

# Upholding EPA Regulation of Greenhouse Gases: The Precautionary Principle Redux

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*The debate over the precautionary principle versus cost-benefit analysis in environmental decision making has engaged legal and policy experts for decades. At its heart, the precautionary principle counsels that governmental action should be taken to reduce the risk of serious harms, even if the evidence defining the harm is not sufficient to meet the evidentiary standard of certainty in a civil proceeding, and even if uncertainty is too great to be able to quantify and compare costs and benefits with precision. In *Coalition for Responsible Regulation v. EPA*, the U.S. Court of Appeals for the District of Columbia Circuit upheld EPA's regulation of greenhouse gas emissions from motor vehicles on the ground that such emissions endanger public health and welfare. Both EPA and the court placed primary reliance on the precautionary principle of the Clean Air Act's endangerment standard as construed in the 1976 D.C. Circuit case *Ethyl Corp. v. EPA*, upholding EPA's regulation of another motor vehicle pollutant, lead emissions resulting from the use of lead additives in gasoline. This Article contends that the issues and outcomes of the two regulatory decisions demonstrate why a precautionary approach—balancing probability and severity of harm and acting before full quantification of benefits and costs is possible—is a necessary framework for sound decision making on the most complex and consequential threats to the environment, including the extraordinary challenge of climate change.*

*Reliance on quantified cost-benefit analysis has become the prevailing approach in U.S. environmental decision making. The Article*

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*rejects the view that cost-benefit analysis alone should determine environmental regulatory decisions as well as the opinion that precaution excludes consideration of such analysis. To explore these issues, the Article analyzes and compares the lead additive and greenhouse gas decisions with reference to the uncertainty of the relevant science and the level of quantification of regulatory benefits and costs. The Article also considers whether scientific advances since each decision was made confirm or call into question EPA's regulatory actions and contends that a precautionary approach will be necessary and appropriate to assess the justification for regulating existing electric power plants under the Clean Air Act. The conclusion identifies several elements of reasoned decision making under a precautionary standard as well as the major public benefits gained and likely to be gained by the two EPA decisions reducing automotive lead and greenhouse gas emissions.*

Introduction.....	685
I. Defining and Debating the Precautionary Principle.....	687
A. The Precautionary Principle Defined.....	687
B. The Value of a Precautionary Principle in U.S. Environmental Decision Making.....	689
C. The Utility of Cost-Benefit Analysis in U.S. Environmental Decision Making.....	694
II. The Central Role of the Precautionary Principle in the EPA Endangerment Decisions.....	699
A. Precaution in Weighing the Evidence in the Coalition and Ethyl Cases .....	699
1. The Evidence for Control of Lead Additives in Gasoline to Protect Public Health .....	703
2. The Evidence for Control of Automotive GHG Emissions to Protect Public Health and Welfare .....	710
B. The Quest for Quantification of Source Contributions, Impacts, and Costs .....	714
1. Quantification Issues in the Lead Emissions Case .....	714
2. Quantification Issues in the GHG Emissions Case .....	717
III. Aftermath of the Lead and GHG Decisions .....	720
A. New Support for Regulation of Lead Additives to Protect Public Health .....	720
B. New Support for GHG Regulation .....	728
C. A Precautionary Approach for Power Plant GHG Emissions .....	734
IV. Rationality and Results in Precautionary Decision Making.....	741
A. Weighing Harms and Probabilities and Choosing Remedies .....	742
B. Adaptability of Remedies and Incremental Decision Making.....	745

## INTRODUCTION

On June 26, 2012, the U.S. Court of Appeals for the D.C. Circuit upheld the U.S. Environmental Protection Agency's (EPA) finding that greenhouse gas (GHG) emissions from cars and light trucks "may reasonably be anticipated to endanger public health or welfare" under section 202(a)(1) of the Clean Air Act (CAA).<sup>1</sup> In *Coalition for Responsible Regulation, Inc. v. EPA (Coalition)*,<sup>2</sup> the court primarily relied on its 1976 ruling on EPA's lead in gasoline standards in *Ethyl Corp. v. EPA (Ethyl II)*,<sup>3</sup> the first of its decisions construing the meaning of "endangerment" under Title II of the CAA. In both cases, the court sustained the rules at issue as *precautionary* standards enabling EPA to take regulatory action in the face of scientific uncertainty. Similarly, it rejected the need for a more precise quantification of the regulated source contributions, health and environmental impacts, and control costs at issue in these cases.

The precautionary principle calls for risk assessment decisions that weigh and balance the probability and severity of the harm to be regulated.<sup>4</sup> The two elements of the principle are reciprocal in that the decision maker may act on a higher probability of a lesser harm or a lower probability of a greater harm in determining whether a risk merits regulatory action.<sup>5</sup> The important effect of so weighing probability and severity is to reduce the level of probability of harm to less than the traditional evidentiary standard in civil cases. That standard

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1. 42 U.S.C. § 7521(a)(1) (2012); Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496 (Dec. 15, 2009) (to be codified at 40 C.F.R. ch. 1) [hereinafter GHG Endangerment Finding]. The court also upheld the Tailpipe Rule, Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, 75 Fed. Reg. 25,324 (May 7, 2010) (to be codified at 49 C.F.R. pts. 531, 533, 536, 537, 538); the Timing Rule, Reconsideration of Interpretation of Regulations That Determine Pollutants Covered by Clean Air Act Permitting Programs, 75 Fed. Reg. 17,004 (Apr. 2, 2010) (to be codified at 40 C.F.R. pts. 50, 51, 70, 71); and the Tailoring Rule, Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule, 75 Fed. Reg. 31,514 (June 3, 2010) (to be codified at 40 C.F.R. pts. 51, 52, 70, 71).

2. 684 F.3d 102 (D.C. Cir. 2012), *aff'd in part, rev'd in part sub nom.* Util. Air Regulatory Grp. v. EPA, 134 S. Ct. 2427 (2014). The Supreme Court's grant of certiorari did not extend to review of the D.C. Circuit's ruling upholding EPA's endangerment finding but was limited to the question "[w]hether EPA permissibly determined that its regulation of greenhouse gas emissions from new motor vehicles triggered permitting requirements under the Clean Air Act for stationary sources that emit greenhouse gases." *Chamber of Commerce v. EPA*, 134 S. Ct. 468 (2013) (mem.), *granting cert. to* 684 F.3d 102 (D.C. Cir. 2012). The Court reversed the D.C. Circuit's decision and held that EPA exceeded its authority by "rewriting the statutory thresholds" specified in the CAA, which imposed a permit requirement on sources with the potential to emit more than 100 to 250 tons per year. *Util. Air Regulatory Grp.*, 134 S. Ct. at 2444–45. Using the Tailoring Rule, the EPA substituted a 100,000 ton threshold to avoid imposing permit requirements on a very large number of GHG emission sources. *Id.* The Court further held that EPA could require sources already subject to permitting to use "best available control technology" for GHGs because those sources emitted conventional pollutants exceeding the statutory thresholds. *Id.* at 2448–49.

3. See 541 F.2d 1 (D.C. Cir. 1976) (en banc).

4. Compare Judge Learned Hand's formulation of endangerment, asking whether "the gravity of the 'evil,' discounted by its improbability, justifies such invasion of free speech as is necessary to avoid the danger." See *United States v. Dennis*, 183 F.2d 201, 212 (2d Cir. 1950), *aff'd*, 341 U.S. 494 (1951).

5. *Ethyl II*, 541 F.2d at 18.

requires that the facts relied upon be more likely than not to be true.<sup>6</sup> Coupled with the “arbitrary and capricious” standard for review of informal rulemaking, the precautionary principle reinforces the conclusion that the decision maker need not establish by a preponderance of the evidence that harm is occurring or would occur in the future to take action—only that the possible harm is serious and the risk or probability of harm is “significant.”<sup>7</sup>

*Coalition* and *Ethyl II* and the EPA regulations they upheld demonstrate the power of the precautionary principle to animate action to address serious health and environmental risks before the probability of the harm is certain and before the evidence is complete enough to support comprehensive quantitative analysis of costs, benefits, and impacts. Regulation of automotive GHG emissions, like lead emissions before them, illustrates the unique complexity of health and environmental science and regulatory systems, and the potential for severe and irreversible impacts. Analysis of the decisions of the two EPA administrators and the courts in these two cases also shows that both administrators succeeded in balancing the probability and severity of harms, choosing appropriate remedies, articulating a reasonable basis for their conclusions, and explaining their judgments in comprehensible terms to the parties and the public. This Article’s review of the administrative and judicial rulings, and developments in the scientific evidence since the rulings were made, will show that they were sound. The precautionary standard of the CAA provided rapid and substantial benefits to public health by reducing exposure to airborne lead and built the foundation for long-overdue measures to confront the risks of climate change to the health and well-being of Americans and the rest of the world.

This Article contends that the precautionary principle remains an essential tool to assess today’s most complex and consequential environmental issues, especially the extraordinary challenge of climate change. It rejects the contention that cost-benefit analysis alone should dictate the level of environmental standards, as well as the notion that precaution excludes all consideration of quantitative comparisons of costs and benefits.<sup>8</sup> Part I of the

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6. *Id.* at 37.

7. *Id.* at 31–32.

8. The literature on the merits of precautionary approaches and cost-benefit analysis is vast. Sources principally relied upon in this Article include: FRANK ACKERMAN & LISA HEINZERLING, PRICELESS: ON KNOWING THE PRICE OF EVERYTHING AND THE VALUE OF NOTHING (2004); DANIEL A. FARBER, ECO-PRAGMATISM: MAKING SENSIBLE ENVIRONMENTAL DECISIONS IN AN UNCERTAIN WORLD (1999) [hereinafter ECO-PRAGMATISM]; DOUGLAS A. KYSAR, REGULATING FROM NOWHERE: ENVIRONMENTAL LAW AND THE SEARCH FOR OBJECTIVITY (2010) [hereinafter REGULATING FROM NOWHERE]; RICHARD A. POSNER, CATASTROPHE: RISK AND RESPONSE (2005) [hereinafter CATASTROPHE]; RICHARD L. REVESZ & MICHAEL A. LIVERMORE, RETAKING RATIONALITY: HOW COST-BENEFIT ANALYSIS CAN BETTER PROTECT THE ENVIRONMENT AND OUR HEALTH (2008) [hereinafter RETAKING RATIONALITY]; CASS R. SUNSTEIN, SIMPLER: THE FUTURE OF GOVERNMENT (2013) [hereinafter SIMPLER]; CASS R. SUNSTEIN, WORST-CASE SCENARIOS (2009) [hereinafter WORST-CASE SCENARIOS]; William Boyd, *Genealogies of Risk: Searching for Safety, 1930s–1970s*, 39 ECOLOGY L.Q. 895 (2012); Gail Charnley & E. Donald Elliott, *Risk Versus Precaution: Environmental Law and Public Health Protection*, 32 Env’tl. L. Rep. (Env’tl. Law Inst.) 10,363 (2002); Daniel A. Farber,

Article begins with a brief summary of key issues in the ongoing debate over the merits of the precautionary approach versus reliance on cost-benefit analysis—"the argument between the tree huggers and the bean counters," as one scholar describes it.<sup>9</sup> Part II examines and compares the use of the precautionary principle in the GHG and lead additive decisions. Part III considers the rapid evolution of the scientific evidence on lead and GHG emissions in the years following the two precautionary decisions. Part IV concludes with observations on the value of the precautionary principle in making the most complex and consequential regulatory decisions to protect public health and the environment.

## I. DEFINING AND DEBATING THE PRECAUTIONARY PRINCIPLE

This Part presents the precautionary principle<sup>10</sup> as invoked by EPA in the *Coalition* decision and briefly compares it to other versions of the principle. It argues that the precautionary principle advances the values of U.S. environmental law and responds to the unique challenges of regulating to protect public health and the natural environment. The policy and political movement to replace the principle with cost-benefit analysis as the primary or exclusive basis for environmental decision making is described and evaluated, setting the stage for the Article's assessment of the utility of the precautionary principle in EPA's decisions to regulate automotive lead and GHG emissions.

### A. The Precautionary Principle Defined

The most familiar version of the precautionary principle is contained in Article 15 of the Rio Declaration on Environment and Development of 1992. That Article provides: "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."<sup>11</sup> A

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*Rethinking the Role of Cost-Benefit Analysis*, 76 U. CHI. L. REV. 1355 (2009) [hereinafter *Rethinking the Role of Cost-Benefit Analysis*]; Douglas A. Kysar, *Ecologic: Nanotechnology, Environmental Assurance Bonding, and Symmetric Humility*, 28 UCLA J. ENVT. L. & POL'Y 201 (2010) [hereinafter *Ecologic*]; Robert V. Percival, *Who's Afraid of the Precautionary Principle?*, 23 PACE ENVT. L. REV. 21 (2005–2006); Cass R. Sunstein, *Beyond the Precautionary Principle*, 151 U. PA. L. REV. 1003, 1003–05 (2003) [hereinafter *Beyond the Precautionary Principle*]; see also John D. Graham, Administrator, Office of Info. & Regulatory Affairs, The Role of Precaution in Risk Assessment and Management: An American's View, Remarks before the European Commission et al. (Jan. 11–12, 2002), available at [http://www.whitehouse.gov/omb/inforeg\\_eu\\_speech](http://www.whitehouse.gov/omb/inforeg_eu_speech) (comparing the precautionary principle to a unicorn, identifying both as "mythical concepts").

9. See ECO-PRAGMATISM, *supra* note 8, at 39.

10. The original version of the precautionary approach is said to be the German word *Vorsorgeprinzip*, meaning "the principle of prior care and worry." See Percival, *supra* note 8, at 23–26 (providing a good recounting of the evolution of the precautionary principle in Europe and the United States).

11. U.N. Dep't of Econ. & Social Affairs, *Rio Declaration on Environment and Development: Report of the United Nations Conference on Environment and Development*, ¶ 15, U.N. Doc. A/CONF. 151/26 (Vol. I) (Aug. 12, 1992), available at <http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm>.

stronger version was developed in the United States by a group of government and civil society organizations at a meeting at the Wingspread Center in Racine, Wisconsin.<sup>12</sup> The Wingspread statement implies that less serious threats can trigger precautionary action, in comparison with Article 15, and would shift the burden of proof to the proponents of the activity in question.<sup>13</sup> This version of the principle has been supported or implemented in Europe,<sup>14</sup> while it is more limited in application in the United States.<sup>15</sup>

The EPA's approach to decision making aligns with the Rio Declaration. In the EPA's preamble to the GHG endangerment finding, the agency defended the use of the precautionary principle as requiring a lower level of certainty and proof to support action.<sup>16</sup> It emphasized that this approach is an alternative to insisting on traditional evidentiary standards of proof as in tort proceedings, on the one hand, and shifting the burden of proof to the proponent of the product or activity to demonstrate its safety, on the other.<sup>17</sup> EPA Administrator Lisa Jackson cited the legislative history of the 1977 amendments to the CAA, in which Congress made the Title II standard more permissive in light of the initial *Ethyl I* panel decision setting aside the lead in gasoline rules,<sup>18</sup> and stated

12. See *The Wingspread Statement on the Precautionary Principle*, SCI. & ENVTL. HEALTH NETWORK (Jan. 1998), available at <http://www.sehn.org/state.html#w> ("When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of the activity, rather than the public, should bear the burden of proof.").

13. *Id.*

14. For example, the European Union's comprehensive chemical reporting and regulation system places the burden of producing information and attesting to chemical safety on manufacturers. See Council Regulation 1907/2006, Concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), 2006 O.J. (L 136) 3, 5 ¶ 25, available at <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:136:0003:0280:en:PDF>. Critics of this more potent version of the precautionary principle consider it a "hyper-cautious approach to change," advocated by antitechnology environmental and consumer groups. See RETHINKING RISK AND THE PRECAUTIONARY PRINCIPLE 13 (Julian Morris ed., 2000). Opponents of government regulation of technology and the economy generally are not likely to favor a standard for decision making that makes regulation in the face of uncertainty more likely. The titles of the essays in *Rethinking Risk and the Precautionary Principle* convey the general tenor of this criticism. See, e.g., Henry I. Keller & Gregory Conko, *Genetically Modified Fear and the International Regulation of Biotechnology*, in RETHINKING RISK AND THE PRECAUTIONARY PRINCIPLE, *supra*, at 84; Bruce Yandle, *The Precautionary Principle as a Force for Global Political Centralization: A Case Study of the Kyoto Protocol*, in RETHINKING RISK AND THE PRECAUTIONARY PRINCIPLE, *supra*, at 167.

15. It is noteworthy that a National Academy of Sciences panel report in 1975 endorsed shifting the burden of proof as an option for regulating new chemicals. COMM. ON PRINCIPLES OF DECISION MAKING FOR REGULATING CHEMS. IN THE ENV'T, NAT'L ACAD. OF SCIS., DECISION MAKING FOR REGULATING CHEMICALS IN THE ENVIRONMENT 18 (1975).

16. See GHG Endangerment Finding, *supra* note 1, at 66,505–07.

17. See *id.*

18. See *id.* at 66,506. The Supreme Court opinion in *Massachusetts v. EPA* also noted this change:

The 1970 version of § 202(a)(1) used the phrase "which endangers the public health or welfare" rather than the more protective "which may reasonably be anticipated to endanger public health or welfare." Congress amended § 202(a)(1) in 1977 to give its approval to the decision in *Ethyl Corp. v. EPA*, which held that the Clean Air Act "and common sense . . . demand regulatory action to prevent harm, even if the regulator is less than certain that harm is otherwise inevitable."

that Congress explicitly intended to authorize a “middle road between those who would impose a nearly impossible standard of proof on the Administrator before he may move to protect public health and those who would shift the burden of proof for all pollutants to make the pollutant source prove the safety of its emissions as a condition of operation.”<sup>19</sup>

*B. The Value of a Precautionary Principle in U.S. Environmental Decision Making*

The purpose of environmental law in the United States is precautionary; it is grounded in a political judgment that the environment demands and deserves proper protection and stewardship to preserve life and advance well-being.<sup>20</sup> Its policy goals concern both human and nonhuman life and natural beauty.<sup>21</sup> The National Environmental Policy Act of 1969 still stands as the clearest statement of U.S. national policy on the environment.<sup>22</sup> One of its purposes is “to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man[.]”<sup>23</sup> To that end, it directs the federal government to use “all practicable means” consistent with “other essential considerations of national policy” to achieve a set of specific environmental goals.<sup>24</sup> The law calls on the government to “fulfill the responsibilities of each generation as trustee of the environment for succeeding generations” and to “assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings.”<sup>25</sup> Precaution as an element of environmental law and decision making serves these national purposes.

Environmental law’s objectives and its operation in and on the natural world distinguish it from other areas of civil and administrative law. Professor Richard Lazarus defines those differences as resulting from the character of environmental injury, including the high degree of uncertainty in addressing the

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549 U.S. 497, 506 n.7 (2007) (citations omitted).

19. GHG Endangerment Finding, *supra* note 1, at 66,507 (citation omitted).

20. ECO-PRAGMATISM, *supra* note 8, at 103–04. For example, the goal of the Clean Water Act of 1972 is to restore and maintain “the chemical, physical, and biological integrity of [the] nation’s waters.” 33 U.S.C. § 1251(a) (2012). For an international statement of the dependence of the life, economy, and community of the planet on the earth’s air, land, and water, see MILLENNIUM ECOSYSTEM ASSESSMENT, ECOSYSTEMS AND HUMAN WELL-BEING 1 (2005) (“Everyone in the world depends completely on [e]arth’s ecosystems and the services they provide, such as food, water, disease management, climate regulation, spiritual fulfillment, and aesthetic enjoyment.”).

21. Lisa Heinzerling, *New Directions in Environmental Law: A Climate of Possibility*, 35 HARV. ENVTL. L. REV. 263, 271–72 (2011).

22. The National Environmental Policy Act of 1969, 42 U.S.C. §§ 4321–4370h (2012).

23. *Id.* § 4321.

24. *Id.* § 4331(b).

25. *Id.* § 4331(b)(1)–(2); see JAMES R. MCELFIN & ELISSA PARKER, ENVTL. LAW INST., REDISCOVERING THE NATIONAL ENVIRONMENTAL POLICY ACT: BACK TO THE FUTURE (1995), available at <http://www.eli.org/sites/default/files/eli-pubs/d4.00.pdf> (analyzing the National Environmental Policy Act).

impacts of human activities on natural resources.<sup>26</sup> Complex biological and ecological systems make it harder to predict both human health and environmental consequences and to determine cause and effect relationships even after the fact.<sup>27</sup> The potential for irreversible effects is usually present, and may include catastrophic ecosystem effects, as in the case of major climate disruption.<sup>28</sup> Professor Douglas Kysar emphasizes that environmental lawyers and regulators must assess risks in the context of “overlapping dynamic systems”<sup>29</sup> that do not fit easily into conventional analytic decision making models.

Beyond its sheer complexity, other features of environmental regulation make conventional cost-benefit analysis less well-suited to decision making. In the environmental context, costs and benefits are often separated so that the people or resources harmed do not benefit from the activity causing the environmental burden.<sup>30</sup> The entity required to abate the harm may or may not benefit directly from controls either, though this inequity produces less concern when a polluter is imposing negative environmental impacts on another party.<sup>31</sup> Most public officials and policy analysts recognize that distributional and equity issues are important. In setting standards to protect public health under environmental laws such as the CAA and the Safe Drinking Water Act,<sup>32</sup> agency officials strive to protect sensitive populations like children and the elderly.<sup>33</sup> The environmental justice movement asserting disproportionate impacts of pollution on poor communities and minorities also calls for addressing these concerns.<sup>34</sup>

26. RICHARD J. LAZARUS, *THE MAKING OF ENVIRONMENTAL LAW* 5–15 (2004) [hereinafter *THE MAKING OF ENVIRONMENTAL LAW*]; Richard J. Lazarus, *Restoring What's Environmental About Environmental Law in the Supreme Court*, 47 UCLA L. REV. 703, 744–48 (2000) [hereinafter *Restoring What's Environmental*].

27. The assessment of human health effects is made more difficult by the inability to test exposure to potentially harmful materials on people directly and the resulting need to extrapolate from animal toxicology studies and epidemiologic and other indirect methods of research to identify such health effects. See *THE MAKING OF ENVIRONMENTAL LAW*, *supra* note 26, at 21.

28. *Id.* at 12, 23.

29. *REGULATING FROM NOWHERE*, *supra* note 8, at 73.

30. *Restoring What's Environmental*, *supra* note 26, at 746.

31. One writer has observed that purchasers of automobiles with emission controls are paying to benefit city residents exposed to higher levels of pollution. See Matthew E. Kahn, *The Beneficiaries of Clean Air Act Regulation*, REGULATION, Spring 2001, at 34, 35–37, available at <http://object.cato.org/sites/cato.org/files/serials/files/regulation/2001/4/kahn.pdf>. This kind of distributional effect, if true, would not concern most government regulators.

32. 42 U.S.C. §§ 7401–7671q (2012); 42 U.S.C. § 300(f)–(j).

33. The CAA requires EPA to publish “information on other measures which may be employed to reduce the impact on public health or protect the health of sensitive or susceptible individuals or groups . . . .” *Id.* § 7408(f)(1)(C). The Safe Drinking Water Act requires EPA to conduct a continuing program of studies to identify subpopulations that may be at greater risk than the general population from exposure to drinking water contaminants and to report periodically to Congress on the results. See *id.* § 300j-18.

34. See EPA, PLAN EJ 2014: INCORPORATING ENVIRONMENTAL JUSTICE INTO RULEMAKING (2011), available at <http://www.epa.gov/environmentaljustice/resources/policy/plan-ej-2014/plan-ej->

In other circumstances, the benefits of an environmental regulatory action may be distant in place and time. The impacts of pollution may affect another state, another country, or another generation of people.<sup>35</sup> International transboundary impacts are harder to estimate, and controlling them may be considered beyond the purview of national authorities.<sup>36</sup> However, pollution impacts across international borders are becoming much more common in environmental regulation, as the fight over mercury emissions from U.S. power plants and the growing impact of Asian emissions in the American West have shown.<sup>37</sup> Consideration of environmental impacts predicted to occur in the future also presents challenges to cost-benefit analysis. The benefits of governmental action to reduce exposure to carcinogens or to protect the ozone layer may occur decades in the future. Discount rates that reduce benefits over time have major impacts on whether benefits exceed costs.<sup>38</sup> Discounting such future benefits is especially problematic when considering the intergenerational benefits of climate change.<sup>39</sup> Some analysts dispose of intergenerational impacts either by discounting their value to almost nothing<sup>40</sup> or eliminating them from consideration because future generations may not even exist; or, if they do, they will be rich enough with predicted economic growth to have the

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rulemaking-2011-09.pdf (describing EPA's policy statement on incorporating environmental justice considerations into its regulatory decisions).

35. *Restoring What's Environmental*, *supra* note 26, at 745–47.

36. Professor Eric Posner argues that government officials have the power to maximize the welfare of the current generation of Americans, and not future generations or foreigners, a point cited in *REGULATING FROM NOWHERE*, *supra* note 8, at 178. *But see* MCELISH & PARKER, *supra* note 25, at 7–10, 16–19 (arguing that the National Environmental Policy Act provides federal agencies with independent legal authority to apply its policies, including concern for intergenerational impacts).

37. The electric utility industry argued that it was unreasonable to regulate U.S. mercury emissions when the contribution of non-U.S. emissions to U.S. mercury levels remained unaddressed. *See* National Emission Standards for Hazardous Air Pollutants from Coal- and Oil-Fired Electric Utility Steam Generating Units, 77 Fed. Reg. 9304, 9338–39 (Feb. 16, 2012) (to be codified at 40 C.F.R. pts. 60, 63) [hereinafter NESHAPS for EGUs]. The Obama administration has initiated action to support international controls on mercury emissions, a departure from the Bush administration's policy. *See* *REGULATING FROM NOWHERE*, *supra* note 8, at 146 (discussing the impact of Asian emissions on ozone levels in the western United States); Kate Galbraith, *If Mercury Pollution Knows No Borders, Neither Can its Solution*, N.Y. TIMES (Dec. 12, 2012), [http://www.nytimes.com/2012/12/13/business/energy-environment/if-mercury-pollution-knows-no-borders-neither-can-its-solution.html?\\_r=0](http://www.nytimes.com/2012/12/13/business/energy-environment/if-mercury-pollution-knows-no-borders-neither-can-its-solution.html?_r=0); Daniel A. Reifsnnyder, Deputy Assistant Sec'y for Env't & Sustainable Dev., U.S. Dep't of State, Statement before the United Nations Environmental Programme: United States Proposes Decision on Mercury at 25 GC/GMEF (Feb. 16, 2009), *available at* <http://www.unep.org/documents.multilingual/default.asp?documentID=566&ArticleID=6083&l=en&t=long>.

38. *See generally* RUTH GREENSPAN BELL & DIANNE CALLAN, WORLD RES. INST., MORE THAN MEETS THE EYE: THE SOCIAL COST OF CARBON IN U.S. CLIMATE POLICY, IN PLAIN ENGLISH (2011), *available at* [http://www.eli.org/sites/default/files/eli-pubs/d21\\_03.pdf](http://www.eli.org/sites/default/files/eli-pubs/d21_03.pdf) (discussing “the limitations that the special nature of climate change imposes on cost-benefit analysis”).

39. Lazarus believes that intergenerational impacts are “not readily susceptible to monetary valuation” and therefore receive inadequate weight in conventional cost-benefit analysis. *Restoring What's Environmental*, *supra* note 26, at 748.

40. Professor Daniel A. Farber explains well the complexities of discounting future gains and losses and the unscientific assumptions often underlying the discount factors chosen. *See* ECO-PRAGMATISM, *supra* note 8, at 133–162.

wherewithal to deal with diminished natural capital stock.<sup>41</sup> An emphasis on investment to replace exhaustible resources is appealing in the context of advancing sustainability,<sup>42</sup> but it does not adequately engage the ethical implications of knowingly subjecting future generations to the scale of natural resource damage threatened by climate change.<sup>43</sup>

Finally, proponents of a precautionary approach see both practical and philosophical problems in adopting cost-benefit analysis as the exclusive or primary framework for decisions. They stress the difficulty of producing accurate quantifications of health and environmental benefits and costs, and are skeptical of the quality of the numbers marshaled to monetize them.<sup>44</sup> Quantified estimates of impacts on nonhuman species and other ecological impacts have been especially hard for environmental agencies to develop.<sup>45</sup>

41. Wilfred Beckerman, *The Precautionary Principle and Our Obligations to Future Generations*, in RETHINKING RISK AND THE PRECAUTIONARY PRINCIPLE, *supra* note 14, at 47, 50–54 (noting that “[u]nborn people simply cannot *have* anything,” and that they will be far richer and can take care of themselves).

42. John Hartwick’s rule holds that investment of rent from exhaustible resources in capital goods can maintain per capita consumption for the future. John M. Hartwick, *Intergenerational Equity and the Investment of Rents from Exhaustible Resources*, 67 AM. ECON. REV. 972, 972–74 (1977).

43. Professors Richard Revesz and Michael Livermore describe discounting in the intergenerational context as “punting on one of the most important moral questions of our time.” RETAKING RATIONALITY, *supra* note 8, at 146; *see also* REGULATING FROM NOWHERE, *supra* note 8, at 180–86.

44. Most of the information on the costs of regulating industry comes from the companies to be regulated, which have a legitimate interest in presenting very conservative estimates of both cost and technical feasibility. They need to be concerned about being able to comply with a new standard and also are reluctant to reveal early information on technical advances that could provide a competitive advantage to other companies. Many examples confirm this upward bias in industry cost estimates. *See* THE MAKING OF ENVIRONMENTAL LAW, *supra* note 26, at 252. Government agencies cannot match industry’s access to both data and experts on particular industrial sectors. RETAKING RATIONALITY, *supra* note 8, at 134, 138–40. These realities tend to make the factual record reflect the status quo in terms of technology and to overstate the costs and difficulty of compliance.

45. For a thorough report on valuation of ecological issues and ecosystem services prepared over a period of six years, *see* SCI. ADVISORY BD., EPA, VALUING THE PROTECTION OF ECOLOGICAL SYSTEMS AND SERVICES: A REPORT OF THE EPA SCIENCE ADVISORY BOARD (2009) [hereinafter VALUING THE PROTECTION OF ECOLOGICAL SYSTEMS AND SERVICES], *available at* <http://yosemite.epa.gov/sab/sabproduct.nsf/WebBOARD/ValProtEcolSys&Serv>. The report notes that the Office of Management and Budget’s circular on regulatory analysis provides that where EPA cannot quantify a benefit in monetary terms, the agency should try to measure impacts in terms of “physical units” or, where that is not possible, to define the effects in qualitative terms. *Id.* at 3. The Science Advisory Board report recommends that EPA adopt a broader suite of evaluation methods and generally improve its capabilities in demonstrating value in this context. *Id.* at 3–5. Professor Lisa Heinzerling points out that the benefits of air pollution rules reducing fine particulate pollutants are now highly quantifiable and substantial, but that rules addressing water quality, hazardous waste disposal, and toxic pollutants are much more difficult to defend under strict cost-benefit calculations and have not fared well under the Obama administration’s regulatory review process. Lisa Heinzerling, *Inside EPA: A Former Insider’s Reflections on the Relationship between the Obama EPA and the Obama White House*, 31 PACE ENVTL. L. REV. 325, 352–53 (2014) [hereinafter *Insider’s Reflections*]. Actions to prevent water pollution and to protect aquatic resources have never fared well on the cost-benefit scale because valuation of ecological and amenity benefits has been and continues to be weak. *See* J. CLARENCE DAVIES & JAN MAZUREK, POLLUTION CONTROL IN THE UNITED STATES: EVALUATING THE SYSTEM 132–35 (1998).

The efforts of industry and independent organizations to monetize ecosystem services like the benefits of wetlands or forest cover are commendable,<sup>46</sup> but the complexity of ecological impacts at issue in many decisions makes these estimates especially problematic.<sup>47</sup> These impacts are center stage in assessing the impacts of climate change.

On a more fundamental level, most environmentalists reject the assumption that only impacts monetized as if in a market transaction are legitimate and do not trust commercial markets to be a reliable measure or driver of environmental protection.<sup>48</sup> After all, the early common law of nuisance and modern governmental regulation of the environment were both developed to address market externalities—the imposition of health and environmental burdens on neighbors and the public by property owners and industries behaving as if they owned resources like the ambient air.<sup>49</sup> Shifting the ground of arguments over environmental goals to the domain of commercial values and short-term financial perspectives<sup>50</sup> is not favored by

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46. See, e.g., WORLD BUS. COUNCIL FOR SUSTAINABLE DEV., GUIDE TO CORPORATE ECOSYSTEM VALUATION (2011), available at <http://www.wbcsd.org/work-program/ecosystems/cev/downloads.aspx>; WORLD RES. INST. ET AL., THE CORPORATE ECOSYSTEM SERVICES REVIEW: GUIDELINES FOR IDENTIFYING BUSINESS RISKS AND OPPORTUNITIES ARISING FROM ECOSYSTEM CHANGE (2012), available at [http://pdf.wri.org/corporate\\_ecosystem\\_services\\_review.pdf](http://pdf.wri.org/corporate_ecosystem_services_review.pdf). Dow Chemical Company and The Nature Conservancy entered into an innovative partnership to develop ways to value and incorporate the economic benefits of nature in business decisions at both the corporate level and at company sites. For a description of results to date, see THE NATURE CONSERVANCY & DOW CHEM. CO., 2012 PROGRESS REPORT (2012), available at <http://www.dow.com/sustainability/pdf/2012-tnc-collaboration-report.pdf>.

47. Kysar provides an example of the incomplete assessment of the effects of electric power plant discharges of heated water in his discussion of EPA's efforts to set a best available technology standard for cooling water intake structures under section 316 of the Clean Water Act to control entrainment and impingement of organisms sucked in with the water. REGULATING FROM NOWHERE, *supra* note 8, at 211–12. Only the potential impacts on commercial fish species were counted. *Id.* Kysar notes that EPA acknowledged its inability to monetize many other ecological impacts at issue in its decision on what investment in cooling systems should be required and therefore excluded them from consideration. *Id.* These other ecological impacts included decreased numbers of popular species that are not fished; threatened or endangered species; increased numbers of exotic or disruptive species; disturbance of ecological niches; organic and nutrient transfer through the food web; local biodiversity; predator-prey relationships; age class structures; and natural succession processes. *Id.*

48. Even the most ardent advocates of governance through markets have found market behavior to be disappointing in recent years. Former chairman of the Federal Reserve, Alan Greenspan, who presided over the development of both stock market and real estate bubbles, confessed his surprise that the markets were not self-correcting. *The Financial Crisis and the Role of Federal Regulators: Hearing before the H. Comm. on Gov't Oversight & Reform*, 110th Cong. (2008) (statement of Alan Greenspan, former chairman of the Federal Reserve), available at <http://www.gpo.gov/fdsys/pkg/CHRG-110ohrg55764/html/CHRG-110ohrg55764.htm>.

49. “The role of environmental law has been to attempt through common law, state and federal statutory and regulatory systems, and even constitutional theories to force externalized environmental and social costs back into the politics and economics of the marketplace.” ZYGMUNT J.B. PLATER ET AL., ENVIRONMENTAL LAW AND POLICY: NATURE, LAW, AND SOCIETY 60 (3d ed. 2010).

50. Economic analysis, Lazarus maintains, is “doctrinally predisposed to the more immediate benefits presented by resource exploitation and development and against the long-term, uncertain benefits of environmental protection.” THE MAKING OF ENVIRONMENTAL LAW, *supra* note 26, at 28.

environmental advocates who see the environment as the foundation of the economy and not the other way around.

In summary, most environmental law and policy experts and decision makers believe that decision making for the environment demands giving significant weight to less quantifiable factors. These include the scientific complexity of ecological systems, equity and the distributive impacts of environmental harms and their remedies, potential irreversible impacts, and the need to consider the interests of nonhuman life, transboundary impacts, and the implications of today's actions on the well-being of future generations.<sup>51</sup> These considerations have special salience in environmental decisions and demand a precautionary approach to decision making.

### *C. The Utility of Cost-Benefit Analysis in U.S. Environmental Decision Making*

Today, the use of cost-benefit analysis to weigh the costs of remedies against their benefits is well established, and the precautionary principle has been characterized as a "recessive strain" in environmental decision making.<sup>52</sup> The weaker version of the precautionary principle, lacking a general shift in the burden of proof, initially attracted broad early support for the concept that the absence of scientific certainty should not preclude action on risks of substantial harm, the acceptance of the concept of a margin of safety in standard setting, and the imposition of best available technology requirements to control pollution as insurance against unrecognized future harms.<sup>53</sup> However, greater disagreement over the role of the principle emerged when environmental laws took aim at products, like lead additives or other industrial chemicals, whether new or in use. In the United States, the bias for innovation and expanding commerce has set the bar higher to prevent or restrict the introduction of

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51. In defining a role for lawyers in bridging the gap between law and science, Judge Richard Posner, an advocate for cost-benefit analysis, cites the factors of neutrality and value judgments as important contributions. His statement refers to catastrophic risk assessments specifically, but his insight is pertinent to cost-benefit analysis generally. He writes:

Unless the regulation of science and technology is to be left entirely to scientists and the market, which would be perilous . . . there is a role for experts in regulation. Not that lawyers are the only such experts. Cost-benefit analysis is central to the management of the catastrophic risks and is primarily the domain of economics rather than of law. But the inescapability of value judgments in cost-benefit analysis of the catastrophic risks, and the indispensability of neutrality in the conduct of such analysis open up, even in cost-benefit analysis, a potentially important role for the legal profession.

CATASTROPHE, *supra* note 8, at 207.

52. Boyd, *supra* note 8, at 904. Professor William Boyd traces the development of U.S. health, safety, and environmental decision making since the 1930s and describes the triumph of quantitative risk assessment and cost-benefit analysis in decision making with a good measure of regret. *See generally id.*

53. *Beyond the Precautionary Principle*, *supra* note 8, at 1014–17 (citing Richard Stewart, *Environmental Regulatory Decision Making under Uncertainty*, in 20 RESEARCH IN LAW AND ECONOMICS 71, 78 (Timothy Swanson ed., 2002)).

potentially harmful products, except therapeutic drugs, food additives, and pesticides,<sup>54</sup> than to control industrial waste streams.<sup>55</sup> Over the years, the justification for primary, if not exclusive, reliance on cost-benefit analysis in environmental decision making has expanded from a focus on avoiding excessive costs of regulation to an emphasis on the value of quantification in promoting more rational decision making in general. This evolution is described in more detail in this Part of the Article.

In the environmental arena, the drive to elevate the role of quantification of costs and market valuation of benefits grew stronger in the late 1970s and 1980s when proposed standards for toxic chemicals and cleanup of land disposal sites contaminated by industrial waste rose higher on the EPA agenda.<sup>56</sup> Some emission controls and cleanup standards, especially for carcinogens without known thresholds for adverse impacts, produced very high estimates of the cost of lives saved. Many of the rules deemed most alarming by cost-benefit partisans never moved forward,<sup>57</sup> but the concern that standards for similar risks seemed to be inconsistent and unreasonably costly led to a stronger role for cost-benefit analysis in regulatory decision making.<sup>58</sup> This

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54. The Toxic Substances Control Act, 15 U.S.C. §§ 2601–2629 (2012), places the burden on the government to demonstrate a sufficient risk to justify limitations on the introduction of new chemicals, to regulate those in use, and even to require testing of chemicals to determine whether they are harmful. The widely perceived inefficacy of the Toxic Substances Control Act has prompted arguments in favor of reforming the law to shift greater burdens onto the proponents of new chemicals to demonstrate their safety. See Noah Sachs, *Rescuing the Strong Precautionary Principle from Its Critics*, 2011 U. ILL. L. REV. 1285, 1307 (2011). Professor Noah Sachs points out that the burden has been shifted to the proponents of products in the food, drug, and pesticide industries. *Id.* at 1307–09. Precautionary regulation in the chemical field has been largely ceded to the European Union and California, both of which have developed more extensive regulatory programs for new and in-use chemicals. See, e.g., Council Regulation 1907/2006, *supra* note 14 (placing the burden of producing information and attesting to chemical safety on manufacturers); Safe Drinking Water and Toxic Enforcement Act of 1986, CAL. HEALTH & SAFETY CODE §§ 25249.5–25259 (West 2014). The California law known as Proposition 65 authorized the California Environmental Protection Agency to list chemicals known to cause cancer, birth defects, or other reproductive harm and to require businesses using such chemicals to warn the users of their products of any significant harm from exposure to the chemicals, among other notification requirements. See generally HEALTH & SAFETY §§ 25249.5–25259. The law requires labeling or posting of the chemicals listed and used, as appropriate. See generally OFFICE OF ENVTL. HEALTH HAZARD ASSESSMENT, CAL. ENVTL. PROT. AGENCY, PROPOSITION 65 IN PLAIN LANGUAGE 1–4 (2013), available at <http://www.oehha.ca.gov/prop65/pdf/P65Plain.pdf>.

55. See, e.g., THE MAKING OF ENVIRONMENTAL LAW, *supra* note 8, at 103 (explaining Lazarus’s position that cost-benefit analysis deserves a place in product regulation but not in waste regulation).

56. See RETAKING RATIONALITY, *supra* note 8, at 21–25, 37–39 (discussing the principal studies by advocates of antiregulatory policies in general and cost-benefit analysis in particular). In his excellent essay on past and present trends in U.S. administrative law, Professor Richard Stewart describes one view of cost-benefit analysis as a response to “a largely uncontrolled, hydra-headed array of federal regulatory agencies, afflicted with tunnel vision and spurred by ‘public interest’ advocates [that] were using vague statutes to adopt ever more intrusive, rigid, and costly regulatory requirements, oblivious to their burden on the economy and U.S. international competitiveness.” Richard B. Stewart, *Administrative Law in the Twenty-First Century*, 78 N.Y.U. L. REV. 437, 443 (2003).

57. Lisa Heinzerling, *Regulatory Costs of Mythic Proportions*, 107 YALE L.J. 1981, 2000–10 (1998).

58. A book by Justice Stephen Breyer, then of the First Circuit Court of Appeals, compared numerous health and safety rules across federal agencies and found a wide range in the costs per

trend was institutionalized in 1981, when the Reagan administration issued Executive Order 12,291, establishing cost-benefit analysis as the method for reviewing agency rules unless the governing statute barred its use.<sup>59</sup> The Clinton administration revised and reissued the order, with greater emphasis on ensuring timeliness and transparency of review by the Office of Information and Regulatory Affairs and the addition of a definition of a “significant regulatory action” as requiring cost-benefit analysis for those actions with an annual cost exceeding \$100 million.<sup>60</sup> The Obama administration retained most of the Clinton order, while adding specific references to considering human dignity and fairness as well as conventional costs and benefits.<sup>61</sup>

Cost-benefit analysis has often been touted by policy analysts and conservatives generally skeptical of government and desirous of greater reliance on markets and private legal remedies to protect people against harmful products or pollution. Many favor measuring public opinion by referring to consumer preferences and willingness to pay for public benefits like clean water, rather than giving weight to citizen preferences for a cleaner environment as expressed through political processes.<sup>62</sup> Today’s cost-benefit partisans place less emphasis on advancing economic goals and are likely to defend the decision-making tool as a means of counteracting all manner of pressures toward irrational judgments by decision makers. As Kysar describes the difference, the ground has shifted to arguments over differing “conceptions of rational decision making that compete for acceptance within cognitive psychology.”<sup>63</sup>

Supporters of cost-benefit analysis as a prerequisite for sound decisions increasingly stress newer information suggesting that citizens and regulators alike are not very good at making objective decisions without the aid of quantitative information.<sup>64</sup> Psychologists have studied the strengths and

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premature death avoided. See STEPHEN BREYER, *BREAKING THE VICIOUS CIRCLE: TOWARD EFFECTIVE RISK REGULATION* (1993). There was also a focus during the 1980s on comparative risk assessment that produced reports on how to choose more serious risks for action, but the effort foundered when some environmental organizations, suspicious of both motives and methodologies, increasingly focused on reducing the use of chemicals or outright bans rather than finely tuned regulations based on quantitative risk assessments. See Frederick R. Anderson, *CRA and Its Stakeholders: Advice to the Executive Office*, in *COMPARING ENVIRONMENTAL RISKS: TOOLS FOR SETTING GOVERNMENT PRIORITIES* (J. Clarence Davies ed., 1996).

59. Exec. Order No. 12,291, 46 Fed. Reg. 13,193 (Feb. 17, 1981).

60. Exec. Order No. 12,866, 58 Fed. Reg. 51,735 (Oct. 4, 1993).

61. Exec. Order No. 13,563, 76 Fed. Reg. 3821 (Jan. 21, 2011). President Barack Obama revoked a Bush administration order requiring reference to market failure and subjecting agency guidance as well as rules to scrutiny. Exec. Order No. 13,497, 74 Fed. Reg. 6113 (Jan. 30, 2009); see also Exec. Order No. 13,422, 72 Fed. Reg. 2763 (Jan. 18, 2007). However, the Obama Office of Information and Regulatory Affairs has continued to review guidance and even applies cost-benefit analysis to rules that are not “economically significant,” particularly with regards to EPA’s rules. See *Insider’s Reflections*, *supra* note 45, at 348.

62. ECO-PRAGMATISM, *supra* note 8, at 35–39; REGULATING FROM NOWHERE, *supra* note 8, at 113–15.

63. *Ecologic*, *supra* note 8, at 228.

64. SIMPLER, *supra* note 8, at 42–44; see *id.* at 125 (commenting on the trend to relate the preference for cost-benefit analysis to the need to counter bias and cognitive limitations rather than advancing economic welfare).

weaknesses of cognitive processes as well as the power of cultural influences on both individual and expert ways of evaluating facts and arguments. Professor Daniel Kahneman's influential book, *Thinking, Fast and Slow*, examines recent developments in cognitive and social psychology and divides a person's thought processes into System 1 and System 2, the intuitive and the deliberative, respectively.<sup>65</sup> System 1 is automatic, intuitive, and informed by experience, and its initial reactions are appropriate, but it has biases and weaknesses in the areas of logic, considering probabilities, and jumping to conclusions.<sup>66</sup> System 2 applies more mental effort to a problem and can "follow rules, compare objects on several attributes, and make deliberate choices between options."<sup>67</sup> Professor Kahneman observes that children seem to have a natural affinity for grammar, but not for statistics.<sup>68</sup>

Other characteristics relevant to making decisions about environmental regulations include the "availability heuristic," the human tendency to judge the frequency of events by the ease with which examples come to mind.<sup>69</sup> These tend to be dramatic events, like plane crashes or Hurricane Sandy, that are recalled to mind when considering a problem. People tend to rate chronic, low-level health risks like asthma lower on the frequency scale for causes of death than tornadoes, although in reality deaths from tornadoes are much more rare. People are also influenced by the emotions attached to salient events. Both contribute to the common failure to consider and accurately weigh probabilities.<sup>70</sup> Another tendency confirmed by psychological testing is loss aversion. According to Professor Kahneman, studies show that the fear of losing \$100 is more intense than the hope of gaining \$150.<sup>71</sup> Or, as Judge Henry J. Friendly put it many years ago, "Whatever the mathematics, there is a human difference between losing what one has and not getting what one

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65. DANIEL KAHNEMAN, *THINKING, FAST AND SLOW* 20–23 (2011). Professor Kahneman attributes the terms System 1 and System 2, widely used in psychology, to psychologists Keith Stanovich and Richard West. *Id.* at 20–21. Kahneman's book defines the main features of the two systems, examines their strengths and weaknesses, and applies the insights gained to an analysis of many forms of decision making. *See id.* at 13–14. The book builds on his early work on judgment and decision making in collaboration with Professor Amos Tversky, *see id.* at 4–10, for which Kahneman received the Nobel Prize in economics in 2002. *Id.* at 10. Professor Tversky died in 1996. *Id.*

66. *See id.* at 20–25.

67. *See id.* at 22–23, 36.

68. *Id.* at 5. His survey data indicated that even professional statisticians were not intuitive statisticians. Kahneman devotes a chapter of his book to summarizing a study in which adult subjects were given a description of a man and asked to choose what area of study the man was likely to be pursuing. *See id.* at 146–155. The subjects decided the man's description fit a reserved person who tended to fit the stereotype of someone who would study computer science. *Id.* The subjects ignored the fact that the personality description was presented as based on tests of "uncertain validity" and that the number of students studying computer science was likely to be much smaller than those in other fields such as the humanities and education. *Id.* Even statistics students focused on slender evidence of the "representativeness" of the personality type and ignored the weakness of the evidence about the man and the greater likelihood that he would be in a field with more students. *See id.*

69. *Id.* at 8–9.

70. *See id.* at 139–40.

71. *Id.* at 274.

wants.”<sup>72</sup> These findings and observations underscore the human bias toward the status quo and away from considering opportunities that potentially offer greater gains.

Professors Dan M. Kahan and Donald Braman provide further support for the conclusion that an individual’s judgment is subject to diverse influences and bias in their work on “cultural cognition.”<sup>73</sup> They define this term as “a series of interlocking social and psychological mechanisms that induce individuals to conform their factual beliefs about contested policies to their cultural evaluations of the activities subject to regulation.”<sup>74</sup> They argue that the availability and accessibility of scientific information are unimportant compared to cultural biases and the tendency to refer to the opinions of people whom we trust, who are likely to share our own worldviews.<sup>75</sup> The authors cite studies in anthropology and social psychology to divide people into categories that can predict their views on particular issues.<sup>76</sup> In their view, “seemingly empirical” debates on public policy will actually be guided by “conflicting cultural worldviews . . .”<sup>77</sup> Cultural predispositions are reinforced by the tendency to avoid the “cognitive dissonance” experienced when confronting a conflicting opinion, a pattern of processing information that affects scientists as well as lay people. People tend to accept information that conforms to their preconceptions, however derived.<sup>78</sup> These human tendencies can produce unreasonable decisions unless counteracted by the discipline of decisional procedures like cost-benefit analysis.

In summary, advocates of the cost-benefit approach to regulatory decision making believe that a quantified analysis of a set of policy choices is the only effective antidote for errors in evaluation due to emotion, bias, or the failure to see the big picture and make intelligent trade-offs.<sup>79</sup> They also view cost-benefit analysis as a neutral tool for decision making that can stand up to irrational public opinion on the one hand, and to rent-seeking industry pressure for public policy decisions favoring industry interests on the other. While cost-benefit analysis is most commonly championed as a tool to reduce regulation of the economy and property, such analysis has, in some cases, served to persuade skeptics of regulation that it may be warranted.<sup>80</sup>

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72. Henry J. Friendly, *Some Kind of Hearing*, 123 U. PA. L. REV. 1267, 1295–96 (1975).

73. Dan M. Kahan & Donald Braman, *Cultural Cognition and Public Policy*, 24 YALE L. & POL’Y REV. 149, 150 (2006).

74. *Id.* at 171.

75. *Id.* at 149–51.

76. *See id.* at 152.

77. *Id.* at 157.

78. *Id.* at 165–66.

79. SIMPLER, *supra* note 8, at 161–63; *Beyond the Precautionary Principle*, *supra* note 8, at 1003, 1005, 1018–20. These concerns appear to stem in part from Professor Cass Sunstein’s negative reactions to the management of public health controversies such as Love Canal and the Alar apple pesticide episode. *See* KAHNEMAN, *supra* note 65, at 141–43 (discussing Sunstein’s views on the Love Canal and Alar decisions).

80. RETAKING RATIONALITY, *supra* note 8, at 10–16. Professor Sunstein offers a good example of using cost-benefit analysis to persuade the Reagan administration to support aggressive regulation of

## II. THE CENTRAL ROLE OF THE PRECAUTIONARY PRINCIPLE IN THE EPA ENDANGERMENT DECISIONS

The precautionary principle played a decisive role in supporting EPA's first major rule to reduce automotive emissions of lead and its most recent motor vehicle rule to reduce GHG emissions, notwithstanding the chorus of criticism the principle has received since the late 1970s. The cases of lead additives and GHGs present similarities and differences in the degree and nature of uncertainty in defining the harm to health and the environment at stake and the likelihood that lead and GHGs were contributing significantly to that harm. In both cases, the impact of regulatory action taken to address the risks was too uncertain to be quantified or converted into monetary terms when the decisions needed to be made. Despite these limitations, EPA made legal findings of endangerment that were upheld by reviewing courts in reliance on the precautionary principle. This Part reviews in detail the basis for these administrative and judicial decisions.

### A. *Precaution in Weighing the Evidence in the Coalition and Ethyl Cases*

In the *Coalition* decision, the D.C. Circuit upheld the GHG endangerment finding supporting the GHG emission standards for motor vehicles set by EPA pursuant to section 202(a) of the CAA and further determined that the CAA requires major stationary sources of GHGs, such as power plants, to obtain construction and operating permits for those emissions.<sup>81</sup> This Article examines only the endangerment finding supporting the automotive GHG emission standards. Petitioners challenged EPA's interpretation of the statutory standard, the adequacy of the scientific record to sustain it, and the agency's failure to quantify the level of atmospheric concentration at which GHGs endanger health or the environment.<sup>82</sup> Petitioners also raised other second order issues.<sup>83</sup> Most

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chlorofluorocarbons (CFCs) to prevent further destruction of the ozone layer, which protects the earth from harmful sun exposure. The prospect of a vast increase in skin cancer cases, the centerpiece of the analysis, was both frightening and potentially expensive. WORST-CASE SCENARIOS, *supra* note 8, at 72–85. The risk of skin cancer may also have influenced the relatively small number of large CFC manufacturers, including DuPont and Imperial Chemical, to accelerate the introduction of CFC substitutes to avoid potential product liability. In the case of CFCs, the general public got the message pretty quickly without the aid of cost-benefit analysis. Much of the public understood the threat of skin cancer, saw a picture of the ozone hole, and stopped using aerosol sprays. Sometimes System 1 thinking works just fine.

81. *Coal. for Responsible Regulation, Inc. v. EPA (Coalition)*, 684 F.3d 102, 113–14 (D.C. Cir. 2012) (per curiam), *aff'd in part, rev'd in part sub nom. Util. Air Regulatory Grp. v. EPA*, 134 S. Ct. 2427 (2014). The Supreme Court reversed, in part, the D.C. Circuit's decision upholding EPA's determination regarding the applicability of GHG standards in certain CAA permitting programs. *See Util. Air Regulatory Grp.*, 134 S. Ct. at 2439.

82. *Coalition*, 684 F.3d at 117.

83. Petitioners made claims that EPA had improperly defined the air pollutant as an aggregate of six different GHGs, had failed to consult with the Science Advisory Board, and had improperly denied a petition for reconsideration asking the agency to take account of new evidence showing that the science relied upon was seriously flawed. *Id.* at 117, 124. The D.C. Circuit found that no party had standing to challenge the inclusion of two nonautomotive GHGs in the aggregate of six and that consultation with

of the industry petitioners represented stationary sources of GHGs, such as electric generating utilities, that were likely to be subject to future permit requirements. The major domestic auto manufacturing companies and their trade associations had agreed to support the setting of national emission control standards in a negotiation with EPA, the U.S. Department of Transportation, the California Air Resources Board, and the White House.<sup>84</sup> None of those companies challenged the endangerment finding or the tailpipe standards.<sup>85</sup>

An army of attorneys for industry, states, environmental organizations, and the federal government present at two days of arguments before Chief Judge David Sentelle, Judge Judith Rogers, and Judge David Tatel may have been surprised to receive a decision in less than four months. Concise and occasionally curt, the per curiam opinion sifts through numerous complex scientific and legal issues and reaches clear conclusions. In the end, the court found that EPA's interpretations of the endangerment standard were proper, that the scientific record amply supported EPA's finding, and that the automotive GHG standards were neither arbitrary nor capricious.<sup>86</sup> The court stated at the outset that EPA's endangerment finding followed the Supreme Court's decision in *Massachusetts v. EPA*.<sup>87</sup> In 2007, the Supreme Court had set aside EPA's denial of a petition from environmental organizations to

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the Science Advisory Board was not required except for rules subject to formal interagency review. *Id.* at 123–28; see also *infra* notes 162–164 and accompanying text (discussing new evidence issues).

84. On May 19, 2009, President Obama announced a program to set fuel efficiency and GHG reduction standards for motor vehicles covering model years 2012 to 2016 in a program jointly proposed by EPA and the Department of Transportation and representing an “unprecedented collaboration” among the major auto manufacturers, the United Auto Workers, environmental leaders, the State of California, and other state governments. Press Release, White House, President Obama Announces National Fuel Efficiency Policy (May 19, 2009), available at <http://www.whitehouse.gov/the-press-office/president-obama-announces-national-fuel-efficiency-policy>. On May 22, 2009, EPA and the Department of Transportation issued a notice of joint rulemaking to begin the process of setting such standards. Notice of Upcoming Joint Rulemaking to Establish Vehicle GHG Emissions and CAFE Standards, 74 Fed. Reg. 24,007 (May 22, 2009). These actions were accompanied by letters of commitment to the program from California state officials, two automobile trade associations, and most major auto manufacturers, and included standard statements by the manufacturers that the companies would “not contest” the agencies’ rules if adopted as substantially proposed. *Regulations & Standards: Presidential Announcements and Letters of Support*, EPA, <http://epa.gov/otaq/climate/letters.htm> (last updated Mar. 7, 2014). The development of this program and the auto industry’s reasons for supporting it are analyzed in an excellent article by Professor Jody Freeman, who participated in its development while serving on the White House staff. Jody Freeman, *The Obama Administration’s National Auto Policy: Lessons from the “Car Deal”*, 35 HARV. ENVTL. L. REV. 343 (2011). Professor Freeman emphasizes that EPA’s authority to waive federal preemption of state motor vehicle emission standards, principally to allow more stringent California standards, see 42 U.S.C. § 7543(b)(1) (2012), and California’s action to set its own standards for 2009 to 2016 presented conflicts with the auto industry’s desire for “regulatory clarity, certainty, and uniformity” in auto emission standards. Freeman, *supra*, at 349, 364.

85. In fact, the auto manufacturers and their trade associations intervened in the *Coalition* case on the side of the government. Freeman, *supra* note 84, at 363.

86. *Coalition*, 684 F.3d at 113–14.

87. 549 U.S. 497 (2007).

regulate GHG emissions from vehicles, reversing the D.C. Circuit's decision.<sup>88</sup> EPA had ruled that carbon dioxide is not an air pollutant under the CAA and that even if it were, the agency could refrain from regulating automotive emissions for policy reasons unrelated to whether such emissions constituted an endangerment to public health or welfare.<sup>89</sup> In a five to four decision, the Court rejected EPA's arguments for inaction and remanded the matter to EPA for a regulatory decision on whether such emissions constituted an endangerment.<sup>90</sup> As will be seen, the language in the opinion by Justice John Paul Stevens made it difficult for the opponents of EPA's endangerment finding to succeed in discounting the significance of the risk and the contribution of auto emissions.

In upholding EPA's endangerment finding, the D.C. Circuit placed major reliance on its 1976 ruling in *Ethyl II*, the first case interpreting the endangerment standard of Title II of the CAA and the second major federal court decision to address the level of scientific evidence necessary to support environmental decision making.<sup>91</sup> *Ethyl II* upheld EPA's regulations limiting lead additives in gasoline to reduce automotive lead emissions and airborne

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88. The organizations had filed the petition on October 20, 1999. *Id.* at 510. EPA replied fifteen months later with a notice seeking public comment. *See* Control of Emissions from New and In-Use Highway Vehicles and Engines, 66 Fed. Reg. 7486 (Jan. 23, 2001). The agency denied the petition on September 8, 2003. Control of Emissions from New Highway Vehicles and Engines, 68 Fed. Reg. 52,922 (Sept. 8, 2003). States and other parties joined in the appeal of the denial of the petition in the D.C. Circuit. *Massachusetts v. EPA*, 415 F.3d 50, 53 (D.C. Cir. 2005), *rev'd*, 549 U.S. 497 (2007). The circuit panel, including Chief Judge Sentelle, Judge Raymond Randolph, and Judge Tatel, upheld the denial, with Judge Tatel dissenting. *Id.*

89. *See* Control of Emissions from New Highway Vehicles and Engines, 68 Fed. Reg. at 52,925. The agency also referenced a statement from the National Research Council in 2001 that a causal link between human sources of GHGs and climate change was not "unequivocally" established. *Id.* at 52,930 (citing COMM. ON THE SCI. OF CLIMATE CHANGE, NAT'L RESEARCH COUNCIL, CLIMATE CHANGE SCIENCE: AN ANALYSIS OF SOME KEY QUESTIONS 17 (2001) [hereinafter CLIMATE CHANGE SCIENCE: AN ANALYSIS OF SOME KEY QUESTIONS], available at [http://www.nap.edu/openbook.php?record\\_id=10139](http://www.nap.edu/openbook.php?record_id=10139)).

90. *Massachusetts*, 549 U.S. at 533–34.

91. The first appellate decision dealing with the level of scientific evidence needed to support precautionary action to protect health and the environment was the *Reserve Mining Co. v. EPA* decision in 1974. *See* *Reserve Mining Co. v. EPA (Reserve I)*, 498 F.2d 1073 (8th Cir. 1974). The case involved the disposal of asbestos mine tailings into Lake Superior, and the Eighth Circuit upheld a schedule for ending the disposal to comply with the Federal Water Pollution Control Act where the evidence of adverse health effects from the discharge was considerably weaker than the evidence for regulation of lead additives in gasoline at issue in *Ethyl*. *See id.* at 1074–75, 1084–85. A panel of the court had initially stayed an enforcement order by the district court ordering abatement of the discharge on the basis that the mining company was likely to prevail on the merits. *Id.* at 1084–85. The first appellate panel decision held that the asbestos fibers in the water posed an "unquantifiable risk" and found a lack of a "demonstrable hazard." *Id.* at 1082–83. Next came the D.C. Circuit's initial panel decision in *Ethyl Corp. v. EPA (Ethyl I)*, 7 E.R.C. 1353 (D.C. Cir. Jan. 28, 1975), *reh'g granted*, 541 F.2d 1 (D.C. Cir. 1976) (en banc). The Eighth Circuit then granted rehearing en banc of its panel decision and cited Judge Skelly Wright's dissenting opinion from *Ethyl I* at several points in its opinion upholding, in part, the district court's decision. *Reserve Mining Co. v. EPA (Reserve II)*, 514 F.2d 492, 507 n.20, 520, 528 (8th Cir. 1975) (en banc). Two days after the Eighth Circuit's en banc decision, the D.C. Circuit granted the petition to rehear *Ethyl I* en banc. *See Ethyl II*, 541 F.2d 1.

lead levels endangering public health.<sup>92</sup> The ruling was a five to four en banc decision following a two to one panel decision that overturned the rules in 1975.<sup>93</sup>

The court in *Coalition* quoted extensively from the *Ethyl II* decision. The first important paragraph is as follows:

Industry petitioners do not find fault with much of the substantial record EPA amassed in support of the Endangerment Finding. Rather, they contend that the record evidences too much uncertainty to support that judgment. But the existence of some uncertainty does not, without more, warrant invalidation of an endangerment finding. If a statute is “precautionary in nature” and is “designed to protect the public health,” and the relevant evidence is “difficult to come by, uncertain, or conflicting because it is on the frontiers of scientific knowledge,” EPA need not provide “rigorous step-by-step proof of cause and effect” to support an endangerment finding. As we have stated before, “Awaiting certainty will often allow for only reactive, not preventive, regulation.”<sup>94</sup>

The per curiam opinion also upheld EPA’s decision not to “quantify” the risk of endangerment to health and welfare created by climate change and found the finding of endangerment to be supported by a substantial record. Again, the court referenced the *Ethyl II* decision, stating that section 202(a) entails:

a case-by-case, sliding scale approach to endangerment because “[d]anger . . . is not set by a fixed probability of harm, but rather is composed of reciprocal elements of risk and harm, or probability and severity.” EPA need not establish a minimum threshold of risk or harm before determining whether an air pollutant endangers. It may base an endangerment finding on “a lesser risk of greater harm . . . or a greater risk of lesser harm” or any combination in between.<sup>95</sup>

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92. See *Ethyl II*, 541 F.2d at 7.

93. See *id.* at 6; *Ethyl I*, 7 E.R.C. 1353.

94. Coal. for Responsible Regulation, Inc. v. EPA (*Coalition*), 684 F.3d 102, 325 (D.C. Cir. 2012) (per curiam) (citations omitted), *aff’d in part, rev’d in part sub nom.* Util. Air Regulatory Grp. v. EPA, 134 S. Ct. 2427 (2014).

95. *Id.* at 326–27 (citations omitted).

The court relied on *Ethyl II* to accept what the Supreme Court in *Massachusetts v. EPA* helpfully characterized as “some residual uncertainty”<sup>96</sup> and to sidestep the need to set a quantitative measure of safe levels of GHGs.

In its brief on behalf of the Coalition for Responsible Regulation, the American Chemistry Council sought to distinguish *Coalition* from *Ethyl II* by contending that lead is a toxin while carbon dioxide is natural in origin.<sup>97</sup> The brief goes on to say: “Surely, in regulating [carbon dioxide], EPA has an obligation to explain its policy choices that is at least the equal of the explanatory obligation it confronted (and satisfied) in regulating lead.”<sup>98</sup> As this Article will show, the level of scientific evidence and expert opinion EPA provided in support of the contribution of GHGs to climate change and EPA’s elucidation of its policy judgments were far more extensive than the scientific evidence and policy analysis offered to support the lead regulations.

### 1. *The Evidence for Control of Lead Additives in Gasoline to Protect Public Health*

The case for regulating lead additives in gasoline to protect public health from airborne lead may have looked like a simple matter in 1971. Since 1923, lead had been added to gasoline to prevent engine “knock” caused by premature ignition of the fuel.<sup>99</sup> By 1970, 200,000 tons of lead were emitted each year from motor vehicles, constituting 90 percent of airborne lead.<sup>100</sup> Despite this large source of air pollution, EPA struggled to formulate and defend its central finding that “lead particle emissions from motor vehicles present a significant risk of harm to the health of urban populations, particularly to the health of city children.”<sup>101</sup> The first problem was establishing that airborne and dustfall lead made a significant contribution to lead exposure, which comes from multiple sources, including food, water, and leaded paint. The second issue was making the case that comparatively low levels of lead absorption could cause adverse health effects. Lead had been

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96. *Massachusetts v. EPA*, 549 U.S. 497, 534 (2007).

97. Joint Opening Brief of Non-State Petitioners & Supporting Intervenors at 25, *Coalition*, 684 F.3d 102 (D.C. Cir. 2012) (No. 09-1322), 2011 WL 1935458, at \*25. Lead as an element can also claim to be “natural” if not benign. The amicus brief submitted by the Atlantic Legal Foundation went so far as to say that “[b]y contrast with carbon dioxide and other GHGs, the toxicity of lead at low levels was well-known—and was conceded by the *Ethyl* petitioners,” citing page eight of the *Ethyl II* decision. Corrected Brief of Amici Curiae in Support of Petitioners at 16, *Coalition*, 684 F.3d 102 (D.C. Cir. 2012) (No. 09-1322), 2011 WL 2161920, at \*16. There is no support for this statement in the case in general or on the page cited.

98. Joint Opening Brief of Non-State Petitioners & Supporting Intervenors, *supra* note 97, at \*25.

99. See *Ethyl II*, 541 F.2d 1, 7 (D.C. Cir. 1976) (en banc); *Who’s Afraid of the Precautionary Principle?*, *supra* note 8, at 41–49 (discussing the development and introduction of lead additives); Jamie Lincoln Kitman, *The Secret History of Lead*, *NATION*, Mar. 20, 2000, <http://www.thenation.com/article/secret-history-lead?page=0,0>.

100. See *Ethyl II*, 541 F.2d at 9; *id.* at 112 (appendix).

101. Control of Lead Additives in Gasoline, 38 Fed. Reg. 33,734 (Dec. 6, 1973) (to be codified at 40 C.F.R. pt. 80) [hereinafter 1973 Lead Regulations].

recognized as a neurotoxin for decades,<sup>102</sup> and ingestion of leaded paint by children was known to cause mental retardation and even death.<sup>103</sup> However, at the time, the health effects of lower levels of lead found in many children had hardly been studied. Indeed, the *Ethyl II* decision noted that despite many years of lead use and questions about its safety, “virtually all the evidence cited by both EPA and the petitioners” had been developed in the past five years.<sup>104</sup>

Between January 1971, when EPA issued an advance notice of proposed rulemaking informing the public that it was considering regulation of lead additives,<sup>105</sup> and November 1973, when the final rules were promulgated, EPA issued three different documents on the health effects of airborne lead and repropose the rules to obtain further public comment.<sup>106</sup> The first document attempted to defend a two microgram per cubic meter of air ( $\mu\text{g}/\text{m}^3$ ) ambient air quality standard for lead as a health effects threshold.<sup>107</sup> From this target, EPA calculated the need for a 60 percent reduction in the use of lead additives and corresponding lead emissions.<sup>108</sup> After intense criticism of the basis for any threshold, the agency repropose the rules with the same limits but found that due to the numerous sources of human lead intake, it was impossible to establish a precise target for airborne lead.<sup>109</sup> However, EPA concluded that lead emissions should be reduced as much as possible, despite not yet proposing the total elimination of lead in gasoline.<sup>110</sup> The third and final health document and preamble retreated from the apparent intention to remove all lead

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102. See *Ethyl II*, 541 F.2d at 116 (appendix).

103. See *Lead Poisoning and Health*, WORLD HEALTH ORG. (Sept. 2013), <http://www.who.int/mediacentre/factsheets/fs379/en/>.

104. *Ethyl II*, 541 F.2d at 47 n.97. Almost all the available research on lead additives was supported by the lead industry itself. Kitman, *supra* note 99, at 13–14. Dr. Robert Kehoe, a prominent expert who headed the Kettering Laboratory founded by General Motors and other industry groups at the University of Cincinnati, stated in 1966 that his laboratory was the only source of information on the occupational and public health standards for lead. *Id.* at 15. As early as 1922, the surgeon general of the United States, H.C. Cummings, wrote to Pierre du Pont, representing one of the lead additive manufacturers, stating:

“Inasmuch as it is understood that when employed in gasoline engines, this substance will add a finely divided and nondiffusible form of lead to exhaust gases, and furthermore, since lead poisoning in human beings is of the cumulative type resulting frequently from the daily intake of minute quantities, it seems pertinent to inquire whether there might not be a decided health hazard associated with the extensive use of lead tetraethyl in engines.”

*Id.* at 6. Despite this concern, public health authorities did not conduct any independent research, deferred to the opinions of the industry researchers, and actively defended the use of lead additives to officials from municipalities who sought to ban it. See generally *id.*

105. Regulation of Fuel Additives: Advance Notice of Proposed Rule Making, 36 Fed. Reg. 1486 (Jan. 30, 1971) (to be codified at 42 C.F.R. pt. 479).

106. *Ethyl II*, 541 F.2d at 54–55.

107. See 1973 Lead Regulations, *supra* note 101, at 33,734.

108. See *id.* at 33,740.

109. *Ethyl II*, 541 F.2d at 10.

110. Regulation of Fuels and Fuel Additives, 38 Fed. Reg. 1258, 1259 (Jan. 10, 1973) (to be codified at 40 C.F.R. pt. 80).

from gasoline at some future date. The document defended a standard of no more than an average of 0.5 grams per gallon as a reasonable response to the risk and other factors.<sup>111</sup>

An obvious question is why the agency lacked more scientific information on the two critical issues: the contribution of airborne lead and the effects of lower level exposure. The answers are found in a number of internal documents from EPA officials discussing the weaknesses of the health effects evidence.<sup>112</sup> Some officials considered lead additives to be on their way out because of the requirement to remove lead from gasoline for use in catalytic emission control devices, so a further commitment to research seemed less pressing.<sup>113</sup> Many considered the existing evidence to be sufficient to establish a risk of harm, and that the kind of research needed to identify effects of lower levels of lead absorption would require years to complete.<sup>114</sup> EPA had, however, collaborated with the Lead Liaison Group, an industry advisory committee, to continue conducting comparative studies of air and blood levels in selected cities beginning in 1968, including the “Seven Cities” study of lead exposure.<sup>115</sup> The agency also jointly sponsored “chamber studies” with the lead industry, which involved exposing two prisoners to inhaled lead and measuring the increase in their blood lead levels.<sup>116</sup> Notwithstanding criticisms of both studies, the *Ethyl*

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111. *Ethyl II*, 541 F.2d at 10. This history is summarized in *Ethyl II*, 541 F.2d at 54–55. EPA defended the final rule, which provided a 60 percent reduction in lead use, as “reasonable from the standpoint of protection of health and from the standpoint of economic and technological feasibility.” See 1973 Lead Regulations, *supra* note 101, at 33,734. In fact, the ultimate standard of 0.5 grams per gallon was justified on cost effectiveness grounds because it was well-known that the first half gram of lead provided twice the octane boost of the next half gram of lead. See Regulation of Fuels and Fuel Additives, 38 Fed. Reg. at 1259; Supplemental Brief for the Respondent at 63, *Ethyl II*, 541 F.2d 1 (D.C. Cir. 1976) (No. 73-2205) (on file with author) (referencing a study in the record containing graphs showing the octane-boosting effect of the first 0.5 grams of lead).

112. Many internal EPA documents, including those that would be considered deliberative and not required to be disclosed, were produced for the administrative record because of a settlement of a Freedom of Information Act suit by Ethyl Corporation seeking all EPA documents pertaining to lead. *Ethyl II*, 541 F.2d at 53 n.118; see *Ethyl Corp. v. EPA*, 478 F.2d 47, 48 (4th Cir. 1973). The settlement resulted in the production and placement in the record of essentially all available internal memoranda and papers on lead, even drafts of the preamble presenting EPA’s policy conclusions. For a detailed history of the development of the health documents, EPA’s position, and the views of the Department of Health, Education, and Welfare (HEW), see Leslie Ann Carothers, Regulation of Lead Additives in Gasoline: A Case Study of Environmental Decision Making (Sept. 30, 1978) [hereinafter Lead Additive Case Study] (unpublished LL.M. thesis, National Law Center, George Washington University) (on file with the Jacob Burns Law Library under catalog no. AS36.G31978).

113. Lead Additive Case Study, *supra* note 112, at 62–63 & n.102.

114. *Id.* at 69 & n.126.

115. Robert Gillette, *Lead in the Air: Industry Weight on Academy Panel Challenged*, SCIENCE, Nov. 1971, at 800, 802. The Seven Cities study did not show a correlation between air and blood lead levels when cities were compared. *Ethyl II*, 541 F.2d at 57. It did, however, show a correlation between urban and suburban air and blood lead levels. *Id.*

116. Supplemental Brief for the Respondent, *supra* note 111, at 48–49 & n.46; Lead Additive Case Study, *supra* note 112, at 63–64. Representatives of industry, though a cosponsor of the chamber studies, argued that particle size differences between air in the environment and air in the chamber study vitiated the results showing significant increases in blood lead levels in the persons exposed. *Ethyl II*, 541 F.2d at 61–62.

*It* court's painstaking review of the evidence found the studies to be persuasive on the question of the contribution of airborne lead to human body burdens.

The prolonged lead rulemaking, with repeated requests for comments on the health effect documents, itself caused the initiation of new research on the question of the effects of lower levels of lead exposure. At a 1973 conference on low-level lead toxicity sponsored by EPA and the Department of Health, Education, and Welfare (HEW),<sup>117</sup> numerous new papers were presented tending to show that lower blood lead levels in the range of forty to sixty micrograms per one hundred grams of blood were associated with minimal brain damage, including hyperactivity, perceptual handicap, and impaired fine motor coordination.<sup>118</sup> In presenting its case to the D.C. Circuit, EPA cited an article by Dr. Jane Lin-Fu, the leading pediatric lead expert at HEW, finding that children with undue lead absorption but never overt lead poisoning showed evidence of these neurological disorders.<sup>119</sup> EPA's brief stressed the implications of these findings, as follows:

[T]he ability to concentrate, to discriminate between shapes and spatial relationships, physical coordination and reaction time, and the capacity to translate what is seen into a motor response (e.g., eye-hand coordination) are the skills that enable a growing child to understand his environment and, later, to learn to read and write. *That these and other symptoms of toxicity are occurring at blood lead levels considered only moderately elevated by traditional standards is crucial not only in determining the harm to health but also in weighing the significance of automotive lead emissions as a contributor to that harm.*<sup>120</sup>

As will be seen, these adverse health effects were in fact occurring, and at lower levels of exposure than the initial studies suggested. Notwithstanding the significance of this early evidence, Judge Skelly Wright did not rely on it in his

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117. *Ethyl II*, 541 F.2d at 49.

118. See, e.g., Jane Lin-Fu, *Undue Absorption of Lead Among Young Children: A New Look at an Old Problem*, 286 NEW ENG. J. MED. 702 (1972). Dr. Jane Lin-Fu, a leading pediatric lead expert at HEW, commented on the new studies. She stated: "There is mounting evidence that many children that have undue lead absorption but never overt lead poisoning give evidence of minimal brain damage such as hyperactivity, perceptual handicap and impaired fine motor co-ordination." Jane Lin-Fu, *Vulnerability of Children to Lead Exposure and Toxicity*, 289 NEW ENG. J. MED. 1289, 1291 (1973) [hereinafter *Vulnerability of Children*], available at <http://www.nejm.org/doi/full/10.1056/NEJM197312132892407?view>. Her article was in press when the rules were promulgated. While at HEW, Dr. Lin-Fu had successfully fought to define blood lead levels of forty to sixty micrograms per one hundred grams of blood in children as constituting "undue lead absorption" worthy of medical concern even without clinical symptoms of poisoning. LYDIA DENWORTH, *TOXIC TRUTH: A SCIENTIST, A DOCTOR, AND THE BATTLE OVER LEAD* 85-86 (2008) [hereinafter *TOXIC TRUTH*].

119. *Vulnerability of Children*, *supra* note 118, at 1291.

120. Supplemental Brief for the Respondent, *supra* note 111, at 32 (emphasis in original).

en banc opinion for the majority. He stated that he had reviewed the evidence but that it was not necessary to summarize it and cited several key studies in a footnote.<sup>121</sup> By contrast, in his earlier dissent from the panel decision striking down the rules, Judge Wright cited a number of the more recent studies as supporting the choice of a forty microgram blood lead level as a valid indicator of health impacts, though not a very conservative one in his view.<sup>122</sup> Later, he referenced an article by Dr. Lin-Fu that noted that lead concentrations were higher at the lower physical heights of children, indicating he had read the study.<sup>123</sup> Judge Wright dismissed the complaint in the panel majority opinion that the information was too new to be relied upon, stating that it is “absurd to suggest that in a rapidly developing scientific area regulating agencies must proceed on information no more current than their last public notice.”<sup>124</sup>

In his majority opinion for the en banc court, Judge Wright did not mention Dr. Lin-Fu’s study or rely to any significant degree on the more recent studies identifying the neurological impacts of low lead absorption. This omission was probably because Judge Malcolm Wilkey dropped much of his more substantive criticism of the science in his dissent from the en banc decision. Instead, Judge Wilkey devoted sixteen pages (up from one and a half in his panel opinion) to arguing that industry and the public did not have fair notice and an adequate opportunity to comment on the newer studies,<sup>125</sup> even though all were placed in the public rulemaking record as received and many were presented and discussed at a public conference in early October.<sup>126</sup> To parry this procedural argument, Judge Wright emphasized that the major studies relied on had been available “well before” the regulations were promulgated and that the new work, described by EPA as new in the preamble, was not needed or used to support its conclusion that the dustfall route of exposure was significant.<sup>127</sup> He opined that the newer studies played no role in the decision to regulate.<sup>128</sup>

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121. *Ethyl II*, 541 F.2d at 39 & n.85.

122. *Ethyl I*, 7 E.R.C. 1353, 1404-05 & n.71 (D.C. Cir. Jan. 28, 1975) (Wright, J., dissenting), *reh’g granted*, 541 F.2d 1 (D.C. Cir. 1976) (en banc).

123. *Id.* at 1409 & n.86. He also cited the El Paso smelter study, the Sayre study on house and hand dust, and the Needleman study. *Id.* at 1412 nn.93-95. All of these studies were received by EPA for the public record after the second public notice of EPA’s proposed action on lead additives.

124. *Id.* at 1414.

125. *Ethyl II*, 541 F.2d at 79-94 (Wilkey, J., dissenting).

126. *See id.* at 49-52 (majority opinion). The conference papers were included in the administrative record as received pursuant to the Freedom of Information Act settlement with Ethyl Corporation referenced above. *See id.* at 49-52 & n.115; *see also* Supplemental Brief for the Respondent, *supra* note 111, at 68 (noting that counsel for Ethyl Corporation submitted new information); *id.* at 87-89 (providing documentation of the comments).

127. *See Ethyl II*, 541 F.2d at 49-52.

128. *Id.* at 52. At the conclusion of its preamble to the rules, EPA stated that “[s]tudies of subclinical lead effects in children continue to suggest that fine motor function and behavior are affected. Though this issue is not completely resolved, the new data emphasize the potential subclinical risk.” *See id.* at 117 (appendix). Subclinical effects are defined as those that do not manifest observable symptoms but require testing to identify. The Merriam-Webster dictionary defines subclinical as “not detectable or producing effects that are not detectable by the usual clinical tests.” MERRIAM-WEBSTER’S

The slender record of evidence available when EPA's lead rulemaking began in 1971 on both the contribution of airborne lead to human exposure and the effects of lower level lead exposure was not the only challenge EPA faced in defending its judgment that lead emissions presented a significant risk of harm. Also unhelpful was a skeptical assessment by a committee of the National Academy of Sciences in its report, *Airborne Lead in Perspective*, commissioned by EPA and published in 1972.<sup>129</sup> Indeed, the preface to the report addresses the committee's need to consider the biological effects not necessarily attributable to airborne lead or at lower levels of exposure, because "lead attributable to emission and dispersion into general ambient air has no known harmful effects."<sup>130</sup> With respect to low levels of lead exposure, the panel of experts cited evidence that at blood lead levels exceeding forty micrograms and even below, there was evidence of inhibited synthesis of heme, a blood enzyme in circulating red blood cells, which was "undesirable" but of dubious biologic significance.<sup>131</sup> The panel also explained that there might be subtle effects on behavior after low levels of lead exposure, including "the dulling of mentation and chronic hyperkinesis," also known as lower intelligence and hyperactivity.<sup>132</sup> But the panel concluded that "no information on cause and effect" was available.<sup>133</sup> The report did express some support for the proposition that dustfall lead could be contributing to higher blood lead levels in city children.<sup>134</sup> Critics of the report pointed out that several members of the Academy panel were affiliated with or funded by lead additive manufacturers, major portions of the report were drafted by employees of or consultants to lead manufacturers, and several academic scientists doing new work on the subject were not invited to participate.<sup>135</sup> These facts may have influenced the panel's highly conservative conclusions.<sup>136</sup>

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COLLEGIATE DICTIONARY (11th ed. 2008), available at <http://www.merriam-webster.com/dictionary/subclinical>. Judge Wright's majority opinion cited one of the studies, but did not reference the behavioral impacts referenced in the study and commented favorably on EPA's placing minimal weight on evidence of subclinical effects. *Ethyl II*, 541 F.2d at 39 & nn.84–85.

129. COMM. ON BIOLOGICAL EFFECTS OF ATMOSPHERIC POLLUTANTS, NAT'L ACAD. OF SCIS., LEAD: AIRBORNE LEAD IN PERSPECTIVE (1972) [hereinafter AIRBORNE LEAD IN PERSPECTIVE].

130. *Id.* at viii.

131. *Id.* at 208.

132. *Id.*

133. *Id.*

134. *Id.* at 140.

135. Gillette, *supra* note 115, at 800–02.

136. Two principal EPA staff members developing the science and policy documents for the lead rulemaking have stated that they did not rely on the Academy panel study to support the decision to regulate, in part because a number of the panel's members, contributors, and consultants were affiliated with the lead industry or supported by industry members. See Kenneth Bridbord & David Hanson, *A Personal Perspective on the Initial Federal Health-Based Regulation to Remove Lead from Gasoline*, 117 ENVTL. HEALTH PERSP., no. 8, Aug. 2009, at 1195, 1198, available at <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2721861>. Two of the panel members, including its chair, were prominent specialists in veterinary medicine and authored articles listed in the report on bovine lead poisoning. AIRBORNE LEAD IN PERSPECTIVE, *supra* note 129, at iii, 282, 293–94. Experts on the prevalence of lead in the environment were not invited. See, e.g., *id.* at 287 (listing articles by Dr. Chow, not a panelist). The composition of the panel and work teams raised questions of balance even by the

Compounding a thin record of studies on low-level effects and the essentially neutral report from the Academy was the downright hostile position of HEW regarding EPA's stance on the need to reduce lead in gasoline to protect public health. EPA expected opposition from an industry-focused agency like the Department of Commerce, but the lack of support from an agency with a common public health mission was a surprise to EPA staff.<sup>137</sup> This situation resulted from personal and professional differences, including the perception that EPA's initiative to control lead in gasoline was competitive instead of complimentary to HEW's program to deal with other lead hazards, especially leaded paint.<sup>138</sup> Near the end of the rulemaking, counsel for the Natural Resources Defense Council, David Schoenbrod, requested HEW's views, pointing out a study by the Food and Drug Administration that endorsed reducing lead from all sources.<sup>139</sup> The counsel's inquiry resulted in a highly qualified statement of support from then Secretary Caspar Weinberger.<sup>140</sup>

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standards of the time, *see* Gillette, *supra* note 115, at 801, but the larger problem was the limited information that was available to the panel when they had to produce their report within nine months. Specifically, the panel had little information on the effects of lower levels of lead exposure and very few independent studies by government or academic scientists on the health effects of lower lead levels. That situation began to change as a result of EPA's regulatory proposal action.

137. The divergence of opinions between the senior management of HEW and EPA is discussed in detail in the Lead Additive Case Study, *supra* note 112, at 80–92. Internal documents included in the administrative record indicate that the staff at HEW thought EPA staff had failed to consult them and were reportedly miffed at receiving a late copy of EPA's proposed rules. *See id.* For their part, many EPA staff had been employees of the HEW National Air Pollution Control Administration staff before their transfer to EPA under President Richard Nixon's Reorganization Plan establishing the EPA only a few months before the first notice of intent to regulate lead additives was issued. Reorganization Plan No. 3 of 1970, 35 Fed. Reg. 15,623 (Oct. 3, 1970), *reprinted as amended* in 5 U.S.C. app. at 202 § 2(3)(i) (2012). Managers of the air pollution program now at EPA thought their former colleagues already understood and supported control of airborne lead. Lead Additive Case Study, *supra* note 112, at 81 & n.165 (noting a personal communication from Irwin Auerbach, then special assistant to the deputy assistant administrator of EPA's air programs). In addition, some HEW staff saw EPA's health rationale as detracting from the effort to abate leaded paint, a more acute hazard. *Id.* at 82. Another official viewed the health-based rule as intended to support the provision of unleaded gasoline. *See id.* at 83. According to an EPA memorandum of a meeting between EPA and HEW officials, personnel from HEW "expressed concern that EPA's health rationale would detract from resources and community action directed toward lead-based paint as the prime source of childhood lead-poisoning." *Id.* at 82 (citing Memorandum from Carl Shy, Deputy Dir., Div. of Health Effects Research, to John H. Knelson, Dir., Nat'l Env'tl. Research Ctr. (Feb. 28, 1972)). This difference of perspective between environmental and more traditional public health professionals also manifested itself in the conflicting comments on the rule submitted by the environmental and health commissioners of the City of New York. *See id.* at 91 & nn.192–93. The environmental commissioner strongly supported the rule, while the health department commenter did not. *Id.* at 91.

138. Bridbord & Hanson, *supra* note 136, at 1198–99.

139. Lead Additive Case Study, *supra* note 112, at 86.

140. The Weinberger letter to David Schoenbrod, counsel for the Natural Resources Defense Council, stated that the lead in gasoline "should be removed because it provides no known benefit for human health and *may* contribute to the body burden of lead, but this should not be done unless it is clear that the health consequences associated with the alternatives to lead in gasoline are indeed less hazardous." *Id.* at 87 & nn.182–83. Only after the regulations were promulgated did the supporting views of many experts at HEW become a matter of public record. The chair of the Senate Committee on Public Works solicited comments on the health effects issue from named individuals and subordinate bureaus of HEW. Their responses were markedly more supportive than those at the Secretary's level of

HEW's public views and level of support changed dramatically not long after EPA's rule was published, but the lack of HEW support before then was highlighted in Judge Wilkey's dissenting opinion criticizing the rule.<sup>141</sup>

In summary, EPA faced many challenges throughout the lead rulemaking process. The new agency lacked experience in presenting a complicated scientific case in a vigorously contested regulatory proceeding.<sup>142</sup> The science on low-level effects of lead pollution was just beginning to emerge, and EPA's inability to secure support from the Academy panel and other government health experts allowed its opponents to argue that its peers in the public health community disagreed that airborne lead presented a significant health risk. Still, EPA's science and policy experts remained confident that they were correct in their judgment on the harmful health effects of lead in gasoline. EPA's leaders accepted their analysis and held their ground despite strong pressure from the White House to retreat.<sup>143</sup> Relying predominantly on the precautionary approach, the D.C. Circuit agreed.

## 2. *The Evidence for Control of Automotive GHG Emissions to Protect Public Health and Welfare*

The scientific information involved in assessing the impact of anthropogenic GHG emissions on climate is extensive, complex, and hard to interpret.<sup>144</sup> But in comparison to the scientific record on the effects of low-level exposure to airborne lead in 1971, the body of evidence on the impact of

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HEW. See *Automotive Lead Emissions: Hearings before the Subcomm. on Envtl. Pollution*, 93d Cong. 73–77 (1974).

141. Judge Wilkey devoted several pages of his opinion to the critical comments of HEW and other agencies, and quoted the “biting” comment of HEW Assistant Secretary Merlin DuVal: “*The decision having been made on grounds other than those having to do with hazard to the public health, your staff now wish to explore with us the question of whether or not hazard to the public health could be invoked as a reason for accelerating the implementation date of the primary decision.*” *Ethyl II*, 541 F.2d 1, 74–77 (D.C. Cir. 1976) (en banc) (Wilkey, J., dissenting). The judge apparently perceived an ulterior motive in what was a reference to the initial action to provide unleaded gasoline to protect catalytic emission control devices.

142. The case also presented novel issues for the reviewing court in part because it involved “a departure from the judicial tradition of making judgments on the basis of proof and past events, rather than incomplete evidence and possible future effects.” See Editorial, *Getting the Lead Out*, WASH. POST, Mar. 29, 1976, at A18.

143. In particular, many federal agencies submitted comments to EPA “critical of the cost and energy impacts of the lead regulation.” Lead Additive Case Study, *supra* note 112, at 225.

144. For example, climate change will indirectly affect health through its adverse impacts on agriculture, water supply, and disease vectors, but these effects begin with effects on water, land, and plant and animal species that are less understood than more direct impacts on health from air pollution, for example. See VALUING THE PROTECTION OF ECOLOGICAL SYSTEMS AND SERVICES, *supra* note 45, at 3–4 (discussing the need to relate ecological impacts to services of direct concern to people). For example, see Judge Janice Rogers Brown's dissent from the D.C. Circuit's denial of rehearing en banc of the *Coalition* decision, in which she stresses the extreme impacts of air pollution in the 1970s in support of her argument that climate science, by comparison, involves harm “at the end of a long speculative chain,” and is too uncertain to support EPA's endangerment finding, with its sweeping regulatory implications. *Coal. for Responsible Regulation, Inc. v. EPA*, No. 09-1322, 2012 WL 6621785, at \*7 (D.C. Cir. Dec. 20, 2012) (Brown, J., dissenting).

GHGs on climate change when EPA issued its endangerment finding in 2009 is huge. The agency was able to rely on largely consistent reviews of climate science by the international Intergovernmental Panel on Climate Change (IPCC), the U.S. Global Climate Research Program, and the National Research Council of the National Academy of Sciences.<sup>145</sup> According to the *Coalition* court, these expert bodies “synthesized thousands of individual studies on various aspects of [GHGs] and climate change and drew ‘overarching conclusions’ about the state of the science in this field.”<sup>146</sup> As noted earlier, the major domestic motor vehicle manufacturers directly affected by the tailpipe standards had already endorsed the setting of stringent federal carbon dioxide standards.<sup>147</sup> Finally, the relevant Obama administration agencies were aligned on the conclusion that GHGs are causing climate change and should be controlled, so there was no opportunity for opponents of the rule to point to internal dissent casting doubt on EPA’s conclusions.

In support of its decision, EPA issued a 210-page technical support document summarizing scientific panel reports, a fifty-page preamble summarizing its factual and legal conclusions, and a multivolume set of responses to the 380,000 comments on the rule.<sup>148</sup> All but 11,000 were standardized comments, but even this smaller number of individual comments is extraordinary.<sup>149</sup> Petitioners had much less basis to criticize the underpinnings of EPA’s endangerment ruling than the opponents of the health-based lead regulations could muster. In addition, Congress had made the terms of the precautionary standard of Title II of the CAA *less* demanding in the aftermath of the first *Ethyl* decision overturning the lead phasedown rules.<sup>150</sup> Congress amended the “will endanger” language to require a finding that automotive emissions “cause or contribute to air pollution which *may reasonably be anticipated to* endanger public health or welfare,” a change intended to make the standard of certainty less demanding, as was duly noted in the majority opinion in *Massachusetts v. EPA*.<sup>151</sup>

EPA Administrator Jackson found that GHG air pollution is reasonably anticipated to endanger public health by increasing the risk of “morbidity and mortality,” considering “direct temperature effects, the potential for changes in vector borne diseases, and the potential for changes in the severity and

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145. GHG Endangerment Finding, *supra* note 1, at 66,497.

146. *Coal. for Responsible Regulation, Inc. v. EPA (Coalition)*, 684 F.3d 102, 119 (D.C. Cir. 2012), *aff’d in part, rev’d in part sub nom.* *Util. Air Regulatory Grp. v. EPA*, 134 S. Ct. 2427 (2014).

147. See GHG Endangerment Finding, *supra* note 1, at 66,502.

148. See *Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act*, EPA, <http://www.epa.gov/climatechange/endangerment/> (last updated Nov. 22, 2013). The preamble to the lead additive regulations, by contrast, was a remarkably brief eight pages! See *Control of Lead Additives in Gasoline*, 38 Fed. Reg. 33,734, 33,734–41 (Dec. 6, 1973) (to be codified at 40 C.F.R. pt. 80).

149. See GHG Endangerment Finding, *supra* note 1, at 66,500.

150. See *Massachusetts v. EPA*, 549 U.S. 497, 506 n.7 (2007); GHG Endangerment Finding, *supra* note 1, at 66,507 (discussing the congressional deliberations in detail).

151. See *Massachusetts*, 549 U.S. at 506 n.7 (emphasis added).

frequency of extreme weather events.”<sup>152</sup> As to welfare effects, the administrator found that climate change will “fundamentally rearrange” U.S. ecosystems and cited the impacts of climate change on food and agriculture, forestry, energy, infrastructure, wildlife, and water resources.<sup>153</sup> These findings were supported by the three major international and national assessments whose conclusions were summarized in a technical support document.<sup>154</sup> For example, a 2008 report by the National Academy of Sciences summed up the risk of harm from GHG emissions and climate change in unequivocal terms:

Most scientists agree that the warming in recent decades has been caused primarily by human activities that have increased the amount of greenhouse gases in the atmosphere . . . . The scientific understanding of climate change is now sufficiently clear to begin taking steps to prepare for climate change and to slow it. Human actions over the next few decades will have a major influence on the magnitude and rate of future warming.<sup>155</sup>

The petitioners were hard pressed to formulate persuasive substantive showings that the scientific basis for EPA’s finding was inadequate. They first contended that EPA should not have relied on reports prepared by outside expert panels.<sup>156</sup> Petitioners also argued that EPA’s scientific evidence did not support the endangerment finding, such as EPA’s reliance on computer modeling assumptions.<sup>157</sup> The D.C. Circuit summarily rejected the complaint that EPA had delegated its judgment to these outside agencies, noting that it made no difference that the reports were a synthesis of individual studies.<sup>158</sup> “This is how science works,” the court observed, adding “EPA is not required

152. GHG Endangerment Finding, *supra* note 1, at 66,524.

153. *Id.* at 66,498.

154. BENJAMIN DEANGELO ET AL., CLIMATE CHANGE DIV., EPA, ENDANGERMENT AND CAUSE OR CONTRIBUTE FINDINGS FOR GREENHOUSE GASES UNDER SECTION 202(a) OF THE CLEAN AIR ACT (2009) [hereinafter EPATSD], *available at* <http://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100DDDS.PDF>.

155. NAT’L ACAD. OF SCIS. ET AL., UNDERSTANDING AND RESPONDING TO CLIMATE CHANGE 2 (2008) [hereinafter NAS REPORT], *available at* [http://www.southernclimate.org/documents/resources/Understanding\\_and\\_Responding\\_to\\_Climate\\_Change\\_2008.pdf](http://www.southernclimate.org/documents/resources/Understanding_and_Responding_to_Climate_Change_2008.pdf). The Academy’s statement does not mean there are no dissenters, but the climate issue does not appear to present a Galileo case where one or more contrarians turn out to be right. Judge Posner took an interesting, semistatistical approach to assessing the credibility of prominent climate skeptics, most notably Dr. S. Fred Singer. Posner surveyed the top journals of “meteorology and atmospheric sciences,” identified then current articles on climate (from 2002 to 2003), examined every fifth article, and defined the ratio of believers to skeptics as 53:2. CATASTROPHE, *supra* note 8, at 58. Dr. Singer, he noted, had not cited any of his own work in journals specializing in climate science or related fields, a more traditional lawyerly approach to discrediting a witness. *Id.* at 54.

156. See *Coal. for Responsible Regulation, Inc. v. EPA (Coalition)*, 684 F.3d 102, 119 (D.C. Cir. 2012), *aff’d in part, rev’d in part sub nom. Util. Air Regulatory Grp. v. EPA*, 134 S. Ct. 2427 (2014).

157. *Id.* at 120–21.

158. *Id.* at 120.

to re-prove the existence of the atom every time it approaches a scientific question.”<sup>159</sup> The court went on to note that EPA had reviewed the processes used to develop the reports and assessed the depth of the consensus.<sup>160</sup> On the question of computer modeling, the court noted that such models are used to simulate recent climate change and endorsed EPA’s statement in the preamble that the models have “only been able to replicate the observed warming by including anthropogenic emissions of greenhouse gases in the simulations.”<sup>161</sup>

The court was obliged to return to the issue of the validity of the science to rule on the claim by ten states that their petition for reconsideration had been improperly denied. The petition cited newly publicized errors in the IPCC work—misstating the portion of the Netherlands that is below sea level and the rate at which Himalayan glaciers are receding—and contended that these and other alleged errors established a “pattern” of flawed science.<sup>162</sup> The court did not agree that these errors were material to EPA’s decision.<sup>163</sup> Similarly, the court rejected petitioners’ claim that a new study contradicted EPA’s reliance on a projection of more violent storms in the future, on the grounds that the new study cited only past trends, not projections of future storms.<sup>164</sup>

The court’s treatment of the evidence, while brief, was responsive to the specific objections that petitioners raised. It would have been impossible as well as unwarranted for the court to review the evidence on the contribution of GHGs to climate change in the extraordinary level of detail undertaken in *Ethyl II*.<sup>165</sup> In *Coalition*, the industry petitioners mainly relied on the claim that too much uncertainty about the impacts of GHGs on public health and welfare made EPA’s endangerment finding arbitrary and capricious.<sup>166</sup> This was an uphill battle considering the strong scientific record, the standard of review of informal rulemaking, and the precautionary standard of endangerment. It is also worth noting that many of the companies whose associations joined the lawsuits are on record as acknowledging the risk presented by climate change and could not and would not want to be characterized as climate change

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159. *Id.*

160. *Id.*

161. *Id.* at 121; *see, e.g.*, EPATSD, *supra* note 154, at 49 (presenting three graphs that clearly illustrate this point); NAS REPORT, *supra* note 155, at 6.

162. *Coalition*, 684 F.3d at 125.

163. *Id.*

164. *Id.*

165. Chief Judge David Bazelon and Judge Harold Leventhal, as part of a then current discussion of the level of scrutiny reviewing courts should and could provide in complex technical cases, debated the level of scientific review in both Judge Wright’s majority opinion and Judge Wilkey’s dissent. *See Ethyl II*, 541 F.2d 1, 66 (D.C. Cir. 1976) (en banc) (Bazelon, C.J., concurring); *id.* at 68 (Leventhal, J., concurring); *see also* Harold Leventhal, *Environmental Decisionmaking and the Role of the Courts*, 122 U. PA. L. REV. 509, 540–41 (1974). The *Coalition* court cited its more recent precedents for a searching inquiry but an extreme degree of deference to an agency’s evaluation of science within its area of technical expertise. *Coalition*, 684 F.3d at 120 (citing *Am. Farm Bureau Fed’n v. EPA*, 559 F.3d 512, 519 (D.C. Cir. 2009)).

166. *See, e.g.*, *Coalition*, 684 F.3d at 122–23.

“deniers.”<sup>167</sup> This factor may have inhibited more sweeping arguments against climate science.

*B. The Quest for Quantification of Source Contributions, Impacts, and Costs*

In both the lead and the GHG cases, challenges to the regulations beyond the claim that the science was too uncertain to be relied upon were based on a demand for quantification of source contributions, impacts, and, in several areas, costs. Here again, the problem of quantifying the impact of airborne lead was more troublesome for EPA and the reviewing court than was the set of quantification issues in the GHG endangerment finding.

*1. Quantification Issues in the Lead Emissions Case*

In the appeal of the lead in gasoline regulations, the petitioners argued that the endangerment standard required an EPA determination that lead emissions from motor vehicles “in and of themselves” posed a direct hazard to health.<sup>168</sup> They contended that the “will endanger” standard required EPA to distinguish that contribution from the lead normally ingested from food and, in some cases, paint, and to demonstrate the precise contribution of airborne lead to an endangerment to health.<sup>169</sup> The two-judge majority of the initial D.C. Circuit panel that set aside the regulations and the three dissenters from the en banc decision upholding them acknowledged that the effects of other sources of human intake of lead had to be taken into account.<sup>170</sup> However, the judges imposed a rigorous standard of quantifying the contribution and effect of motor vehicle lead emissions that could not be met given the presence of those other sources. To regulate lead additives in gasoline, in their view, EPA had to find that “the lead from auto emissions by itself or alone contributes a *measurable*

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167. For example, the U.S. Climate Action Partnership is made up of a group of companies that have joined with major environmental organizations to advocate for congressional climate change legislation. See U.S. CLIMATE ACTION PARTNERSHIP, <http://www.us-cap.org/> (last visited Aug. 31, 2014). Another example is the Business Environmental Leadership Council of the Center for Climate and Energy Solutions, which is made up of companies that recognize the risks of climate change and support both voluntary steps and governmental action to combat it. See CENTER CLIMATE & ENERGY SOLUTIONS, [http://www.c2es.org/companies\\_leading\\_the\\_way\\_belc](http://www.c2es.org/companies_leading_the_way_belc) (last visited Aug. 31, 2014). Many companies prefer legislation to EPA’s regulation of GHGs because it offers greater potential for flexible strategies such as broad-based emissions trading, but they do not fundamentally doubt the science tending to show that manmade emissions are magnifying a risk of climate change.

168. Ethyl Corporation made creative use of a part of the legislative history of the authority to regulate fuels and fuel additives in which Senator Howard Baker used the words “in and of themselves” to describe the agency’s authority to regulate lead emissions to protect public health. *Ethyl II*, 541 F.2d at 30. The more plausible reading of the senator’s comments is that he was distinguishing the regulation of lead additives to protect public health from the part of CAA section 211 that authorizes the regulation of fuels and fuel additives to prevent deactivation of motor vehicle emission control devices. This was the view accepted by Judge Wright and the *Ethyl II* majority. *Id.*

169. See Supplemental Brief for the Respondent, *supra* note 111, at 41.

170. See *Ethyl I*, 7 E.R.C. 1353, 1357 (D.C. Cir. Jan. 28, 1975), *reh’g granted*, 541 F.2d 1 (D.C. Cir. 1976) (en banc); *Ethyl II*, 541 F.2d at 95 (Wilkey, J., dissenting).

*increment of lead to the human body, and that this measurable increment causes a significant health hazard.*"<sup>171</sup> The en banc dissenters also rejected on both substantive and procedural grounds the studies that *were* available to show with a degree of precision the contribution of inhaled lead pollution.<sup>172</sup>

The *Ethyl II* majority, relying on its expansive interpretation of the endangerment standard, determined that precise quantification of the contribution was neither possible, because of the multiple sources of human lead exposure, nor necessary to establish an endangerment to health.<sup>173</sup> The court emphasized that the addition of automotive lead emissions to other sources raised body burdens and that as a practical matter such emissions were the "most readily reduced significant source of environmental lead."<sup>174</sup> In a footnote, the court observed that the incremental effect of lead emissions was relevant to a decision whether this source could "fruitfully be attacked" and that the emissions must make "more than a minimal contribution to total exposure" to justify regulation.<sup>175</sup> The court accepted EPA's characterization of the contribution as "significant."<sup>176</sup>

Turning to the question of cost, the economic impact of regulation is an important issue in regulatory and judicial decision making in environmental cases, except where its consideration is excluded by statute. However, costs played a relatively minor role in the *Ethyl II*<sup>177</sup> decision because of the unusual circumstances of the rulemaking. EPA's consultants conducted numerous economic studies to estimate gasoline production costs and energy supply impacts.<sup>178</sup> Lead additive manufacturers and representatives of the smaller refiners less able to finance the upgrading of refining capacity to produce gasoline without large quantities of lead were most critical of the analysis and the applicability of the regulations to them.<sup>179</sup> However, the major oil refiners

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171. *Ethyl I*, 7 E.R.C. at 1357; *Ethyl II*, 541 F.2d at 95 (Wilkey, J., dissenting).

172. *Ethyl II*, 541 F.2d at 82–94 (Wilkey, J., dissenting). The lead rulemaking record contained "the chamber studies," which studied the impact of inhaled lead on the blood lead levels of inmate volunteers, but the dissenters worried that the study, sponsored jointly by EPA and the lead industry's research organization, was available only in preprint form in early 1973 when the second health document was issued, a completely spurious notice issue. *See id.* at 50, 61 (majority opinion). Toward the end of the lead rulemaking process, a study using lead isotopes to "label" dietary lead and presented at an October 1973 conference showed the relative contributions of respired and dietary lead on the blood lead levels of two subjects monitored in a controlled metabolic unit. *Id.* at 49, 62. The initial panel rejected the isotope study as involving only two subjects. *See Ethyl I*, 7 E.R.C. at 1373. In his dissenting opinion, Judge Wilkey seemed to suggest that the isotope study was placed in the public file too late to be relied on. *See Ethyl II*, 541 F.2d at 79–80 (Wilkey, J., dissenting).

173. *See Ethyl II*, 541 F.2d at 30–31.

174. *Id.* at 31.

175. *Id.* at 31 n.41.

176. *Id.* at 31.

177. Issues other than health were relegated to the footnotes in the *Ethyl II* majority decision. *Id.* at 32–33 nn.66–68, 53 n.124.

178. The multiple economic studies as well as the studies of alternative emission control strategies, such as lead traps, are summarized in detail in Chapter IV of the Lead Additive Case Study, *supra* note 112, at 220–45.

179. The small refiners, then defined in the rule as those not having more than 30,000 barrels a day of crude oil or feedstock capacity, 1973 Lead Regulations, *supra* note 101, at 33,741, were represented

were ready to produce the unleaded fuel the auto industry needed to market catalyst-equipped vehicles and expected to profit in the new fuel market. The incremental cost of the moderate additional lead reductions required by the health-based rules was not substantial to them, and they did not seriously contest the projected economic impacts or argue that they made the regulation unreasonable.<sup>180</sup>

However, other federal agencies in the Nixon administration did weigh in on consumer costs and energy supply issues.<sup>181</sup> When EPA's health-based lead regulations were undergoing final interagency review in the fall of 1973, long lines were forming at service stations as a result of the Arab oil embargo following the Yom Kippur War.<sup>182</sup> The secretary of the Department of Transportation, a former oil company executive, stated that the timing of the regulations was "inopportune."<sup>183</sup> As EPA Deputy Administrator John Quarles recalled in his firsthand account of EPA's battle with White House staff in November 1973, one of the major lead processors ran full-page newspaper ads in the *Washington Post* and the *New York Times* claiming that the rules would waste one million barrels of oil per day.<sup>184</sup> Although this wild claim was never substantiated, EPA agreed with the staff of the Office of Management and Budget to change the lead reduction schedule to reduce the first-year impacts and extend the final compliance date, while achieving a slightly greater level of total lead reduction.<sup>185</sup>

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in the appeal of the regulations by the National Petroleum Refiners Association. Supplemental Brief for the Respondent, *supra* note 111, at 66–68 (summarizing the arguments of the National Petroleum Refiners Association on their behalf). EPA acknowledged that the rules were expected to cause twelve to sixteen small refiners to go out of business and provided a two-year extension of time for compliance to enable those refiners to continue in business to make the transition. *See id.* at 67–68; 1973 Lead Regulations, *supra* note 101, at 33,741.

180. The standard adopted also allowed averaging, which allowed refiners to decide which refineries to upgrade to producing unleaded or low-lead fuel and to pick the most economical reduction strategy. *See Ethyl II*, 541 F.2d at 53 n.124 (stating that EPA had well understood and considered the costs and found them to be minimal). The total costs of the lead program in the 1979 to 1980 time period were estimated at \$200 million compared to the costs of compliance with the motor vehicle emission standards then estimated at \$19.8 billion and the stationary source controls estimated at \$13 billion. *See* EPA, THE COST OF CLEAN AIR: ANNUAL REPORT OF THE ADMINISTRATOR, at I-4 tbl.III-17 (1974).

181. Some challenged the auto manufacturers' choice of catalytic emission control devices to meet the statutory standard. That was not a technology chosen by EPA; and the argument for a different emission control approach, specifically tailpipe lead traps, was studied but rejected as ineffective in controlling lead emissions from older vehicles without catalytic systems or future non-catalyst-equipped vehicles. *Ethyl II*, 541 F.2d at 32 & n.66.

182. Lead Additive Case Study, *supra* note 112, at 230.

183. *Id.*; *see also Ethyl II*, 541 F.2d at 89 & n.90 (Wilkey, J., dissenting) (citing Letter from Claude Brinegar, Sec'y of Transp., to Russell Train, Adm'r, EPA (Nov. 26, 1973)).

184. JOHN R. QUARLES, CLEANING UP AMERICA: AN INSIDER'S VIEW OF THE ENVIRONMENTAL PROTECTION AGENCY 137–38 (1976).

185. *See id.* at 138; Lead Additive Case Study, *supra* note 112, at 231. The dogged efforts of EPA Administrator Russell Train and his deputy were aided by the order of a motions panel of the District of Columbia Court of Appeals directing the agency to make a decision within thirty days of its final order regarding "whether lead additives should be regulated for health reasons." *Ethyl II*, 541 F.2d at 10. The Natural Resources Defense Council had brought suit in the D.C. Circuit seeking a prehearing conference, summary reversal, or expedited hearing to challenge EPA's issuance of regulations making

EPA was fortunate that the economic impact of setting health-based limits on the use of lead additives was significantly reduced by the introduction of unleaded gasoline for new motor vehicles equipped with catalytic converters. Without this independent and parallel requirement, the cost directly attributable to the health-based rules would have been much greater, and the powerful petroleum industry might have mobilized to oppose EPA and to warn of much higher gasoline prices caused by the regulations. The lead additive manufacturers punched well above their weight in an aggressive campaign to defeat the rules, but they and the small independent refiners who joined them did not have nearly the political heft that the petroleum industry would have had if it had chosen to mount a serious challenge to the rules. It is ironic that General Motors chief executive officer Edward Cole, whose company pioneered the development and introduction of lead additives, ushered in their demise in the United States by choosing the catalytic converter to meet the automotive emission reduction requirements of the 1970 CAA.<sup>186</sup>

## 2. *Quantification Issues in the GHG Emissions Case*

As in the automotive lead case, the quantitative significance of the contribution of U.S. auto emissions to the pollution problem at hand, climate change, was contested in the case of GHG emissions. Opponents of the endangerment finding contended that auto emissions were not a significant contributor to the total GHG emissions and that no quantitative target for *overall* GHG emissions had been set as a basis for measuring their impact.<sup>187</sup>

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unleaded gasoline generally available, “urging the immediate need for across-the-board controls on lead additives.” *Natural Res. Def. Council, Inc. v. EPA*, 512 F.2d 1351, 1352 (D.C. Cir. 1975). The motion was denied without prejudice to its renewal if EPA “did not take final action in deciding whether to promulgate such controls” within sixty days. *Id.* After further delays, the motions panel then issued an order on October 29, 1973, directing EPA to make a final decision within thirty days. *Id.* Acting EPA Administrator Quarles signed the final rules on November 28, 1973. 1973 Lead Regulations, *supra* note 101, at 33,741.

186. The CAA of 1970 laid out the requirement that automotive manufacturers must by 1975 reduce emissions of hydrocarbons and carbon monoxide from light duty vehicles by at least 90 percent from the permissible emission level in 1970. *See* Clean Air Act of 1970, Pub. L. No. 91-604, § 202(b)(1)(A), 84 Stat. 1676, 1690 (1970). For nitrogen oxides, the Act specified that auto manufacturers must produce a 1976 model of light duty vehicles that reduced by 90 percent “the average of emissions of oxides of nitrogen actually measured . . . during model year 1971 . . .” *Id.* § 202(b)(1)(B). The Act authorized the EPA administrator to suspend the standards for one year upon a showing of technical infeasibility. *See id.* § 202(b)(5)(B). Administrator William D. Ruckelshaus initially denied manufacturers’ suspension requests for a year delay. However, his decision was reversed by the D.C. Circuit in *International Harvester Co. v. Ruckelshaus*, 478 F.2d 615 (D.C. Cir. 1973). In July 1971, EPA promulgated regulations limiting light duty vehicle hydrocarbon emissions to 0.41 grams per vehicle mile and carbon monoxide emissions to 3.4 grams per vehicle mile. *See* Exhaust Emission Standards Applicable to 1975 and Later Model Year Light Duty Vehicles, 36 Fed. Reg. 12,657, 12,658 (July 2, 1971) (to be codified at 45 C.F.R. pt. 1201). The setting of specific percentage reduction requirements in the CAA itself made it impossible for the industry to change them without obtaining relief from Congress, so they sought more time to comply under the suspension provision but did not lobby for a change in the emission reduction requirement.

187. *See* *Coal. for Responsible Regulation, Inc. v. EPA (Coalition)*, 684 F.3d 102, 122 (D.C. Cir. 2012), *aff’d in part, rev’d in part sub nom.* *Util. Air Regulatory Grp. v. EPA*, 134 S. Ct. 2427 (2014).

EPA found that automotive emissions contributed 4 percent of global “well-mixed” GHGs and 23 percent of U.S. emissions.<sup>188</sup> In its preamble to the regulations, EPA stated that it *could* interpret CAA section 202 as requiring a level of contribution that “while more than de minimis or trivial, does not rise to the level of significance.”<sup>189</sup> However, EPA then stated that the contribution is in fact significant, since U.S. auto emissions are “larger than the great majority of emitting countries,” including several major ones.<sup>190</sup>

The *Coalition* court referred again to the *Ethyl II* court’s decision holding that “only a showing of significant contribution was required,” and the court agreed with EPA that automotive emissions were significant.<sup>191</sup> The court referenced EPA’s estimate that the rule would reduce “about 960 million metric tons of [carbon dioxide] emissions” over the lifetime of the model years regulated and concluded that the record was “fulsome.”<sup>192</sup> The D.C. Circuit’s confidence in this finding was buttressed by the Supreme Court’s observation in *Massachusetts v. EPA* that “the U.S. transportation sector emits an enormous quantity of carbon dioxide into the atmosphere.”<sup>193</sup>

Texas and the nine other state petitioners made a second quantification argument: that the endangerment finding was arbitrary and capricious because EPA did not attempt to show the atmospheric concentration at which GHGs endanger health or welfare, the rate or type of climate change expected to cause harm, or its risks or impacts.<sup>194</sup> Acknowledging that EPA did not provide a numerical value, the *Coalition* court again turned to the *Ethyl II* case where, the court noted, EPA had initially tried to determine a specific level of ambient lead pollution that would be considered safe and found that it could not be done because of the multiple sources of lead exposure.<sup>195</sup> The court characterized the request for this quantification as a variant of the claim that the science was too uncertain and rejected all of these arguments on the ground that the record was sufficient for a precautionary standard.<sup>196</sup>

Petitioners challenging EPA’s GHG endangerment finding could not claim that the tailpipe emission standards were too costly because they lacked standing to challenge a set of standards applicable to auto manufacturers, who did not appeal them.<sup>197</sup> Instead, they argued that the cost of GHG controls on

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188. GHG Endangerment Finding, *supra* note 1, at 66,499.

189. *Id.* at 66,542.

190. *Id.*

191. *Coalition*, 684 F.3d at 128 (emphasis omitted).

192. *Id.*

193. *Massachusetts v. EPA*, 549 U.S. 497, 499 (2007).

194. *Coalition*, 684 F.3d at 122.

195. *Id.* at 123.

196. *Id.*

197. Former Office of Information and Regulatory Affairs chief, Professor Cass Sunstein, who headed the office when the tailpipe emission standards were subjected to a cost-benefit analysis, reported that the fuel economy rules for automobiles will increase fuel economy to more than fifty-four miles per gallon by 2025 and save consumers more than \$1.7 trillion, with those benefits exceeding the costs by billions of dollars each year. Cass R. Sunstein, *Climate Change: Lessons from Ronald Reagan*,

stationary industrial sources, especially the potential for future controls on new and existing power plants, should have been considered.<sup>198</sup> The court rejected this contention, referring to the terms of section 202(a) and its prior decision that the law does not mandate consideration of costs to entities “not directly subject to the proposed standards.”<sup>199</sup> There will undoubtedly be significant costs of any GHG controls on electric utilities and possibly other sources in the future; but as a practical matter, there will be no record for a court to review until the rules and supporting documents are developed and promulgated.

The petitioners also argued that it was unprecedented and improper for EPA to divorce its risk assessment, the endangerment finding, from the regulatory response.<sup>200</sup> This is a version of a common argument made by industry that costs must be taken into account when deciding on the *level* of a health protection standard. Industry’s notorious challenge to EPA’s failure to consider costs in the setting of national ambient air quality standards resulted in the Supreme Court’s unanimous decision that the CAA bars basing those standards on considerations other than health.<sup>201</sup> The frequent contention that health and cost considerations should be telescoped in decision making reflects the expectation that costs may alter the assessment of health risks. Although there is nothing analytically impossible about setting pollution limits based on health considerations alone, there is also a recognized tendency for people to lower their rating of risk when confronted with the cost of its abatement.<sup>202</sup> In the *Coalition* decision, the court was able to ignore the argument that EPA should have considered all the cost implications of GHG controls before arriving at a determination of endangerment.<sup>203</sup> Such issues would only arise in issuing an individual GHG facility operating or construction permit or after promulgating generally applicable CAA standards for source categories, such as electric power generating units.<sup>204</sup>

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N.Y. TIMES (Nov. 10, 2012), [http://www.nytimes.com/2012/11/11/opinion/sunday/climate-change-lessons-from-ronald-reagan.html?\\_r=0](http://www.nytimes.com/2012/11/11/opinion/sunday/climate-change-lessons-from-ronald-reagan.html?_r=0).

198. *Coalition*, 684 F.3d at 128.

199. *Id.*

200. Joint Opening Brief of Non-State Petitioners & Supporting Intervenors, *supra* note 97, at \*14–15.

201. *Whitman v. Am. Trucking Ass’ns*, 531 U.S. 457, 468–71 (2001). In this decision, Justice Antonin Scalia noted, “Were it not for the hundreds of pages of briefing respondents have submitted on this issue, one would have thought it fairly clear that this text does not permit the EPA to consider costs in setting the standards.” *Id.* at 465.

202. For polling data showing that opinions may change when costs are cited, see *Beyond the Precautionary Principle*, *supra* note 8, at 1052–53. See also *Whitman*, 531 U.S. at 469 (Scalia, J.) (“[That] cost factor is *both* so indirectly related to public health *and* so full of potential for cancelling the conclusions drawn from direct health effects that it would surely have been expressly mentioned in [sections] 108 and 109 had Congress meant it to be considered.”).

203. See, e.g., *Coalition*, 684 F.3d at 118.

204. EPA has now undertaken rulemaking for electric power generating units emitting GHGs. See *infra* Part III.C.

## III. AFTERMATH OF THE LEAD AND GHG DECISIONS

This Part examines the evidence of the impacts of automotive lead and GHG emissions that emerged following the EPA endangerment findings and regulatory actions on the two subjects. For the lead additives case, the evidence available within the first twelve years of the EPA action is considered, concluding with the issuance of one of the first cost-benefit analyses issued for a federal health protection rule. For the GHG case, only five years have passed since the decision. However, both international and U.S. scientific review bodies have recently issued updated analyses of the scientific evidence and its implications. In both cases, the new evidence strongly supports EPA's precautionary decisions, and in the case of the global warming assessment, adds further impetus to the need to regulate the largest source of GHG emissions in the United States: electric power plants.

*A. New Support for Regulation of Lead Additives to Protect Public Health*

The day that the D.C. Circuit upheld EPA's regulation of lead additives to protect public health, an executive vice president and counsel at Ethyl Corporation compared the long legal battle to "the New England witch-hunts in the [seventeenth century]."<sup>205</sup> He continued, "Those deaths of innocent people who couldn't prove that they weren't witches were also upheld by the courts swept up by the emotions of the day. That chapter in American history soon came to be an embarrassment to all intelligent people, and so will this proceeding."<sup>206</sup> In fact, only seven years after the *Ethyl II* decision, a panel of the D.C. Circuit, including even Judge Wilkey, upheld a rule tightening the lead standard for gasoline with the following remarkable statement: "In sum, the demonstrated connection between gasoline lead and blood lead, the demonstrated health effects of blood lead levels of 30 µg/dl or above, and the significant risk of adverse health effects from blood lead levels as low as 10–15 µg/dl, would justify EPA in banning lead from gasoline entirely."<sup>207</sup> What happened to change the record originally offering "no firm evidence" that lead in gasoline was harmful to a judicial opinion supporting a ban before EPA even proposed one?

In the first major advance in the science on lead impacts, EPA's former antagonist HEW made one of many important contributions to the case for regulating gasoline lead additives by adding testing for lead to its National Health and Nutrition Examination Survey in 1978. The study, which surveyed 27,801 people and took 16,563 blood samples, demonstrated "remarkably strong and consistent relationships between gasoline lead and blood lead."<sup>208</sup> A

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205. Editorial, *Court Says EPA Can Regulate Lead in Gasoline*, WALL ST. J., Mar. 22, 1976, at 7.

206. *Id.*

207. *Small Refiner Lead Phase-Down Task Force v. EPA*, 705 F.2d 506, 531 (D.C. Cir. 1983).

208. JOEL SCHWARTZ ET AL., EPA, COSTS AND BENEFITS OF REDUCING LEAD IN GASOLINE: FINAL REGULATORY IMPACT ANALYSIS, at E-4 (1985) [hereinafter LEAD RIA], available at [http://yosemite.epa.gov/ee/epa/eeerm.nsf/vwAN/EE-0034-1.pdf/\\$file/EE-0034-1.pdf](http://yosemite.epa.gov/ee/epa/eeerm.nsf/vwAN/EE-0034-1.pdf/$file/EE-0034-1.pdf).

different study published in 1983 showed that blood lead levels in the population surveyed dropped 37 percent between February 1976 and February 1980, with a “statistically significant” correlation of blood lead levels with the amount of lead in gasoline.<sup>209</sup>

Substantial progress was also made in confirming the harm to health caused by even moderately elevated blood lead levels. When EPA issued its National Ambient Air Quality Standard (NAAQS) for lead in 1980,<sup>210</sup> the agency was able to describe in more detail the harmful effects of the disturbance of heme synthesis in blood and the resulting elevation of free erythrocyte protoporphyrin noted as “undesirable” but of unknown biological significance in the National Academy of Sciences’ lead report.<sup>211</sup> Scientists had shown that lead disrupts a wide variety of physiological processes, such as oxygen transport to all organ systems, vitamin D production and calcium uptake, and the functioning of renal and neurological systems.<sup>212</sup>

By 1980, EPA’s new NAAQS for lead was also strongly supported by action taken by the Center for Disease Control and Prevention of HEW. That agency had reduced the screening level for undue lead exposure from forty µg/dl to thirty µg/dl in 1978, a decision reflecting the consensus of clinicians and the American Academy of Pediatrics that free erythrocyte protoporphyrin “should be used as an indicator of a significant and worrisome body burden of lead.”<sup>213</sup> Since then, the Center has reduced the screening level from thirty µg/dl to ten µg/dl, and finally, to five µg/dl in 2012.<sup>214</sup> The changes lowering the Center’s screening levels reflect mounting evidence, beginning in the 1970s, that lead exposure causes neurological damage manifested in behavioral disorders, fine motor function impacts, and significant losses in mental capacity as measured by the intelligence quotient (IQ). Studies available when the lead

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209. Joseph L. Annett et al., *Chronological Trend in Blood Lead Levels between 1976 and 1980*, 308 NEW ENG. J. MED. 1373, 1375 (1983).

210. National Ambient Air Quality Standards for Lead, 73 Fed. Reg. 66,964 (Nov. 12, 2008) (to be codified at 40 C.F.R. pts. 50, 51, 53, 58). The D.C. Circuit upheld the standard in *Lead Industries Ass’n v. EPA*, 647 F.2d 1130, 1184 (D.C. Cir. 1980). The Natural Resources Defense Council successfully sued EPA in 1973 for failure to set an ambient air quality standard for lead. *See* *Natural Res. Def. Council, Inc. v. Train*, 411 F. Supp. 864, 871 (S.D.N.Y. 1976), *aff’d*, 545 F.2d 320, 324 (2d Cir. 1976). EPA argued that it had discretion to reduce lead in gasoline and emissions from other major sources rather than to set a NAAQS requiring all states to consider and, where necessary, adopt strategies to control sources of lead. *See id.* at 867–68. However, the courts held that EPA had made the necessary finding to support a standard under sections 108 and 109 of the CAA and had no discretion not to set such a standard. *See id.* at 870–71. The court ordering EPA to set the standard turned out to be beneficial in compelling regular reviews of the science on the health effects of lead exposure and has provided a strong record of the results of EPA’s issuance of a precautionary standard to control automotive lead emissions before complete information on the impacts was available.

211. *See* National Ambient Air Quality Standards for Lead, 73 Fed. Reg. at 66,975; AIRBORNE LEAD IN PERSPECTIVE, *supra* note 129, at 208.

212. *Lead Indus. Ass’n*, 647 F.2d at 1158–59.

213. *Id.* at 1157–59. The court rejected the Lead Industries Association’s contention that a “mere ‘subclinical effect’” did not have a health significance. *Id.* at 1156.

214. *See What Do Parents Need to Know to Protect Their Children?*, CENTER DISEASE CONTROL & PREVENTION, [http://www.cdc.gov/nceh/lead/acclpp/blood\\_lead\\_levels.htm](http://www.cdc.gov/nceh/lead/acclpp/blood_lead_levels.htm) (last updated June 19, 2014).

rules were issued in 1973 provided early evidence of neurological impacts.<sup>215</sup> However, as we have seen, EPA and the reviewing court in *Ethyl II* chose not to emphasize these studies because the information was so new. EPA and the D.C. Circuit did not rely on pioneering work by Drs. Herbert Needleman, Sergio Piomelli, and Ellen Silbergeld on the neurological effects of lower levels of lead absorption in the promulgation and judicial review of the 1980 NAAQS. However, this work did inspire a much clearer definition of the health impacts of lead in gasoline. In 1978, Dr. Silbergeld and Dr. H.S. Adler published a study showing lead-induced blockage of neurotransmitter release in peripheral nerves.<sup>216</sup> In 1979, Dr. Needleman published a study showing an inverse correlation between dentine lead levels and IQ after controlling for age, parents' IQ, and socioeconomic status.<sup>217</sup>

By 1985, enough information had been compiled to produce an impressive health risk assessment and cost-benefit analysis: EPA's 500-page Regulatory Impact Analysis (RIA) on the costs and benefits of reducing lead in gasoline.<sup>218</sup> Plans were afoot in the early years of the Reagan administration to relax the controls on lead in gasoline, and EPA Administrator Ann Gorsuch proposed changes to the rules in February 1982.<sup>219</sup> Under fire for this and other reasons,

215. See, e.g., *Ethyl II*, 541 F.2d 1, 116 (D.C. Cir. 1976) (en banc) (Wilkey, J., dissenting).

216. LEAD RIA, *supra* note 208, at IV-31.

217. See *id.* at IV-34. The EPA reanalyzed Dr. Needleman's results and confirmed them in 1983. See Herbert Needleman et al., *Lead and IQ Scores: A Reanalysis*, SCIENCE, Feb. 15, 1985, at 701, 701-04. Dr. Needleman and his work were attacked by representatives of the lead industry, their lawyers, and several scientists critical of his methodology. See generally TOXIC TRUTH, *supra* note 118. Dr. Silbergeld confirmed the author's detailed account of this controversy. See Ellen Silbergeld, *Annotation: Protection of the Public Interest, Allegations of Scientific Misconduct, and the Needleman Case*, 85 AM. J. PUB. HEALTH, no. 2, Feb. 1995, at 165. The campaign to discredit Dr. Needleman's studies focused on challenges to the statistical methods and conclusions in his 1979 study on neurological impacts, including IQ. See TOXIC TRUTH, *supra* note 118, at 213. EPA's Clean Air Scientific Advisory Committee evaluated and approved the study in 1984. *Id.* at 151, 191, 213. A subsequent claim of scientific misconduct was filed, again criticizing the 1979 study. No misconduct but some misrepresentation was found. *Id.* at 196. By that time, a dozen more published papers had confirmed Dr. Needleman's association between lead and IQ. *Id.* at 186. Another scientist who battled the lead industry was Dr. Clair Patterson, a geophysicist, who in the course of determining the age of the earth discovered that the levels of lead in the environment and in humans were mainly manmade and not natural in origin. His discovery and his advocacy for the regulation of lead were featured on April 17, 2014, in the television series *Cosmos: A Spacetime Odyssey*, with an animated story of his work. Miriam Kramer, 'Cosmos' Recap: What Lead Poisoning and Earth's Age Have in Common, SPACE.COM (Apr. 21, 2014), [www.space.com/25579-cosmos-recap-earth-age-leadpoisoning.html](http://www.space.com/25579-cosmos-recap-earth-age-leadpoisoning.html). He became another target of the lead industry and its allies, and his work was controversial enough to be excluded from governmental studies and panels on lead. See TOXIC TRUTH, *supra* note 118, at 113-17. His finding contradicted what had been the received opinion for decades, based on the work of Dr. Robert Kehoe, head of the Kettering Laboratory and a leading expert specializing in the study of high levels of lead exposure. Kehoe had popularized the view that the body burdens prevalent in humans were natural, generally kept in balance, and not harmful except at high levels. *Id.* at 59-60. None of these conclusions proved to be correct.

218. See LEAD RIA, *supra* note 208.

219. Charles Schmidt, *Joel Schwartz: Full Throttle Environmentalist*, HARV. PUB. HEALTH REV., Summer/Fall 2005, at 12, 12-16, available at [http://www.hsph.harvard.edu/review/review\\_fall\\_05/rvwfall05\\_schwartz.html](http://www.hsph.harvard.edu/review/review_fall_05/rvwfall05_schwartz.html). Administrator Gorsuch proposed rescission or modification of the limits on lead in leaded gasoline in a brief notice stating that

Administrator Gorsuch resigned in March 1983, and EPA's first administrator, William Ruckelshaus, returned to head the agency.<sup>220</sup> His deputy, Alvin Alm, tasked the agency's policy office with performing a cost-benefit analysis of all aspects of the lead in gasoline regulations.<sup>221</sup> The report evolved into a comprehensive analysis, bristling with statistics, of whether and how to make further cuts in lead in gasoline to protect public health. It also addressed the larger than expected problem of gasoline misfueling, the term for the introduction of leaded gasoline into vehicles equipped with catalytic converters, which deactivated the equipment and increased emissions.<sup>222</sup>

The RIA for lead was among the first studies prepared to implement President Ronald Reagan's order requiring a cost-benefit analysis for major rules.<sup>223</sup> It demonstrated the strengths and weaknesses of cost-benefit analysis in environmental decision making and affirmed the powerful contribution of the precautionary approach in the lead additives decision. The first part of the report covered in great detail the impacts of alternative levels of lead reduction on gasoline costs, auto maintenance costs, and even fuel economy, finding that unleaded gasoline provided better fuel economy. From a chapter on refining

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the standard might not be necessary because of the growth of the vehicle population requiring unleaded gasoline. See Regulation of Fuels and Fuel Additives: Withdrawal of Proposed Rule, 47 Fed. Reg. 38,070, 38,070 (Aug. 27, 1982) (to be codified at 40 C.F.R. pt. 80). Acting Administrator John Daniel withdrew the notice six months later, stating flatly that there was no new evidence that would cause EPA to determine that continuing controls were inappropriate, and that any of the proposed changes would increase lead use from 31 percent to 86 percent in 1983. See *id.* at 38,070–71. He also cited a 1980 National Academy of Sciences report urging efforts to control exposures from all sources of lead. *Id.* at 38,071–73. EPA promulgated revised rules establishing a standard of 0.10 grams per leaded gallon for large refiners and a more lenient standard for smaller ones. Regulation of Fuel and Fuel Additives, 47 Fed. Reg. 49,322 (Oct. 29, 1982) (to be codified at 40 C.F.R. pt. 80). The D.C. Circuit upheld this rule in *Small Refiner Lead Phase-Down Task Force v. EPA*, 705 F.2d 506 (D.C. Cir. 1983).

220. See GERALD MARKOWITZ & DAVID ROSNER, *LEAD WARS: THE POLITICS OF SCIENCE AND THE FATE OF AMERICA'S CHILDREN* 88–89 (2013).

221. *Who's Afraid of the Precautionary Principle?*, *supra* note 8, at 69–70.

222. Because the petroleum industry priced unleaded gasoline much higher than leaded fuel (well above the cost differential to produce it), there was a price incentive for motorists to use leaded fuel. This practice was raising lead use and reducing the efficacy of catalytic emission controls for other automotive pollutants. EPA therefore considered eliminating the remaining lead allowed in gasoline in part to prevent this problem. See LEAD RIA, *supra* note 208, at E-1 to E-2. Ruckelshaus and Alm did not need a completed cost-benefit analysis to conclude that the lead in gasoline standard should be tightened, and on August 2, 1984, they proposed to reduce the permissible lead level to 0.10 grams per leaded gallon by January 1, 1986, both to reduce misfueling and to respond to greater concern about the health impacts of automotive lead emissions. (The EPA intended for the trace amount of lead left to prevent engine valve seat recession in older vehicles and agricultural equipment.) See Regulation of Fuels and Fuel Additives; Lead Phase Down, 49 Fed. Reg. 31,032, 31,032 (proposed Aug. 2, 1984) (to be codified at 40 C.F.R. pt. 80). The notice summarizes many of the new findings on the contribution and effects of lead emissions but without the detailed statistical analysis subsequently provided in the complete RIA. The EPA promulgated these rules, backed by the complete RIA, on March 7, 1985. Regulation of Fuel and Fuel Additives; Gasoline Lead Content, 50 Fed. Reg. 9386 (Mar. 7, 1985) (to be codified at 40 C.F.R. pt. 80). Congress finally banned lead in gasoline for on-road vehicles by statute, effective January 1, 1996, and the EPA followed up with a revised regulation shortly thereafter. See 42 U.S.C. § 7545(n) (2012); Prohibition on Gasoline Containing Lead or Lead Additives for Highway Use, 61 Fed. Reg. 3832 (Feb. 2, 1996) (to be codified at 40 C.F.R. pt. 80).

223. See Exec. Order No. 12,291, 46 Fed. Reg. 13,193 (Feb. 17, 1981).

cost featuring seventeen scenarios, based on the Department of Energy's refinery models, the report estimated the additional refinery cost impact for 1986, the year of greatest stringency, at \$608 million.<sup>224</sup> The estimated annual consumer cost savings from lower vehicle maintenance (\$914 million) and greater fuel economy (\$187 million)<sup>225</sup> substantially exceeded projected additional refinery costs.

The assessment of the contribution of gasoline lead emissions to human body burdens and the assessment of the health impacts of that contribution were similarly thorough. The HEW survey of lead air and human blood lead levels and available data on leaded gasoline sales in particular geographic areas enabled analysts to compare the relationship between gasoline lead emission levels and human blood lead levels directly over the early years of the lead reduction schedule. A summary chart showed a very close correlation between the reduction of lead in gasoline and blood lead levels measured in human populations from 1976 to 1980.<sup>226</sup> The assessment stated that this striking correlation alone would support a finding of cause and effect under a precautionary standard, but the authors also performed a series of statistical tests to prove that no confounding variables factored into the correlation. Following a detailed statistical analysis, the conclusions, at least, were crystal clear:

Regressions on all the data sets showed that gasoline lead was an extremely significant explanatory variable both for individual blood lead levels and for the percent of children with undue lead exposure or lead toxicity. Gasoline lead appeared to have accounted for 60 percent of the lead in Americans in the second half of the 1970s, and to have explained both the seasonal increases in blood lead levels from winter to summer and the long-term drop in blood lead levels during the late 1970s.<sup>227</sup>

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224. LEAD RIA, *supra* note 208, at E-3. The seventeen "sensitivity analyses" estimating costs based on differing assumptions are summarized in the tables at II-52 to II-53. The final estimate did not include savings from the banking system, then under consideration, that would allow refiners with excess lead allowances to bank them for later use or sell them to other refiners. *Id.* at E-3. The refining industry stood to save \$200 million with the banking option. *Id.*

225. *Id.* at VIII-15 (summary table of the costs and benefits assuming partial misfueling).

226. *Id.* at E-5. Ethyl Corporation contended that this correlation provided no evidence of association between blood lead and gasoline lead in comments on EPA's proposal to tighten the standard. A scientific group and EPA rejected the company's arguments. *See* Regulation of Fuels and Fuel Additives; Lead Phase Down, 49 Fed. Reg. at 31,036.

227. LEAD RIA, *supra* note 208, at III-19 to III-21. In addition, discovery of a completely new health issue boosted the evidence of the harmful impacts of lead. The National Health and Nutrition Examination Survey revealed, for the first time, a very strong correlation between *moderate* levels of lead exposure and increased blood pressure in adult white males. *See id.* at E-6. Once again, EPA did not rely on this study in promulgating its final rule, though the study was published, because it was so new. *Id.* at E-7. However, the Lead RIA used the study to predict the impacts of reducing blood pressure on hypertension, cardiovascular diseases, and strokes. *See id.* This "informational" analysis estimated that

The RIA's evaluation of the effects of this lead exposure on children's health and cognitive effects concluded as follows:

Lead can interfere with blood-forming processes, vitamin D metabolism, kidney functioning, and neurological processes. The negative impact of lead on cognitive performance (as measured by IQ tests, performance in school, and other means) is generally accepted at moderate-to-high blood-lead levels (30 to 40 ug/dl and above). Several studies also suggest cognitive effects at lower levels.<sup>228</sup>

Again, the chapter supporting these conclusions examined in detail studies indicating correlations between higher blood lead levels and IQ decrements. The authors conclude that despite methodological flaws in most of the individual studies, the data as a whole showed a "consistent dose-dependent interference with normal neurological functioning."<sup>229</sup>

The analysis then estimated the impact of further gasoline lead reductions on children's body burdens—an exercise supported by the established correlation between the two—and attempted to monetize the benefits of reducing those impacts. The measures chosen were the cost of medical treatment, including chelation therapy in higher exposure cases,<sup>230</sup> and the cost of compensatory education—\$900 for medical treatment and \$2600 for compensatory education per case.<sup>231</sup> The value of health benefits from the avoided costs was estimated at \$600 million for the year 1986.<sup>232</sup> The authors acknowledged that "[t]he health benefits of reducing children's exposure to lead are diverse and difficult to . . . value in monetary terms," and that the two measures of benefit "exclude many important factors, such as reduced pain and

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reducing the blood pressure impacts of lead totaled in benefits of almost \$6 billion, ten times the estimate of the benefits of reducing lead to protect children. *Id.* at E-7, VIII-15. This is a regulatory example of praeteritio. See also James L. Pirkle et al., *The Relationship between Blood Lead Levels and Blood Pressure and Its Cardiovascular Risk Implications*, 121 AM. J. EPIDEMIOLOGY, no. 2, Feb. 1985, at 246, 246–48 (referencing the study).

228. LEAD RIA, *supra* note 208, at E-6, IV-5 ("The biological basis of lead toxicity is its ability, as a metallic cation, to bind to bio-molecular substances crucial to normal physiological functions, thereby interfering with these functions.")

229. See *id.* at IV-33; see also 4 EPA, AIR QUALITY CRITERIA FOR LEAD 12-282 (1986), available at <http://cfpub2.epa.gov/ncea/cfm/recordisplay.cfm?deid=32647#Download> (finding that asymptomatic children exhibited five-point decrements in IQ at fifty to seventy µg/dl blood lead levels, four points at thirty to fifty µg/dl, and one to two points below thirty µg/dl).

230. Chelation therapy involves taking a medication that binds with lead in the body so that it is excreted in the urine. *Lead Poisoning: Treatments and Drugs*, MAYO CLINIC (June 10, 2014), <http://www.mayoclinic.org/diseases-conditions/lead-poisoning/basics/treatment/con-20035487>. This treatment is normally used for more severe cases of lead poisoning. *Id.* The RIA notes that chelation therapy can remove necessary minerals and cause severe side effects, including kidney damage. LEAD RIA, *supra* note 208, at IV-52.

231. LEAD RIA, *supra* note 208, at E-6.

232. *Id.*

suffering, or higher earnings in later life.”<sup>233</sup> EPA impact analyses since the preparation of the 1985 RIA have projected significant impacts on earnings, utilizing research by Dr. Joel Schwartz and others.<sup>234</sup> Other studies have shown that the effects of childhood lead body burdens are not reversible.<sup>235</sup>

EPA’s RIA and the detailed quantitative assessment of costs and benefits ended most doubts about the wisdom of removing lead from gasoline; even the Reagan administration’s Office of Management and Budget regulatory chief embraced its results.<sup>236</sup> This outcome demonstrated the ability of cost-benefit analysis to identify regulatory options and to persuade skeptical audiences of the value of the lead program. Even so, the analysis omits many of the most important consequences of childhood lead exposure from the assessment of benefits and provides a good example of why many environmental advocates disdain cost-benefit analysis. Compensation for medical treatment and special education are only partial measures of the price of harm from childhood exposure to lead. In addition, the effects of reduced intelligence on a person’s quality of life extend well beyond the ability to earn a living. The RIA also fails to estimate and value the impact of behavioral impairment on family, social,

233. *Id.* at E-6, IV-47.

234. In later years, EPA’s analysis of the impacts of IQ losses due to lead was much more detailed, calculating the impact on future wages of persons affected by lead and producing much higher estimates. Dr. Schwartz estimated that one point of IQ produced a 1.76 percent gain in earnings. EPA, REGULATORY IMPACT ANALYSIS OF THE PROPOSED REVISIONS TO THE NATIONAL AMBIENT AIR QUALITY STANDARDS FOR LEAD, at ES-10 (2008), available at [www.epa.gov/ttn/ecas/regdata/RIAs/finalpbria.pdf](http://www.epa.gov/ttn/ecas/regdata/RIAs/finalpbria.pdf). Another analyst proposed a higher percentage gain. *Id.* After a very complex set of calculations, EPA’s analysis values one point of IQ at \$8760 in earnings using a 3 percent discount rate and at \$1094 using a 7 percent discount rate. *Id.* at 34. These estimates produce benefits of reducing childhood lead exposure valued in the billions of dollars. *Id.* at 46. Note that EPA prepared but did not formally consider this RIA because cost considerations are not given weight in setting NAAQS, which must be based solely on health considerations. *Id.* at ES-1 to ES-2.

235. A study by Dr. Needleman in 1990 demonstrated the persistence of cognitive and behavioral impairments well beyond the years of childhood exposure. See Herbert L. Needleman et al., *The Long-Term Effects of Exposure to Low Doses of Lead in Children*, 322 NEW ENG. J. MED. 83, 83 (1990). Other commentators continue to suggest that impacts of lead endure despite regulatory efforts to reduce exposure. See, e.g., Alexandra Sifferlin, *The Legacy of Lead: How the Metal Affects Academic Achievement*, TIME (Feb. 27, 2013), <http://healthland.time.com/2013/02/27/the-legacy-of-lead-how-the-metal-affects-academic-achievement>. Scientists examined blood lead test results for over 21,000 children under six years old who had been tested between 1990 and 2008 and compared their test scores on Michigan assessment tests between 2008 and 2010. *Id.* High blood lead levels were associated with low academic performance in math, science, and reading in grades three, five, and eight. *Id.*

236. Christopher DeMuth ultimately described the Lead RIA as “a model of how regulatory issues in the health care area ought to be approached.” TOXIC TRUTH, *supra* note 118, at 155. Bruce A. Ackerman and Richard B. Stewart credited the phaseout of lead to the cost-benefit analysis, stating that the “key to this decision was an economic analysis . . . showing that the move would achieve major health benefits at little or no net cost.” Bruce A. Ackerman & Richard B. Stewart, *Reforming Environmental Law*, 37 STAN. L. REV. 1333, 1363 (1985). The economic analysis was indeed persuasive to budget officials and nailed the case for eliminating lead, but it is likely that the health effects data alone was enough to convince EPA leadership to take action to remove lead. See *supra* note 235 and accompanying text.

educational, or workplace relationships and success.<sup>237</sup> It is a small wonder that the health benefits of lead reduction were valued at slightly less than the costs of additional refining to accomplish it. But by the time the RIA was completed, almost no one considered the case for eliminating a fuel additive causing neurological damage to children to be close.<sup>238</sup>

Besides revealing the limitations of analyzing health effects, especially compared to the engineering estimates for impacts on vehicles and gasoline refining, EPA's RIA also demonstrated the value of the precautionary standard. It should be stressed that the exposure and health effects data relied on in the RIA would not have existed had EPA not already taken action to regulate lead in gasoline and to win the support of HEW's survey team. The fact that lead levels were declining in the 1976 to 1980 period enabled the HEW survey to identify with uncommon precision the contribution of automotive lead emissions to human blood lead levels and to develop very specific dose-response relationships.<sup>239</sup> The rulemaking itself attracted and focused new attention from the scientific community and provided the impetus for new, independent research. EPA's early action on lead also had major unexpected beneficial side effects for consumers in reducing vehicle maintenance costs and increasing fuel economy.<sup>240</sup>

The CAA's precautionary standard enabled EPA to clear many hurdles to promulgating the first set of health-based regulations to reduce automotive lead emissions and to lay the foundation for eliminating lead in gasoline. Those hurdles included: 1) defeating the lead industry's well-executed shell game in which all the problems with lead were attributable to a source of exposure other than the 200,000 tons of annual lead emissions from automobiles; 2) assembling the best available scientific evidence from numerous scientific disciplines and defending a judgment that the *totality* of the complicated evidence demonstrated a significant risk of harm to the health of city children;<sup>241</sup> 3) expanding a body of scientific evidence then focused almost

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237. Similarly, the costs estimated by the RIA for strokes caused by hypertension associated with lead explicitly *exclude* reductions in quality of life caused by partial paralysis of victims. See LEAD RIA, *supra* note 208, at E-7.

238. Administrator Ruckelshaus reportedly considered the evidence of harm to children's brains to be "overwhelming." TOXIC TRUTH, *supra* note 118, at 155. EPA's policy chief, Joseph Cannon, an advocate of reliance on markets, viewed the evidence and concluded that the declining market for unleaded gasoline would not achieve the protection needed. "The health studies are so compelling that you can't look away. You just can't look away." *Id.* However, Ethyl's Vice Chairman Lawrence Blanchard was unpersuaded, describing the EPA analysis as "intellectual fraud," and a "juvenile and simplistic approach." *Id.* at 154.

239. As Lydia Denworth observed, "By the 1990s, it was clear just how pervasive the effects of lead had been. It took its absence to clearly define its presence." TOXIC TRUTH, *supra* note 118, at 199.

240. LEAD RIA, *supra* note 208, at E-9.

241. The government's brief relied on a summary—prepared by Dr. John Knelson, director of EPA's Human Studies Laboratory—of the types, strengths, and limitations of the scientific method in assessing the health effects of pollution exposure. That study was later quoted in full in the majority opinion:

exclusively on studies of the adverse effects of high levels of lead exposure and introducing new types of evidence from a new generation of scientists working on the effects of environmental lead pollution; 4) sidelining a skeptical expert assessment from a National Academy of Sciences panel lacking sophistication in evaluating low-level exposure to air pollutants and possibly biased due to affiliations with the lead industry; 5) surviving turf conflicts and professional competition causing top management of the main federal agency traditionally responsible for public health, HEW, to withhold its support; and 6) persuading the Nixon administration to promulgate regulations with a modest but real impact on petroleum production in the midst of the 1973 oil embargo.

The CAA's precautionary endangerment standard kept the focus on the serious harm to be prevented and the population at risk—urban children—whether or not EPA could prove that the harm was certain to be occurring. The resulting regulations reduced lead emissions by 98 percent between 1970 and 2003.<sup>242</sup> The mean blood lead level in children measured in surveys from 1976 to 1980 was fifteen  $\mu\text{g}/\text{dl}$ .<sup>243</sup> It declined to one to two  $\mu\text{g}/\text{dl}$  in surveys from 2000 to 2004.<sup>244</sup> By any measure of benefits, EPA's precautionary decision to phaseout the use of lead additives in gasoline was vindicated.

### B. New Support for GHG Regulation

The evidence of GHG risks in the five years since EPA's endangerment finding has strengthened significantly, if not as dramatically as did the evidence of the health effects of lead less than ten years after the *Ethyl* decision. This subpart presents examples from recent climate assessments of impacts more likely and more severe than projected in past years. The discussion also

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Each of these investigative approaches [sic] classic toxicology, epidemiology, and clinical research has its advantages and disadvantages. The toxicologist can control the dose and use invasive or destructive techniques in measuring response in the animal, but is always faced with the problem of extrapolating results to humans. Epidemiology is most relevant because it studies phenomena actually occurring in humans under "natural" conditions, but can only draw inference from observed correlations rather than prove cause and effect relationships. Clinical research can provide the most accurate dose-response relationships in the species of interest. Precisely because the study subjects are humans, however, many experimental design problems are encountered in assuring their safety. Although the dose of an atmospheric pollutant can be carefully controlled and measured in the clinical laboratory, qualitative comparability to the multiplex variable of atmospheric pollution cannot always be assured.

The best scientific criteria for establishing air quality standards result from interactions between these disciplines . . . . Biomedical data from all these sources, taken in their entirety, should be used for the prudent definition of air pollution control needs.

*Ethyl II*, 541 F.2d 1, 26 (D.C. Cir. 1976) (en banc).

242. National Ambient Air Quality Standards for Lead, 73 Fed. Reg. 66,964, 66,973 (Nov. 12, 2008) (to be codified at 40 C.F.R. pts. 50, 51, 53, 58).

243. *Id.*

244. *Id.*

addresses the growing frequency and significance of extreme weather events as an element of endangerment. The Summary for Policy Makers from the IPCC's Fifth Assessment Report on climate change, issued in 2013, reported growing confidence in the central findings on global warming and human contributions.<sup>245</sup> The report projected that average world temperatures will increase 2.7°F to 7.2°F by 2100,<sup>246</sup> that sea level rise will be 50 percent higher than earlier estimates,<sup>247</sup> and that the Arctic region is likely to be ice-free in the summer much more rapidly than predicted in the past.<sup>248</sup>

The report also noted that the rate of the warming of the earth's air temperatures at the surface has been relatively flat over the last fifteen years despite significant increases in carbon dioxide loading.<sup>249</sup> Numerous possible explanations were offered for this observation.<sup>250</sup> The principal explanation from climate scientists is that the "pause" in steady temperature increases during the past fifteen years is far too short to contradict the evidence of longer-term trends demonstrating the warming effect.<sup>251</sup> The IPCC's Fifth Assessment concludes that to avoid exceeding an average temperature increase of 2°C (about 3.6°F), the international goal,<sup>252</sup> carbon dioxide emissions from all sources should not exceed 1000 gigatonnes (Gt) (trillions of tons).<sup>253</sup> About 515 Gt have been emitted already, and the world is on track to exceed the target by 2040 at current emission rates.<sup>254</sup>

245. The report found it "extremely likely" that human activities caused more than half of the observed warming since the 1950s with a 95 percent level of confidence, up from 90 percent in 2007 and 66 percent in 2001. Lisa V. Alexander et al., *Summary for Policymakers*, in IPCC, CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS 4, 17 (Thomas F. Stocker et al. eds., 2013) [hereinafter IPCC FIFTH ASSESSMENT], available at [http://www.climatechange2013.org/images/report/WG1AR5\\_SPM\\_FINAL.pdf](http://www.climatechange2013.org/images/report/WG1AR5_SPM_FINAL.pdf).

246. *Id.* at 20.

247. *Id.* at 25–26. Sea level rise is now predicted to be ten to twenty-two inches under a low GHG emissions scenario and twenty to thirty-nine inches under a high emissions scenario by 2100. *Id.*

248. *Id.* at 24–25.

249. *Id.* at 5.

250. These include the strong El Niño effect raising temperature well above average fifteen years ago, the cooling effect of several volcanic eruptions, and the possibility of oceanic absorption of carbon dioxide emissions. *See id.* at 5, 15.

251. The Economist has published good commentary on the pause issue. *See* Editorial, *A Sensitive Matter*, ECONOMIST, Mar. 30, 2013, <http://www.economist.com/news/science-and-technology/21574461-climate-may-be-heating-up-less-response-greenhouse-gas-emissions>.

252. The narrative international goal for climate protection was set in Article 2 of the United Nations Framework Convention on Climate Change, available at [http://unfccc.int/not\\_assigned/b/items/1417.php](http://unfccc.int/not_assigned/b/items/1417.php). The Convention called for action to stabilize GHG concentrations at a level that would "prevent dangerous anthropogenic interference with the climate system." The subordinate goal is to limit warming to less than 2°C above 1861 to 1880 levels. *See* IPCC FIFTH ASSESSMENT, *supra* note 245, at 27. An official endorsement of the two-degree goal appears on page five of the 2009 Copenhagen Accord, available at <http://unfccc.int/resource/docs/2009/cop15/eng/11a01.pdf>. For a history of the development of this target, see Samuel Randalls, *History of the 2°C Climate Target*, WIRES CLIMATE CHANGE, July/August 2010, at 598.

253. IPCC FIFTH ASSESSMENT, *supra* note 245, at 27.

254. *Climate Change 2013: The Physical Science Basis*, CENTER CLIMATE & ENERGY SOLUTIONS, <http://www.c2es.org/science-impacts/ipcc-summaries/fifth-assessment-report-working-group-1> (last

The development of scientific evidence more directly defining possible impacts in the United States is of particular interest to U.S. policy makers. In the past, many economists and climate policy analysts have downplayed the impacts of global warming on major northern hemisphere countries such as the United States, Russia, and China, concluding that they have less reason to incur costs to mitigate climate change.<sup>255</sup> This view is increasingly dated, although it remains true that tropical and southern hemisphere nations are likely to suffer more severe negative impacts, as they have less adaptive capacity.<sup>256</sup> New assessments of warming's impacts on the United States as well as the projections of more frequent extreme weather events are changing the calculus significantly.

In the United States, the IPCC Fifth Assessment's projection of greater increases in sea level rise from thermal expansion of ocean waters and melting ice, as well as more intense precipitation, means more severe impacts on U.S. coastal regions.<sup>257</sup> The risk of coastal flooding is higher for the nearly five million people who live within four feet of the local high tide level; nearly a foot of sea level rise is described as the "realistic low end" by 2100, and four feet as a plausible high end in the U.S. Global Change Research Program assessment issued on May 6, 2014.<sup>258</sup> Another example of climate change impacts in the United States is projected in the National Research Council's 2011 report on climate stabilization targets, which predicts that an increase of

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visited Sept. 21, 2014) (discussing the IPCC's Fifth Assessment Report). Only the most rigorous GHG mitigation scenario evaluated in the IPCC's Fifth Assessment Report could forestall exceeding the 1000 Gt goal. IPCC FIFTH ASSESSMENT, *supra* note 245, at 27. The IPCC's statement was perceived by some commentators as a more explicit carbon budget or upper limitation to guide the international community. See Justin Gillis, *U.N. Climate Panel Endorses Ceiling on Global Emissions*, N.Y. TIMES (Sept. 27, 2013), <http://www.nytimes.com/2013/09/28/science/global-climate-change-report.html?pagewanted=all>.

255. See, e.g., CATASTROPHE, *supra* note 8, at 155 (observing that U.S. investments in climate change mitigation would primarily benefit the descendants of the inhabitants of poor countries); WORST-CASE SCENARIOS, *supra* note 8, at 91–94, 105–06 (discussing the Kyoto Protocol debate and describing the United States and China as less vulnerable than Africa and India in terms of climate change impacts to agriculture and health).

256. See, e.g., Christopher B. Field et al., *Summary for Policymakers*, in IPCC, CLIMATE CHANGE 2014: IMPACTS, ADAPTATION, AND VULNERABILITY 19–20, 21–24 (Christopher B. Field et al. eds., 2014) [hereinafter IPCC IMPACT STATEMENT], available at [http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5\\_SPM\\_FINAL.pdf](http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf). The report charts the vulnerabilities and adaptation capacities of the world's major regions and notes that dry, subtropical regions face greater risks from temperature increases such as reduction of water resources and exacerbation of food insecurity. *Id.* at 14, 21–24.

257. See IPCC FIFTH ASSESSMENT, *supra* note 245, at 23, 25.

258. U.S. GLOBAL CHANGE RESEARCH PROGRAM, 2014 NATIONAL CLIMATE ASSESSMENT: CLIMATE CHANGE IMPACTS IN THE UNITED STATES (Jerry M. Melillo et al. eds., 2014) [hereinafter USGCRP ASSESSMENT], available at [http://nca2014.globalchange.gov/NCA3\\_Highlights\\_LowRes-PDF\(SECURED\)](http://nca2014.globalchange.gov/NCA3_Highlights_LowRes-PDF(SECURED)). The U.S. Global Change Research Program is made up of thirteen federal agencies. *Id.* The assessment was written by a team of more than 300 experts and a sixty-member federal advisory committee. *Id.*

1°C is likely to increase the median acreage of wildfires in parts of the western United States by 200 to 400 percent, depending on the area.<sup>259</sup>

The general public naturally pays more attention to extreme weather events like severe storms than to gradual trends like earlier spring temperatures. The now-familiar “availability heuristic” has created strong interest in whether climate change is increasing the frequency and intensity of droughts, wildfires, floods, hurricanes, or tornadoes. Hurricane Sandy in October 2012, which caused the loss of 130 lives and an estimated \$62 billion in direct damage costs and indirect costs from loss of business in New York and New Jersey,<sup>260</sup> has focused even more attention on this question. A 2012 IPCC report specifically addressing extreme events stressed that the evidence cannot establish causal connections between climate change and *specific* extreme weather events.<sup>261</sup> Experts agree, however, that global warming is causing increases in extreme heat, heavy downpours, droughts, and drought-associated wildfires in many areas because statistical records over decades demonstrate that these events are occurring with greater frequency and/or intensity.<sup>262</sup> The 2014 report of the U.S. Global Change Research Program emphasized the increase in torrential rains and severe flooding in the United States.<sup>263</sup>

Extreme events provide “snapshots of a larger statistical trend” toward more frequent and intense storms, even though cause and effect cannot be demonstrated in a particular case.<sup>264</sup> Hurricane Sandy demonstrates how destructive a combination of sea level rise and more intense precipitation can be for coastal communities and their infrastructure, whether or not a direct causal connection can be made in that specific case. Given the scale and

259. NAT’L RESEARCH COUNCIL, CLIMATE STABILIZATION TARGETS: EMISSIONS, CONCENTRATIONS, AND IMPACTS OVER DECADES TO MILLENNIA 7 (2011), *available at* [http://www.nap.edu/catalog.php?record\\_id=12877](http://www.nap.edu/catalog.php?record_id=12877). The latest U.S. Global Change Research Program report stressed the growing number of periods of abnormally hot weather lasting for weeks or months in the United States and cited evidence that human influence on climate has already more than doubled the probability of extreme heat events, such as the record-breaking heat experienced in Texas and Oklahoma in the summer of 2011. USGCRP ASSESSMENT, *supra* note 258.

260. Jaison R. Abel et al., *What Are the Costs of Superstorm Sandy?*, LIBERTY STREET ECON. (Dec. 17, 2012, 8:46 AM), <http://libertystreeteconomics.newyorkfed.org/2012/12/what-are-the-costs-of-superstorm-sandy.html>. The New York governor’s office estimated that the storm would cost New York \$32.8 billion, and the New Jersey governor’s office estimated a cost to New Jersey of \$29.5 billion. *Id.*

261. IPCC, MANAGING THE RISKS OF EXTREME EVENTS AND DISASTERS TO ADVANCE CLIMATE CHANGE ADAPTATION 5–6 (Christopher B. Field et al. eds., 2012), *available at* [http://ipcc-wg2.gov/SREX/images/uploads/SREX-All\\_FINAL.pdf](http://ipcc-wg2.gov/SREX/images/uploads/SREX-All_FINAL.pdf).

262. See DANIEL G. HUBER & JAY GULLEDGE, CTR. FOR CLIMATE & ENERGY SOLUTIONS, EXTREME WEATHER & CLIMATE CHANGE: UNDERSTANDING THE LINKS AND MANAGING THE RISK 1, 9 (2011), *available at* <http://www.c2es.org/publications/extreme-weather-and-climate-change>.

263. The amount of precipitation falling in the heaviest 1 percent of events increased by 71 percent in the Northeast, 37 percent in the Midwest, and 27 percent in the Southeast between 1958 and 2012, with major implications for the risk of severe flooding. USGCRP ASSESSMENT, *supra* note 258. Nearly twenty inches of rainfall in two days in Nashville, Tennessee, in 2010 caused massive flood damage, as did extremely intense rainfall in Colorado in 2013. See Justin Gillis, *U.S. Climate Has Already Changed, Study Finds, Citing Heat and Floods*, N.Y. TIMES (May 6, 2014), [www.nytimes.com/2014/05/07/science/earth/climate-change-report.html](http://www.nytimes.com/2014/05/07/science/earth/climate-change-report.html).

264. See HUBER & GULLEDGE, *supra* note 262, at 3.

vulnerability of U.S. coastal development, the growing risk of a greater incidence of extreme weather events has to affect the assessment of the benefits and costs of climate mitigation action.

In summary, the news since the EPA's endangerment finding is not good. Yellow and red world maps in the IPCC's Fifth Assessment depict projected increases in temperature during the time period 2081 to 2100 ranging from significant to severe depending on the emission scenario.<sup>265</sup> Many adverse impacts are unavoidable, given existing and probable continued loadings of GHGs. Two additional IPCC Working Group reports issued after the physical sciences assessment address current and future impacts and adaptation<sup>266</sup> and mitigation options.<sup>267</sup> The report on mitigation—interventions to reduce the sources or enhance the sinks of GHGs—confirms the gravity of the challenge. The report presents scenarios relating predicted GHG concentrations to specific temperature levels.<sup>268</sup> Stabilizing temperature levels at less than a 2°C increase (3.6°F) above preindustrial levels, the international goal, will require a huge increase in mitigation activity over the next fifteen years.<sup>269</sup>

Considering the growing evidence of temperature increases and sea level rise in many areas, the confirmation of human impacts on these changes, and the significant and well-defined contributions of automotive carbon dioxide emissions to the U.S. and global GHG inventory, the 2009 EPA endangerment finding would probably have been supportable without reliance on a precautionary standard providing a less demanding burden of proof. This conclusion is supported by comparing the evidence surrounding EPA's finding to the evidence available seventeen years earlier when most nations, including the United States, ratified the 1992 Framework Convention on Climate Change at the Earth Summit in Rio de Janeiro.<sup>270</sup> In 1990, the First Assessment of the IPCC described the condition and cause of global warming, but the report did not define manmade emissions as the major cause.<sup>271</sup> Nevertheless, the

265. IPCC FIFTH ASSESSMENT, *supra* note 245, at 22.

266. IPCC IMPACT STATEMENT, *supra* note 256. The impact statement flatly states that impacts on natural systems are occurring across all continents and oceans, and emphasizes that a negative impact on major crops—namely, wheat and corn—is greater than any positive effect. *Id.* at 7. Though the report was described as alarmist for its sharper description of impacts, readers also praised the report for its realism in discussing how the impacts of climate change can be mitigated. Editorial, *Climate Change: In the Balance*, *ECONOMIST*, Apr. 3, 2014, <http://www.economist.com/news/science-and-technology/21600080-new-report-ipcc-implies-climate-exceptionalism-notion>.

267. Ottmar Edenhofer et al., *Summary for Policymakers*, in IPCC, CLIMATE CHANGE 2014: MITIGATION OF CLIMATE CHANGE (Ottmar Edenhofer et al. eds., 2014) [hereinafter IPCC MITIGATION REPORT], available at [http://report.mitigation2014.org/spm/ipcc\\_wg3\\_ar5\\_summary-for-policy-makers\\_approved.pdf](http://report.mitigation2014.org/spm/ipcc_wg3_ar5_summary-for-policy-makers_approved.pdf).

268. *Id.* at 13.

269. Justin Gillis, *Climate Efforts Falling Short, U.N. Panel Says*, *N.Y. TIMES* (Apr. 13, 2014), <http://www.nytimes.com/2014/04/14/science/earth/un-climate-panel-warns-speedier-action-is-needed-to-avert-disaster.html>.

270. United Nations Framework Convention on Climate Change art. 2, May 9, 1992, 1771 U.N.T.S. 107 [hereinafter UNFCCC], available at [http://unfccc.int/not\\_assigned/b/items/1417.php](http://unfccc.int/not_assigned/b/items/1417.php).

271. IPCC, CLIMATE CHANGE: THE IPCC SCIENTIFIC ASSESSMENT (John T. Houghton et al. eds., 1990), available at

evidence was considered compelling enough to support the negotiation of the Framework Convention on Climate Change; its objective was to “stabiliz[e] [] greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.”<sup>272</sup> President George H.W. Bush signed this convention, and the U.S. Senate ratified it.<sup>273</sup> Given the state of climate science at the time, the 1992 convention could accurately be described as a “precautionary” standard.<sup>274</sup> Only in the second IPCC assessment, in June 1996, did the authors conclude that despite the complexities and confounding variables, “the balance of evidence suggests that there is a discernible human influence on global climate,”<sup>275</sup> the first consensus statement to credit human influence.<sup>276</sup>

Despite the relative strength of the scientific evidence, EPA aggressively argued its case for the endangerment finding and the motor vehicle emission standards under the rubric of the precautionary principle. The D.C. Circuit found it useful to frame its decision in terms of a reciprocal balancing and, in several areas, to reject arguments for further quantification of the risks and the benefits of U.S. action. Even though the evidence on climate risk and the contribution of automotive emissions were well defined, no quantitative

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[http://www.ipcc.ch/publications\\_and\\_data/publications\\_ipcc\\_first\\_assessment\\_1990\\_wg1.shtml#UpkffWRDtPR](http://www.ipcc.ch/publications_and_data/publications_ipcc_first_assessment_1990_wg1.shtml#UpkffWRDtPR).

272. UNFCCC, *supra* note 270, art. 2.

273. A.C. Thompson, *Timeline: The Science and Politics of Global Warming*, PBS (Apr. 24, 2007), <http://www.pbs.org/wgbh/pages/frontline/hotpolitics/etc/cron.html>.

274. It also lacked any enforceable limitations. Such limitations were provided in the Kyoto Protocol, which went into force in 1997 without the United States as a signatory. *See* Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 11, 1997, 2303 U.N.T.S. 148. By then, the U.S. Senate had made it clear that it would not ratify an agreement without the participation of China, and neither President Bill Clinton nor President George W. Bush pressed the issue. *See* S. Res. 98, 105th Cong. (1997) (enacted).

275. IPCC, CLIMATE CHANGE 1995: THE SCIENCE OF CLIMATE CHANGE 5 (J.T. Houghton et al. eds., 1995), *available at* [http://www.ipcc.ch/ipccreports/sar/wg\\_1/ipcc\\_sar\\_wg\\_1\\_full\\_report.pdf](http://www.ipcc.ch/ipccreports/sar/wg_1/ipcc_sar_wg_1_full_report.pdf).

276. Subsequent IPCC reports issued before Administrator Jackson’s endangerment finding strengthened the evidence of human contribution and the scope of the risks. Even in 2001, the National Research Council of the National Academy of Sciences opined that the causal link between the buildup of GHGs and observed climate changes in the twentieth century “cannot be unequivocally established.” CLIMATE CHANGE SCIENCE: AN ANALYSIS OF SOME KEY QUESTIONS, *supra* note 89, at 17. The Academy prepared the report on short notice in response to a White House request for the Academy’s answers to a series of questions. *Id.* at vii. The report generally endorsed the IPCC findings, but the EPA referenced the above-quoted statement in denying the petition requesting a finding of endangerment and rulemaking on auto emission standards. *See* Control of Emissions from New Highway Vehicles and Engines, 68 Fed. Reg. 52,922, 52,930 (Sept. 8, 2003). Shortly after the Academy report, the IPCC’s Third Assessment concluded that there was “new and stronger evidence that most of the warming observed over the last [fifty] years is attributable to human activities,” and that carbon dioxide emissions due to fossil fuel burning were “virtually certain” to be the dominant factor accounting for carbon dioxide trends in the twenty-first century. Robert T. Watson et al., *Summary for Policymakers*, in IPCC, CLIMATE CHANGE 2001: SYNTHESIS REPORT 5, 27 (2001), *available at* <https://www.ipcc.ch/pdf/climate-changes-2001/synthesis-syr/english/summary-policymakers.pdf>. The IPCC’s 2007 report increased the confidence level for this finding, characterizing the increase in global average temperatures as “very likely” due to increased anthropogenic GHG concentrations. *See* LENNY BERNSTEIN ET AL., IPCC, CLIMATE CHANGE 2007: SYNTHESIS REPORT 38–41 (Abdelkader Allali et al. eds., 2007), *available at* [http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4\\_syr.pdf](http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf).

measure of benefits from a modest U.S. reduction on worldwide GHG emissions was possible in 2009. And by contrast to the lead additives case, the characterization of the risk of harm from GHGs depends significantly on the uncertain trajectory of climate change many years into the future. The *Coalition* court referred to both “current and future effects” of this warming on public health and welfare.<sup>277</sup> Although Judge Wright’s opinion in *Ethyl II* mentions the possibility of future harms from lead additives,<sup>278</sup> the harm from automotive lead emissions was already happening and, at least in the near term, exposure was unlikely to worsen with the introduction of unleaded gasoline to protect catalytic emission controls. The impacts of warming temperatures are also occurring now; but the continued rise in emissions, even if the world takes more aggressive action to reduce them, threatens much more severe impacts and magnifies both the uncertainty and the scale of the harm. The uncertainty of future impacts, including the undetermined and perhaps indeterminate risk of abrupt changes or tipping points that would accelerate climate disruption,<sup>279</sup> makes the application of a precautionary principle even more appropriate for the assessment and decisions to be made.

In addition, the next phase of any regulatory program under the CAA—control of GHGs from the electric power-generating sector—presents tremendous challenges in estimating the costs as well as the benefits of any rules. A precautionary standard for decision making and a less demanding standard for quantifying source contributions, source control impacts, and their associated costs will be needed to support regulatory action. A brief summary of these issues is presented in the following subpart.

### C. A Precautionary Approach for Power Plant GHG Emissions

President Barack Obama’s revived initiative to reduce GHGs confirmed his intention that EPA proceed to set carbon pollution standards for both new and existing electric generating units (EGUs).<sup>280</sup> EPA has proposed regulation of GHGs from both categories.<sup>281</sup> The addition of *existing* power plants to the GHG regulation agenda greatly increases the potential benefits and costs of

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277. *Coal. for Responsible Regulation, Inc. v. EPA (Coalition)*, 684 F.3d 102, 121 (D.C. Cir. 2012) (per curiam), *aff’d in part, rev’d in part sub nom. Util. Air Regulatory Grp. v. EPA*, 134 S. Ct. 2427 (2014).

278. *Ethyl II*, 541 F.2d 1, 25 (D.C. Cir. 1976) (en banc).

279. Examples include the displacement of the Gulf Stream, which warms the North Atlantic (including Europe); the sudden release of methane from the tundra; or the rapid melting of Greenland or Antarctica. CATASTROPHE, *supra* note 8, at 45–50.

280. See, e.g., Press Release, White House, Remarks by the President on Climate Change (June 25, 2013), available at [www.whitehouse.gov/the-press-office/2013/06/25/remarks-president-climate-change](http://www.whitehouse.gov/the-press-office/2013/06/25/remarks-president-climate-change).

281. See Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 79 Fed. Reg. 34,830 (proposed June 18, 2014) (to be codified at 40 C.F.R. pt. 60); Standards of Performance for Greenhouse Gas Emissions from New Stationary Sources: Electric Utility Generating Units, 79 Fed. Reg. 1430 (proposed Jan. 8, 2014) (to be codified at 40 C.F.R. pts. 60, 70, 71, 98).

GHG controls. Fossil fuel combustion by electric generating plants is the largest source of GHGs, accounting for nearly 40 percent of all energy-related carbon dioxide emissions,<sup>282</sup> and the aging inventory of coal-fired power plants has long been a major source of adverse impacts on air, water, and land. Regulation of the latter impacts is long overdue.<sup>283</sup> Yet, electric power is also a critical component of the economy. The cascading effects of higher energy costs throughout the economy and the impacts on consumers are both potentially large and highly uncertain.

Before outlining some of the key issues likely to require reliance upon a precautionary principle to support power plant GHG rules, it should be stressed that most advocates of GHG regulation, including business leaders cognizant of climate risks, support the use of regulatory tools such as a carbon tax or a cap-and-trade system to mobilize the market to achieve GHG reductions most efficiently and cheaply. Both approaches send a price signal to regulated entities, motivating them to reduce energy use and emissions or, in the case of trading regimes, to purchase emission credits from entities that can reduce emissions at a lower cost.<sup>284</sup> The severity of the impact of higher energy prices on the economy depends on 1) how rapidly users can offset price increases by switching to lower carbon fuels and reducing energy use through investments in more energy-efficient technology, and 2) how much those actions will cost. Whatever its merits, federal legislation to establish a carbon tax or a cap-and-trade system is unlikely to be enacted by Congress any time soon.<sup>285</sup>

Without federal legislation, the burden fell to EPA to develop and justify direct controls on EGUs as authorized by section 111 of the CAA.<sup>286</sup> Section 111(b) empowers EPA to set new source performance standards for any stationary source category that causes or contributes to air pollution that “may

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282. Carbon Pollution Emission Guidelines for Existing Stationary Sources, 79 Fed. Reg. at 34,843.

283. It took more than twenty years to establish toxic air pollution standards for electric generating plants because of changes to the statutory requirements. *See* *White Stallion Energy Ctr., LLC v. EPA*, 748 F.3d 1222, 1229–32 (D.C. Cir. 2014) (upholding the rules). Approximately three quarters of all coal-fired plants are at least thirty years old, and most of the older plants lack environmental controls. *See* Valerie Green, Panel Presentation on Hot Topics in Environmental and Energy Law at the Annual Meeting of the American Bar Association (Aug. 10, 2013) (on file with author).

284. The intent of both regulatory approaches is to raise energy prices enough to induce investments in greater efficiency or emissions trading that reduce energy use, carbon dioxide emissions, and costs. Both systems could generate government resources to compensate vulnerable industries or people. *See* LAWRENCE H. GOULDER, RES. FOR THE FUTURE, USING CAP AND TRADE TO REDUCE GREENHOUSE GAS EMISSIONS 1–3 (2010), *available at* <http://www.rff.org/RFF/Documents/RFF-BCK-Goulder-CT.pdf> (giving an overview of the two main market-oriented tools to reduce GHGs); CTR. FOR CLIMATE & ENERGY SOLUTIONS, OPTIONS AND CONSIDERATIONS FOR A FEDERAL CARBON TAX 4 (2013), *available at* [www.c2es.org/publications/options-considerations-federal-carbon-tax](http://www.c2es.org/publications/options-considerations-federal-carbon-tax). Tax revenues or revenues from auctioning carbon emission credits could be used to reduce economic impacts on the groups or commercial sectors most vulnerable to higher energy costs.

285. The political story of congressional action in the House of Representatives and inaction in the Senate is told in two excellent accounts, *see* ERIC POOLEY, *THE CLIMATE WAR: TRUE BELIEVERS, POWER BROKERS, AND THE FIGHT TO SAVE THE EARTH* (2010), and Ryan Lizza, *As the World Burns*, *NEW YORKER* (Oct. 11, 2010), <http://www.newyorker.com/magazine/2010/10/11/as-the-world-burns>.

286. *See* 42 U.S.C. § 7411 (2012).

reasonably be anticipated to endanger public health or welfare.”<sup>287</sup> Regulation of new source categories triggers regulation by states of existing sources under section 111(d).<sup>288</sup> Standards for both new and existing sources are to be based on the “best system of emission reduction” that the EPA administrator considers to be “adequately demonstrated,” taking into account cost, any nonair quality health and environmental impacts, and energy requirements.<sup>289</sup> Air pollution policy experts have advocated that the states be given flexibility to consider their entire fleet of EGUs and not necessarily apply the standards on a plant-by-plant basis; such flexibility allows emissions trading or credit for other state initiatives to reduce GHGs, including renewable portfolio standards and energy efficiency standards to reduce electricity demand.<sup>290</sup> EPA’s June 18, 2014 proposal appears to offer maximum flexibility in these respects.<sup>291</sup>

The EPA proposal and the accompanying RIA describe what may be the most complex and potentially costly environmental regulations ever proposed.<sup>292</sup> The simplest finding in support of the regulation is the significance of the U.S. electric power industry as a source of GHG emissions. In 2012, the industry contributed 38 percent of U.S. carbon dioxide emissions; coal combustion contributed nearly 29 percent, or 74 percent of the industry’s

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287. *Id.* § 7411(b)(1)(A).

288. *Id.* § 7411(d).

289. *Id.* § 7411(a).

290. See, e.g., DAVID D. DONIGER, NATURAL RES. DEF. COUNCIL, QUESTIONS AND ANSWERS ON THE EPA’S AUTHORITY TO SET “SYSTEM BASED” CARBON POLLUTION STANDARDS FOR EXISTING POWER PLANTS UNDER CLEAN AIR ACT SECTION 111(d) (2013), available at <http://www.nrdc.org/air/pollution-standards/files/system-based-pollution-standards-IB.pdf>; Robert R. Nordhaus & Ilan W. Gutherz, *Regulation of CO<sub>2</sub> Emissions from Existing Power Plants under § 111(d) of the Clean Air Act: Program Design and Statutory Authority*, 44 *Envtl. L. Rep. (Envtl. Law Inst.)* 10,366 (2014), available at [http://www.eli.org/sites/default/files/docs/article\\_2014\\_04\\_44.10366.pdf](http://www.eli.org/sites/default/files/docs/article_2014_04_44.10366.pdf); William F. Pedersen, *Should EPA Use Emissions Averaging or Cap and Trade to Implement Section 111(d) of the Clean Air Act?*, 43 *Envtl. L. Rep. (Envtl. Law Inst.)* 10,731 (2013). Section 111(d) has been used to set standards for four pollutants from five source categories in the federal air pollution program. Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 79 *Fed. Reg.* 34,830, 34,879 (proposed June 18, 2014) (to be codified at 40 C.F.R. pt. 60). In the case of GHG regulation, section 111’s terms, calling for a “system of emission reduction,” consideration of multiple technical and economic factors, and state leadership in developing applicable limits and enforcing federal “guidelines,” seem to allow significant flexibility in developing standards and programs. Many legal challenges will be mounted against the EPA’s 111(d) proposal, including the claim that standards and requirements must be confined to specific EGUs. But on its face, section 111(d) contains no limiting provisions like the tonnage limits cited by the Supreme Court in *Utility Air Regulatory Group*, which specifies “in no uncertain terms” what sources will be subject to the prevention of significant deterioration and operating permit requirements. *Util. Air Regulatory Grp. v. EPA*, 134 S. Ct. 2427, 2444–45 (2014). There are many legal issues in a proposal of this magnitude, but addressing them is beyond the scope of this Article.

291. See generally Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 79 *Fed. Reg.* 34,830 (proposed June 18, 2014) (to be codified at 40 C.F.R. pt. 60).

292. EPA, REGULATORY IMPACT ANALYSIS FOR THE PROPOSED CARBON POLLUTION GUIDELINES FOR EXISTING POWER PLANTS AND EMISSION STANDARDS FOR MODIFIED AND RECONSTRUCTED POWER PLANTS (2014) [hereinafter EPA RIA FOR POWER PLANT RULES], available at <http://www2.epa.gov/sites/production/files/2014-06/documents/20140602ria-clean-power-plan.pdf>.

total.<sup>293</sup> The total worldwide emissions contribution from the United States is estimated as of 2011 to be 15 percent of total GHG emissions and 16.5 percent of worldwide carbon dioxide emissions.<sup>294</sup> Although there is no question that U.S. reductions will be offset by growth in developing countries for some time, action by the United States to reduce its share by a significant percentage would still have a measurable impact on future GHG loadings.<sup>295</sup> Equally important, if not quantifiable, will be the possibility of opening the door to discussing reduction commitments from developing countries such as China and India. Without serious first steps by the United States, a major contributor to the current GHG inventory,<sup>296</sup> cooperation by the new generation of major emitters will not be forthcoming.<sup>297</sup> Action by the United States would also

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293. CTR. FOR CLIMATE & ENERGY SOLUTIONS, EPA REGULATION OF GREENHOUSE GASES FROM NEW POWER PLANTS (2013), *available at* <http://www.c2es.org/federal/executive/epa/ghg-standards-for-new-power-plants> (noting that because less efficient coal-fired plants continue to be closed, their contributions are declining). On October 23, 2013, EPA released emissions data for 2012 showing that in the two years since required GHG reporting began, emissions from power plants have declined by 10 percent. Press Release, EPA, EPA Releases Greenhouse Gas Emissions Data from Large Facilities / Carbon Pollution from Power Plants Declines 10 Percent from 2010 Due to Growing Use of Natural Gas (Oct. 23, 2013), *available at* <http://yosemite.epa.gov/opa/admpress.nsf/bd4379a92ceceec8525735900400c27/eeeb62db73ee67b485257c0d0058936b>. This resulted from transitions from coal to natural gas and a slight decrease in electricity production. *Id.*

294. Total GHG Emissions in 2011 Sorted by Country, WORLD RESOURCES INST., <http://cait2.wri.org> (last visited July 4, 2014). These calculations were gathered using figures that exclude land use change and forestry contributions.

295. See *Massachusetts v. EPA*, 549 U.S. 497, 526 (2007) (“A reduction in domestic emissions would slow the pace of global emissions increases no matter what happens elsewhere.”).

296. Existing atmospheric loadings of GHGs will decline extremely slowly, especially carbon dioxide levels. See *The IPCC Explains... Emissions and Atmospheric Reductions in Greenhouse Gases*, CO2NOW, <http://co2now.org/Know-GHG/Emissions/ipcc-faq-emissions-reductions-and-atmospheric-reductions.html> (last visited Sept. 7, 2014) (quoting Gerald A. Meehl et al., 2007: *Global Climate Projections*, in IPCC, CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS (S. Solomon et al. eds., 2007), *available at* [http://www.ipcc.ch/publications\\_and\\_data/publications\\_ipcc\\_fourth\\_assessment\\_report\\_wg1\\_report\\_the\\_physical\\_science\\_basis.htm](http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg1_report_the_physical_science_basis.htm)).

297. Most observers agree that U.S. action on major GHG sources is a precondition for significant cuts in GHGs by China. See, e.g., Cass R. Sunstein, *Of Montreal and Kyoto: A Tale of Two Protocols*, 31 HARV. ENVTL. L. REV. 1, 47 (2007). The agreement between U.S. and Chinese presidents to cooperate on reducing use of hydrofluorocarbons, a potent GHG still used in refrigeration, is an encouraging if small step. See Press Release, White House, United States and China Reach Agreement on Phase Down of HFCs (Sept. 6, 2013), *available at* <http://www.whitehouse.gov/the-press-office/2013/09/06/united-states-and-china-reach-agreement-phase-down-hfcs>; Press Release, White House, United States and China Agree to Work Together on Phase Down of HFCs (June 8, 2013), *available at* <http://www.whitehouse.gov/the-press-office/2013/06/08/united-states-and-china-agree-work-together-phase-down-hfcs>. The Chinese government has also adopted ambitious plans to reduce energy use and carbon intensity (use or emissions per unit of gross domestic product) and to expand use of renewable sources of energy, and is experimenting with regional cap-and-trade systems. See JOANNA LEWIS, CTR. FOR CLIMATE & ENERGY SOLUTIONS, ENERGY AND CLIMATE GOALS OF CHINA’S 12TH FIVE-YEAR PLAN 1–2 (2011), *available at* <http://www.c2es.org/international/key-country-policies/china/energy-climate-goals-twelfth-five-year-plan>. These objectives do not change the fact that coal-fired energy production in China continues to grow and that the Chinese government has shown no inclination to accept any form of binding international commitment to reduce GHGs.

strengthen the resolve of the European Union and other nations that have already made commitments to significant GHG reductions.<sup>298</sup>

The limited purpose of this Part of the Article is to demonstrate that the objectives and strategies of EPA's proposed rule call for reliance upon the precautionary principle and its less demanding requirements for certainty and quantitative precision in evidence and analysis to support governmental action. The proposed rule intends to reduce total GHG emissions from power plants subject to the rule by 30 percent by 2030 compared to 2005 emission levels.<sup>299</sup> The state goals are based on calculations of each state's 2012 baseline of carbon emissions from EGUs and estimates of what emission reductions can be achieved using "building blocks" defined by EPA as elements of the "best system of emission reduction" achievable.<sup>300</sup> The proposed rules prescribe four categories of reduction measures, "the building blocks," for states to pursue to achieve reductions. The first two are direct regulation of EGUs by increasing their heat rates (efficiency), and redirecting (dispatching) electric generation from high carbon intensive EGUs to lower intensive EGUs as demand for service rises.<sup>301</sup> The menu also includes two "beyond the fence line" strategies that reduce carbon emissions by substituting low or zero emission sources for high carbon generating sources or by reducing total electricity demand by

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298. For a concise summary of the European Union's climate policies and programs, see EUROPEAN COMM'N, CLIMATE ACTION: BUILDING A WORLD WE LIKE, WITH A CLIMATE WE LIKE (2013), *available at* [http://europa.eu/pol/pdf/flipbook/en/climate\\_action\\_en.pdf](http://europa.eu/pol/pdf/flipbook/en/climate_action_en.pdf). See also JOHANNA CLUDIUS ET AL., GHG MITIGATION IN THE EU: AN OVERVIEW OF THE CURRENT POLICY LANDSCAPE (2012), *available at* [http://www.wri.org/sites/default/files/pdf/ghg\\_mitigation\\_eu\\_policy\\_landscape.pdf](http://www.wri.org/sites/default/files/pdf/ghg_mitigation_eu_policy_landscape.pdf). The European Union's carbon emission trading program is explained in PETER SOPHER & ANTHONY MANSELL, THE WORLD'S CARBON MARKETS: A CASE STUDY GUIDE TO EMISSIONS TRADING (2014), *available at* <http://www.ieta.org/assets/EDFCasestudyMarch2014/eu%20ets%20case%20study%20march%202014.pdf>.

299. Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 79 Fed. Reg. 34,830, 34,832 (proposed June 18, 2014) (to be codified at 40 C.F.R. pt. 60). Reductions in power plant GHGs of 15.8 percent were achieved between 2005 and 2012 according to the U.S. Energy Department. U.S. ENERGY INFO. ADMIN., MONTHLY ENERGY REVIEW 165 tbl.12.6 (2014), *available at* <http://www.eia.gov/totalenergy/data/monthly/pdf/mer.pdf> (providing data from the table on carbon dioxide emissions from the electric power sector showing emissions for 2005 at 2417 million metric tons reduced to 2035 by the end of 2012, a reduction of 382 million metric tons, or 15.8 percent). The reductions required by the proposal itself are estimated to produce a 17 percent reduction in GHG emissions toward the 30 percent by 2030 goal. See JAMES R. MCCARTHY ET AL., CONG. RESEARCH SERV., R43572, EPA'S PROPOSED GREENHOUSE GAS REGULATIONS FOR EXISTING POWER PLANTS: FREQUENTLY ASKED QUESTIONS 8-9 (2014) [hereinafter CRS REPORT ON 111(d)], *available at* <http://fas.org/sgp/crs/misc/R43572.pdf>. EPA's proposal with a 2030 compliance date and the use of only state rather than regional plans (known as "Option 1") is used in this discussion to explain the setting of the standard and the calculation of benefits and costs. EPA has proposed another scenario, "Option 2," for comment. EPA RIA FOR POWER PLANT RULES, *supra* note 292, at ES-3.

300. Carbon Pollution Emission Guidelines for Existing Stationary Sources, 79 Fed. Reg. at 34,837, 34,892-96. The standard used to develop state goals is defined as an adjusted carbon dioxide emission rate in pounds per megawatt-hour from all affected EGUs. *Id.* at 34,863.

301. *Id.* at 34,856-58.

increasing end-use energy efficiency.<sup>302</sup> The guidelines also allow state plans to count reductions from existing or future state or regional carbon reduction programs such as the emission trading regimes in California and the regional GHG initiative in the Northeastern states.<sup>303</sup> Allowing all of these approaches introduces not only beneficial flexibility into compliance plans but also significant complexity in developing and implementing those plans.

The two largest areas of uncertainty in the evidence supporting the EPA's proposal are 1) the projections of the carbon reduction benefits secured by the proposed rule and 2) the cost and economic impact of implementing state-based reduction strategies. The translation of emission reductions into estimates of annual global climate benefits of \$17 to \$18 billion by 2020 is based on a methodology to define the social cost of carbon (SCC), a tool that estimates "the monetary value of impacts associated with marginal changes in [carbon dioxide] emissions in a given year."<sup>304</sup> The authors of EPA's RIA for the power plant rules describe the many sources of uncertainty associated with the estimates, beginning with integrating the results of three separate models to generate the estimates.<sup>305</sup> The RIA notes that the models do not completely capture the possibilities of catastrophic impacts, adaptation, and technological change<sup>306</sup> and do not assign values to all of the impacts recognized in the literature because of a lack of precise information. The report concludes that

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302. *Id.* at 34,830, 34,843. The proposal defines assumptions for the percentage emission reductions achievable by these building blocks as based on the agency's review of engineering studies, the potential increase in the rate of dispatching, averages of projected regional impacts of renewable portfolio standards, and results of existing energy efficiency programs in reducing electricity demand. CRS REPORT ON 111(d), *supra* note 299, at 11, 13.

303. Carbon Pollution Emission Guidelines for Existing Stationary Sources, 79 Fed. Reg. at 34,897.

304. EPA RIA FOR POWER PLANT RULES, *supra* note 292, at ES-20, 4-1; *see also* INTERAGENCY WORKING GRP. ON THE SOCIAL COST OF CARBON, TECHNICAL UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS (2013), *available at* [http://www.whitehouse.gov/sites/default/files/omb/inforeg/social\\_cost\\_of\\_carbon\\_for\\_ria\\_2013\\_update.pdf](http://www.whitehouse.gov/sites/default/files/omb/inforeg/social_cost_of_carbon_for_ria_2013_update.pdf). EPA also provided, in the preamble to its proposal, its assessment of the state of climate science since EPA's 2009 endangerment determination. Carbon Pollution Emission Guidelines for Existing Stationary Sources, 79 Fed. Reg. at 34,842-43. The EPA cites a number of recent reports discussed in this Article as supporting a stronger case for taking action to reduce GHG emissions. *See id.*

305. EPA RIA FOR POWER PLANT RULES, *supra* note 292, at ES-8 to ES-11. For a useful explanation of the main differences in the three models and other issues in the SCC methodology, *see* BELL & CALLAN, *supra* note 38, at 57. Many thorny issues in modeling climate costs and benefits are also analyzed in *Rethinking the Role of Cost-Benefit Analysis*, *supra* note 8, at 1392.

306. Judge Posner offers the opinion that technological innovation cannot be predicted. CATASTROPHE, *supra* note 8, at 123. The RIA does not consider the possibility of carbon capture and storage, a potential method of preventing the release of carbon emissions from power plants by capturing carbon dioxide emissions and injecting them underground, because the rules do not propose retrofitting technology on existing plants. Carbon Pollution Emission Guidelines for Existing Stationary Sources, 79 Fed. Reg. at 34,830, 34,856-57, 34,876. For a discussion of the prospects of this technology in the future, *see Hearing on the Future of Coal: Utilizing America's Abundant Energy Resources before the H. Subcomm. on Energy*, 113th Cong. (2013) (statement of Judi Greenwald, Vice President for Tech. & Innovation, Ctr. for Climate & Energy Solutions), *available at* <http://neori.org/greenwald-testimony>.

the SCC estimates are likely conservative.<sup>307</sup> In addition, the report uses a discount rate of 3 percent, while acknowledging that “no consensus exists” on the appropriate rate to use in an intergenerational context.<sup>308</sup>

The cost estimates are also highly uncertain because of the dynamics of the electricity industry and the flexibility provided to states in developing their compliance plans. Estimated costs of \$7.3 to \$8.8 billion in 2030 include the change in electric power-generating costs between the base year and the target level, as well as demand-side efficiency improvement costs.<sup>309</sup> It is challenging to identify the cost impacts of the proposed rules against the background of the enormous changes in the electric generating sector already underway because of the retirement of old coal plants,<sup>310</sup> and the rapid increase in natural gas and renewable energy capacity as well as efficiency investments. The EPA emphasized in its preamble to the proposed rule for regulating GHG emissions from existing sources that its estimated costs do not reflect the full suite of compliance flexibility, noting that there is considerable uncertainty with

307. EPA RIA FOR POWER PLANT RULES, *supra* note 292, at 4-10.

308. *Id.*

309. *Id.* at ES-7 to ES-8. Costs include changes in the costs of investing in new units, heat rate improvements, pollution control operation, and fuel switching. *Id.* at ES-8. EPA also estimates that increases in retail costs of energy will be within the range of variability already experienced because of weather and fuel supply fluctuations. Carbon Pollution Emission Guidelines for Existing Stationary Sources, 79 Fed. Reg. at 34,885. The potential benefits of efficiency improvements spurred by state plans are substantial. Several studies have demonstrated the potential of existing technology to reduce energy use in the commercial and residential building sector. This sector consumes 40 percent of U.S. energy and 35 percent of electricity. See *Frequently Asked Questions: How Much Energy is Consumed in Residential and Commercial Buildings in the United States?*, U.S. ENERGY INFO. ADMIN., <http://www.eia.gov/tools/faqs/faq.cfm?id=86&t=1> (last visited Sept. 7, 2014). Analyses by McKinsey Consulting and the World Business Council for Sustainable Development conclude that substantial reductions in energy use by new and existing buildings can be accomplished by investments with an attractive rate of return. See MCKINSEY & CO., PATHWAYS TO A LOW CARBON ECONOMY: VERSION 2 OF THE GLOBAL GREENHOUSE GAS ABATEMENT COST CURVE (2009), available at <http://www.iipnetwork.org/pathways-low-carbon-economy-version-2-global-greenhouse-gas-abatement-cost-curve>; WORLD BUS. COUNCIL FOR SUSTAINABLE DEV., TRANSFORMING THE MARKET: ENERGY EFFICIENCY IN BUILDINGS (2009), available at <http://www.wbcsd.org/Pages/EDocument/EDocumentDetails.aspx?ID=11006&NoSearchContextKey=true>. The well-recognized barriers to efficiency are the disinclination of commercial or apartment owners to invest in equipment benefiting tenants and the challenge of financing and installing equipment in the residential sector because of the numbers involved. The World Business Council for Sustainable Development study calls for modernizing and enforcing building codes for energy as has been done for safety, and for developing financial mechanisms related to mortgages that would be attractive to homeowners. See MCKINSEY & CO., *supra*; WORLD BUS. COUNCIL FOR SUSTAINABLE DEV., *supra*; TREVOR HAUSER, PETERSON INST. FOR INT'L ECON., THE ECONOMICS OF ENERGY EFFICIENCY IN BUILDINGS 9-10 (2009), available at <http://www.iie.com/publications/pb/pb09-17.pdf>.

310. About half of U.S. electricity was produced by coal plants in 2005, but by March 2012, that amount had dropped to 34 percent. Michael B. McElroy & Xi Lu, *Fracking's Future*, HARV. MAG. (Jan.-Feb. 2013), <http://harvardmagazine.com/2013/01/frackings-future>. The contribution of coal-fired plants is being reduced by the inability of older plants to meet existing air pollution rules for toxic air pollutants and the economic advantages of switching to natural gas where feasible. See *id.* Coal-fired plants contributed an estimated 74 percent of energy-related carbon dioxide emissions in 2012. See *Frequently Asked Questions: What Are the Energy-Related Carbon Dioxide Emissions by Source and Sector for the United States?*, U.S. ENERGY INFO. ADMIN., <http://www.eia.gov/tools/faqs/faq.cfm?id=75&t=11> (last visited Aug. 1, 2014).

regards to the precise measures that states will adopt to meet the proposed requirements.<sup>311</sup> Indeed, EPA's executive summary characterizes the costs and benefits described as "illustrative estimates."<sup>312</sup> Environmental scientists and economists all have their work cut out for them in understanding the ecological and economic systems at play well enough to define the best options for controlling emissions from existing electric generating plants.<sup>313</sup> Given the magnitude of the uncertainties and the stakes for the next generation of Americans, regulators and judges are likely to find the precautionary principle essential to weigh and balance the evidence and choose among the alternatives.

#### IV. RATIONALITY AND RESULTS IN PRECAUTIONARY DECISION MAKING

Preventing harm to health or the environment remains a fundamental tenet of U.S. environmental laws. At its heart, the precautionary principle counsels that governmental action should be taken to reduce the risk of serious harms, even if the evidence defining a harm is not sufficient to meet the evidentiary standard of certainty required in a tort proceeding, and even if the uncertainty is too great to be able to quantify and compare the costs and benefits of action with precision. The lead additives and GHG decisions examined in this Article demonstrate the prevalence of scientific uncertainty and the difficulty of defining and quantifying benefits and costs in environmental decision making. These conditions define the prime case for a precautionary approach. This Part

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311. Carbon Pollution Emission Guidelines for Existing Stationary Sources, 79 Fed. Reg. at 34,830, 34,839. In addition to the novelty and uncertainty of the benefits analysis based on the SCC methodology, two other elements of EPA's analysis are likely to draw fire from opponents of the power plant rules. The first is the use of global benefits estimates to support regulatory action imposing costs only in the United States. The RIA explains that the estimates represent global measures because the climate problem is unusual in two respects:

First, emissions of most GHGs contribute to damages around the world even when they are emitted in the United States. The SCC must therefore incorporate the full (global) damages caused by GHG emissions in order to address the global nature of the problem. Second, climate change presents a problem that the United States alone cannot solve. The [United States] now operates in a global, highly interconnected economy such that impacts on the other side of the world now affect our economy.

EPA RIA FOR POWER PLANT RULES, *supra* note 292, at 4-8. The second unusual element of EPA's analysis is the presentation and quantification of major "co-benefits" from the power plant rules in reducing pollutant precursors to harmful levels of ozone and fine particulate pollution. *Id.* at 4-14. The agency maintains that the rules achieve reductions and benefits beyond those achieved in prior independent rulemakings, including the mercury and toxic air pollution rules for EGUs, and estimates the benefits for Option 1 in 2030 at \$27 to \$62 billion in avoided health impacts. *Id.*; Carbon Pollution Emission Guidelines for Existing Stationary Sources, 79 Fed. Reg. at 34,839-41.

312. Carbon Pollution Emission Guidelines for Existing Stationary Sources, 79 Fed. Reg. at 34,839.

313. Kysar would say this situation calls for "symmetric humility" on the part of both categories of experts. *See Ecologic*, *supra* note 8, at 148-49.

considers some of the thought processes and methods for making precautionary decisions and what they accomplished in the lead additive and GHG cases.

*A. Weighing Harms and Probabilities and Choosing Remedies*

Decisions to regulate environmental risks under applicable laws emerge from a process of answering basic questions: What is the harm to people, natural resources, or amenities (i.e., recreation and aesthetics) presented by an activity or substance? How severe is the harm in terms of morbidity, mortality, destruction or impairment of natural resources, and the reversibility of impacts? How likely is the harm to be occurring now or in the future? What are the remedies offering partial or complete relief and what are their costs in dollars or loss of unquantified private or public values, like freedom of action?<sup>314</sup> What is the best governmental response, weighing the severity and probability of harm and considering proportionate remedies? Precautionary decisions demand a case-by-case analysis of the balance of evidence, framed by the terms of the laws being implemented and drawing on the analytical tools at hand. No one has recommended a better verbal threshold for precautionary decision making than requiring a “significant risk of harm” because the principle calls for a balancing test comparing the probability and severity of harm.<sup>315</sup> Weighing these elements requires experienced judgment, but decision makers do not require elaborate quantified rules of decision to make and explain their choices.

The degree of confidence required in the probability assessment can be stated in percentage terms and will vary according to the seriousness of the harm. Defining the results of analysis in terms of probabilities or “odds” is a way of thinking about risk that is familiar to most people. We understand probabilities in terms of weather forecasts and the outcome of elections or

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314. There is little danger today that federal decision makers will neglect consideration of the impacts of their decisions beyond advancing their own agency’s mission. In addition to the specific provisions of governing statutes, like the CAA, as has been seen in this Article, a plethora of executive orders require decision makers to consider the impacts of their regulations on social and economic groups or interests. Examples are children’s health and safety, Exec. Order No. 13,045, 62 Fed. Reg. 19,885 (Apr. 23, 1997); environmental justice in minority and low-income communities, Exec. Order No. 12,898, 59 Fed. Reg. 7629 (Feb. 11, 1994); and many economic interests and issues, including small business, Regulatory Flexibility Act, 5 U.S.C. §§ 603, 604 (2012); energy, Exec. Order No. 13,211, 66 Fed. Reg. 28,355 (May 22, 2001); and economic growth, innovation, competitiveness, and job creation, Exec. Order No. 13,563, 76 Fed. Reg. 3821 (Jan. 21, 2011). The drive to institutionalize sustainability as a framework for decision making is another trend intended to improve decisions by systematically considering the environmental, economic, and social implications of actions. See NAT’L RESEARCH COUNCIL, SUSTAINABILITY AND THE U.S. EPA 1–2 (2011), available at [http://www.nap.edu/openbook.php?record\\_id=13152](http://www.nap.edu/openbook.php?record_id=13152). A major challenge is to design processes that accommodate consideration of broader issues and interests without further slowing the often sclerotic pace of decision making.

315. The term “probable cause” for an arrest in criminal law provides an example of phrasing a standard that requires only “a reasonable ground to suspect that a person has committed or is committing a crime . . . more than a bare suspicion but less than evidence that would justify a conviction.” BLACK’S LAW DICTIONARY 1321 (9th ed. 2009). This test concerns the accused and the possibility of guilt, and is not a balancing test of probability and severity of harm.

sporting events;<sup>316</sup> and we know that a 10 percent chance of skin cancer is worse than a 10 percent chance of a rash. The IPCC's classification of the strength of scientific evidence in the climate context uses both words and percentages to communicate levels of probability in an understandable way: for example, 95 percent means highly likely.<sup>317</sup> A workable taxonomy of regulatory options does not require greater precision than this. Public officials and decision makers, including judges, have the opportunity to communicate within a familiar frame to explain their reasons for making precautionary decisions, and they have an obligation to provide understandable explanations of how they are striking the balance and why. Lawyers can help by sharpening analysis of issues in precautionary decisions and improving clarity in their communication to nonexpert and very important audiences, like reviewing courts and the public.<sup>318</sup>

Cognitive limitations and personal biases certainly influence a decision maker's thinking, but good decision makers bring experience<sup>319</sup> and self-awareness to the task. They pay attention to the views of other officials, experts, and the public, aided by a rigorous administrative process. They undergo the discipline of justifying their decisions in writing and explaining them to the public. The most important element of judgment is a sense of proportion, weighing the fitness of alternative remedies to the risk. A thoughtful description of what this means for lawyers, judges, or regulators was written by Judge Michael Boudin, now a senior judge on the First Circuit, when he was a visiting practitioner at the Harvard Law School. He describes qualities of mind and character that can help people reach the right answer:

a sense of proportion . . . . an ability to fasten upon the relationship between the wrong . . . and the remedy being considered. It brings to mind a sense of "fit," illustrated by such expressions as "overreacting," "making the punishment

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316. DAVIES & MAZUREK, *supra* note 45, at 44.

317. The IPCC's classifications of scientific conclusions include virtually certain (99 percent probability of occurrence); extremely likely (greater than 95 percent); very likely (90 to 99 percent); likely (66 to 90 percent); more likely than not (greater than 50 percent); about as likely as not (33 percent to 66 percent); and unlikely (10 percent to 33 percent). See IPCC FIFTH ASSESSMENT, *supra* note 245, at 4 n.2. There are also verbal characterizations of the degree of confidence in particular scientific findings. *Id.* at 4 n.1.

318. Lawyers have long been concerned that statistical justifications for decisions are frequently hard to translate into terms comprehensible to nonexpert audiences, especially the general public. See, e.g., ECO-PRAGMATISM, *supra* note 8, at 122; Harold P. Green, *Cost-Risk-Benefit Assessment and the Law: Introduction and Perspective*, 45 GEO. WASH. L. REV. 901, 910 (1977). The environmental regulatory process would be better served by greater emphasis on more effective risk communication to general audiences than by endless refinement of quantitative methodologies for risk analysis. See Bernard David Goldstein, *Risk Assessment of Environmental Chemicals: If It Ain't Broke . . .*, 31 RISK ANALYSIS 1356, 1361 (2011).

319. Professor Kahneman finds that not all intuitive judgments under certainty are determined by the heuristics he and Professor Tversky studied. "In particular, the accurate intuitions of experts are better explained by the effects of prolonged practice than by heuristics . . . [S]kill and heuristics are alternative sources of intuitive judgments and choices." KAHNEMAN, *supra* note 65, at 11.

fit the crime,” and “enough is enough.” What creates this capability is unclear. It may be an aesthetic sense, or it may be an unconscious tendency to ask the question, “is this too much or too little.”<sup>320</sup>

Judge Boudin goes on to explain why he believes the character of decision makers similarly influences the quality of their judgment. He writes:

The qualities of character that enhance sound judgment are, if anything, even more elusive; but a check list might include the following: an ability to gauge in advance the reactions of others to events and arguments; a sense of calm or self-discipline, enabling one to separate and prefer the reasoned response to one based on emotion; a willingness to make decisions and to do so based on incomplete data; a certain seriousness of mind, and perhaps an instinct for order or pattern.<sup>321</sup>

While words like “aesthetic sense” or “instinct for order or pattern” may sound irrational to some economists, they are among the qualities of mind that may inform sound judgments on actions in a particular case.

Environmental laws generally offer a menu of choices in fitting remedies to a defined risk, ranging from no action or further research, information disclosure or other market mechanisms, to regulatory limitation or even prohibitions of unacceptable risks. Experienced decision makers can readily divine whether a remedy or cost is “wholly disproportionate”<sup>322</sup> or “grossly disproportionate”<sup>323</sup> to the risk at hand. Choosing can be more difficult or at least more time consuming when numerous options are sliced and diced into smaller and smaller pieces with less difference between them.<sup>324</sup> For decision makers in most situations, cost is relevant; and cost-benefit comparisons can be a useful way to organize information for decision makers.<sup>325</sup> Adopting the most efficient and cost-effective *remedies* for the risk addressed is appropriate. The danger of excessive reliance on cost-benefit analysis to define the *goal* of

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320. Michael Boudin, *Common Sense in Law Practice (Or, Was John Brown a Man of Sound Judgment?)*, HARV. L. BULL., Spring 1983, at 22, 23.

321. *Id.* at 23–24.

322. *Indus. Union Dep’t v. Am. Petroleum Inst.*, 448 U.S. 607, 667 (1979) (Powell, J., concurring).

323. See ECO-PRAGMATISM, *supra* note 8, at 12, 131 (noting that environmental standards that Congress intends to be set with minimal weight given to cost, such as best available control technology standards, still permit exclusions that would meet such a test of severe disproportionality).

324. See, for example, Lisa Heinzerling’s reference to the multiplicity of options in EPA’s proposal on toxic water pollution standards from power plants. Lisa Heinzerling, *Who Is Running OIRA?*, REG BLOG (Apr. 29, 2013), <http://www.regblog.org/2013/04/29-heinzerling-oira-review.html>.

325. See CATASTROPHE, *supra* note 8, at 207. Judge Posner modestly describes cost-benefit analysis as “just a way of giving some structure to instrumental (means-end) reasoning.” *Id.*

regulation lies in its “false precision,”<sup>326</sup> its consistent neglect and undervaluing of health and environmental benefits less quantifiable in market terms, and its tendency to tilt the decision toward current economic interests and the technology status quo. These limitations disqualify cost-benefit analysis as a rule of decision in the most complex and consequential environmental regulatory decisions.

### *B. Adaptability of Remedies and Incremental Decision Making*

Intelligent and careful decision making does not eliminate all errors. The precautionary approach demands humility in the face of complexity and uncertainty and is applied “with a view toward proportionality of response and adaptability over time.”<sup>327</sup> Many environmental legal experts agree that the ability to adopt interim or partial remedies and to change or correct them upon further investigation and evaluation is an essential condition of precautionary decision making.<sup>328</sup> This element was emphasized by Judge Wright in a law review article where he described the regulatory enterprise as “essentially experimental” and concluded that “[t]he search for intelligent means of regulating our economy, industry, and ecology” is best implemented through “informed, candid, and careful experimentation.”<sup>329</sup>

Historically, retrospective analysis by government of regulations already in effect has been a low priority, given resource constraints.<sup>330</sup> Although it seems reasonable to suggest that precautionary standards, like other rules, can always be adjusted if they turn out to be too stringent or too lax, environmental lawyers know that it is very difficult to revisit or undo regulatory decisions.<sup>331</sup> Beyond the reluctance of agency personnel to admit error or stakeholders to accept it, any change must undergo the burdensome, long, and costly process of rulemaking. Institutional complexity and rigidity impede reform of regulatory mistakes as well as revisions needed to adapt regulations to new risks or conditions, such as climate impacts. Achieving greater flexibility in regulation remains an elusive goal.

Given the practical obstacles to revising regulations, it is important to stress that new information about environmental hazards has rarely shown that

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326. Cass R. Sunstein, *The Arithmetic of Arsenic*, 90 GEO. L.J. 2255, 2259 (2002).

327. REGULATING FROM NOWHERE, *supra* note 8, at 12.

328. ECO-PRAGMATISM, *supra* note 8, at 12, 184. Professor Lazarus considers experimentation and policy reversals to be “the natural byproduct of any good-faith efforts to address complex problems, such as those presented by environmental pollution . . .” *Restoring What’s Environmental*, *supra* note 26, at 160. Professor Sunstein agrees that in conditions of true uncertainty and irreversibility, what is needed is a “sequential decision-making process.” WORST-CASE SCENARIOS, *supra* note 8, at 182.

329. J. Skelly Wright, *Court of Appeals Review of Federal Regulatory Agency Rulemaking*, 26 ADMIN. L. REV. 199, 211 (1974).

330. The Obama administration has given longstanding policies to review regulations higher priority. See SIMPLER, *supra* note 8, at 177–86.

331. See Charnley & Elliott, *supra* note 8, at 5.

substantive environmental standards are too stringent.<sup>332</sup> The converse has commonly been true. NAAQS, including the lead standard, have often been made more stringent after required periodic reviews of new information.<sup>333</sup> Even the much-criticized standard for arsenic in drinking water, thought by some to be too stringent, was ultimately found to be justified and retained.<sup>334</sup> Although it may not be realistic to defend precautionary action on the assumption that erroneous decisions can be readily revised, there is also no evidence that early action to address potentially serious harms has produced many costly blunders needing correction in the past or is likely to do so in the future.

The relative absence of such mistakes may well be a product of a pattern of cautious incremental decision making on environmental issues. Kysar describes the debate between partisans of cost-benefit analysis and a precautionary approach as presenting “a sharp contrast . . . between decision-making techniques that aim to pursue optimal outcomes through the application of formal analytical systems and those that aim to achieve realistically satisfactory outcomes through less formalized, more incremental decision-making processes.”<sup>335</sup> EPA’s regulatory decisions on lead additives and GHGs were indeed “less formalized” and “more incremental.”<sup>336</sup> They respected the complexity and uncertainty of the scientific data and provided a proportionate and phased response. The EPA administrator’s lead additive decision offered a candid assessment of the multiple forms of imperfect evidence on the contribution of automotive lead emissions to human health risks and chose to rely on evidence pointing to serious risks at lower levels of exposure. His decision in 1973 provided for a gradual reduction in lead without its total elimination from gasoline in a context where incremental costs and impacts were moderate and the benefits of the first half gram of lead were retained, pending further study. The schedule was as aggressive as it could be given the

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332. Most of the EPA rules listed on its agenda for retrospective review involve administrative requirements and not substantive standards regulating pollutants or materials. The substantive reviews include drinking water rules for lead and copper, cleanup guidance for polychlorinated biphenyls, and a hazardous air pollutant standard for reinforced plastics. EPA, IMPROVING OUR REGULATIONS: A PRELIMINARY PLAN FOR PERIODIC RETROSPECTIVE REVIEWS OF EXISTING REGULATIONS (2011), available at <http://www.whitehouse.gov/files/documents/2011-regulatory-action-plans/EnvironmentalProtectionAgencyPreliminaryRegulatoryReformPlan.pdf>.

333. See, e.g., 42 U.S.C. § 7409(d)(1) (2012) (requiring review of the NAAQS every five years). The standards for lead, particulate matter, and ozone have all been tightened at least once. See *National Ambient Air Quality Standards*, EPA (Dec. 14, 2012), <http://www.epa.gov/air/criteria.html>.

334. Professor Sunstein comments on the issue of excessive stringency in his article on the arsenic drinking water standard and concludes that though many arguments against “a wide range” of environmental regulations can be made on various grounds, including that money might be better spent on other goals, “those regulations, on balance, have been vindicated by history.” Sunstein, *supra* note 326, at 2296.

335. REGULATING FROM NOWHERE, *supra* note 8, at 12.

336. *Id.*

state of the science and the need to issue the standard during the oil embargo in 1973.

In the case of automotive GHGs, EPA action was spurred by environmental groups' petition for regulation and a Supreme Court decision paving the way for an endangerment finding. The support of major auto manufacturers for national GHG emission standards set the stage for regulating that category of emitters. These circumstances presented an opportunity for the Obama administration and EPA to act, and they took it. In the GHG endangerment finding, again the administrator's evaluation of the evidence was thorough and careful. Her determination that automotive GHG emissions endangered public health and the environment was well supported and laid the foundation for a phased U.S. strategy to control important sources of GHGs. The lead additive and GHG endangerment decisions, though precautionary and aggressive in their assessment of risk, were cautious and incremental in their choice and phasing of remedies.

The *Ethyl* and *Coalition* decisions show that agency officials can make rational regulatory choices among options without definitive evidence of probable harm and without the aid of comprehensive cost-benefit analyses. In fact, these decisions show that agencies must do so in cases where the responsible course is to act on early evidence of the risk of serious harm. In the lead additive decision, a precautionary standard produced enormous health protection benefits for both children and adults by accelerating the decision to control automotive lead emissions by more than a decade before more conclusive evidence and a quantified, though incomplete cost-benefit analysis were at hand. The benefits for children protected from neurological damage caused by automotive lead pollution are incalculable.

Relying on the precautionary principle to respond to mounting climate risks, the United States finally took significant regulatory action to reduce its carbon footprint, ten years after environmental organizations first petitioned EPA to act and seventeen years after President George H.W. Bush signed an international agreement to work to stabilize GHG emissions. We may hope that the risk of severe ecosystem disruption by climate change proves to be lower than projected, but the scientific consensus on the gravity of the threat is very high; and the time to confront it is fast running out. These actions by the EPA administrators and the judicial decisions upholding them are important landmarks in environmental law, but the people harmed by decades of lead pollution and the generations of future Americans who will live with the impacts of climate change are entitled to hold their applause. From their perspective, precautionary regulation of lead additives in gasoline and GHGs has not been too much, too soon, but too little, too late.

