020).

256. *Id.* at 1019.

257. *Id.*

258. *Id.*

259. *Id.* at 1020.

260. *Id.*

261. *Id.*

262. *Id.*

263. *Id.*

to be arbitrary and capricious because it was “both illogical and inconsistent with the cautious approach demanded by the ESA.”<sup>264</sup>

(4) *Reverse-Engineered Science*

In at least one case, a court based its determination that agency action was arbitrary on its conclusion that the agency reached its desired result and then manipulated its reading of the science to support that result.<sup>265</sup> In *Defenders of Wildlife v. Jewell*,<sup>266</sup> FWS responded to a petition filed with it under the ESA by issuing a proposed rule to list the North American wolverine as a threatened species. In doing so, it relied heavily on two studies of the projected impacts of climate change on the species.<sup>267</sup> Both studies, which at the time of the proposal FWS characterized as the best available science, projected range losses for the wolverine as a result of shrinking spring snow cover projected by multiple global climate models.<sup>268</sup> The proposed rule found that a distinct population segment (“DPS”) of the wolverine met the definition of a threatened species due to the likelihood of habitat loss caused by climate change, which would in turn result in population declines “leading to breakdown of metapopulation dynamics.”<sup>269</sup> Within weeks of its proposed listing, FWS drafted recovery and translocation plans.<sup>270</sup>

FWS received a flood of comments on its proposal, including negative comments from some of the western states in which the wolverine is found.<sup>271</sup> A year and a half after issuing its initial proposal, FWS withdrew the proposed listing rule, determining “that based on new information and further analysis of the existing and new data, factors affecting the DPS cited in the proposed listing rule do not place the wolverine in danger of extinction now or likely to become so in the foreseeable future.”<sup>272</sup> It now took the position that it lacked “sufficient information to understand the response of wolverines to future . . . changes in climate.”<sup>273</sup>

The court framed the issue in the challenge to the withdrawal initiated by ENGOs simply—why? Why did FWS first propose to list the wolverine based

264. *Id.* at 1021. The Ninth Circuit, in a decision issued after the close of our survey period, affirmed on this issue. *Crow Indian Tribe v. United States*, 965 F.3d 662, 678–80 (9th Cir. 2020).

265. *Kunaknana v. U.S. Army Corps of Eng’rs*, 23 F. Supp. 3d 1063, 1092–93 (D. Alaska 2014) (faulting the Corps for its *post hoc* rationalization for failing to prepare a supplemental EIS).

266. 176 F. Supp. 3d 975 (D. Mont. 2016).

267. *Id.* at 982.

268. *Id.* at 982–85.

269. *Id.* at 985.

270. *Id.* at 986.

271. *Id.* at 986–89.

272. *Id.* at 995.

273. *Id.* at 996.

on what it regarded as the best available science and then change its mind<sup>274</sup> The court identified a possible answer—“the immense political pressure that was brought to bear on the issue, particularly by a handful of western states.”<sup>275</sup> But the court put these suspicions aside, concentrating on the agency’s treatment of climate science. In explaining its withdrawal, FWS discounted the studies it had previously relied on by arguing that it was unable to reliably downscale the studies’ findings to the habitat of this DPS of the wolverine.<sup>276</sup> The court discerned two “fatal flaws” in the agency’s analysis of one of the studies.<sup>277</sup> First, it discounted the study based on the “unpublished, unreviewed, personal opinion elicited by [the Regional Director] in the eleventh hour to back fill her foregone conclusion to withdraw the Proposed Rule.”<sup>278</sup> Further, none of the state comments urging FWS to ignore the study provided any scientific evidence to rebuff the study’s conclusions.<sup>279</sup> These and other related reasons for rejecting the initial study’s findings provided an explanation that was counter to the evidence in the record.<sup>280</sup> Second, FWS discredited the initial study on the ground that it failed to analyze projected precipitation trends at a finer scale, even though it conceded that no other study had provided that kind of analysis for the wolverine.<sup>281</sup> The ESA requires FWS to base its listing determinations on the best scientific data available and “accepts agency decisions in the face of uncertainty.”<sup>282</sup> The agency could not reject the study simply because it did not provide evidence that was *better* than the best available science.<sup>283</sup> The court remanded to FWS to reconsider its conclusions concerning the effects of climate change on wolverine denning habitat.<sup>284</sup>

#### 4. *Lessons from the Scientific Uncertainty Cases*

Courts have traditionally been reluctant to wade too deeply into evaluation of the relative merits of competing interpretations of scientific evidence lest they find themselves weighing in on matters on which their lack of expertise

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274. *Id.* at 1000.

275. *Id.*

276. *Id.* at 1001.

277. *Id.* at 1001–02.

278. *Id.* at 1002; *see also id.* (noting that the timing of the critical personal comments “gives them a sort of ‘shoot first ask questions later’ feel”).

279. *Id.*

280. *Id.*

281. *Id.* at 1003.

282. *Id.*

283. The court rejected FWS’s reasons for discounting the second study it had relied on in issuing the proposed listing rule for similar reasons, finding that it misunderstood the purpose of the study and erroneously demanded conclusiveness in order to credit scientific evidence. *Id.* at 1003–05 (concerning the causal relationship between snow and denning).

284. *Id.* at 1001.

risks producing uninformed judgments.<sup>285</sup> That reluctance is magnified when one of the contesting parties is an administrative agency whose mandate includes making factual and policy determinations based on its evaluation of the science before it.<sup>286</sup> Statutory decrees that agencies make decisions based on the “best available” science, like those in the ESA’s listing and no jeopardy provisions, are likely to push courts still further toward deferential review. Such decrees reflect a judgment by Congress that agency determinations should pass judicial muster even if they fall short of conclusiveness or perfection, which in contexts such as assessments of the impacts of climate change, may be impossible to achieve.<sup>287</sup> Finally, when the scientific issues being decided arise in the context of uncertainty, which surely characterizes significant aspects of climate science, one might expect the highest likelihood of deference. In such cases, courts may feel particularly uncomfortable second-guessing agencies on issues for which there are no definitive answers.

It is therefore not surprising that in a majority of the cases in our database, the courts reviewing agency scientific determinations in cases involving uncertainties relating to the impacts on the environment and on agency projects of climate change deferred to those determinations. These cases suggest that litigants challenging agency scientific factual findings or related policy judgments in this context generally are unlikely to prevail if they cannot identify more credible science than the agency’s science, even if the agency’s science is admittedly imperfect. To put themselves in the best position of prevailing, litigants should seek to present information that does not replicate the flaws in the agency’s science, such that the agency should have replaced its scientific information with the litigants’ alternative science or at least considered that informa-

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285. *See, e.g.*, *Baze v. Rees*, 553 U.S. 35, 29 (2008) (warning against “embroil[ing] the courts in ongoing scientific controversies beyond their expertise”); Kenneth J. Markowitz, *Legal Challenges and Market Rewards to the Use and Acceptance of Remote Sensing and Digital Information as Evidence*, 12 DUKE ENV’T L. & POL’Y F. 219, 220 (2002) (“Until scientists and attorneys work together to educate triers of fact to develop protocols for general acceptance, courts will be reluctant to work through the associated complex science and mathematics necessary to assign evidentiary value to the information.”).

286. *See, e.g.*, Reitz, *supra* note 183, at 272 (“With respect to technical and scientific matters, courts may or may not see the agency as having greater expertise than the challenging parties, but they most likely see the agencies as having greater expertise, or at least access to greater expertise, than the courts, and they may therefore be especially reluctant to second-guess the agency’s decisions on these grounds.”); Scott D. Deatherage, *Scientific Uncertainty in Regulating Deliberate Release of Genetically Engineered Organisms: Substantive Judicial Review and Institutional Alternatives*, 11 HARV. ENVTL. L. REV. 203, 224 (1987) (“Courts are reluctant to scrutinize agency decisions involving complex and uncertain science because judges often lack formal training in science and risk assessment and have only little familiarity with computer or mathematical modeling.” (footnote omitted)).

287. *See, e.g.*, *Alaska Oil & Gas Ass’n v. Jewell*, 815 F.3d 544, 555 (9th Cir. 2016) (stating that the best available science mandate in the ESA’s listing and critical habitat designations “requires use of the best available technology, not perfection”).

tion in addition to its own favored science. Litigants also start at a significant disadvantage when they challenge an agency's choice of scientific approach, such as its choice of climate models or other research methodology. The prospects of success in these challenges are likely to increase if litigants can demonstrate that agency modeling was mismatched to the scientific issue for which it was relied upon. In most if not all of the cases in our deference cluster, the courts did not delve too deeply into an evaluation of the merits of the agency's treatment of science. In a sense, deference substituted for deliberation.

Notwithstanding the impetus for courts to defer to agency treatment of science in contexts of uncertainty, parties challenging agency scientific determinations prevailed in a considerable number of the cases in our database. A review of these cases allowed us to identify agency practices that make them vulnerable to reversal and that may make courts feel competent to single out justifications for intervening in what otherwise might be foreign territory to them.

The overarching rubric invoked by the courts that took issue with agency treatment of science in contexts of uncertainty was a determination of inadequate reasoning, which is the essence of arbitrary and capricious review.<sup>288</sup> Our database includes cases in which courts found lack of clarity in agency explanations, internal inconsistencies, unsupported assumptions, and unjustified discounting of record evidence that seemed both relevant and reliable. Further, we identified four forms of arbitrary and capricious reasoning that are likely to pose a risk of thwarting agency science-based initiatives. These included irrationality in agency reasoning; incomplete analysis; evidentiary shortcomings; and "motivated,"<sup>289</sup> pretextual, or manipulated reasoning.

These practices provided red flags that induced courts to give more than a "soft glance" to the agency's determination and to reject rote acceptance of the agency's pleas for deference to its expert judgment.<sup>290</sup> In these cases, the courts were willing to play a more proactive role in evaluating the science and even to act as the arbiter of competing conceptions of the available science. The rulings in our non-deference cluster may reflect the judges' perception that the agencies were shirking their responsibilities by characterizing future environmental effects as uncertain rather than doing the hard work of evaluating evidence that did not correspond to the information the agency preferred to use in reaching its desired result.<sup>291</sup>

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288. See *supra* Part III.B.2.

289. See David Schraub, *Deliberation and Dismissal*, 22 U. PA. J. CONST. L. 1319, 1338 (2020) (describing "[e]valuative motivated reasoning" as based on "a biased appraisal of evidence").

290. See Wendy E. Wagner, *Administrative Law, Filter Failure, and Information Capture*, 59 DUKE L.J. 1321, 1407 (2010) (describing "soft glance" judicial review as considerably deferential).

291. See, e.g., *Defs. of Wildlife v. Jewell*, 176 F. Supp. 3d 975 (D. Mont. 2016) (discussed *supra* notes 266–84 and accompanying text).



## CONCLUSION

Scientific issues are often at the heart of environmental litigation, including litigation under NEPA and the ESA.<sup>292</sup> A nuanced understanding of the technical evidence presented in those cases may require expertise that the judges called on to resolve the legal issues that turn on scientific knowledge do not possess.<sup>293</sup> As the Supreme Court noted in addressing the requirements for the introduction of scientific expert testimony in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*,<sup>294</sup> “[t]he adjective ‘scientific’ implies a grounding in the methods and procedures of science.”<sup>295</sup> Judges typically lack such grounding.

For understandable reasons, judges may be reluctant to stray outside the bounds of their perceived expertise by choosing sides when presented with conflicting scientific interpretations. When one of the parties in litigation implicating scientific issues is a federal agency, the agency begins with a decided advantage. Agencies hire experts in scientific fields relevant to an understanding of the environmental implications of their decisions.<sup>296</sup> In addition, Congress delegates fact-finding and other decision-making responsibilities to the agencies, not the courts. Finally, statutory standards of judicial review, as interpreted by the Supreme Court, dictate a deferential posture of judicial review when implementation of those responsibilities is challenged.

Although judges may not be steeped in scientific expertise, they “are trained lawyers who have been socialized to look at problems with a focus on logic and analysis.”<sup>297</sup> The focus of arbitrary and capricious review on whether

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292. See Stephen E. Snyder, Daniel Luecke & John E. Thorson, *Adversarial Collaboration: Court-Mandated Collaboration Between Opposing Scientific Experts in Colorado’s Water Courts*, 28 NAT. RES. & ENV’T 8, 8 (2013) (“Natural resource and environmental litigation almost universally involves conflicting scientific claims.”); Frank Tuerkheimer, *The Daubert Case and Its Aftermath: A Shot-Gun Wedding of Technology and Law in the Supreme Court*, 51 SYRACUSE L. REV. 803, 829 (2001) (“Environmental litigation almost invariably involves science . . .”).

293. See *Palila (Psittirostra bailleui) v. Haw. Dep’t of Land & Nat. Res.*, 512 F. Supp. 1006, 1008 (D. Haw. 1981) (“Complex environmental litigation such as this case requires skills and specialization beyond that possessed by most attorneys in general practice.”).

294. 509 U.S. 579 (1993).

295. *Id.* at 590.

296. Jodi L. Short, *The Political Turn in American Administrative Law: Power, Rationality, and Reasons*, 61 DUKE L.J. 1811, 1862 (2012) (“Agencies hire experts to study and corroborate their policy decisions, staff to review and respond to comments, economists to evaluate the costs and benefits of different policies, and lawyers to draft preambles explaining the reasons for policy decisions and to defend agency actions.”); cf. Ellen L. Weintraub & Carlos A. Valdivia, *Strike and Share: Combatting Foreign Influence Campaigns on Social Media*, 16 OHIO ST. TECH. L.J. 701, 720 (2020) (“Having in-house experts within federal agencies can mean the difference between sensible, impactful policy solutions and doomed-to-fail regulation.”).

297. Adam M. Gershowitz, *12 Unnecessary Men: The Case for Eliminating Jury Trials in Drunk Driving Cases*, 2011 U. ILL. L. REV. 961, 983 (2011); see also C.J. Williams, *Advocating*

an agency has supplied adequate reasons for its decision therefore allows judges to review agency decisions by using the tools with which they have been trained. Review of agency reasoning “reminds judges that they are not to substitute their judgment for the policy choices of an agency.”<sup>298</sup> As Judge Harold Leventhal advocated, however, substantive review of agency reasoning to determine whether an agency has “conform[ed] to statutory standards and requirements of rationality” requires judges to “act with restraint. Restraint, yes, abdication, no.”<sup>299</sup>

Of the fifty-one cases in our study that involved scientific uncertainty over the effects of climate change decided by federal courts over a span of thirty years, the majority reflected deference to agency treatment of conflicting interpretations of science in decision-making under NEPA and the ESA. In these cases, the courts for the most part did not engage in extensive review of the science, choosing instead to accept the agencies’ reasons for resolving scientific issues, even if (especially if) the agency conceded that the science was unsettled.

In a significant number of cases, however, litigants were able to convince courts that agencies did not provide adequate reasons in support of their treatment of scientific uncertainty. Lack of clarity, internal inconsistencies, unsupported assumptions, failure to credit seemingly reliable record evidence, and reasoning that seemed concocted to support a preordained result all signaled problematic reasoning that demanded a better explanation from the agency. In some of these cases, the flaws were so glaring that the courts were willing to take a deeper dive into the scientific evidence than one might expect in cases that turn on highly specialized knowledge. When agency reasoning seemed patently deficient, deference gave way to relatively rigorous scrutiny.

The cases we analyzed represent a small slice of cases that implicate scientific uncertainty. They arise under only two statutes, NEPA and the ESA. The CEQ regulations adopted under NEPA include a provision specifically directed to agency treatment of scientific uncertainty.<sup>300</sup> More than a dozen states have adopted their own versions of NEPA.<sup>301</sup> It would be illuminating to see if state courts have afforded more or less deference to state agencies under those laws than the federal courts in the cases we surveyed did on issues of scientific uncertainty.

The ESA requires agencies, including FWS and NMFS, to premise their judgments on the best available science.<sup>302</sup> A host of other federal environmen-

*Altering Advocacy Academics: A Proposal to Change the Pedagogical Approach to Legal Advocacy*, 25 SUFFOLK J. TRIAL & APP. ADVOC. 203, 228 (2020) (“[J]udges are legally trained and mentally disciplined to make dispassionate decisions based on reason and logic.”).

298. Shapiro & Levy, *supra* note 199, at 437.

299. *Ethyl Corp. v. EPA*, 541 F.2d 1, 69 (D.C. Cir. 1976) (Leventhal, J., concurring).

300. 40 C.F.R. § 1502.21 (2021).

301. See MANDELKER ET AL., *supra* note 159, § 12:2.

302. 16 U.S.C. §§ 1533(b)(1)(A), 1536(a)(2), 1536(c)(1), 1536(h)(2)(B)(i).

tal statutes also require agencies to root their decisions in the best available science.<sup>303</sup> Further research would be helpful in determining whether the resolution of claims concerning scientific uncertainty relating to climate change reflects the same pattern of results that we found in the NEPA and ESA cases.<sup>304</sup>

Future research projects might also track how the courts address agency treatment of scientific uncertainty over time. Advances in climate science, such as the development of attribution science,<sup>305</sup> may narrow the range of issues for which the science is uncertain. Even in areas with persistent uncertainty, agency methods of managing and responding to it (such as the use of predictive computer modeling) may develop. Courts may shift the ways in which they review agency judgments in contexts of uncertainty, either in response to changes in principles governing standards of review driven by the Supreme Court or the appellate courts, or as a body of precedent builds up that more clearly sets the parameters of judicial review in climate cases. Finally, litigants may change the manner in which they pitch their challenges to agency treatment of scientific uncertainty in climate cases in response to past failures and successes. All of these potential developments bear watching as courts continue to strike the balance between deferential review and insistence that agencies provide adequate reasons for their actions.

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303. *See, e.g., id.* §§ 1362(19)(B), 1371(a)(3)(A), 1373(a), 1374(c)(5)(C)(ii), 1378(a)(2)(B)(iv), 1386(a) (Marine Mammal Protection Act); *id.* § 1645(d)(1) (National Forest Management Act); *id.* §§ 1851(a)(2), 1853(b)(2)(C)(i), 1865(a) (fishery conservation and management); *id.* § 3638(a) (Pacific salmon fishing); *id.* §§ 6591b(b)(1)(B), 6951d(b)(1)(B), 6951e(1)(A)(vii)(II) (Healthy Forests Restoration Act); 33 U.S.C. § 1321(27) (oil spills); *id.* § 2102 (artificial reef protection); 42 U.S.C. § 300g-1(b)(3)(A)(ii) (Safe Drinking Water Act); *id.* § 10363(b)(1) (reclamation climate change and water program).

304. *See, e.g., All. for the Wild Rockies v. Pena*, 865 F.3d 1211, 1221 (9th Cir. 2017) (quoting *Ecology Ctr. v. Castaneda*, 574 F.3d 652, 659 (9th Cir. 2009)) (rejecting claim that the USFS violated the its regulatory obligation to use the best available scientific information in the forest planning process because “[a] party challenging the Forest Service’s scientific analysis cannot simply ‘cite studies that support a conclusion different from the one the Forest Service reached’ and must instead provide ‘scientific studies that indicate the Forest Service’s analysis is outdated or flawed’”).

305. *See supra* notes 17–19 and accompanying text.

## APPENDIX 1

*Cases in Our Database*

1	Alaska Oil & Gas Ass'n v. Jewell Nos. 3:11-cv-0025-RRB, 3:11-cv-0036-RRB, 3:11-cv-0106-RRB, 2013 WL 11897792 (D. Alaska May 15, 2013), <i>aff'd in part, rev'd in part, and remanded</i> , 815 F.3d 544 (9th Cir. 2016)
2	Alaska Oil & Gas Ass'n v. Nat'l Marine Fisheries Serv. Nos. 4:14-cv-00029-RRB, 4:15-cv-00002-RRB, 4:15-cv-00005-RRB, 2016 WL 1125744 (D. Alaska Mar. 17, 2016)
3	Alaska Oil & Gas Ass'n v. Pritzker 840 F.3d 671 (9th Cir. 2016)
4	All. for the Wild Rockies v. Pena No. 2:16-CV-294-RMP, 2016 WL 6123236 (E.D. Wash. Oct. 19, 2016), <i>aff'd</i> , 865 F.3d 1211 (9th Cir. 2017)
5	All. for the Wild Rockies v. Brazell No. 3:12-cv-00466-MHW, 2013 WL 6200199 (D. Idaho Nov. 27, 2013), <i>aff'd</i> , 595 Fed. App'x 700 (9th Cir. 2015)
6	Amigos Bravos v. Bureau of Land Mgmt. 816 F. Supp. 2d 1118 (D.N.M. 2011)
7	Appalachian Voices v. FERC No. 17-1271, 2019 WL 847199 (D.C. Cir. Feb. 19, 2019)
8	Buffalo Field Campaign v. Zinke 289 F. Supp. 3d 103 (D.D.C. 2018)
9	Ctr. for Biological Diversity v. Bureau of Land Mgmt. 937 F. Supp. 2d 1140 (N.D. Cal. 2013)
10	Ctr. for Biological Diversity v. U.S. Dep't of the Interior 563 F.3d 466 (D.C. Cir. 2009)
11	Ctr. for Biological Diversity v. Jewell No. CV-12-02296-PHX-DGC, 2014 WL 116408 (D. Ariz. Jan. 13, 2014)
12	Ctr. for Biological Diversity v. Lubchenco 758 F. Supp. 2d 945 (N.D. Cal. 2010)
13	Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin. 508 F.3d 508 (9th Cir. 2007), <i>vacated</i> , 538 F.3d 1172 (9th Cir. 2008)
14	Ctr. for Biological Diversity v. U.S. Bureau of Land Mgmt. No. 3:17-CV-553-LRH-WGC, 2019 WL 236727 (D. Nev. Jan. 15, 2019)
15	Ctr. for Biological Diversity v. U.S. Fish & Wildlife Serv. 342 F. Supp. 3d 968 (N.D. Cal. 2018)
16	City of Los Angeles v. Nat'l Highway Traffic Safety Admin. 912 F.2d 478 (D.C. Cir. 1990)

17	Colo. River Indian Tribes v. Dep't of the Interior No. ED CV14-02504 JAK (SPx), 2015 WL 12661945 (C.D. Cal. June 11, 2015)
18	Crow Indian Tribe v. United States 343 F. Supp. 3d 999 (D. Mont. 2018)
19	Defcs. of Wildlife v. Jewell 176 F. Supp. 3d 975 (D. Mont. 2016)
20	Defcs. of Wildlife v. U.S. Fish & Wildlife Serv. No. 16-CV-01993-LHK, 2016 WL 4382604 (N.D. Cal. Aug. 17, 2016)
21	Desert Survivors v. U.S. Dep't of the Interior 321 F. Supp. 3d 1011 (N.D. Cal. 2018), <i>subsequent determination</i> , 336 F. Supp. 3d 1131 (N.D. Cal. 2018)
22	Earth Island Inst. v. Gibson 834 F. Supp. 2d 979 (E.D. Cal. 2011), <i>aff'd</i> , 697 F.3d 1010 (9th Cir. 2012)
23	EarthReports, Inc. v. FERC 828 F.3d 949 (D.C. Cir. 2016)
24	Greater Yellowstone Coal., Inc. v. Servheen 665 F.3d 1015 (9th Cir. 2011)
25	High Country Conservation Advocs. v. U.S. Forest Serv. 52 F. Supp. 3d 1174 (D. Colo. 2014)
26	Hillsdale Env't Loss Prevention, Inc. v. U.S. Army Corps of Eng'rs Nos. 10-2008-CM-DJW, 10-2068-CM-DJW, 2011 WL 1102868 (D. Kan. Mar. 23, 2011), <i>aff'd</i> , 702 F.3d 1156 (10th Cir. 2012)
27	Idaho Rivers United v. U.S. Army Corps of Eng'rs No. C14-1800JLR, 2016 WL 498911 (W.D. Wash. Feb. 9, 2016)
28	<i>In re</i> Polar Bear Endangered Species Act Litig. 709 F.3d 1 (D.C. Cir. 2013)
29	Indigenous Env't Network v. U.S. Dep't of State 347 F. Supp. 3d 561 (D. Mont. 2018), <i>amended and supplemented</i> , 369 F. Supp. 3d 1045 (D. Mont. 2018)
30	Kunaknana v. U.S. Army Corps of Eng'rs 23 F. Supp. 3d 1063 (D. Alaska 2014)
31	League of Wilderness Defcs. v. Martin No. 2:10-CV-1346-BR, 2011 WL 2493765 (D. Or. June 23, 2011)
32	League of Wilderness Defcs./Blue Mountains Biodiversity Project v. Connaughton 752 F.3d 755 (9th Cir. 2014)
33	Los Padres Forestwatch v. U.S. Bureau of Land Mgmt. No. CV-15-4378-MWF (JEMx), 2016 WL 5172009 (C.D. Cal. Sept. 6, 2016)

34	Mayo Found. v. Surface Transp. Bd. 472 F.3d 545 (8th Cir. 2006)
35	N. Plains Res. Council v. Surface Transp. Bd. 668 F.3d 1067 (9th Cir. 2011)
36	Nat'l Wildlife Fed'n v. Nat'l Marine Fisheries Serv. 184 F. Supp. 3d 861 (D. Or. 2016)
37	Native Vill. of Point Hope v. Jewell 740 F.3d 489 (9th Cir. 2014)
38	Nat. Res. Def. Council v. Zinke 347 F. Supp. 3d 465 (E.D. Cal. 2018)
39	Nat. Res. Def. Council v. Kempthorne 506 F. Supp. 2d 322 (E.D. Cal. 2007)
40	Nw. Env't Advocs. v. Nat'l Marine Fisheries Serv. 460 F.3d 1125 (9th Cir. 2006)
41	Oceana, Inc. v. Pritzker 75 F. Supp. 3d 469 (D.D.C. 2014)
42	Permian Basin Petroleum Ass'n v. Dep't of the Interior No. MO-14-CV-50, 2015 WL 12910553 (W.D. Tex. June 24, 2015)
43	Protect Our Communities Found. v. Jewell No. 13CV575 JLS (JMA), 2014 WL 1364453 (S.D. Cal. Mar. 24, 2015), <i>aff'd</i> , 825 F.3d 571 (9th Cir. 2016)
44	San Juan Citizens All. v. U.S. Bureau of Land Mgmt. 326 F. Supp. 3d 1227 (D.N.M. 2018)
45	San Luis & Delta-Mendota Water Auth. v. Salazar 760 F. Supp. 2d 855 (E.D. Cal. 2010)
46	Seattle Audubon Soc'y v. Lyons 871 F. Supp. 1291 (W.D. Wash. 1994), <i>aff'd sub nom.</i> Seattle Audubon Soc'y v. Moseley, 80 F.3d 1401 (9th Cir. 1996)
47	Sierra Club v. Clinton 746 F. Supp. 2d 1025 (D. Minn. 2010)
48	Sierra Club v. Fed. Highway Admin. 715 F. Supp. 2d 721 (S.D. Tex. 2010), <i>aff'd</i> , 435 F. App'x 368 (5th Cir. 2011)
49	WildEarth Guardians v. U.S. Dep't of the Interior 205 F. Supp. 3d 1176 (D. Mont. 2016)
50	WildEarth Guardians v. U.S. Forest Serv. 713 F. Supp. 2d 1243 (D. Colo. 2010)
51	WildEarth Guardians v. U.S. Forest Serv. 870 F.3d 1222 (10th Cir. 2017)

## APPENDIX 2

*Research Methodology*

Starting with the database of 828 lawsuits initially compiled for another publication in which we participated,<sup>306</sup> we made a series of revisions,<sup>307</sup> which resulted in a final database of 222 climate-related federal lawsuits filed from 1990 to 2018 in which scientific evidence relating to climate change is discussed. From this set of 222 cases, we collected all publicly available documents from each lawsuit (i.e., 5,695 documents in total). We sorted the documents into one of six author groups: plaintiff, defendant, plaintiff's amici, defendant's amici, court, and other. For this Article, we only used the judicial decisions handed down in these cases.

In an attempt to select the group of lawsuits in which judges engaged in discussion about scientific uncertainty, we took a two-step approach: an automated search followed by an additional filtering process.

## STEP 1: AUTOMATED SEARCH USING NVIVO

First, we conducted an automated keyword search using NVivo with words and phrases we identified as indicative of a discussion about scientific uncertainty. These words and phrases (which we collectively refer to as *keywords*) are listed in Table 2. NVivo searched these keywords in the court opinions of the 222 lawsuits in the database.

The keyword list was constructed based on two main sources: (1) evidentiary standards frequently used in civil cases (“legal keywords”) and (2) scales of scientific uncertainty developed by the IPCC (“scientific keywords”). We chose these sources because both sets of terms aim to translate scientific language into lexicon used in the legal/policy fields. In addition to the keywords from these two sources, we added a few more keywords (also listed in Table 2) that directly describe scientific uncertainty (e.g., synonyms and antonyms of scientific uncertainty; “main keywords”).

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306. See McCormick et al., *supra* note 131.

307. See *supra* Part II (describing this culling process).

TABLE 2. CODES THAT INDICATE DISCUSSION OF SCIENTIFIC UNCERTAINTY

Main keywords	
<ul style="list-style-type: none"> <li>• Scientific (+) Uncertainty</li> <li>• Scientific (+) Certainty</li> <li>• Scientific (+) Confidence</li> <li>• Scientific (+) Agreement</li> <li>• Level of uncertainty</li> <li>• Level of certainty</li> <li>• Level of confidence</li> <li>• Level of agreement</li> </ul>	
Legal keywords	Scientific keywords
<p>Main</p> <ul style="list-style-type: none"> <li>• Burden of proof</li> <li>• Evidentiary standard</li> <li>• Standards of proof</li> </ul> <p>Standards of Proof</p> <ul style="list-style-type: none"> <li>• Beyond a reasonable doubt</li> <li>• Clear and convincing evidence</li> <li>• Preponderance of the evidence</li> </ul> <p>Search Warrant</p> <ul style="list-style-type: none"> <li>• Probable cause</li> </ul> <p>Other relevant legal terms</p> <ul style="list-style-type: none"> <li>• Substantial evidence</li> </ul>	<p>IPCC Likelihood Scale</p> <ul style="list-style-type: none"> <li>• Virtually certain</li> <li>• Extremely likely</li> <li>• Very likely*</li> <li>• Likely*</li> <li>• More likely than not</li> <li>• About as likely as not</li> <li>• Unlikely*</li> <li>• Very unlikely*</li> <li>• Extremely unlikely</li> <li>• Exceptionally unlikely</li> </ul> <p>IPCC Confidence Scale</p> <ul style="list-style-type: none"> <li>• Very high confidence</li> <li>• High confidence</li> <li>• Medium confidence</li> <li>• Low confidence</li> <li>• Very low confidence</li> </ul>

\*These words were searched using a slightly different approach because of a software limitation

The main keyword category is comprised of a group of synonyms and antonyms of scientific uncertainty that are frequently mentioned in climate assessment reports from the IPCC and USGCRP. The IPCC assessment reports use three main scales for describing the strength of scientific information: (1) the level of consensus of scientific information within the scientific community (Table 3); (2) the level of confidence in being correct about the information (Table 4); and (3) the likelihood of the future occurrence of the predicted phenomenon (Table 5).



Table 3 shows the scale for (1) the amount of evidence available in support of scientific findings and (2) the degree of consensus among experts on their interpretation.<sup>308</sup>

TABLE 3. LEVEL OF EVIDENCE V. DEGREE OF AGREEMENT

Agreement	High agreement Limited evidence	High agreement Medium evidence	High agreement Robust evidence
	Medium agreement Limited evidence	Medium agreement Medium evidence	Medium agreement Robust evidence
	Low agreement Limited evidence	Low agreement Medium evidence	Low agreement Robust evidence
	Evidence (type, amount, quality, consistency)		

Table 4 is the level of confidence that describes the validity of scientific information as determined through the assigned level of evidence and agreement. Confidence level increases as the level of evidence and agreement increases, and vice versa.

TABLE 4. QUANTITATIVELY CALIBRATED LEVELS OF CONFIDENCE

Terminology	Degree of confidence in being correct
Very high confidence	At least 9 out of 10 chance of being correct
High confidence	About 8 out of 10 chance
Medium confidence	About 5 out of 10 chance
Low confidence	About 2 out of 10 chance
Very low confidence	Less than 1 out of 10 chance

Table 5 depicts the level of likelihood, or uncertainty, defined as the probability of a phenomenon actually occurring as predicted.

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308. See GUIDANCE NOTES, *supra* note 28, at 3.

TABLE 5. LIKELIHOOD SCALE

Terminology	Likelihood of the Outcome
Virtually certain	99-100% probability
Very likely	90-100% probability
Likely	66-100% probability
About as likely as not	33-66% probability
Unlikely	0-33% probability
Very unlikely	0-10% probability
Exceptionally unlikely	0-1% probability

The legal keywords listed in Table 2 include the terms frequently mentioned in describing the evidentiary standards for civil cases. We selected them through a literature review (e.g., a novel scale developed in 2003),<sup>309</sup> complemented with discussions with law professors who teach courses in Civil Procedure.

To minimize the unnecessary noise in our search results, we decided to exclude some words that are commonly used in non-scientific contexts. For example, the word “likely” may be used in contexts other than the discussions of scientific uncertainty. The word “likely” appeared 18,642 times in the database, but many of those appearances were irrelevant to any discussions of scientific uncertainty. For this type of keyword, we used the search wildcards embedded in the NVivo program.<sup>310</sup> For example, we searched [“IPCC likely”~10], which would search for each instance of the words “IPCC” and “likely” within ten words of each other.

Working separately on each grouping of keywords identified in Table 2 (i.e., main, legal, and scientific) due to limitations in NVivo’s processing times, we took several steps to complete the automated search. First, we searched for the exact keywords as listed in the table (e.g., “scientific uncertainty”). Second, we expanded the search by using various wildcards embedded in the NVivo program in order to search for any relevant quotes without the exact keywords. The list of the wildcards we used is in Table 6. Third, we integrated the auto-

309. See Charles Weiss, *Scientific Uncertainty and Science-Based Precaution*, 3 INT’L ENV’T AGREEMENTS 137, 143 (2003), <https://perma.cc/XH3S-CNPZ>.

310. According to QSR International, the developer and the distributor of NVivo software, “wildcard characters are used in place of one or more characters when you do not know what the real character is or you do not want to type the entire name.” *Special Characters and Operators*, NVIVO, <https://perma.cc/UK2C-XY7S>. Wildcards cannot be used as the first character of a search and they can only be used in single terms (not phrases). An asterisk (\*) may be used as a substitute for zero or more characters (for example, g\*t will find get, great and gt). A question mark (?) may be used as a substitute for a single character (for example—g?t will find get and got but not great or grunt).

mated search results from the three groups of keywords. These steps rendered 89 court opinions that mentioned any of the keywords in Table 2.

TABLE 6. SEARCH COMMANDS FOR NVIVO AUTOMATED TEXT SEARCH

	Examples of text search commands		# of appearances
Main	“level of certainty” OR “level of uncertainty” OR “level of confidence” OR “scientific uncertainty” OR “scientific certainty” OR “scientific confidence” OR “scientific agreement”	Exact text search	39
	scien* AND certain~	Documents that have both 1) words that start with <b>scien</b> 2) synonyms of <b>certain</b> in one document	
	“scientific uncertainty”~10, 20, 30 “scientific certainty”~10, 20, 30 “scientific confidence”~10, 20, 30 “scientific agreement”~10, 20, 30	Documents that have both 1) scientific 2) uncertainty with max 10, 20, 30 words in between	
Legal	“burden of proof” OR “evidentiary standard” OR “beyond reasonable doubt” OR “clear and convincing evidence” OR “preponderance of the evidence” OR “probable cause” OR “substantial evidence”	Exact text search	80
Scientific	“virtually certain” OR “extremely likely” OR “extremely unlikely” OR “exceptionally unlikely” OR “high confidence” OR “medium confidence” OR “low confidence”	Exact text search	21
	“IPCC likely”~10, 20, 30 “IPCC unlikely”~10, 20, 30 “IPCC confidence”~10, 20, 30	Documents that have both 1) IPCC 2) Likely/unlikely/confidence with max 10, 20, 30 words in between	
Total			89*

\*The total number is not the total sum of the three number above. The lawsuits from each category are not mutually exclusive. Calculating the overlaps, the total study sample, in Step 1, came to 89.

STEP 2: NON-AUTOMATED FILTERING PROCESS

After the automated keyword search, we conducted a qualitative analysis of the 89 court opinions by reading through the paragraphs in which the keywords were embedded. This process included three steps. First, we excluded the opinions that did not engage in any discussion of scientific uncertainty. This step filtered out 19 cases from the 89, yielding 70 cases. This process was

essential because many of the 89 cases, even though they did have the keywords from Table 2 appear somewhere in the opinion, did not actually discuss scientific uncertainty. At this step, we excluded cases in which courts discussed legal and procedural matters without referring to any scientific discussion.

Conversely, certain kinds of discussion provided important signals that the courts were addressing scientific uncertainty. We paid special attention to any discussion about the following subjects when determining which opinions discussed scientific uncertainty in sufficient detail to warrant further study:

- The scientific models and projections and whether they constituted the best available science
- The research methodologies used by defendants and whether they were scientifically supported
- The credibility of a scientific study and the rationale for its use by defendants
- The scientific/economic models that were unreasonably ignored by defendants

An example of the qualitative filtering process is shown below in Table 7.

TABLE 7. EXAMPLE OF NON-AUTOMATED QUALITATIVE FILTERING PROCESS

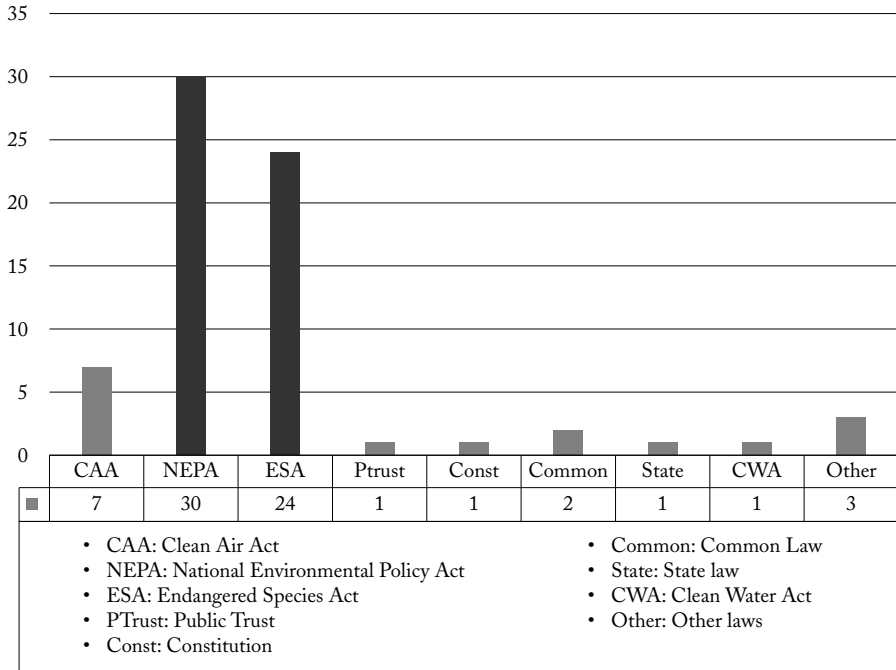
Case Number	Number of Paragraphs	Number of Opinions (district/ appellate/ Supreme)	Discussion Points	Decision
#14	13	3	<p>@27 “At the outset, as Defendants point out, Plaintiffs have failed to identify better data that FWS should have considered.”</p> <p>@20 “The best available data requirement [of the ESA] ‘merely prohibits [an agency] from disregarding available scientific evidence that is in some way better than the evidence [it] relies on.’ Condensing this principle to its essence, FWS ‘cannot ignore available biological information.’”</p> <p>@27 “Plaintiffs’ failure to identify any better science or to point any other existing data available makes this claim a ‘non-starter.’”</p> <p>@29: “Courts must defer to the Forest Service’s ‘technical expertise where the record demonstrates that the agency reasonably relied on data concluding the Project meets the standards imposed by the National Forest Management Act (NFMA).”</p>	Include
#291	NA	2	<p>This case is generally about the allowance of a settlement to be put in place while the service fixed their BiOp (Biological Opinion). There is no consideration on the merits of discussion of scientific uncertainty etc.</p>	Exclude

Second, we narrowed down the sample size to cover only lawsuits focusing on the ESA and NEPA, excluding cases that focused on other statutory programs (such as the Clean Air Act), common law theories, constitutional law, and state law. This reduced our database from 70 to 54 cases. As Figure 7 indicates, the NEPA cases were most frequent (30), followed by ESA cases (24), with CAA cases numbering only seven. Although the CAA provides the federal EPA with the authority to regulate GHG emissions,<sup>311</sup> we decided that

311. See *Massachusetts v. EPA*, 549 U.S. 497, 532 (2007).

the seven CAA lawsuits in which the courts that discussed scientific uncertainty were too small a number to provide a meaningful basis for analysis.

FIGURE 7. LAWS (TOTAL 70 CASES). (DARKER BARS ARE NEPA AND ESA)



Thus, we focused on the statutes in which the courts addressed scientific uncertainty most frequently: NEPA and the ESA. Doing so allowed us to provide an effective qualitative analysis of cases filed under the two statutes, to sharpen our focus on the cases with statistical power (e.g., adequate sample size). We wanted to focus on the environmental laws with a case sample size large enough to strengthen the external validity of our findings.

Third, of the remaining 54 cases, we decided to focus on the 51 cases with federal agencies as defendants. The excluded three were filed against an industry group, local government, and state government. We chose to focus on lawsuits against federal agencies because we wanted to see if we could ascertain patterns of judicial application of a common standard of review—the arbitrary and capricious test that applies under § 706(2)(A) of the APA,<sup>312</sup> which governs judicial review in NEPA cases and in relevant ESA cases.<sup>313</sup>

312. 5 U.S.C. § 706(2)(A).

313. See *supra* notes 145–52 and accompanying text.

In conclusion, Step 2 provided a final database of a total of 51 cases in which litigants brought alleged agency violations of NEPA (30) or the ESA (21) in which scientific uncertainty figures prominently in the courts' opinions.

