CONGRESS, SCIENCE, AND ENVIRONMENTAL POLICY

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Attempts to legislate solutions to environmental problems have been unsatisfactory in a number of important ways. Most commentators have attributed the environmental laws' poor track record to failures of agencies and the judiciary that frustrate the administration of the laws. In this article, however, Professor Wendy Wagner shifts the focus to those who write the laws establishing environmental policy, the members of Congress. As Professor Wagner explains, the development of effective environmental legislation poses unique scientific challenges to Congress. Rather than failing to appreciate the importance of scientific data to solving environmental problems, however, Congress has put too much emphasis on scientific data—operating under the mistaken belief that science, alone, can provide the solutions to environmental problems.

Professor Wagner begins by defining the limited usefulness of scientific findings to the development of effective environmental legislation and by explaining the reasons such limits exist. She then explains the reasons Congress has, to this point, failed to recognize these limits. The author examines the three prevailing models of congressional decisionmaking and explains that under each theory Congress has political reasons to overrely on science.

Professor Wagner explains that Congress's continued dependence on science imposes a variety of costs on society and acts as a significant hindrance to effective environmental legislation. To avoid these problems in the future, she offers two suggestions for reform. The first reform proposal is designed to attack the problem

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from within Congress by educating legislators as to the existence of scientific uncertainties and the problems created by these knowledge gaps. The second reform, to be pursued concurrently with the first, attempts to lessen the courts' insistence, in review of agency rulemakings, on scientific evidence, especially when such evidence is not available.

Federal environmental law has experienced more than the normal share of growth pains. Indeed, its development has been so tortured that it is likely setting records for the frequency and volume of amendments,[1] the number of statutory deadlines[2]—most of which are missed,[3] the frequency of judicial review on resulting rulemakings,[4] and the antagonism of congressional oversight.[5] Even academics and

1. On average, Congress passes significant amendments to one of the seven major environmental laws about once every two years. *See* Richard J. Lazarus, *The Tragedy of Distrust in the Implementation of Federal Environmental Law*, LAW & CONTEMP. PROBS., Autumn 1991, at 311, 340 nn.186-87 (listing a total of eight major amendments to seven major environmental laws between the years of 1970 and 1991). These major amendments can be very lengthy; in the case of the Clean Air Act, the 1990 amendments occupied nearly 100 pages of small print in the Congressional Record. *See* 136 CONG. REC. H13,101-97 (daily ed. Oct. 26, 1990). Predictably, the increasing length and complexity of the statutes results in equally lengthy and complex regulations. By 1996, for example, the federal regulations promulgated under the environmental laws occupied 15 volumes of the Code of Federal Regulations, only four less than the number allocated to the Internal Revenue Service for tax regulations. *See* ROBERT PERCIVAL ET AL., ENVIRONMENTAL REGULATION: LAW, SCIENCE, AND POLICY 129 (1996). Former EPA Administrator, William Reilly, has analogized the exponential growth of environmental law and regulation to the Space Invaders video game. "Every time we saw a blip on the radar screen, we unleashed an arsenal of control measures to eliminate it." William Clarke, *Looking at Risk*, ENVTL. FORUM, Mar.-Apr. 1991, at 12, 14.

2. *See, e.g.*, Lazarus, *supra* note 1, at 323 (discussing numerous unrealistic deadlines and citing William Reilly, the EPA's Administrator in the 1980s and early 90s, as reporting that Congress and courts imposed 800 deadlines on the EPA by 1989). The responsibilities and deadlines imposed on the EPA in the 1990 amendments to the Clean Air Act, however, take the prize. *See* E. Donald Elliott, *Implementation Strategy for the Clean Air Act Amendments of 1990*, C637 ALI-ABA 321, 326 (1990) (listing the first two years of the EPA's implementation schedule under the Clean Air Act 1990 amendments).

3. In 1991, Richard Lazarus reported that "fewer than 15 percent of the Clean Air Act's deadlines [prior to the 1990 amendments] were met." Lazarus, *supra* note 1, at 325. By 1985 "only 18 percent of the deadlines established by the federal water pollution control act had been met." *Id.* at 326. The EPA's pace in reviewing pesticides and toxic substances was taking decades rather than the few years that Congress envisioned; and the EPA did not meet any of its 1978 Resource Conservation and Recovery Act (RCRA) deadlines and had completed cleanup on less than 50 abandoned sites by 1989. *See id.* at 326-28. Sadly, set against this backdrop of both mounting and missed work is Lazarus's additional observation that the "EPA . . . has far fewer lawyers per significant regulation and fewer dollars for evaluation than other federal agencies." *Id.* at 330.

4. *See* Oliver A. Houck, *Of Bats, Birds and B-A-T: The Convergent Evolution of Environmental Law*, 63 MISS. L.J. 403, 462 (1994) (observing that "[i]ndustry has challenged virtually every regulation the EPA has issued under the CAA [Clean Air Act], CWA [Clean Water Act] and RCRA"); Lazarus, *supra* note 1, at 334 (reporting, based on several sources, that between 80% and 85% of the EPA's major decisions had been challenged in court). Professor William Rodgers has also noted that the complexity of environmental laws may have led many courts towards lengthy per curiam opinions to avoid responsibility for possibly misunderstanding these laws. *See* 4 WILLIAM H. RODGERS, JR., ENVIRONMENTAL LAW: HAZARDOUS WASTES AND SUBSTANCES iii (Supp. 1994).

5. *See* Richard J. Lazarus, *The Neglected Question of Congressional Oversight of EPA: Quis Custodiet Ipsos Custodes (Who Shall Watch the Watchers Themselves?)*, LAW & CONTEMP.

lawyers who dedicate most, if not all, of their life's work to environmental law speak of it largely in derogatory terms that, at their most tender, prophesy a bleak future.[6]

There are a number of reasons why environmental law has had such a difficult adolescence, and considerable scholarly attention has been dedicated to elucidating and evaluating these reasons. Most of this commentary, however, has focused on only two of the three institutional culprits—the Environmental Protection Agency (EPA) and the judiciary.[7] Congress's seemingly obvious contribution to this sorry state of affairs, particularly in light of the tremendous competency needed to master the scientific, economic, and other esoteric details that are so vital to developing sound environmental legislation, has gone largely unexamined.[8] This article moves the analytical target down the street a few blocks to Congress and begins with perhaps the most obvious question—whether Congress is able to deal with the sci-

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PROBS., Autumn 1991, at 205, 206 (concluding that "Congress appears to engage in more intense and pervasive oversight of EPA than it does of other agencies" and that "the character of Congressional oversight of EPA appears to be consistently adversarial and negative").

6. *See, e.g.*, Eric W. Orts, *Reflexive Environmental Law*, 89 NW. U. L. REV. 1227, 1240-41 (1995) (collecting a mix of scholarly commentary lamenting unwieldy "mounds" of environmental laws that escape understanding); William D. Ruckleshaus, *Environmental Protection: A Brief History of the Environmental Movement in America and the Implications Abroad*, 15 ENVTL. L. 455, 463 (1985) (observing that a "spiral of unachievable standards, missed deadlines, resulting citizen suits, and even more prescriptive legislation by Congress continues"). *See generally* Houck, *supra* note 4, at 403 ("Today, eyeing the tangle of statutes, regulations and court decisions [in environmental law] . . . the question arises: why is there so much of this stuff and why is it so hard?").

7. *See, e.g.*, Alyson C. Flournoy, *Legislating Inaction: Asking the Wrong Questions in Protective Environmental Decisionmaking*, 15 HARV. ENVTL. L. REV. 327, 327 n.1 (1992) (listing books and articles on agency decisionmaking on environmental issues involving scientific uncertainties). I contributed to this veritable forest of commentary in a prior article by documenting the damaging tendency of administrative agencies to overstate the scientific grounding of their regulations and attributing this behavior to a number of agency-specific forces. *See generally* Wendy E. Wagner, *The Science Charade in Toxic Risk Regulation*, 95 COLUM. L. REV. 1613 (1995).

8. *See, e.g.*, Bruce Bimber & David H. Guston, *Politics by the Same Means: Government and Science in the United States, in* HANDBOOK OF SCIENCE AND TECHNOLOGY STUDIES 554, 559 (Sheila Jasanoff et al. eds., 1995) [hereinafter JASANOFF HANDBOOK] (observing that "[l]egislatures receive little attention in studies of science policy, which typically favor executive and administrative decision making over the ostensibly less orderly and less predictable process of legislative policymaking"). For a complete (or nearly complete) list of the articles addressing some aspect of Congress and environmental law, see generally Holly Doremus, *Listing Decisions Under the Endangered Species Act: Why Better Science Isn't Always Better Policy*, 75 WASH. U. L.Q. 1029 (1997) (criticizing the "strictly science" mandate of the Endangered Species Act and tracing its adverse impacts on agency decisionmaking); John P. Dwyer, *The Pathology of Symbolic Legislation*, 17 ECOLOGY L.Q. 233 (1990) (discussing Congress's tendency to escape responsibility for hard choices through symbolic legislation); E. Donald Elliott et al., *Toward a Theory of Statutory Evolution: The Federalization of Environmental Law*, 1 J.L. ECON. & ORG. 313 (1985) (discussing the role of interest groups and other public choice motivations in the creation of environmental legislation); Lazarus, *supra* note 1 (tracing the role of Congress, primarily through oversight and appropriation powers, to current dysfunctions in the EPA's regulatory problems); Barry G. Rabe, *Legislative Incapacity: The Congressional Role in Environmental Policymaking and the Case of Superfund*, 15 J. HEALTH POL. POL'Y & L. 571 (1990) (blaming the legislative inadequacies of Superfund law on fragmentation within congressional committees and subcommittees).

entific challenges posed by environmental problems. Naturally, if there are some systemic weaknesses in the scientific capabilities of Congress, and if these weaknesses are reflected in environmental legislation, this information will be critical to the search for new and improved environmental laws.

Not surprisingly, problematic traits that run through most of the major environmental laws indicate that Congress has some scientific deficiencies and that these deficiencies have been taking a significant toll on the quality of environmental programs. What is surprising, however, is the nature of the problem. Rather than shying away from scientific facts and figures in the development of environmental law as one might expect, Congress may often be relying *too* heavily on the scientific enterprise to guide its lawmaking in the area of environmental protection. On occasion, individual members of Congress do attempt to discredit established scientific consensus on various environmental questions in pursuit of political ends. However, this blatant politicization of science is often exposed and ultimately condemned due to the high esteem in which the public generally holds science and the heated adversarial climate in which laws are born and debated.[9] The much more significant and costly legislative errors occur when Congress places an unrealistic overreliance on science to resolve policy questions that lie well beyond the present capabilities of the scientific enterprise. Establishing a basis for regulating pollutants, pesticides, and toxic substances, for example, can be informed by science but cannot be completely resolved by it because of both preventable and unpreventable limits to experimentation. Despite these limits, Congress continues to develop laws and policies that frame multidisciplinary environmental problems as if they could be resolved largely or exclusively by science.

The costs of Congress's overdependence on science are quite high. Indeed, environmental policies may be uniquely vulnerable to and impaired by Congress's failure to appreciate the limits of science.[10] Disturbingly long administrative delays occur as agencies at-

9. *See infra* Part II.A, notes 62-77 and accompanying text.

10. *See infra* Part IV, notes 270-304 and accompanying text. Other policy areas that are dependent on esoteric social scientific information, like tax law, appear to suffer similar problems. *See infra* note 79. An examination of these other policy areas is beyond the scope of the current research project, although this type of research would provide a valuable perspective on both the extent and scope of the "scientification" phenomenon in Congress. There are some features of environmental policy's dependence on the natural sciences, however, that could cause the scientification phenomenon to be both more pronounced and more socially damaging in relation to other policy areas where social science is a critical source of policy-relevant information. First, it seems likely (but would require considerable added research) that a far greater number of uncertainties arise in resolving a single environmental policy question as compared to other policy areas. As many as fifty unpreventable gaps in scientific knowledge can arise in a single risk assessment, for example. *See infra* Part I.B, notes 42-46; *see also* Wagner, *supra* note 7, app. at 1720-23 (listing scientific knowledge gaps). Second, the uncertainties arising in the social sciences may be more accessible to lay persons than the uncertainties arising in the natural sciences. *See infra* Part I.C, notes 47-57. Indeed, Professors Lindblom and Cohen argue that

tempt to rewrite or avoid unrealistic statutory directions.[11] An inconsistent series of appellate opinions emerges as the courts struggle to determine whether an agency's delays or statutory rewrites are legally permissible in light of the legislators' unrealistic demands.[12] These inconsistencies, in turn, stimulate still more litigation and likely discourage agencies from acting quickly or at all.[13] Finally, once the resulting regulatory dysfunctions capture the attention of Congress, a stream of legislative amendments and oversight hearings may be generated that, at best, counteract only a few badly conceived provisions and do not address the fundamental problem—Congress's failure to face the fact that science, standing alone, cannot resolve difficult environmental policy problems.[14]

The continued tolerance of these costs by a government that is characterized by multiple checks and balances is explained, in part, by the distressing fact that Congress's scientific handicaps are not an isolated disability in government. Instead, Congress's weaknesses reverberate in perverse syncopation with the administrative agencies' and the courts' unfortunate tendencies to place unrealistic demands on science.[15] This not only allows Congress's overdependence on science to go unchecked, but it dramatically complicates reform efforts.

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much of the information provided by the social sciences (and presumably information not capable of being provided by social sciences) is "ordinary knowledge," although they do not discuss the implications of their research for the natural sciences. *See infra* notes 55-57 and accompanying text. Finally, the public's general respect for and trust in natural scientists appears to be higher than for social scientists, which again may change the extent to which lay decisionmakers defer to these experts in seeking policy relevant answers. *See infra* notes 157-58 and accompanying text.

By contrast, in other areas where technological and scientific advancements are proceeding rapidly, very different legislative problems may arise at the science policy interface. *See, e.g.*, Richard D. Marks, *High Technology Legislation as an Eighteenth Century Process*, 6 STAN. L. & POL'Y REV. 17, 22 (1994) (concluding that with regard to legislation governing rapidly evolving technologies in the telecommunications field, "the erratic pace of the legislative process compared to the speed of technology's advance assures that new legislation will be obsolete before the President signs it").

11. *See infra* note 292 and accompanying text.

12. *See* Devra Lee Davis, *The "Shotgun Wedding" of Science and Law: Risk Assessment and Judicial Review*, 10 COLUM. J. ENVTL. L. 67, 85-86 (1985) (criticizing the failure of the courts to recognize scientific uncertainty and to rule in a consistent way on these uncertain issues).

13. *See* Thomas O. McGarity, *Some Thoughts on "Deossifying" the Rulemaking Process*, 41 DUKE L.J. 1385, 1412-26 (1992) (citing judicial "hard look" requirements as one of several causes slowing the pace of informal rulemakings).

14. *See infra* Part IV.B, notes 278-90 and accompanying text.

15. The administrative agencies, for their part, already face multiple incentives to seek scientific-sounding justifications for regulatory decisions that in reality have little to do with the scientific enterprise—incentives that take root, in part, in Congress's unrealistic mandates. *See* Wagner, *supra* note 7, at 1650-73. In their review of agency rulemakings, judges also tend to expect or even demand scientific bases for regulatory judgments that often do not account for the manifold uncertainties that currently elude experimentation. *See* Industrial Union Dep't v. American Petroleum Inst., 448 U.S. 607, 653 (1980) (requiring OSHA to show substantial evidence "that it is at least more likely than not that long-term exposure to 10 ppm of benzene presents a significant risk of material health impairment"); Gulf South Insulation v. United States Consumer Prod. Safety Comm'n, 701 F.2d 1137, 1146 (5th Cir. 1983) (striking down Consumer Product Safety Commission (CPSC) standard for urea-formaldehyde foam insulation be-

This article discusses in detail the various, significant problems created by Congress's failure to respect the limits of science in environmental policymaking and offers some initial proposals for reform. Part I considers the limits of what science can bring to environmental policymaking.[16] Although science can provide valuable positive scientific knowledge about the world, developed through scientifically valid methodologies, there are also a number of unpreventable knowledge gaps that elude scientific experimentation and prevent science from offering definitive answers to most environmental questions. Part II argues that Congress's lack of appreciation of the knowledge gaps creates a recognizable pattern of failure in environmental laws.[17] The reasons why Congress fails to recognize and adapt to the limits of science are explored in part III.[18] Part IV outlines the ramifications of Congress's legislative errors,[19] and part V proposes several reforms that may partially counteract this problem.[20]

I. THE UTILITY AND LIMITS OF SCIENCE TO ENVIRONMENTAL POLICY

Resolution of environmental problems requires a mix of science and values, and both provide their share of policymaking aggravations.[21] Values obviously play an important role in framing environmental policy options.[22] Indeed, environmental controversies are often portrayed as battles between starkly divided proeconomy and proenvironment forces.[23] How these issues are addressed in environmental legislation depends, to a great extent, on the political philosophies of legislators.

Science also plays an important role in the development of environmental legislation. General cause-and-effect relationships between

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cause the standard was based on a single study and "it is not good science to rely on a single experiment. . . . To make precise estimates, precise data are required."); Howard Latin, *Good Science, Bad Regulation, and Toxic Risk Assessment*, 5 YALE J. ON REG. 89, 131 (1988) (criticizing courts for failing to appreciate inherent scientific uncertainties). In comparison to that of the administrative agencies, Congress's overconfidence in science appears both more inadvertent and more directly caused by democratic features of decisionmaking.

16. *See infra* notes 21-57 and accompanying text.

17. *See infra* notes 58-144 and accompanying text.

18. *See infra* notes 145-269 and accompanying text.

19. *See infra* notes 270-304 and accompanying text.

20. *See infra* notes 305-68 and accompanying text.

21. *See generally* R. SHEP MELNICK, REGULATION AND THE COURTS: THE CASE OF THE CLEAN AIR ACT 247-49 (1983) (discussing four types of policy choices that define acceptable risk but have scientific dimensions).

22. Value choices range from decisions of what constitutes an acceptable risk of cancer in society to determining how many resources should be allocated to protecting unique ecosystems or attaining fishable and swimmable waters. *See* Flournoy, *supra* note 7, at 347 (observing that terms such as "'unreasonable' risk" or "'adequate' margin of safety" in science-based mandates involve "value judgment[s]" as to "socially acceptable level[s] of harm").

23. *See, e.g.*, STEVEN LEWIS YAFFEE, THE WISDOM OF THE SPOTTED OWL: POLICY LESSONS FOR A NEW CENTURY xv (1994) (discussing conflict between environmental and timber interests over protection of the Spotted Owl).

various pollutants and human health are discovered and elucidated by scientific methods.[24] In general, however, the contributions that science makes to environmental policymaking are much more limited than what one might want or expect.[25] For example, although science is certainly helpful in narrowing and guiding the search for safe pollutant levels, a number of scientific uncertainties prevent science from arriving at definitive quantitative standards that ensure a cancer risk of only one in one million to the average exposed human.[26]

This part of the article discusses the specific contributions science can and cannot make to environmental policymaking and explores the implications for policymaking. The first subsection examines the reasons why science is limited in its ability to address environmental policy questions. The second subsection highlights the complicated ways in which these limits in scientific knowledge (or knowledge gaps) present themselves. The final subsection highlights some important reasons underlying lay policymakers' difficulty with identifying these gaps when developing environmental legislation.

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24. Positive scientific knowledge obviously offers critical information to policymakers. As Carol Weiss has observed with respect to social science research, "Over time, the gradual accumulation of research results can lead to serious and far-reaching changes in the way people and governments address their problems." Carol H. Weiss, *Introduction, in* USING SOCIAL RESEARCH IN PUBLIC POLICY MAKING 1, 16 (Carol H. Weiss ed., 1977); *see also id.* at 16-17 (citing examples of policymakers' reliance on social science generalizations, concepts, and perspectives rather than on hard data and single-study conclusions). Indeed, a considerable amount of academic energy has been dedicated to urging policymakers to devote more effort and financial resources to fostering and learning about this valuable store of information. *See id.* at 3 (asserting as a premise of the book that "[a] wide array of social scientific contributions . . . may be able to inform policy making"). Not surprisingly, then, many environmental programs owe their birth, if not their entire existence, to a scientific consensus—developed through numerous, diverse studies—regarding a causal relationship between types of human activity and resulting environmental degradations. *See, e.g.*, DANIEL SAREWITZ, FRONTIERS OF ILLUSION: SCIENCE, TECHNOLOGY, AND THE POLITICS OF PROGRESS 89-92 (1996) (discussing the accidental "science-policy success" exemplified by the study of stratospheric ozone depletion); Houck, *supra* note 4, at 428-29 (commenting on benefits of science to environmental programs and noting that "an international warning that atmospheric ozone depletion by chlorofluorocarbons could soon be irreversible" is "science at its best" (footnotes omitted)).

25. *See* CARL F. CRANOR, REGULATING TOXIC SUBSTANCES: A PHILOSOPHY OF SCIENCE AND THE LAW 11 (1993) ("Because our present lack of scientific knowledge will probably extend for some time into the future, we are condemned to assessing and regulating toxic substances 'through a glass darkly.'"); SAREWITZ, *supra* note 24, at 108-13 (arguing that "claims that reductionist science and its technological consequences can save us from ecological crisis should be viewed with skepticism" because scientific research tends to be discipline based, rather than interdisciplinary, and because the research is generally reductionist and misses the interconnectedness of complex systems).

26. *See* Giandomenico Majone, *Science and Trans-Science in Standard Setting*, SCI. TECH. & HUM. VALUES, Winter 1984, at 15, 17 (concluding that uncertainties "exemplif[y] how, in standard setting, 'regulatory judgment' is as important as 'engineering judgment'"). *But see* Edward J. Woodhouse, *Translating Scientific Uncertainties into Political Judgments*, *in* SCIENCE OFF THE PEDESTAL: SOCIAL PERSPECTIVES ON SCIENCE AND TECHNOLOGY 145, 148-49 (Daryl E. Chubin & Ellen W. Chu eds., 1989) [hereinafter SCIENCE OFF THE PEDESTAL] (describing uncertainties surrounding quantification of adverse effects of ozone depletion, despite relatively good information regarding the types of adverse effects likely to result at a qualitative level).

A. Why the Offerings of Science to Environmental Policymaking Are Limited

1. Science Defined

Before proceeding with an investigation of what science can and cannot do, it is important to be clear about what science is. "Science" has been conveniently, albeit roughly, defined by the Supreme Court as that knowledge "derived by [or grounded in] the scientific method."[27] Information is generally not scientific knowledge—or what will be referred to in this article as positive scientific knowledge—unless it can be supported by a "scientifically valid" "reasoning or methodology."[28] In most cases this requires the ability to test a hypothesis in a replicable way or to use methods that scientists have generally accepted as valid.[29] When an experiment or observation cannot realistically be conducted (or replicated) to answer a hypothesis or question, the question leaves the province of science and must be resolved in some other way.[30]

As one might expect from this definition, science will rarely be able to answer all questions put to it. Pressing environmental con-

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27. Daubert v. Merrell Dow Pharm., Inc., 509 U.S. 579, 590 (1993). In this article, science is defined more narrowly to encompass only the natural sciences, which include geology, biology, physics, and chemistry. Social sciences, or at least economics, may also follow the patterns of legislative failure described in this article, *see supra* note 10, but their study is beyond the scope of this research project. *Cf.* PAUL MATTICK, JR., SOCIAL KNOWLEDGE: AN ESSAY ON THE NATURE AND LIMITS OF SOCIAL SCIENCE 12-29 (1986) (arguing that social sciences may be distinguished from natural sciences because the methodology is inherently less objective as the investigator is a part of the social system she is studying).

Clearly, however, demarcation of science from nonscience will be a complicated endeavor. *See* Thomas F. Gieryn, *Boundaries of Science*, *in* JASANOFF HANDBOOK, *supra* note 8, at 393, 394 (outlining the competing views on the "analytical problem of demarcating science from nonscience"). This article proceeds on the explicit assumption that science in general has features that distinguish it from nonscience and that the *Daubert* criteria offer a very rough way to distinguish science from other forms of knowledge. *See* ROGER TRIGG, RATIONALITY & SCIENCE: CAN SCIENCE EXPLAIN EVERYTHING? 159 (1993) (pointing out in response to the social constructionist critique of science the important and universally recognized principle of science "of being able to repeat experiments" even if they are conducted "in different social settings"); *see also* RONALD N. GIERE, EXPLAINING SCIENCE: A COGNITIVE APPROACH 3 (1988) (making "one long argument" (the entire book) as to why a cognitive approach to explaining science is more promising than a social constructionist explanation). Even if this assumption is rejected, many of the environmental issues highlighted in this article that are purported by Congress to be scientific questions will be conceded by all parties in the debate to be unlikely to be resolved, even preliminarily, by the scientific enterprise in the near future.

28. *Daubert*, 509 U.S. at 593.

29. *See id.* at 593-94 (listing four factors that assist in determining what constitutes scientific knowledge).

30. Resolution of this larger policy question still often benefits from scientific guidance. *See infra* note 41 and accompanying text. However, in addition to science, other inputs are required to reach a final answer. *See* SAREWITZ, *supra* note 24, at 94 ("Definitive answers are uncommon indeed, and . . . [r]esearch in the natural sciences is therefore an effective tool for alerting society to potential problems, but it is intrinsically ill suited for prescribing solutions to those problems.").

cerns—such as when a species becomes endangered with extinction[31] or what concentration of fine particulates may cause the elderly to experience life-threatening symptoms—evade definitive scientific answers. Although science can provide information on the fatality rates in cities with different levels of fine particulates, on the effects of fine particulates on the lungs of laboratory rats, and even on possible physiological mechanisms by which fine particulates might cause severe health effects like arrhythmia,[32] this accumulated scientific knowledge still falls quite short of revealing the concentration at which fine, airborne particulates will cause fatal effects to only one in one million persons.

In fact, "battles of the experts" that are so commonplace in environmental policymaking are typically not disagreements over the methods or data in the debated scientific studies, but instead concern differences in whether or how to extrapolate the results of these studies to larger policy questions.[33] Values inform decisions about how to extrapolate study results, yet little effort is made to make these value choices explicit.

2. *Why Science Has Limits*

After recognizing that there will be limits to how scientific knowledge can be used to address most environmental questions, it is then important to understand the nature of these limits and why they occur.[34] There are three different types of scientific uncertainty,

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31. See *infra* note 45 for a discussion of why the question of when a species becomes endangered escapes a definitive scientific answer.

32. *But see* Jocelyn Kaiser, *Showdown over Clean Air Science*, 277 SCIENCE 466, 469 (1997) (discussing difficulties researchers have in understanding why particle concentrations equivalent to those found in polluted cities cause arrhythmias in dogs under specific experimental conditions).

33. *See generally* William Gardner et al., *Asserting Scientific Authority: Cognitive Development and Adolescent Legal Rights*, 44 AM. PSYCHOLOGIST 895, 900 (1989) (cautioning fellow scientists of the "dangers associated with overstatement of social scientific findings" and identifying factors related to the scope and nature of an expert opinion that should be disclosed by scientists involved in policymaking); Robert L. Park, *Politics Muddle Thinking on Global Warming: Scientists Aren't Immune to Bias*, CLEV. PLAIN DEALER, May 6, 1998, at 11-B ("The great war over global warming, then, is more about values than it is about science. . . . [even though it] sounds like a scientific debate."). In determining the effect of fine particulates on human health, for example, much of the debate seems to center on how to account for the effects of other pollutants on the subjects in the study, as well as other lifestyle factors that may be more common to some cities than to others (e.g., a more sedentary lifestyle in Steubenville, Ohio, as opposed to Portage, Wisconsin). *See* Kaiser, *supra* note 32, at 468. Although these elements go to the basic assumptions in the methodology of an epidemiology study, they, in essence, address not the integrity of the raw data but how that raw data can be extrapolated to answer the larger policy questions about the effects of one type of pollutant, fine particulates, on public health.

34. Lindblom and Cohen have similarly stressed the importance of identifying when social science will and will not assist in the resolution of a problem. *See* CHARLES E. LINDBLOM & DAVID K. COHEN, USABLE KNOWLEDGE: SOCIAL SCIENCE AND SOCIAL PROBLEM SOLVING 5 (1979) (dedicating entire book to "questions about [social science's] contribution to social problem solving"); *see also* CHARLES E. LINDBLOM, INQUIRY AND CHANGE: THE TROUBLED ATTEMPT TO UNDERSTAND AND SHAPE SOCIETY 35-36 (1991).

although the boundaries between them are not always easily delineated.[35] First, scientific uncertainties exist because scientists simply have not gotten around to researching the question, even though research is quite possible and likely to be undertaken in the near future. Indeed, scientists may be in the process of investigating the question at the time the policymakers' need for the information arises. Because this category of uncertainties is remediable, it is not included within the set of deeply entrenched knowledge gaps that are the focus of this study.

Second, gaps in knowledge may exist because scientists have no financial or professional incentives to research the question.[36] For example, manufacturers of products that could cause cancer or other latent harms may be penalized by regulators and consumers if they test their products and find them dangerous.[37] Until policymakers intervene to correct these entrenched knowledge gaps, they will remain unresolved.[38]

Third, although scientists might be eager to research a question, they may be precluded from doing so because of ethical prohibitions, resource constraints, or limits in the capabilities of experimentation.[39]

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35. For other efforts to develop a taxonomy for the limits of natural and/or social sciences, see BRIAN FAY, CRITICAL SOCIAL SCIENCE 144-46 (1987); Ted Greenwood, *The Myth of Scientific Incompetence of Regulatory Agencies*, SCI. TECH. & HUM. VALUES, Winter 1984, at 83, 85-86.

36. Professor James Coleman has coined the terms "policy research" and "discipline research" to distinguish research that is motivated by and relevant to the outside policymaking world (policy research) from research intended for an audience predominantly composed of academics who seek to advance knowledge within a scientific discipline (discipline research). *See* James S. Coleman, *Policy Research in the Social Sciences*, *in* POLICY ANALYSIS ON MAJOR ISSUES: A COMPILATION OF PAPERS PREPARED FOR THE COMMISSION ON THE OPERATION OF THE SENATE, 94TH CONG., 2D SESS. 26 (Comm. Print 1977) [hereinafter POLICY ANALYSIS]. Policy research may relate to the preventable gaps in knowledge identified here because the incentives to conduct the research lie predominantly outside of the scientific community. *See, e.g.*, *id.* at 40 (citing British report on government research and development advocating that applied research (in contrast to basic research) should be funded by the government on a "customer/contractor basis" because it is so specialized to meet discrete policy needs). More specifically, because it is often redundant and not particularly relevant to the academic world, *see id.* at 27-29, there are few rewards within a discipline for conducting this policy research. As a result, policymakers must provide a strong set of incentives to ensure that it is completed.

37. *See infra* note 138 and accompanying text.

38. Entrenched, but preventable, scientific uncertainties may be particularly significant in environmental research where government funding has been consistently low and industrial interest in the subject matter still lower. *See* SAREWITZ, *supra* note 24, at 40-41 (observing the small research budget of the EPA and the lack of interest in environmental science research by industry, the government, and even the scientific community. Gaps in knowledge often concern missing baseline data or redundant "applied research" necessary to understand the specifics of an environmental problem or product. As such, although it might not affect overarching theories, the provision of this information often proves essential in comprehending the scope and magnitude of a specific environmental problem. *See infra* notes 121-35 and accompanying text.

39. Unpreventable limits to scientific knowledge are particularly common in the study of environmental and public health problems because of the variety of difficulties encountered in studying dynamic, multivariable natural systems. In addition, environmental laws are typically preventive, which puts further strain on scientific knowledge. "When people's lives and welfare are at stake, it is not possible to wait until every technical doubt has been resolved." James D.

Scientists are prevented from running controlled experiments on the effects of carcinogens on humans, for example, because of prevailing ethical norms.[40] Although scientists familiar with the relevant positive scientific knowledge may offer important insights regarding the choices that are most plausible to fill the knowledge gaps, their educated guesses still remain unverifiable hypotheses.[41]

B. The Zigzag of Positive Knowledge and Scientific Uncertainty

Understanding how scientific uncertainty affects policymaking is complicated because knowledge gaps may arise at a number of points in the policymaking process. A series of scientific findings and nonscientific assumptions must be linked together to answer a larger policy question.[42] Even more inconveniently, the gaps in knowledge are not clumped at the beginning or end of the inquiry, but tend to weave in and out, or zigzag, with subquestions that science can answer. As a result, it is difficult to summarize the varied scientific uncertainties that arise in a policymaking exercise as simply the error around a mean.[43]

Wilson & J.W. Anderson, *What the Science Says: How We Use It and Abuse It to Make Health and Environmental Policy*, RESOURCES, Summer 1997, at 5, 6.

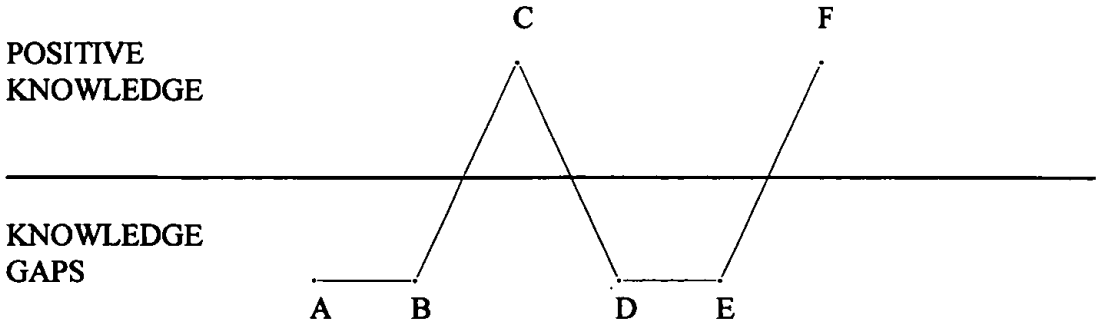
40. *See, e.g.*, Thomas O. McGarity, *Substantive and Procedural Discretion in Administrative Resolution of Science Policy Questions: Regulating Carcinogens in EPA and OSHA*, 67 GEO. L.J. 729, 743 (1979) (noting that carcinogenicity testing on humans is unacceptable).

41. For example, in developing curves to extrapolate from high-dose laboratory tests conducted on rodents for latent effects to possible effects at low doses, some of the curve options are more probable than others based on what is known in related fields about cell biology and the mechanisms of carcinogenesis. Scientific experimentation cannot provide the right answer, but it can offer very rough estimates of which options are more likely than others. *See, e.g.*, COMMITTEE ON THE INSTITUTIONAL MEANS FOR ASSESSMENT OF RISKS TO PUB. HEALTH, NAT'L RESEARCH COUNCIL, RISK ASSESSMENT IN THE FEDERAL GOVERNMENT: MANAGING THE PROCESS 25 (1983) [hereinafter NRC, RISK ASSESSMENT] (observing that although five models for low-dose extrapolations "may fit experimental data equally well, they are not equally plausible biologically"). The scientific validity of these guesses is, nevertheless, less verifiable than the results of a replicable experiment.

42. *See* Nicholas A. Ashford et al., *A Hard Look at Federal Regulation of Formaldehyde: A Departure from Reasoned Decisionmaking*, 7 HARV. ENVTL. L. REV. 297, 315 (1983) (noting that an agency often engages in two levels of analysis in risk assessment, on one level resolving "'hard' scientific issues" that can be resolved with "currently available methodologies" and on a second level resolving science policy issues that cannot be determined solely by technical considerations).

43. *See* Wagner, *supra* note 7, at 1619-27 (discussing the zigzag nature of scientific limitations that often alternate in nonintuitive ways with the results of valid scientific experiments). The frequency and placement of knowledge gaps along the zigzag are often quite specific to the overarching policy question.

FIGURE 1
THE ZIG ZAG FOR DETERMINING WHEN 1-IN-1 MILLION PERSONS WILL DEVELOP CANCER FROM EXPOSURE TO A SUBSTANCE



One example of this zigzag occurs when policymakers ask scientists to determine when one in one million persons exposed to a substance will develop cancer. Largely because ethical prohibitions preclude experimentation on humans, scientists must look to animals and other organisms for insights into possible health effects.[44] But existing scientific knowledge cannot provide definitive (experiment-based) guidance on: which species of rodent to select (point A); whether to count all tumors that form (benign and malignant) or only those that are malignant (point B); how to extrapolate from high dose studies (necessary for practical reasons) to possible low dose effects (point D); and how to extrapolate from animal to human (point E).[45] Resolving these subquestions requires value judgments that zigzag with the positive information that scientific experimentation is able to provide, such as how many tumors (malignant or total) occur in a given species of mice exposed to high concentrations of a suspected toxin (point C); and the average amount of water consumed daily by a normal adult (point F). Each environmental problem will be characterized by its own unique zigzag pattern of positive scientific knowledge and knowledge gaps, and, as this example illustrates, mapping the zigzag for any particular problem requires assistance from scientific experts.[46]

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44. *See supra* note 40.

45. *See* Wagner, *supra* note 7, at 1622-27 (citing literature for each point on the zigzag). To take a different example, the question of how to protect endangered species includes scientifically unresolvable questions such as whether a unique population of individuals is in fact a species or subspecies (Q1); what constitutes a self-sustaining population (Q3); and whether stresses on the population can be avoided through habitat controls (Q6). Science again provides directions—the presence of a unique dorsal fin (Q2); a reduction in the number of mating pairs (Q4); and a dependency on cool, clear stream waters that might be eliminated with construction of a dam (Q5)—but they are isolated points on the larger zigzag of science and values. For an extended discussion of the nonscientific issues presented by implementing the Endangered Species Act, see STEVEN LEWIS YAFFEE, PROHIBITIVE POLICY: IMPLEMENTING THE FEDERAL ENDANGERED SPECIES ACT 75-85 (1982); Doremus, *supra* note 8, at 1087-1129.

46. As discussed in part I.C, the literature contains little accessible discussion of the ways that science *cannot* inform policy questions. Thus, deriving the zigzag for any particular area of inquiry like risk assessment, species protection, or even social science contributions like psychol-

C. *The Elusiveness of the Limits to Policymakers*

Environmental problems that depend on this complicated mix of science and values for their resolution present an extraordinarily difficult problem for decisionmakers.[47] Not only must policymakers gather available positive knowledge, but they also must appreciate where this information leaves off and the various, scattered uncertainties begin. In fact, determining the nature and importance of these various knowledge gaps is an unusually esoteric inquiry, which often depends on an expert consensus that is unwritten or even unspoken.[48] Developing policy on the basis of these mixed, science policy issues presents a great challenge to lay decisionmaking.[49]

There are several reasons why lay decisionmakers have difficulty identifying and understanding knowledge gaps. First, and most significantly, there is rarely a generally accessible discussion of scientific knowledge gaps in the literature.[50] This results, in part, because scientists communicating with one another do not need to remind themselves of the limits of their discipline and may, for professional reasons, avoid being too explicit about the methodological shortcomings of their work. There are also few incentives for scientists to communicate the limits of science to laypersons or to identify how their

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ogy will require careful, and to some extent original, work. The dearth of such zigzag templates in the literature should not, however, be construed as evidence that they cannot be done. For example, in 1983 the National Research Council of the National Academy of Sciences published a report that provides one of the first, and still often cited, efforts to separate questions capable of being resolved by scientific experimentation from transscientific questions that are informed, but cannot be definitively resolved, by current scientific methods in carcinogenic risk assessments. *See* NRC, RISK ASSESSMENT, *supra* note 41, at 29-33 (listing transscientific questions occurring in carcinogenicity risk assessments); *see also* Doremus, *supra* note 8, at 1087-1129 (highlighting scientific judgments and other uncertainties arising in the listing of threatened or endangered species under the Endangered Species Act).

47. *See* NEIL K. KOMESAR, IMPERFECT ALTERNATIVES: CHOOSING INSTITUTIONS IN LAW, ECONOMICS, AND PUBLIC POLICY 102-03 (1994) (observing as an abstract matter that "[w]here low per capita transaction benefits [common in environmental problems] combine with high information costs, we get ignorance that can be manifested in a failure to act or in a mistaken choice that would not be made given better information" (footnotes omitted)).

48. *See* Wagner, *supra* note 7, at 1627-28 (discussing with references and examples the "need for experts in separating science and policy"); *see also infra* note 326.

49. *See* PRESIDENT'S COMM'N FOR A NAT'L AGENDA FOR THE EIGHTIES, SCIENCE AND TECHNOLOGY PROMISES AND DANGERS IN THE EIGHTIES 3 (1980) (positing that "a nascent contradiction may exist between the requisites of science and the requisites of democracy").

50. Reference to virtually any scientific treatise or related source material reveals that by and large these documents are relatively unhelpful in highlighting knowledge gaps. Even EPA products have traditionally shed little light on the delineation of knowledge gaps and positive knowledge, a failing for which they have been occasionally criticized. *See, e.g.*, COMMITTEE ON RISK ASSESSMENT OF HAZARDOUS AIR POLLUTANTS, NAT'L RESEARCH COUNCIL, SCIENCE AND JUDGMENT IN RISK ASSESSMENT 7 (1994) [hereinafter SCIENCE AND JUDGMENT] ("[C]ommittee did agree . . . that EPA often does not clearly articulate in its risk-assessment guidelines that a specific assumption is a default option and that EPA does not fully explain in its guidelines the basis for each default option."); MARC K. LANDY ET AL., THE ENVIRONMENTAL PROTECTION AGENCY: ASKING THE WRONG QUESTIONS 279 (1990) ("EPA repeatedly treated 'safety' as if it were a scientific notion definable by experts, rather than a social construct necessarily based on values as well as science.").

research fits within the larger zigzag of scientific knowledge and knowledge gaps.[51] As a result, nonscientists may not be able to rely on the literature to elucidate the zigzag pattern of positive scientific knowledge and knowledge gaps that inform a particular inquiry.

Knowledge gaps are also unusually difficult for lay decisionmakers to identify because they can easily be mistaken for, or even camouflaged as, positive knowledge.[52] Determining whether an experiment can be conducted to successfully elucidate a narrow question—such as how particulates are absorbed and react in the human lung—requires a high level of scientific expertise in a particular subfield. The zigzag that defines subquestions that can and cannot be resolved by science is thus capable of being blurred, confusing the points where science leaves off and opinion begins. Yet, to detect this blurring and to identify the true knowledge gaps, an observer must be conversant with the current scientific methodologies, theories, norms, and assumptions accepted within a particular scientific subspecialty.[53] Few policymakers have this expertise. As a result "politicians have to rely on experts not only to provide them with answers to technical

51. As with any academic discipline, scientific rewards through tenure, professional stature, and grants are not likely to be meted out for such frank discussions that do little to advance scientific knowledge. In fact there may be disincentives for scientists to candidly admit to the limits of their discipline. *See infra* notes 205-27 and accompanying text.

52. *See, e.g.*, Alvin M. Weinberg, *Science and Trans-Science*, 10 MINERVA 209, 220 (1972) (discussing how current environmental debates illustrate that "scientists often appear reluctant to concede limits to the proficiency of their science"); *see also* Thomas F. Gieryn, *Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists*, 48 AM. SOC. REV. 781, 782 (1983) (providing several examples of "ideological efforts by scientists to distinguish their work and its products from non-scientific intellectual activities" for professional gain). Even exploration of the different reasons for knowledge gaps must be guided in large part by scientists. Isolating the entrenched uncertainties from other types of gaps in knowledge, for example, requires sophistication about whether the market or other forces will encourage its collection without legal direction.

53. *See, e.g.*, Susan E. Fallows, Technical Staffing for Congress: The Myth of Expertise 18 (1980) (unpublished Ph.D. dissertation, Cornell University) (on file with the *University of Illinois Law Review*) (observing how the "interplay of fact and value in expert opinion" poses problems for policymakers because they may have "trouble sorting out where the experts' subjective assumptions and preferences color interpretation or presentation of objective factors"). For example, widely publicized battles of the experts over issues like the safety of Alar, dioxin, global warming, and acid rain instead largely concern expert disputes over value choices. In the controversy over Alar, for example, the feuding scientists disagreed about which correction factors should be incorporated into the risk assessment models used to determine the extent to which this growth stimulant used on apples could harm children. Although these correction factors derived in large part from very crude decisions about risk aversity and other associated value judgments, the scientists involved in both sides of the dispute presented their debate as one over "good science." *See, e.g.*, RONALD E. GOTS, TOXIC RISKS: SCIENCE, REGULATION, AND PERCEPTION 251 (1993) ("These differences [between NRDC, EPA, Uniroyal, and other groups regarding carcinogenicity of Alar] are based on the levels of the chemical to which experimental animals were exposed and on the numerous and often irreconcilable assumptions underlying their respective risk assessments."); Leslie Roberts, *Alar: The Numbers Game—The Dispute over the Cancer Danger from Alar Highlights Just How Uncertain Risk Assessment Is*, 243 SCIENCE 1430, 1430 (1989) ("What's lost in all the charges and counter-charges [on Alar] is a sense of just how squishy the numbers are, on either side. Risk estimates . . . really represent a best guess, built on myriad assumptions, some of which are invariably value laden.").

questions but also to inform them of the value assumptions imbedded in those answers and their implications for policy choices."[54]

Finally, understanding the limits of science is typically not within the realm of lay common sense or "ordinary knowledge."[55] Lindblom and Cohen have argued that the contributions of most social scientific research is already part of a policymaker's intuition or common sense, making this research of considerably less value to policymakers than the researchers contend.[56] By contrast, identifying gaps in scientific knowledge is an extremely esoteric undertaking that lies well outside the ordinary knowledge of lay policymakers. The ability of scientists to conduct relatively accurate and inexpensive tests to screen substances for potential human carcinogens, but not for reproductive or neurological hazards,[57] for example, is not intuitive or easily predicted. Indeed, in an era when seemingly miraculous technological developments are commonplace, lay policymakers may come to expect an endless stream of scientific answers. At the same time the scientific community, which is best able to correct the misimpression that science has all of the answers, may not be inclined to do so.

II. CONGRESS'S SCIENTIFICATION OF ENVIRONMENTAL POLICY

Resolving the mixed science policy questions that lie at the core of environmental disputes requires sophisticated legislative techniques. Members of Congress must identify the different types of knowledge gaps that arise in understanding environmental problems and then build legislation around these gaps. Perhaps predictably, however, legislators rarely do this. In a number of major environmental laws, Congress frames the legislative resolution of these multidisciplinary problems as essentially science puzzles.[58] Rather than

54. Fallows, *supra* note 53, at 18; *see also* Weinberg, *supra* note 52, at 216 (noting that identifying knowledge gaps "often requires the kind of selfless honesty which a scientist or engineer with a position or status to maintain finds hard to exercise"). Naturally, this wholesale dependence on scientists to delineate the limits of their discipline has significant dangers. *See infra* notes 205-27 and accompanying text.

55. Ordinary knowledge, by definition, includes all "knowledge that does not owe its origin, testing, degree of verification, truth status, or currency to distinctive PSI [professional social inquiry] . . . techniques but rather to common sense, casual empiricism, or thoughtful speculation and analysis." LINDBLOM & COHEN, *supra* note 34, at 12.

56. *See id.* at 14-17.

57. *See* Telephone Interview with Dr. Mike Shelby, Specialist in Reproductive Toxicology, Laboratory of Toxicology, National Institute of Environmental Health Sciences (Mar. 25, 1997) (reporting that scientists have not developed reliable, low-cost screening tests for reproductive and neurotoxic effects, although such tests are available to predict carcinogenesis in rodents).

58. In this article, members of Congress are lumped together as "Congress" when discussing their collective output in the form of final legislation (concededly, the more awkward phrase "majority of congressmembers" would be more accurate). Because the patterns of congressional use and misuse of science are identified at the aggregate level as they appear in statutes, considerable effort has been made to avoid resorting to quotes or statements from individual legislators as support for this larger pattern. While quotes do shed some light on the quality of Congress's deliberations, they also pose the significant risk of being selected based on their color, humor, or pointed illustration of an argument rather than their generalizability to other members of Con-

address the inevitable and often momentous policy choices that are left in the wake of incomplete science, Congress regularly produces mandates that misconstrue environmental problems as scientific ones.[59] In the development of environmental laws, then, rather than perverting good science in the name of politics, Congress seems to do exactly the reverse and perverts politics in the name of good science.[60]

In this part, these inverted decisionmaking patterns of Congress are discussed in detail. The first section outlines the tendency of members of Congress to generally become acquainted with and faithful to

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gress. Indeed, such information may even distort or obscure the bigger picture of congressional successes or failures. As a result, most references to the views of individual members of Congress, through oral or written statements, are reserved for part III when the behavior of individual congressmembers becomes relevant.

59. Ironically, in fact, Congress often seems to get its responsibilities backwards in developing environmental policy. Administrative agencies were created, in part, to conduct the technical and scientific work of the government, free from the corrupting influence of politics found, for example, in Congress. *See* Marshall J. Breger, *Thoughts on Accountability and the Administrative Process*, 39 ADMIN. L. REV. 399, 399-401 (1987).

60. Congress's use of science in environmental policymaking, in fact, appears to contrast rather sharply with its tendency to marginalize or even discredit valuable scientific inputs in other science policy matters, such as national defense, when scientific advice is more politically salient and outcome-determinative. In environmental issues, as discussed in part I, overreliance on science is unlikely to interfere with desirable policy options (or otherwise obstruct legislators' goals) because of the numerous transscientific uncertainties that preclude scientists from making definitive recommendations. Scientific intrusions on environmental policy discretion are thus the exception rather than the rule. *But see* MARY E. AMES, OUTCOME UNCERTAIN: SCIENCE AND THE POLITICAL PROCESS 124-25 (1978) (detailing Congress's exemption of saccharin from regulatory action that essentially dismissed well-regarded scientific studies, including a large epidemiological study, because of the strong negative public reaction to the FDA's saccharine ban); *supra* note 24 (discussing scientific *certainty* in explaining the loss of ozone in the stratosphere layer as unique in environmental policymaking).

By contrast, in other areas of science policy, scientific advice has, on at least a few occasions, constituted a distinct threat to Congress's political autonomy, and, as a result, Congress has at times either ignored or marginalized the value of this scientific advice in relation to other political considerations. *See* STEVEN BRINT, IN AN AGE OF EXPERTS: THE CHANGING ROLE OF PROFESSIONALS IN POLITICS AND PUBLIC LIFE 137 (1994) (hypothesizing that experts usually enjoy high levels of influence on policy either because of "the volume of demands on the time of politicians, or [because of] the failure of experts' policymaking actions to become politicized"); *see also id.* at 136-37 (describing decisions about using atomic force or allowing creationism in public schools as examples of scientific consensus being overridden by policy decisions); Harry S. Hall, Congressional Attitudes Toward Science and Scientists: A Study of Legislative Reactions to Atomic Energy and the Political Participation of Scientists (1961) (unpublished Ph.D. dissertation, University of Chicago) (on file with author) (examining why members of Congress distrusted scientists more than other participants in policymaking on issues of atomic energy and national security); *cf.* DOROTHY NELKIN, THE CREATION CONTROVERSY: SCIENCE OR SCRIPTURE IN THE SCHOOLS 97-100, 137-39 (1984) (describing state legislatures that "balanced" the teaching of evolution in the schools with the teaching of creationism). In rarer cases, federal lawmakers have also seen political advantage or electoral responsibility in questioning the operations of science itself, activities that generated considerable criticism within the scientific community. *See, e.g.*, Bimber & Guston, *supra* note 8, at 565-68 (recounting Representative John Dingell's oversight of fraud and abuse in scientific research conducted under federal grants); David P. Hamilton, *Lightning Strikes the SSC (Superconducting Super Collider in Jeopardy)*, 256 SCIENCE 1752 (1992) (explaining the House's vote to cancel the SSC and the Senate's pending decision on the matter as colored by "political factors" such as "a looming budget crisis," the recent defeat of a constitutional balanced budget amendment, and the project's pork barrel features, all of which made the SSC "a 'lightning rod' for fiscal discontent" despite general scientific support for the project); *see also infra* note 71.

existing scientific consensus. Although federal legislators may not always seek instruction from available positive scientific knowledge, for legislative matters of great visibility, deviations from the scientific consensus appear minimal. The second subsection describes how congressmembers then often go one step further and actually avoid the many difficult policy choices endemic to environmental policymaking by misframing them as capable of being resolved largely by science. Congress's almost blind allegiance to the "endless frontier" of science is evident in a number of pivotal environmental laws and amendments spanning from 1970 to 1995.[61]

A. Congress's Use of Positive Knowledge

Congress's competency in seeking out and using available positive scientific knowledge appears to depend on the level of scrutiny that the final legislative product will receive: the more visible the law (and, hence, the more politically salient the issues), the less likely the deviations from established scientific consensus. Therefore, it is not difficult to find examples of individual congressmembers using biased or even unreliable science in lower visibility decisions or prelegislative debates.[62] A review of recent environmental skirmishes on the Hill

61. As detailed in part II.B, the expressions of Congress's misframing problem may have evolved from a rudimentary "strictly science" type of mandate found in the early 1970s to the current congressional fascination with requiring cost/benefit and peer review of agency findings. Thus, although the environmental laws may now be moving from "first-generation" to "second-generation" environmental problems, along with all the added legislative complexity that this movement entails, *see, e.g.,* Robert L. Fischman, *The Problem of Statutory Detail in National Park Establishment Legislation and Its Relationship to Pollution Control Law*, 74 DENV. U. L. REV. 779, 801 (1997) (referring to first- and second-generation phases of environmental lawmaking), the overarching pattern of overreliance on science has remained intact, albeit taking on different forms.

62. *See, e.g.*, 144 CONG. REC. H6535, H6536, H6540 (daily ed. July 29, 1998) (discussing and ultimately rejecting a scientifically misguided amendment aimed at cutting National Science Foundation grants based on some congressmembers' misimpression that "billiards" research concerned the game of pool rather than high-energy physics and that ATM research concerned automated teller machines rather than advanced computer technology); Alyson C. Flournoy, *Preserving Dynamic Systems: Wetlands, Ecology and Law*, 7 DUKE ENVTL. L. & POL'Y F. 105, 113-14 (1996) (discussing how unpassed legislative proposals in the 104th Congress defined wetlands using scientific terms, but did so in a rigid and narrow way that would dramatically reduce the number of wetlands subject to protection); Edward Scheier, *The Intelligence of Congress: Information and Public Policy Patterns*, ANNALS AM. ACAD. POL. & SOC. SCI., Mar. 1970, at 14, 18-20. *But see* John V. Tunney, *The Federal Legislative Process: Misinformation, Reaction, and Excessive Delegation*, 7 ENVTL. L. 499, 501-03 (1977) (concluding that a rash of environmental legislation resulted from the public's overreaction to risk and Congress's lack of understanding of the legislation on which it was voting). However, while it may be true that individual legislators are sometimes guilty of ignoring or mischaracterizing relevant positive scientific knowledge to further their own partisan ends, there is little evidence that these problems occur at the aggregate level. *See, e.g.*, SAREWITZ, *supra* note 24, at 75-76 (concluding that "[a]lthough politicians often display a shocking degree of scientific illiteracy, it is rare indeed that any major policy decision hinges on . . . failure to accept the advice of scientists"). Even Justice Breyer's criticism of the capabilities of Congress in legislating risk focuses not on scientific errors in the legislation, but on risk aversity to the point of eliminating any consideration of cost. *See* STEPHEN G. BREYER, BREAKING THE VICIOUS CIRCLE: TOWARD EFFECTIVE RISK REGULATION 41-42 (1993) (noting that Congress at times legislates technical specificities that later prove to be unrealistic

reveals examples of congressmembers (singly or in groups) marginalizing or even trying to stop scientific research on certain problems to further certain predetermined political ends.[63] The elimination of the Office of Technology Assessment (OTA),[64] the apparent resort to "fringe science" and the simultaneous deconstruction of mainstream science to advance political positions on global warming and related issues,[65] and cuts or other efforts to dismantle or ignore environmental research projects are all examples of congressional efforts to channel or even distort positive scientific knowledge to achieve political ends.[66]

However, if these examples of lower visibility and prelegislative efforts are put to one side and one looks only at passed and final environmental legislation,[67] it appears that Congress may actually be doing a good job at finding and using positive scientific knowledge when that knowledge is available. Perhaps most telling is the absence of criticism targeted at this feature of congressional decisionmaking, a silence that is particularly noteworthy given Congress's recent proclivity to legislate scientific minutiae.[68] The fact that few if any of these legis-

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"policy goal[s]" and concluding based on prior analysis that when the public has distorted risk perceptions (as it often does), "Congress is also likely to find it difficult to write an effective agency agenda for addressing risk").

63. Perhaps the best examples (or at least supported allegations) of this activity can be found in Representative George E. Brown, Jr.'s recent report to the Democratic Caucus of the House Committee on Science titled *Environmental Science Under Siege: Fringe Science and the 104th Congress* (1996) (visited June 1, 1998) <http://www.house.gov/science_democrats/envrpt96.htm> [hereinafter *Rep. Brown's Fringe Science Report*]. *See generally* NATIONAL ENVTL. POL'Y INST., ENHANCING THE QUALITY OF REGULATORY SCIENCE (1998) (outlining general types of failure in Congress's use of science).

64. *See infra* note 121 and accompanying text.

65. *See, e.g., Rep. Brown's Fringe Science Report*, *supra* note 63, at 3 (arguing that in congressional hearings, legislators would at times reject the peer review process and substitute in its place "an overtly political process for judging scientific truth"); *id.* at 5-6, 7, 8, 10-11 (expanding on this criticism in depth, often with examples from specific hearings or congressional testimony); Carl Hulse, *Biologist Applying His Science on Capitol Hill*, N.Y. TIMES, June 3, 1998, *available at* <http://www.nytimes.com/yr/mo/day/n...hpol/congress-conservationist.html> (reporting on a number of highly reputable conservation biologists supporting a forest protection bill and congressional opponents of the bill dismissing the scientific support as coming from scientists who "are not qualified based upon their research and expertise to evaluate the proper management of the national forests").

66. *See, e.g., Rep. Brown's Fringe Science Report*, *supra* note 63, at 15 (detailing budget cuts for environmental research and the passage of legislation "to constrain NOAA's climate mission to natural phenomena only and to eliminate the environmental mission of NASA altogether").

67. Even some of the cuts of environmental research monies and the reductions in the environmental activities of specified federal agencies may have been passed with little deliberation or legislative accountability. *See id.* (arguing that the Science Committee recommended budget cuts and changes to agency missions that "occurred prior to . . . hearings and without any actual public record").

68. *See* Lazarus, *supra* note 1, at 340-41 (highlighting a number of statutes which exhibit the same trend of legislative specificity); Sidney A. Shapiro & Robert L. Glicksman, *Congress, The Supreme Court, and the Quiet Revolution in Administrative Law*, 1988 DUKE L.J. 819, 843 (observing detailed statutes passed by Congress in response to Reagan's attempts at deregulation). Of course, it is also possible that some legislation is so technical that scholars avoid critiquing it or are technically unprepared to do so.

lative details have been criticized in the legal, popular, or scientific literature—particularly given the scholarly attention to specific deficiencies in environmental laws[69] and the rash of attacks on junk science that have been mounted during that same time frame[70]—is undoubtedly more than just an academic oversight.[71]

For example, Congress appears to have made relatively effective use of positive scientific knowledge in determining the appropriate chemical properties of various automotive fuels, *see* 42 U.S.C. § 7545 (1994) (setting forth breathtaking details on the regulation of fuels), and in developing initial lists of various toxic pollutants. *See* John C. Dernbach, *The Unfocused Regulation of Toxic and Hazardous Pollutants*, 21 HARV. ENVTL. L. REV. 1, 1-2 (1997) (criticizing toxics lists codified in various environmental statutes as uncoordinated but not scientifically inaccurate); *id.* at 41 (discussing the rather detailed fact-finding approach taken by Congress in establishing a list of air toxins under section 112 of the Clean Air Act and observing the large role played by the EPA in the process). Even in a symposium addressing "how changing paradigms in ecology have influenced environmental law and policy," the sponsors of the symposium indicated that although ecology is undergoing a paradigm shift that threatens to undermine current legal approaches to resources management, the paradigm shift within the scientific community did not occur until the 1980s, after many of the initial laws were passed. *See* Fred P. Bosselman & A. Dan Tarlock, *The Influence of Ecological Science on American Law: An Introduction*, 69 CHI.-KENT L. REV. 847, 847, 869 (1994). The remaining articles in the symposium emphasized the complicated and unsettled challenges lawmakers face in adjusting the laws around this new scientific paradigm. *See, e.g.*, William H. Rodgers, Jr., *Adaptation of Environmental Law to the Ecologists' Discovery of Disequilibria*, 69 CHI.-KENT L. REV. 887, 887 (1994) (discussing how the "'new ecology'. . . revolution in thinking has undermined a legal superstructure that was built on a reality now exposed as nine parts myth").

69. *See generally* LANDY ET AL., *supra* note 50; John S. Applegate, *The Perils of Unreasonable Risk: Information, Regulatory Policy, and Toxic Substances Control*, 91 COLUM. L. REV. 261 (1991); Flournoy, *supra* note 7; Latin, *supra* note 15; Lazarus, *supra* note 1; *see also* DAVID SCHOENBROD, POWER WITHOUT RESPONSIBILITY 111-14 (1993). Unfortunately, however, in these studies an investigation of legislators' scientific competency is generally bypassed.

70. Congress may, in fact, be at the front of the "good science" parade in a comparative institutional sense. *See infra* note 124 and accompanying text. The law journal literature, for example, reflects considerably more discussion about junk science in the courts, and to a lesser extent in the agencies, than it does about junk science in Congress. *See, e.g.*, Search of WESTLAW, All Law Journals (JLR) File (Mar. 10, 1998) (search of (congress! w/50 "junk scien!") resulted in 11 hits, while in contrast, search of (court* w/50 "junk scien!") resulted in 325 hits and ((agenc! epa osh* fda) w/50 "junk scien!") resulted in 27 hits).

71. In fact, one criticism levelled against Congress—the occasional tendency of a study or report to become almost a meditative-like focal point for federal legislators that orients the resulting legislation—further suggests the important role positive knowledge plays in legislative deliberations. For example, legislators' almost exclusive focus on the Love-Canal-type of disaster in the Superfund statute, *see* RODGERS, *supra* note 4, § 8.1, at 471 (describing how the "legislative materials on Superfund give prominence to the hazardous waste dump sites that have become household words—Love Canal"), seemed to overshadow a more rational, searching analysis of the implications of a vigorous liability statute for thousands of moderately contaminated brownfield lands. *See infra* note 113.

Even the much ballyhooed Delaney Clause that prohibits any carcinogens, however low the concentration, in food or drugs, appears to have been based on a relatively good understanding of the available positive knowledge. *See* Richard A. Merrill, *FDA's Implementation of the Delaney Clause: Repudiation of Congressional Choice or Reasoned Adaptation to Scientific Progress?*, 5 YALE J. ON REG. 1, 52, 68 (1988) (relating expert testimony at House hearings on the Delaney Clause that supports Congress's assumption that there is no known safe level ("no threshold") for carcinogens); Wilson & Anderson, *supra* note 39, at 6 (observing that "Congress, like the experts advising it, were under the impression that carcinogens were few and readily identifiable").

Although there is evidence that, at times, Congress has set aside important scientific insights in developing environmental legislation, the decisions to disregard scientific information generally appear to result from a conscious policy decision, rather than from a lack of familiarity with

That Congress makes good use of positive scientific knowledge in these major lawmaking projects also makes sense. At any time, Congress can call upon an enviable array of scientific expert advisors[72] to assist in making sense of the unending stream of information that arrives in its offices.[73] Congress has at its fingertips all of the positive scientific knowledge any deliberative body could ever hope to consider.[74] Several political scientists confirm this fact and note also that scientific studies often command great respect in congressional deliberations, especially if the source appears neutral and the study findings appear accurate.[75] The U.S. Congress has even been spotlighted

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the relevant positive knowledge. For example, an almost exclusive regulatory focus on point sources of water pollution in the Clean Water Act, with little regulatory attention to the equally important nonpoint sources, appears to be the result of policy compromise built on full information and open congressional debate, rather than on scientific ignorance. *See* PERCIVAL ET AL., *supra* note 1, at 969 (observing that nonpoint sources largely escaped federal regulation because of political, administrative, and technical difficulties). The same appears to be true of the air pollution programs mandated by the Clean Air Act that ensure only healthful outside and not equally healthful indoor air quality. Careful attention should, therefore, be paid to the policy considerations at issue in situations where Congress appeared to neglect established scientific findings in developing laws. *See, e.g.*, BRINT, *supra* note 60, at 136-37 (1994) (citing examples of instances in which "even purely technical considerations may take a back seat to political considerations in the allocation of benefits or the distribution of costs"); *cf.* Brian Wynne, *Public Understanding of Science*, *in* JASANOFF HANDBOOK, *supra* note 8, at 361, 382 (observing that "[w]hat is often taken—by scientists but also by social science researchers—to be public misunderstanding of science instead comprises" differences in "framing assumptions" about the use of science in varying policy contexts); *id.* at 363 (observing that "a technical literate person may reject or ignore scientific information as useless in the absence of the necessary social opportunity," while from this same event "scientists may assume . . . public 'neglect' [of science] reflects technical ignorance or naiveté").

72. Congress receives assistance in gathering and analyzing scientific information from four (and more recently three) separate expert advisory offices, *see infra* notes 242-48 and accompanying text, an arsenal of regulatory agencies, and well-staffed offices and committees. *See infra* notes 231-51 and accompanying text. As discussed in part III.C.2.a, however, the analyses of these experts might ignore many of the knowledge gaps that should accompany these facts and figures.

73. *See, e.g.*, Fallows, *supra* note 53, at 88 (reporting that nuclear staffers interviewed in the late 1970s generally complained about information overload—"the problem . . . is managing information," including the determination of which information to pass on to the legislator); *cf.* Philip H. Abelson, *Scientific Advice to the Congress*, *in* SCIENCE AND TECHNOLOGY ADVICE TO THE PRESIDENT, CONGRESS, AND JUDICIARY 395, 395 (William T. Golden ed., 1988) [hereinafter SCIENCE AND TECHNOLOGY ADVICE] (observing that "Congress as a whole and the individual members do not lack for information. If anything, there is an overload."); Michael J. Graetz, *Paint-by-Numbers Tax Lawmaking*, 95 COLUM. L. REV. 609, 679 (1995) (observing that in the economically complex area of tax policy, Congress has an overabundance of revenue estimates and distributional data).

74. *See, e.g.*, Alfred J. Cote, Jr., *Who Tells Congress About Technology?*, INDUS. RES., Sept. 1967, at 78, 82 (observing that "the present system of outside advisory groups, such as NAS, special panels, executive branch information sources, and the Legislative Reference Service, produce more technical information than a Congressman could hope to cope with if he worried only about technological legislation").

75. *See* BRUCE BIMBER, THE POLITICS OF EXPERTISE IN CONGRESS: THE RISE AND FALL OF THE OFFICE OF TECHNOLOGY ASSESSMENT 3 (1996) (arguing and supporting position that "expertise is a significant force in [federal] legislative politics"); BRINT, *supra* note 60, at 136 (observing that for technical matters (like whether drugs are safe enough to be released on the market) "experts often have a near monopoly of influence" in Congress); Sanford A. Lakoff, *Scientists, Technologists and Political Power*, *in* SCIENCE, TECHNOLOGY AND SOCIETY 355, 355-57

by international institutions for its ability to keep abreast of scientific and technological advances.[76]

All of this evidence taken together suggests that, although Congress may not be a poster child for *Science* magazine, in its final laws, Congress is not disregarding or contradicting well-respected scientific findings or theories. Certainly, reports that certain members of Congress missed, misunderstood, or unnecessarily discounted positive knowledge are sporadic, and many of these instances are, in turn, caught and corrected by the vice grip of partisan debate.[77]

B. Congress's Lack of Appreciation of the Knowledge Gaps

Against this rather positive image of Congress's ability to ferret out positive scientific knowledge when developing major environmental laws is a more negative picture of Congress's systemic failure to

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(Ina Spiegel-Rosing & Derek de Solla Price eds., 1977) (discussing the rise of scientists within the political power structure); Dorothy Nelkin, *The Political Impact of Technical Expertise*, 5 SOC. STUD. SCI. 35-54 (1975) (same).

Although not empirically validated, the tendency of members of Congress to discount or ignore scientific information presented by organizations with a stake in the outcome also has support in the literature. *See, e.g.*, BIMBER, *supra*, at 7 ("In Congress, experts are likely to be sanctioned for displaying favoritism and rewarded for signalling neutrality."); *see also* Comment of Y, *Environment, Energy, and Economics: A Seminar Conducted by the Congressional Research Service, Led by Allen M. Schick*, *in* POLICY ANALYSIS, *supra* note 36, at 123 [hereinafter *Environment, Energy, and Economics*] (observing that there are a number of consultants working for all branches of the federal government, but "there is always the question of whether or not the entity doing the analysis has made up its mind and is doing the analysis to support its position, or whether the entity is open to the analysis"); Comment of M, *id.* at 128 (bemoaning how Congress "is looking for credible [objective] analysis" but that it has no secure apolitical source for this information).

76. *See* ORGANISATION FOR ECON. COOPERATION & DEV., REVIEWS OF NATIONAL SCIENCE POLICY: UNITED STATES 86-87 (1968) (praising the U.S. Congress for going "further than any other Parliament" in science policy and for being equipped with "a set of new bodies, most of which have brilliantly fulfilled the role assigned to them"); *see also* Sanford A. Lakoff, *Congress and National Science Policy*, 89 POL. SCI. Q. 589, 610 (1974) (applauding Congress's success in handling difficult science policy conflicts like the ABM (anti-ballistic missile) and the SST and concluding that "Congress offers an ideal forum for the exposure of public issues involving conflicting expertise"). Even 30 years ago, some had concluded that "Congress is fairly well informed on technology. . . . [I]t probably knows more about science and technology than the technocrats know about Congress." Cote, *supra* note 74, at 82.

77. *See* SAREWITZ, *supra* note 24, at 76 (observing that while "political adversaries [may] call upon highly credentialed and well-respected experts to bolster conflicting political positions," these efforts are negated by the political opposition doing the same, and, thus, adversarial use of science is "mutually assured self-destruction" (footnote omitted)); *Rep. Brown's Fringe Science Report*, *supra* note 63, at 2 (conceding that a Republican attack on basic methods of science "went too far, even for a Republican-dominated Senate, and regulatory reform legislation died in the 104th Congress"); *supra* note 67. This partisan filter apparently not only operates within Congress, but also between Congress and the executive branch. *See, e.g.*, Bimber & Guston, *supra* note 8, at 561-64 (describing the adversarial climate prevailing between Congress and the executive branch and how that led Congress to create the Office of Technology Assessment (OTA), so it could retain control over science policy).

As outlined in detail in part III, however, this intensive adversarial process may not function as well in identifying and preventing the overreliance on science to resolve policy problems, even when most or all of the legislators are acting as the Madisonian candidate.

appreciate and adjust to the limits of science.[78] In numerous environmental laws, Congress has framed environmental problems and their appropriate resolutions as matters for "sound science."[79] Given the

78. As Dr. Nichols has observed:

> We legislate the illusion of accomplishing more with targeted programs than present knowledge can confidently guarantee, as in the "cancer conquest." We dismiss an authentic crisis by simply proclaiming that we can accomplish goals faster than even the most ardent technology-hawks think feasible, as in "energy independence" by 1980 or 1985.

Rodney W. Nichols, *R&D Outlook: Selected Issues on National Policies for Science and Technology*, *in* POLICY ANALYSIS, *supra* note 36, at 72, 77.

A distinction must be made, however, between congressional decisions to pass *any* legislation versus congressional decisions about how to resolve a particular problem in legislation. In the former case, the scientific uncertainties often become very politically salient, because often some legislators will take the position that uncertainties are inevitable in environmental decisionmaking, while others will take the position that scientific research must resolve the uncertainties before legislation is enacted. *See supra* note 67. In the latter case, however, these uncertainties may be much less salient. All voting for the bill will get credit for taking some action on the problem, and all working on the bill, for differing reasons, may see the best or only answer to be one that comes from careful scientific analysis. *See infra* notes 145-269 and accompanying text.

79. *See also* Doremus, *supra* note 8, at 1033-34 ("Congress has repeatedly emphasized the importance of science in conservation decisions, behaving as if the science of conservation has no limits."); Magali Sarfatti Larson, *The Production of Expertise and the Constitution of Expert Power*, *in* THE AUTHORITY OF EXPERTS 28, 63 (Thomas L. Haskell ed., 1984) (observing that "[i]n situations which are still insufficiently specified, elected politicians themselves appear to foist or force responsibility upon technical advisors" (citations omitted)); Thomas H. Moss, *Is There a Scientific Basis for Environmental Decision-Making?*, *in* SCIENCE AND PUBLIC POLICY II 29, 29 (Frances S. Sterrett & Bianca L. Rosenberg eds., 1982) (observing, based on his experience as the staff director of the House Subcommittee on Science, Research, and Technology working on a variety of environmental problems, that "[w]hether or not a scientific basis for standard setting exists in any of these areas, one thing is certain: there is great pressure currently to look for or create one, or to believe that a scientific basis can exist"). Michael Graetz's parallel observations of "[c]ongressional decisionmakers routinely suffer[ing] from illusions of precision" in tax policymaking reinforce this observation and suggest that the instant analysis likely extends well beyond environmental matters. Graetz, *supra* note 73, at 613. A growing body of science-law scholarship also suggests that this overconfidence in science may, in some form or another, pervade all three branches of government. *See, e.g.*, Steven Goldberg, *The Reluctant Embrace: Law and Science in America*, 75 GEO. L.J. 1341, 1352 (1987) (concluding that courts' treatment of basic research—even when it is mission oriented—reflects a "remarkable degree of deference to the scientific community"); *see also* BRINT, *supra* note 60, at 141 (observing that "[e]xpert influence . . . depends on how issues are framed"); ROBERT N. PROCTOR, CANCER WARS: HOW POLITICS SHAPES WHAT WE KNOW AND DON'T KNOW ABOUT CANCER 270-71 (1995) (arguing that the "cancer research establishment likes us to believe that a shortage of research funds is the primary problem [in eliminating cancer]" but in reality this obscures the overarching policy question of "'what can be done to prevent cancer'" that can be resolved without definitive scientific answers); SAREWITZ, *supra* note 24, at 189 (arguing that there may be the equivalent of an "intellectual crisis" in science and technology policy, because society mistakenly "continues to throw science and technology at its accelerating scientific and technological problems" rather than confront them head-on); Susan E. Cozzens & Edward J. Woodhouse, *Science, Government, and the Politics of Knowledge*, *in* JANSOFF HANDBOOK, *supra* note 8, at 533, 541 (observing that in weapons policy, "a narrow set of participants, including the technical community, defense contractors, congressional committees, and military management, frame issues in terms that screen most people out of the discussion. Even public interest groups . . . have trouble penetrating the protective shield of expertise" (citations omitted)). Although there are certainly conspicuous examples of Congress's overconfidence in science with regard to research and development, care must be taken in including these examples because many of the projects originated as pure pork barrel projects that were intended to satisfy narrow, often local constituencies. This distributive feature distinguishes them in significant ways from the national regulatory programs discussed here. *See also* Fallows, *supra* note 53, at 21 (observing how re-

multidisciplinary context of these social problems, however, this two-dimensional science frame misstates the problem and misdirects its proper resolution. These misframed statutes burden the agency with numerous difficult policy choices, and they also restrict the agency's policy deliberations to predominantly scientific factors. Thus, Congress's delegations to the agencies under these misframed mandates are not just vague or broad, they are scientifically infeasible. As a result, agencies face the unenviable choice of doing nothing or lying about what they are doing and how they got there.[80]

In contrast to the more transparent congressional distortions of positive scientific knowledge, few of these misframing errors are caught by partisan politics, interest group pressure, or media attention. In fact, the consequences of this misframing error are often so distant that Congress's unrealistic overreliance on science—except in the most conspicuous partisan efforts to use sound science as a tactic to delay or paralyze environmental regulation—is not politically obvious or interesting to anyone.[81] As a result, Congress's tendency to "scientificate" environmental policy choices falls through the legislative cracks much more frequently than its more obvious and publicly reprehensible perversion of positive scientific knowledge.

It should be stressed that although Congress often misframes environmental problems as capable of being resolved by science, this is not always the case. In several statutes Congress has shown itself capable of providing agencies with scientifically realistic directions for implementing environmental laws. In key sections of the Clean Air Act and the Clean Water Act, for example, Congress ultimately conceded that it had placed unrealistic demands on science.[82] It replaced unrealistic, science-intensive mandates with mandates that rely on engineering judgment regarding the best technologies available for controlling pollution.[83] These efforts, and a range of other, still

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search and development (R&D) issues differ from problems of regulation because R&D issues involve distributive policies while regulatory issues provoke more conflict in Congress because of their more widely distributed effects).

80. *See* Doremus, *supra* note 8, at 1035 (observing that the Endangered Species Act's "strictly science" mandate sets "an impossible task" for the agencies responsible for the decisions).

81. *See* SAREWITZ, *supra* note 24, at 151-52 (concluding that "the promise of science to create societal benefit often attracts bipartisan support and is viewed as intrinsically nonpolitical").

82. *See* 136 CONG. REC. S17,234 (daily ed. Oct. 26, 1990) (observing that an amended technology basis for toxics in Clean Air Act "is desperately needed to overcome the inertia that plagued the health-based standards in current law"); S. REP. NO. 101-228, at 132 (1989) (admitting in support of 1990 amendments to toxics provision that the "statutory language itself may be responsible for the slow pace of the Nation's air toxic program"); *infra* note 292 and accompanying text.

83. *See, e.g.*, 33 U.S.C. § 1311(b)(2)(A) (1994) (requiring that national standards for water pollutants be based on best available technology rather than ambient water quality); 42 U.S.C. § 7412(d)(2) (1994) (requiring that national standards for air toxics are to be based on best technology rather than ambient air quality). In these amended provisions, reliance on science to determine the standards necessary to protect the public health is largely abandoned in favor of a

unimagined legislative possibilities for dealing with scientific uncertainties in a more multidisciplinary way, confirm that Congress does have legislative options for resolving environmental problems that do not require misframing the problem.[84]

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still complicated, but much more manageable, judgment about available engineering controls. *See* Houck, *supra* note 4, at 417-18, 421-24 (describing the switch from science-based to technology-based regulation for toxics in the Clean Water Act, the Clean Air Act, and RCRA respectively). Congress did retain in both statutes a science-based backup system that requires more stringent discharge or emission standards when the receiving environment cannot assimilate the pollutants satisfactorily. *See* 33 U.S.C. §§ 1313(c)(2)(B), 1314(a)(l) (Clean Water Act science-based backup system); 42 U.S.C. § 7412(f)(2)(A) (Clean Air Act air toxin backup system). As one might expect from the enormous demands these regulatory approaches place on science, both backup systems have generally proved disappointing in their ultimate implementation. *See generally* Oliver A. Houck, *The Regulation of Toxic Pollutants Under the Clean Water Act*, 21 ENVTL. L. REP. (Envtl. L. Inst.) 10,528, 10,537 (Sept. 1991) (observing that, although progress was made under the technology-based approach to regulating water pollution, "a greater number of individual industries remain unregulated than regulated, and a growing list of toxics have escaped scrutiny and standards").

In both statutes, administrative paralysis and overly complicated regulatory programs were publicly linked to the original, science-intensive mandates, making legislative action to correct the deficiencies virtually unavoidable. *See* Troyen A. Brennan, *Environmental Torts*, 46 VAND. L. REV. 1, 27-35 (1993) (discussing 1990 air toxics amendment passed in response to perceived crisis of underregulation); Ridgway M. Hall, Jr., *The Evolution and Implementation of EPA's Regulatory Program to Control the Discharge of Toxic Pollutants to the Nation's Waters*, 10 NAT. RESOURCES LAW. 507, 519-25 (1977) (discussing the EPA's technology-based approach to regulating water toxins that resulted from a court-entered settlement arising from inadequate implementation of the statutory mandate requiring standards to be based on the quality of the receiving waters).

Although the technology-based mandate still requires a mix of science and policy, it is much more effective at circumventing the zigzag of scientific uncertainties encountered because it replaces a science frame (which requires scientific evidence to characterize the cause-and-effect of environmental problems and identify quantitative standards) with a technological judgment about which technology among a finite number of alternatives is superior in terms of cost and effectiveness at pollution control. *See* Wagner, *supra* note 7, at 1680 n.243, 1692-94 (describing these benefits of technology-based standards). Selecting a preferred technology from among a number of finite alternative technologies most certainly involves policy choices, and some that can be both complex and cumbersome. *See* William F. Pedersen, Jr., *Turning the Tide on Water Quality*, 15 ECOLOGY L.Q. 69, 85 (1988) (detailing the expertise required to set technology-based standards). However, such policy choices are still less numerous and often less momentous than the extraordinary diversity and magnitude of uncertainties raised by ambient approaches to air or water pollution control. As a result, the agencies have been much more successful in ultimately setting these standards in a timely fashion. *See, e.g.*, Wagner, *supra* note 7, at 1680 & n.245.

84. Other legislative options could include setting policy-based reduction targets for pollutant limits, like Congress did for acid rain in Title IV of the Clean Air Act, *see* 42 U.S.C. § 7473; setting stringent pollutant limits by legislative fiat (like the Delaney Clause), but providing administrative flexibility to issue de minimis exceptions like the FDA attempted to do administratively, *see infra* note 144; delegating the environmental decisions to agencies with multidisciplinary mandates that provide the agency with the needed flexibility to fill in scientific gaps with explicit policy choices, *see* Doremus, *supra* note 8, at 1136-38 (proposing greater flexibility, with less scientific emphasis, in delegations to agencies for species listing process under the Endangered Species Act); revising the few protective health-based mandates that remain by expressly allowing the agency to consider costs and technological feasibility if the costs of achieving a standard are grossly disproportionate (rather than quantitatively balanced by or irrelevant) to the benefits of the standard; instituting a different type of expert advisory board in which the panels are mandated to lay out the positive knowledge and the knowledge gaps first, before the agency begins the rulemaking process; or simply debating policy issues more openly in the hopes that creative and more scientifically realistic legislative approaches to environmental problems

Despite these few encouraging examples of Congress's ability to understand and adapt to both positive scientific knowledge and knowledge gaps, however, there remains an unmistakable pattern of prominent environmental mandates that place too much reliance on science for resolving difficult social problems. To complicate matters still further, Congress appears to commit this framing error in a variety of ways.[85] This subsection describes five separate varieties of misframing errors that fall roughly into two subheadings, depending on whether the agency or a newly created body of experts is charged with providing the nonexistent scientific answers to the pressing social questions. The section concludes with some examples of related, less common shortcomings in environmental laws that result from Congress's incomplete understanding of scientific uncertainties that are capable of being resolved, but that require focused legal attention.

1. Unrealistic Delegations to Agencies

The pivotal provisions of many federal environmental laws require the tools of science to provide the primary or even exclusive mechanism for determining when pollutant levels are safe or a species will survive.[86] As a result of this legislative misframing of the larger

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will emerge. *Cf.* DONALD A. SCHON & MARTIN REIN, FRAME REFLECTION: TOWARD THE RESOLUTION OF INTRACTABLE POLICY CONTROVERSIES 8 (1994) (detailing components of rational policy design, which often must involve reframing policy conflicts and "frame reflection"); *see also infra* notes 305-68 and accompanying text (outlining more general reforms of the congressional decisionmaking process).

85. Rather than considering that the science relating to a particular problem may be uncertain, contentious, or incomplete, over the past three decades Congress often seems to assume that "good science" will prevail. *See generally infra* notes 86-120 and accompanying text. Although the examples discussed in this article concern only environmental regulations, Congress's regulation of nuclear power has also been faulted for a naive overreliance on science, *see, e.g.*, Woodhouse, *supra* note 26, at 151, and critiques of research and development planning highlight the public leaders' tendency to "build up exaggerated expectations of R&D." Nichols, *supra* note 78, at 76; *see also* Clinton P. Anderson, *Scientific Advice for Congress*, 144 SCIENCE 29, 31 (1964) (conceding—even as early as 1964—that "Congress has made mistakes" in science policy by "push[ing] programs too hard").

86. *See, e.g.*, Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) § 3, 7 U.S.C. § 136a(c)(5) (1994) (prohibiting pesticides that "cause unreasonable adverse effects on the environment"); Toxic Substances Control Act (TSCA) § 4(a)(1)(A)(i), 15 U.S.C. § 2603(a)(1)(A)(i) (1994) (allowing agency to require testing based on potential "*unreasonable* risk of injury to health or the environment" (emphasis added)); § 6(a), 15 U.S.C. § 2605(a) (requiring agency to set standards for any toxic substance that "presents or will present an unreasonable risk of injury to health or the environment"); Endangered Species Act § 7(b)(1), 16 U.S.C. § 1533(b)(1) (1994) (requiring agency to make listing decisions "solely on the basis of the best scientific and commercial information available"); Clean Water Act § 303(c)(2)(B), 33 U.S.C. § 1313(c)(2)(B) (1994) (prohibiting state water quality standards that "interfere with those designated uses adopted by the State"); 33 U.S.C. § 1317(a)(1) (1975) (amended 1977) (requiring that effluent level for toxic pollutants "shall take into account the toxicity of the pollutant, its persistence, degradability, the usual or potential presence of the affected organisms and the nature and extent of the toxic pollutant on such organisms"); Safe Drinking Water Act § 1412, 42 U.S.C. § 300g-1(b)(3)(D)(4) (1994) (requiring that maximum drinking water contaminants "shall be set at a level at which no known or anticipated adverse effects on the health of persons occur and which allows an adequate margin of safety"); Clean Air Act § 109(b)(1), 42 U.S.C. § 7409(b)(1) (1994) (requiring that standards for commonplace "criteria" of air pollutants allow "an adequate

interdisciplinary problem, many environmental programs have floundered.[87] Indeed, this scientification of environmental policymaking appears at least as strong during the 105th Congress, as it was in the early 1970s, during the infancy of our environmental laws.

Congress's unrealistic overreliance on science to resolve environmental problems is manifested in a number of different ways.[88] The

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margin of safety . . . requisite to protect the public health"), and § 112(a)(1), 42 U.S.C. § 7412(a)(1) (1989) (prior to 1990 reauthorization) (requiring that standards for toxic air pollutants should be set at levels lower than "may reasonably be anticipated to result in an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness"); Comprehensive Environmental Response, Compensation, and Liability Act § 121(b)(1), 42 U.S.C. § 9621(b)(1) (1994) ("The President shall select a remedial action that is protective of human health and the environment . . . ."). *Cf.* Occupational Safety and Health Act (OSHA) § 6(b)(5), 29 U.S.C. § 655(b)(5) (1994) (stating that permanent standards for toxic materials should be set at the level "which most adequately assures, to the extent feasible, . . . that no employee will suffer material impairment of health or functional capacity"); Resource Conservation and Recovery Act (RCRA) § 3004(m), 42 U.S.C. § 6924(m)(1) (1994) (requiring that standards for treatment of hazardous wastes disposed onto land shall "substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized"). For a more extended discussion of the science-based mandates under the Clean Air Act and the TSCA, see Flournoy, *supra* note 7, at 338-46. For citations to conservation statutes that require agencies to use the "best available scientific evidence" for their decisionmaking and thereby "invoke the mantra of science," see Doremus, *supra* note 8, at 1033-34 & n.9 (citing conservation statutes with this statutory charge).

87. The fallacy of Congress's overreliance on science for pollution control, although typically not discussed at a general level, has been widely criticized on a statute-by-statute basis. An impressive collection of environmental law scholars have condemned these pollution control statutes for their unrealistic reliance on science. *See, e.g.*, Dwyer, *supra* note 8, at 238 (observing that "short statutory deadlines [of Section 112 of the Clean Air Act] implicitly, and incorrectly, assumed the existence of adequate and reliable scientific data on the amount and geographic distribution of hazardous emissions, the extent of human exposure to hazardous air pollutants, and the size and distribution of health risks from such exposures"); Houck, *supra* note 4, at 410-18 (discussing history of failed science-based pollution control in Clean Water Act and concluding that a technology-based approach is superior); Lazarus, *supra* note 5, at 222 (observing that in its far-reaching ambitions of environmental laws, "Congress did not make any meaningful effort . . . to bridge the gap between the nation's aspirations . . . and its technological, economic, and cultural capacity for change. . . . Nor did the legislation anticipate the scientific complexity of environmental problems."); Woodhouse, *supra* note 26, at 150 (observing with disapproval that "[t]oxic air pollutants likewise have barely been regulated, in part because the relevant legislation is written as if scientific proof of hazard could be pinned down much better than it can be"). Even one of the most vociferous critics of command and control, Richard Stewart, has admitted that technology-based standards may provide the best control option when a lack of information precludes more efficient or creative solutions. *See, e.g.*, Richard B. Stewart, *Models for Environmental Regulation: Central Planning Versus Market-Based Approaches*, 19 B.C. ENVTL. AFF. L. REV. 547, 554-55 (1992).

Both Professor Doremus and Professor Yaffee provide persuasive arguments as to how the science-intensive mandates of the Endangered Species Act have led both to extraordinary delays in listing and to incoherence in the underlying basis and priority for the listings. *See, e.g.*, YAFFEE, *supra* note 45, at 75-85 (discussing these features of the Endangered Species Act); Doremus, *supra* note 8, at 1087-1129 (outlining in detail scientific uncertainties and resulting flaws in the agency's decisionmaking process to list species under Endangered Species Act).

88. The short deadlines imposed on agencies under many of these science-based mandates may also provide an illustration of Congress's tendency to overestimate the capabilities of science. *See supra* notes 2, 3 (recounting unrealistic deadlines common in environmental statutes). Because Congress appears to have unrealistic expectations for all types of agency actions, not just those that appear to require tools of risk assessment or empirical analysis, however, this evidence may require closer investigation. *See* Lazarus, *supra* note 1, at 323-28. Additionally, at

first and most egregious is the "strictly science" mandate in which Congress unequivocally bases environmental protection on science, without any indication that it appreciates science's dramatic limitations in resolving the environmental problems at issue.[89] Section 109(b)(1) of the Clean Air Act,[90] for example, has been read to require the EPA to set standards for various air pollutants "to protect the public health . . . [with an] adequate margin of safety"[91] without any consideration of economic factors in determining what constitutes a safe concentration of ambient air pollutants.[92] This legislative direction leaves the EPA in a rather difficult position because the range of plausible concentrations can vary by several orders of magnitude, with no experimental means of selecting the best estimate.[93] Indeed, the EPA's publicized struggle in promulgating ozone and particulate standards under section 109(b)(1) is a recent reminder of the unrealistic demands this mandate places on science and, hence, on the agency trying to implement the law.[94] A similar, strictly science directive is set

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least one commentator has suggested that short deadlines could evince almost the exact opposite with regard to Congress's scientific competency; they appreciate the uncertainties and do not want the agency to get delayed in attempting to find scientific answers for each step of the standard-setting process. *See* Shapiro & Glicksman, *supra* note 68, at 843.

89. The "strictly science" mandate is a term-of-art developed by Professor Holly Doremus in her research of section 7 of the Endangered Species Act. *See* Doremus, *supra* note 8, at 1051.

90. 42 U.S.C. § 7409(b)(1). For another, similarly drastic mandate that placed unrealistic reliance on science, but has since been amended to correct this scientific overreliance, see section 112 of the pre-1990 Clean Air Act, 42 U.S.C. § 7412 (1988) (amended 1990). The D.C. Circuit ruled that this section precluded consideration of costs in the standard-setting process except with regard to determining "an adequate margin of safety." Natural Resources Defense Council v. EPA, 824 F.2d 1146, 1163-66 (D.C. Cir. 1987).

91. 42 U.S.C. § 7409(b)(1).

92. *See* Lead Indus. Ass'n v. EPA, 647 F.2d 1130, 1148 (D.C. Cir. 1980) (holding that section 109 of the Clean Air Act prohibits the EPA from considering economic and technological feasibility in setting ambient air quality standards).

93. *See* C. Richard Cothern et al., *Estimating Risk to Human Health*, 20 ENVTL. SCI. & TECH. 111, 115 (1986) (commenting that "estimates [of individual risk rates] provide a range of uncertainty equivalent to not knowing whether one has enough money to buy a cup of coffee or pay off the national debt"). In estimating the risk of perchloroethylene in drinking water, for example, one group of researchers found that depending on the assumptions used in the model, "risk estimates varied by a factor of 35,000." Albert L. Nichols & Richard J. Zeckhauser, *The Perils of Prudence: How Conservative Risk Assessments Distort Regulation*, REGULATION, Nov.-Dec. 1986, at 13, 18.

94. *See* Editorial, *Whiter Than White*, WALL ST. J., Feb. 14, 1997, at A14 (citing statements made by Senator Chafee, chairman of the Senate Environment Committee, in the context of the ozone and particulate debates as conceding that the 1970 Clean Air Act requirements mistakenly "assumed the EPA could identify a [purely scientific] standard that would eliminate all harms caused by impure air" and that in retrospect this goal is "'unattainable'"). Congressional opposition to the EPA's proposed standards for ozone and particulates was significant. *See Air Quality Standards: Data Adequate for EPA to Push Ahead with Fine PM Standard, Browner Says*, Env't Rep. (BNA) No. 28, at 184 (May 30, 1997) [hereinafter *Air Quality Standards*] (reporting that industry group identified "at least 86 Democrats and 142 Republicans in Congress who have signed letters to either President Clinton or Browner expressing concern over the proposals"). Ironically, most of the congressional clamor over these rulemakings resulted from two flaws that were endemic to the legislation, not to the EPA's implementation of it. First, members of Congress expressed concern over the EPA's insufficient attention to cost considerations in setting the ambient air standards (a consideration made legally inappropriate by the

forth in the requirements for listing endangered or threatened species under section 7 of the Endangered Species Act.[95]

In a second set of mandates, Congress demands that science provide significant, but not exclusive, direction for the resulting protective standards. Despite some flexibility, however, the statutes still require far more information from science than is reasonable under the circumstances. In portions of the Clean Air Act,[96] the Clean Water Act,[97] and more recently the Resource, Conservation, and Recovery Act (RCRA),[98] for example, Congress requires environmental discharge standards to be based on the assimilative capacity of the receiving environment.[99] Although Congress recognizes that some room

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language of the mandate and the case law interpreting it). *See Air Quality Standards: Committee Chairman Seeks Compromise, Favors Commitment to Fine PM Standard*, Env't Rep. (BNA) No. 27, at 2124 (Feb. 21, 1997) (reporting congressional questioning of EPA Administrator Browner on proposed ozone and particulate rules with regard to the "potential costs of the proposals" and their economic, social, and technological ramifications); *see also Air Pollution: Commerce Panel May Subpoena Browner to Testify on EPA Discussions with OMB*, Daily Env't Rep. (BNA) No. 50, at AA-1 (Mar. 14, 1997) (reporting congressional accusations against the EPA for influencing an Office of Management and Budget (OMB) report that involved a cost assessment of the EPA's proposed rules and quoting an EPA official as responding that this congressional concern was "'silly, and . . . a distraction from the real issue of establishing science-based standards'"). Second, federal lawmakers were concerned that the EPA was "rushing to judgment" before scientific consensus had emerged with regard to a definitive quantitative standard, another delay that the mandate and courts have made clear is inappropriate. *See Air Pollution: Senate Bill Would Overturn EPA Air Rules, Provide Funding for PM, Ozone Research*, Daily Env't Rep. (BNA) No. 148, at A-8 (Aug. 1, 1997) (reporting on a proposed Senate bill that would overturn the EPA's proposed ozone and particulate standards and would authorize $100 million over the next five years to fund additional research on the effects of these pollutants and quoting Senator Inhofe as stating, "'A growing bipartisan coalition is emerging to support this effort to assure that we have adequate scientific justification behind any new air quality standards.'"); *see also General Policy: Pollution's Specific Impacts on Humans Often Ignored in Rulemaking, Panel Says*, Env't Rep. (BNA) No. 28, at 1002 (Sept. 26, 1997) (quoting Rep. Sherwood Boehlert as condemning fellow congressmembers for being too unsophisticated in dealing with inevitable scientific uncertainties and observing that instead "'Congress feels betrayed when science cannot give an absolute measure'"); *cf. Air Quality Standards, supra,* at 184 (quoting Browner as reporting that EPA standards were based on 87 studies and that criteria documents supporting the standards were thousands of pages long).

95. 16 U.S.C. § 1533(b)(1)(A). *See* Doremus, *supra* note 8, at 1051-56 (detailing history and the unrealistic requirements of the listing provisions that require agencies to base listing decisions "solely on the basis of the best scientific and commercial information available").

96. 42 U.S.C. § 7410.

97. 33 U.S.C. § 1317(a)(1) (1975) (amended 1977) (requiring that effluent level of toxic pollutants "shall take into account toxicity of the pollutant, its persistence, degradability, the usual or potential presence of the affected organisms . . . and the nature and extent of the effect of the toxic pollutant on such organisms"); *cf.* 33 U.S.C. § 1313(c)(2)(A)-(B) (1988) (mandating that states' water quality standards must ensure that states' designated use of waters will be protected).

98. 42 U.S.C. § 6924(m)(1) (requiring that standards for treatment of hazardous wastes disposed onto land shall "substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized").

99. Although the mandates look quite similar to the Clean Air Act mandate just mentioned, Congress's inflexible demand that the agency use *only* science was not present in the language or legislative history of the Clean Water Act and RCRA. Indeed, in the case of the Clean Water Act, the legislative history reflects that at least one legislator was aware of and highlighted the scientific uncertainties that could thwart a science-based approach to water pol-

must be left for agency discretion, the requirement that discharge standards be based on the assimilative capacity of the environment necessitates that science largely guide these regulatory decisions.[100] Experience has shown, however, that although positive scientific knowledge can be helpful in setting discharge standards, the gaps in scientific knowledge typically overwhelm any helpful insights provided by available scientific information.[101] As a result, in all three statutes the EPA ultimately attempted to rewrite the mandates to base discharge standards instead on more realistic regulatory targets, such as the installation of specified pollutant control technologies or their equivalent.[102] Congress's recent commands to the EPA to set testing and screening levels for endocrine disrupters in pesticides[103] and

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lution control. *See* H.R. REP. No. 911, at 396 (1972) (statement of Rep. Charles Rangel) (observing that "[T]he history of our water pollution control program suggests that State and Federal governments will continue to founder on the staggering complexity of this control system, which requires working mathematically back from the permitted pollution levels in a waterway to the effluent limitations at the point source needed to achieve them"). Despite this recognition of the pervasive scientific uncertainties by one lawmaker, Congress nevertheless chose to adopt a science-intensive process for the regulation of toxic water pollutants. However, it did not utilize this science-intensive approach for conventional, organic pollutants, but instead resorted to a technology basis for regulation.

Even the much-publicized brownfields problem can be attributed to Congress's failure in the Superfund law to recognize and address the scientific uncertainties in identifying and cleaning up contaminated sites. The disappointing record of redevelopment in brownfields (low to moderately contaminated properties located predominantly in urban areas) over the past two decades is attributed, in part, to the reluctance of purchasers to buy these parcels for fear of inestimable and overwhelming cleanup liabilities. *See* Todd S. Davis & Kevin D. Margolis, *Defining the Brownfields Problem*, *in* BROWNFIELDS: A COMPREHENSIVE GUIDE TO REDEVELOPING CONTAMINATED PROPERTY 6-8 (Todd S. Davis & Kevin D. Margolis eds., 1997) (relating an estimated 130,000 to 450,000 brownfield sites nationwide to the unintended effects of CERCLA and RCRA on brownfield redevelopment). The reluctance to redevelop brownfields also arises out of the reluctance of owners to sell contaminated properties because they too are potentially liable for cleanup costs. Much of this fear, in turn, can be linked to Congress's naive, science-based direction in the Superfund statute with regard to defining when a site is contaminated and, more importantly, what type of cleanup is appropriate (which in a sense defines what constitutes a site). *See id.* at 9 (explaining that the actual risk of liability is difficult to determine under CERCLA); *see also* 42 U.S.C. § 9607(a) (1994) (stating that cleanup can occur if a hazardous substance is entering or threatens to enter the environment); § 9621(d) (specifying general and predominantly science-related guidelines for determining appropriate degree of cleanup); Houck, *supra* note 4, at 428 (noting that the Superfund statute's heavy reliance on "risk-based decisionmaking may yet bring it down").

100. *See, e.g.*, Houck, *supra* note 83, at 10,529-30 (detailing a series of major scientific uncertainties encountered in the effort to set ambient water quality standards that must be squarely addressed in order to arrive at a final standard).

101. *See, e.g.*, Natural Resources Defense Council, Inc. v. EPA, 16 F.3d 1395, 1405 (4th Cir. 1993) (holding that the EPA could approve water quality standards set by the states of Maryland and Virginia that allowed dioxin concentrations almost 1000 times more lenient than recommended by the EPA because of inherent scientific uncertainties regarding risks of dioxin). The EPA's poor performance in expeditiously setting standards under these inflexible, science-based mandates is documented in the literature. *See* Houck, *supra* note 4, at 410-30 (detailing failure of science-based approaches in environmental laws with specific examples from Clean Water Act, Clean Air Act, and RCRA).

102. *See infra* note 337 and accompanying text.

103. *See* 21 U.S.C.A. § 345a(b)(2)(D)(viii) (West Supp. 1998) (detailing research requirements in Food Quality Protection Act of 1996).

drinking water,[104] despite the very primitive nature of existing theories and data in this area of toxicology, provide a much more recent example of this science-intensive mandate, which requires agencies to engage in science-based regulatory activities when, in reality, the uncertainties far overwhelm existing scientific knowledge.[105]

In a third set of environmental mandates, Congress directs the agency to set pollutant levels at a point where the costs are not "unreasonable," a statutory direction that still requires science or at least quantitative point estimates to provide the critical foundation for the regulatory task.[106] The most logical, if not the only, way to implement a statute requiring agencies to set standards sufficient to protect the public from "an *unreasonable* risk of injury to health"[107] (a mandate common to several major environmental laws)[108] is to follow a two-step, cost-benefit standard-setting process, the first step of which depends predominantly on science. In this first step, the agency must use scientific tools to determine risk levels that are correlated with varying concentrations of the pollutant or product—an exercise similar to determining the level of pollutants that can be assimilated by the receiving environment.[109] Only in the separate second step does the agency consider economic factors and select the least "unreasonable" of the

104. *See* 42 U.S.C.A. § 300j-17 (West Supp. 1998) (amended in 1998 to require estrogenic substances screening program).

105. *See generally* Jocelyn Kaiser, *Synergy Paper Questioned at Toxicology Meeting*, 275 SCIENCE 1879 (1997) (discussing the scientific controversy surrounding potential human health effects of endocrine disrupters and the uproar created by a recent Tulane study on the subject that was subsequently withdrawn); William K. Stevens, *Pesticides May Leave Legacy of Hormonal Chaos*, N.Y. TIMES, Aug. 23, 1994, at C1 (reporting on recent scientific controversy about chemicals found in pesticides, plastics, and other materials that may interfere with reproductive hormones); *Major Issues in the Food Quality Protection Act of 1996* (visited June 2, 1998) <http://www.epa.gov/oppfead1/fqpa/fqpa-iss.htm> (providing the EPA's comments on the Food Quality Protection Act amendments that require the EPA to develop and implement an endocrine screening program within three years: "This is a very ambitious schedule. Little is known about mechanisms of endocrine disruption and possible synergistic effects. This is a high priority for EPA."). The PBS documentary series, *Frontline*, ran an excellent program on the scientific and policy confusion surrounding endocrine disrupters entitled *Fooling with Nature*. The transcripts and other information from that program can be accessed at www.pbs.org (Frontline Online) and the program itself is available from PBS at 1-800-328-PBS1. For a particularly insightful discussion of the state of scientific research, see the interview with Dr. Linda Birnbaum at <http://www.pbs.org/wgbh/pages/frontline/shows/nature/interviews/birnbaum.html>.

106. *See* Moss, *supra* note 79, at 29 (observing with skepticism that use "of cost or risk/benefit analysis, especially on a comparative basis, implies a hope for a scientific basis for regulatory decisions . . . [and] presumes . . . a real ability to identify cause and effect relationships").

107. Toxic Substances Control Act (TSCA) § 6(a), 15 U.S.C. § 2605(a) (1994) (emphasis added).

108. *See, e.g.*, Federal Insecticide, Fungicide & Rodenticide Act (FIFRA) § 3(c)(5)(D), 7 U.S.C. § 136a(c)(5)(D) (1994) (prohibiting pesticides that "cause unreasonable adverse effects on the environment"); Occupational Safety and Health Act (OSHA) § 6(b)(5), 29 U.S.C. § 655(b)(5) (1988) (establishing standard for promulgating regulations as the level "which most adequately assures, to the extent feasible . . . that no employee will suffer material impairment of health or functional capacity"); *see also infra* notes 115-18.

109. For this reason, economists have cautioned that cost-benefit approaches are inappropriate when there are numerous, significant uncertainties in the underlying science. Morgenstern & Landy conclude based on 12 case studies of the EPA's utilization of cost-benefit analysis that:

risk options.[110] Despite the obvious inappropriateness of using this approach for environmental policy problems that are data- or science-poor, the courts[111] and agencies[112] charged with implementing and enforcing these mandates interpret them to require this extended scientific analysis, a statutory interpretation they take, at least in part, from Congress's cue. Congress is aware of these now well-established judicial and agency interpretations and has essentially acquiesced to them by its legislative silence, an acquiescence made more meaningful by the widely recognized crippling implementation difficulties these statutes have faced.[113] Indeed, Congress's continued affinity for science-

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in cases where the underlying science or risk assessment is extremely uncertain, a full-scale economic analysis often serves little useful purpose. In such cases, the agency might be well served to abandon any pretext that it is possible to assess whether or not benefits exceed costs. Rather, it might be better to conduct a more limited cost-effectiveness analysis and focus on a frank discussion of the science, including the uncertainties.

Richard D. Morgenstern & Marc K. Landy, *Economic Analysis: Benefits, Costs, Implications*, *in* ECONOMIC ANALYSES AT EPA: ASSESSING REGULATORY IMPACT 455, 465 (Richard D. Morgenstern ed., 1997); *see also id.* at 472, 476 (same). Under conditions of great scientific uncertainty, requiring a cost-benefit analysis could further exacerbate existing policy failures. *See* Thomas O. McGarity & Sidney A. Shapiro, *OSHA's Critics and Regulatory Reform*, 31 WAKE FOREST L. REV. 587, 625-32 (1996) (discussing extensive list of regulatory dysfunctions associated with a cost-benefit approach to setting occupational and health safety standards, including paralysis by analysis and overreliance on unverified industry data).

110. *See* Morgenstern & Landy, *supra* note 109, at 464 ("Economic analysis of the benefits of environmental policies typically depends on the existence of a well-done risk assessment. In general, economic analysis only adds value when scientists have laid the groundwork by developing credible quantitative estimates of the underlying physical relationships.").

111. The most notorious, but not the only, such pronouncement is the *Benzene* case. In striking down an OSHA standard for benzene, Justice Stevens, writing for the plurality, admonished the agency for its scientifically insupportable standard and clarified that future standards would be upheld only if the agency is able to "show, on the basis of substantial evidence, that it is at least more likely than not that long-term exposure to 10 ppm of benzene presents a significant risk of material health impairment." Industrial Union Dep't v. American Petroleum Inst., 448 U.S. 607, 653 (1980). Despite some backpedaling later in the opinion, *see id.* at 655 ("[T]he requirement that a 'significant' risk be identified is not a mathematical straitjacket."); *id.* at 666 (Powell, J., concurring) (stressing that the agency is not precluded from setting standards when quantification cannot be accomplished with "known methods"), the Supreme Court's test has caused agencies to make their policy decisions underground and disguise their rulemakings as technical exercises. *See* JOHN D. GRAHAM ET AL., IN SEARCH OF SAFETY: CHEMICALS AND CANCER RISK 151 (1988) ("Since the Supreme Court's 1980 benzene decision, federal agencies have felt compelled to use such numerical risk estimates to support both priority-setting and standard-setting decisions."); MELNICK, *supra* note 21, at 380 (concluding that judicial opinions requiring agencies to support decisions with more science "led to expansion of the agency's research staff, the creation of special task forces (such as one for airborne lead), and the establishment of a new office to write criteria documents"); Frank B. Cross, *Beyond Benzene: Establishing Principles for a Significant Threshold on Regulatable Risks of Cancer*, 35 EMORY L.J. 1, 12-43 (1986) (arguing that judicial review forces agencies to provide detailed technical explanations for standards); Latin, *supra* note 15, at 132 ("[T]he Court's benzene decision has . . . induced federal agencies to conclude that they must provide quantitative risk estimates even if they lack confidence in the resulting judgments."). It is important to note that OSHA's mandate is one of the least susceptible to an unrealistic technical interpretation because of its explicit inclusion of cost and technological factors in the standard-setting decision. *See supra* notes 88-94 and accompanying text (discussing the much more inflexible science-intensive mandate in the Clean Air Act).

112. *See* Wagner, *supra* note 7, at 1628-50 (discussing agencies' hypertechnical implementation of science-based statutes).

113. *See* FRANK B. CROSS, ENVIRONMENTALLY INDUCED CANCER AND THE LAW: RISKS, REGULATION, AND VICTIM COMPENSATION 111 (1989) (observing that by 1988, "[o]f forty-one

intensive, cost-benefit approaches to regulation[114] is reflected in 1996 amendments that require this cost-benefit analysis to be used to evaluate the safety of pesticide residues in food,[115] a mandate that Congress passed unanimously,[116] and contaminants in drinking water.[117] Over the past few years there have also been numerous attempts by those in

existing chemicals that EPA ha[d] identified as carcinogens subject to [the TSCA], only four ha[d] been listed as significant risks under section 4(f). Of these four, EPA ha[d] yet to issue any TSCA regulations"); JOHN M. MENDELOFF, THE DILEMMA OF TOXIC SUBSTANCE REGULATION: HOW OVERREGULATION CAUSES UNDER REGULATION AT OSHA 2 (1988) (reporting that during first seven years of FIFRA, the EPA had completed reregistration on less than 12 out of 600 active ingredients scheduled for review); OFFICE OF TECH., U.S. CONGRESS, IDENTIFYING AND REGULATING CARCINOGENS: BACKGROUND PAPER 118-19 (1987) [hereinafter OTA, BACKGROUND PAPER] (reporting that by 1987, the EPA had restricted or canceled the registration of only 18 out of 81 preexisting pesticides the EPA had identified as carcinogenic); JOHN WARGO, OUR CHILDREN'S TOXIC LEGACY: HOW SCIENCE AND LAW FAIL TO PROTECT US FROM PESTICIDES 94-103 (1996) (discussing a series of problems arising in the EPA's implementation of FIFRA and relating them in large part to the legislation's failure to address and adjust to the many inevitable scientific uncertainties); Houck, *supra* note 4, at 427-28 (lamenting that science-based regulatory programs established under statutes like TSCA and FIFRA "remain confined to small ecological niches, stymied by the impossibility of the very determinations required and reversed regularly by courts of law the few times that such determinations are offered").

114. Although Congress at times acknowledges the need for qualitative assessments of benefits and costs due to both the limits of science and economics, *see, e.g.*, H.R. 9, 104th Cong. § 324(i)(4)(A), (C) (1995) (allowing costs and benefits to be specified qualitatively); S. 981, 105th Cong. §§ 623(d)(4), 624(c)(2), (e)(5), (f) (1998) (allowing agency to reveal uncertainties and assumptions and to qualitatively specify costs and benefits), in most bills and statutes it places a premium on final, quantitative cost-benefit determinations. *See* Dalton G. Paxman, *Congressional Risk Proposals*, 6 RISK: HEALTH SAFETY & ENV'T 165, 177-78 (1995) (identifying as one of the "major feature[s]" of congressional bills during the 103d Congress the requirement that the EPA "characterize and quantify regulated risks as well as the benefits and costs of regulation"); *see also infra* note 120. Congress also has a continuing fondness for comparative risk assessment and appears to expect it to produce reliable, and perhaps even quantitative, estimates for comparison. *See* Paxman, *supra*, at 179-80 (observing that "[r]elating or comparing disparate risks became a major [legislative] theme in the 103d Congress" and citing bills in which this theme was most apparent). The utility of comparative risk assessment in many instances might similarly be undercut by the rampant scientific uncertainties and data gaps that plague many environmental problems. *See, e.g.*, McGarity & Shapiro, *supra* note 109, at 621-22 (arguing that the "use of comparative risk assessment [in a proposed amendment to OSHA] can be very misleading to decisionmakers and to the general public, because it assumes that existing estimates of 'familiar' risks are accurate and can be confidently displayed in an understandable fashion").

115. 21 U.S.C.A. § 346a(b)(2) (West Supp. 1998). This new risk-benefit test is slightly different from the prior risk-benefit test of the Federal Food, Drug, and Cosmetic Act (FFDCA) insofar as it eliminates the Delaney Clause and replaces it with a risk-benefit test that applies to carcinogenic pesticide residues as well as noncarcinogenic pesticide residues. *See* § 321(s) (changing the definition of pesticide). Furthermore, it requires the EPA to consider the benefits of a pesticide that "protects consumers from adverse effects on health that would pose a greater risk than the dietary risk from the residue." § 346a(b)(2)(B)(iii)(I). For a discussion of potential problems with this risk-benefit test, see Scott D. Bauer, Note, *The Food Quality Protection Act of 1996: Replacing Old Impracticalities with New Uncertainties in Pesticide Regulation*, 75 N.C. L. REV. 1369, 1399-1408 (1997).

116. *See* 142 CONG. REC. S8736-38 (daily ed. July 24, 1996).

117. 42 U.S.C.A. § 300g-1(b)(3), (5) (West Supp. 1998) (employing cost-benefit tests for protection of drinking water). The unrealistic demands that both of these statutory amendments place on the capabilities of science and, more specifically, risk assessment were the subject of a recent conference sponsored by the Society for Risk Analysis. *See* Protecting Sensitive Groups as Mandated by the FQPA and the SDWA: Can Science Meet the Challenge?, Conference of the Society for Risk Analysis (June 1998) (conference agenda on file with author).

Congress to introduce similar cost-benefit measures into other environmental and public health laws, such as the setting of occupational health standards,[118] the cleanup of hazardous waste sites,[119] and the preparation of agencies' risk assessments.[120]

2. *Unrealistic Reliance on Expert Panels*

Congress not only requires agencies to use science to resolve environmental problems when scientific uncertainties make such an approach ill advised, it also establishes scientific panels to assist in resolving environmental problems, again without explicitly acknowledging that the issues to be addressed cannot be resolved exclusively by science.[121] In a fourth set of mandates that adopt a science-inten-

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118. *See, e.g.*, McGarity & Shapiro, *supra* note 109, at 609-33 (discussing and critiquing the Ballenger Bill and omnibus regulatory reform legislation passed by the House of the 104th Congress that would have required cost-benefit analysis and "sound scientific data" as preconditions to setting OSHA standards).

119. *See generally Superfund: Reform Effort Pronounced Dead; Amendments Threatened Compromise*, Daily Env't Rep. (BNA) No. 192, at D-3 (Oct. 6, 1994) (describing Superfund reform efforts in the House that included "cost-benefit requirements for cleanups").

120. *See, e.g.*, H.R. 9, 104th Cong. § 422(a)(2) (1995) (requiring as prerequisite to "major" regulation that agency demonstrate that the benefits of the regulation "justify, and . . . [are] reasonably related to" the cost of implementing and complying with the regulation); S. 981, 105th Cong. § 623(c)(3) (1998) (requiring agencies to make net cost-benefit determinations on final major regulations where possible).

121. *See, e.g.*, SHEILA JASANOFF, THE FIFTH BRANCH 1 (1990) (arguing that care should be taken to ensure that scientific advisory panels are not established or do not function so as to "take the politics out of policymaking"). Although these mandates fall in the same misframing category as the unrealistic delegations to agencies, their creation may often be more deliberate because delegation to expert panels, particularly expert panels that are charged with conducting additional research, can be a substitute for immediate regulation. As such they offer a more transparent vehicle for delaying legislation or the final promulgation of agency regulations and are likely to be more politically salient than at least some of the misframed delegations to agencies discussed above. *See* Nichols, *supra* note 78, at 94-95 (describing the different level of political saliency that attaches to scientific uncertainties as the delays resulting from waiting for "sound science" become more evident to parties on both sides of the debate).

Despite Congress's tendency to defer to scientific experts on matters of environmental policy, Congress did eliminate its largest single source of captive scientific experts, the Office of Technology Assessment (OTA), in 1995. Those studying the decision maintain that is was predominantly a symbolic gesture by Congress to signify that in the process of significant cuts to the executive branch, Congress was tightening its own belt as well by eliminating an entire congressional support agency. *See, e.g.*, BIMBER, *supra* note 75, at 71 (suggesting that the decision to eliminate the OTA was bipartisan and resulted from a confluence of factors such as the OTA's failure to build a large constituency of supporters, the unfamiliarity of freshmen congressmembers with the agency's work, and the lure of short-term political benefits, with only remote and speculative long-term costs). Although at the time of its sudden demise, the OTA did enjoy support from powerful legislators on both sides of the aisle, *see id.* at 69-74 (recounting bipartisan efforts to prevent the elimination of OTA), this limited following was apparently not sufficient to resuscitate it. Reports generated over its 20-year life-span in fact reveal that the OTA's assessments were considered neutral and competent, *see id.* at 51, 71-74 (describing widespread perception of the OTA within Congress as neutral and competent); *infra* note 254 (describing widely regarded neutrality of OTA), but far too slow in coming and often too academic and abstract to be of use. *See* BIMBER, *supra* note 75, at 34 (observing that "OTA studies typically required about two years for completion . . . [and that this] became a source of complaints by legislators and their staff"). A number of process restrictions limiting who could request an OTA assessment and under what conditions may have further limited its perceived usefulness. *See,*

sive frame for isolating and resolving environmental problems, Congress has created a number of scientific advisory boards to assist agencies in setting standards, particularly for toxic substances.[122] Although these advisory panels have proved helpful in ensuring that the agencies use positive scientific knowledge accurately, these panels often find themselves reviewing the agency's policy choices under the auspices of scientific peer review.[123] Despite the nonscientific nature of many of the subquestions directed to scientific panels, however, Congress continues to mandate extensive peer review and related scientific advisory board requirements in environmental legislation and environment-related bills without sufficient flexibility for agencies to arrive at or admit to the many inevitable important policy judgments.[124]

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e.g., James E. Katz, *Congress Needs Informal Science Advisors: A Proposal for a New Advisory Mechanism*, *in* SCIENCE AND TECHNOLOGY ADVICE, *supra* note 73, at 425, 426 (describing the inability of the OTA to respond to requests from individual members of Congress or to "provide information about the consequences of decisions for the member's own state or district"); *see also infra* note 244. Thus, although one cannot conclude much about Congress's overreliance on science by examining the OTA experience, there can be little doubt that the elimination of the OTA is certainly not going to *improve* Congress's appreciation of what information science can and cannot bring to environmental policy decisions.

122. *See* 7 U.S.C. § 136w(d) (1994) (requiring the Scientific Advisory Panel established under FIFRA to review the scientific bases for major regulatory proposals concerning pesticides and to adopt peer review procedures for scientific studies carried out pursuant to FIFRA); 42 U.S.C. § 4365 (1994) (creating a Science Advisory Board to assist the EPA in its research initiatives and science-based regulatory determinations); 42 U.S.C. § 7409(d)(2) (establishing the Clean Air Scientific Advisory Committee to review the EPA's ambient air quality standards); *see also* JASANOFF, *supra* note 121, at 85 tbl.5.1 (listing Science Advisory Board responsibilities); Moss, *supra* note 79, at 32 (citing portions of the 1977 Clean Air Act Amendments that task the EPA and advisory agencies (the NAS and the National Commission on Air Quality) with "technical" responsibilities that are daunting, if not impossible, to satisfy). The FDA is required to seek the assistance of scientific advisory panels only for medical devices, but the FDA also tends to rely heavily on a variety of scientific panels to review many of its regulatory decisions. *See* JASANOFF, *supra* note 121, at 34. OSHA may rely on its technical arm, the National Institute for Occupational Safety and Health (NIOSH), for scientific advice but traditionally has not sought NIOSH review of its scientific decisions. *See id.* at 34-35. Finally, the science-based deliberations of the Consumer Product Safety Commission are subject to mandatory peer review by legislatively created Chronic Hazard Advisory Panels. *See* 15 U.S.C. § 2080 (1994).

123. *See* JASANOFF, *supra* note 121, at 229 ("[Science a]dvisory committees, we know from experience, rarely restrict their deliberations to purely technical issues. In fact, the experts themselves seem at times painfully aware that what they are doing is not 'science' in any ordinary sense, but a hybrid activity that combines elements of scientific evidence and reasoning with large doses of social and political judgment."); *see id.* at 122 (describing the policy role played by the EPA's Clean Air Science Advisory Committee); *id.* at 178 (describing the policy role played by the FDA's scientific advisors and concluding that "[t]he ambiguity of the boundary between science and policy is also strategically useful to the FDA, permitting the agency to harness the authority of science in support of its own policy preferences"); Wilson & Anderson, *supra* note 39, at 6 (describing the EPA's Clean Air Science Advisory Committee's panel that acknowledged prevailing scientific uncertainty but noting that because the law authorized the panel to offer policy advice, "more than half of the panel went on to offer EPA their various and conflicting personal opinions as to where the standard should be set").

124. *See, e.g.*, 42 U.S.C.A. § 300g-1(b)(3)(A)(i) (West 1991 & Supp. 1998) (requiring the EPA to set drinking water standards based on the "best available, peer-reviewed science") (1996 amendments to Safe Drinking Water Act); S. 981, 105th Cong. § 625 (1998) (requiring peer review of agency risk assessments for major regulations); *id.* §§ 628(c)(2), 629 (tasking a *scientific*

A fifth and final type of misframed science mandate is one intended for Congress itself.[125] On several occasions, Congress has commissioned expensive and time-consuming scientific studies of pressing social problems like acid rain and global warming to divine the correct scientific answer to these sorts of problems, only to find, years and millions of dollars later, that science could provide little guidance in resolving the issues.[126] In some cases, the tendency to seek answers to questions that can be only partially answered by science has led to some embarrassing results. In the case of the National Acid Precipitation Assessment Program (NAPAP), for example, Congress created an expert task force to answer policy-relevant questions about acid rain.[127] There is little indication in the publicly recorded debates that those in Congress even considered the possibility that some of these tasks might lie beyond the capabilities of the experts.[128] Not surprisingly, NAPAP's results were of limited value.[129] The report took so

institution with developing techniques for comparative risk assessment); H.R. 9, 104th Cong. § 431 (1995) (requiring peer review of agency risk assessments for all major regulations); Doremus, *supra* note 8, at 1146-48 (citing and questioning wisdom of peer review requirements proposed as amendments to the Endangered Species Act); Paxman, *supra* note 114, at 176-77 (describing "common" theme of "peer review" of agency rules and guidelines in a number of bills proposed in the 103d Congress that concern risk assessment); *see also* Eva Tomkins, *Reauthorization of the Endangered Species Act—A Comparison of Two Bills that Seek to Reform the Endangered Species Act: Senate Bill 768 and House Bill 2275*, 6 DICK. J. ENVTL. L. & POL'Y 119 (1997) (critiquing bills proposed in the 104th Congress to amend the Endangered Species Act that require peer review of all regulatory decisions on request and impose demanding data requirements for listing).

125. This specific legislative command for and financing of scientific research to resolve legislators' questions is along the spectrum, but still distinct from Congress's decisions to fund certain types of research, like that on global warming. For discussions on the politicization of these funding decisions, which have tended to result in cuts in monies dedicated to global warming, see *Rep. Brown's Fringe Science Report*, *supra* note 63, at 15-17.

126. *See* SAREWITZ, *supra* note 24, at 62-63 (describing the National Acid Precipitation Assessment Program and the U.S. Global Change Research Program as examples of "the divergence between research trends and social needs").

127. *See* 42 U.S.C. § 8903.

128. When NAPAP was created in 1980, most members of Congress appeared naively to assume that scientific and economic research would answer their policy-driven questions about the severity of acid rain and how best to control it. *See* 126 CONG. REC. H16,892 (daily ed. June 26, 1980) (statement of Rep. Vento) ("The task force's research and recommendations will provide Congress, the administration, and the public with desperately needed data to deal with the problem."); 125 CONG. REC. S24,631-32 (daily ed. Sept. 14, 1979) (statement of Sen. Moynihan) ("I rise today to introduce a major environmental bill aimed at alleviating the problems caused by acid precipitation in this country. . . . Each year a report will be submitted to Congress documenting the progress made to date toward finding solutions to the acid rain problems . . . for the problems it is intended to solve do affect us all."). It should be noted that unlike district specific "pork barrel" distributions of funds to scientific research, NAPAP's research had no clear impact on specific constituencies or districts. *See supra* note 79.

129. The failure of NAPAP has been attributed to several causes, only one of which includes Congress's "political ambivalence" and its resulting unrealistic directions and poor oversight of the project. *See* Edward S. Rubin et al., *Keeping Climate Research Relevant*, 8 ISSUES SCI. & TECH., Winter 1991-92, at 49, 51, 54 (describing Congress's ambivalence and recommending how Congress could set up the program better to elucidate uncertainties). Other causes include both the President's failure to focus the program with directed funding or by appointing a supreme agency or director to manage the research and the motivations of the NAPAP experts themselves who appeared to pay very little attention to critical policy questions or to making the final

long to complete that Congress developed Title IV of the Clean Air Act,[130] which addresses the acid rain problem, without the benefit of its $500-million and ten-year investment in this expert study.[131] Equally distressing, NAPAP experts made virtually no effort to meet Congress's unrealistic demands and instead simply "produced a lot of good science [that was] . . . largely irrelevant to the policy decisions."[132] Despite, or perhaps in response to, NAPAP's failure, Congress has decided to recommission continued and additional acid rain studies over the next decade.[133] A similar error may be occurring with regard to Congress's unrealistic expectations of scientific studies and

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result intelligible to a nonscientific audience. *See id.* at 48-49. Rubin et al. quote from the summary of the NAPAP report to emphasize this latter, unintelligibility factor:

> NAPAP's final Integrated Assessment, which was supposed to be policy-oriented, summarized the impact of acid rain on soils by writing that a 'reduction of sulfur deposition by 50 percent over 10 years would cause a slight increase in base saturation of some shallow sensitive soils with low cation exchange capacity, but most soils would not be affected.' Oh.

Id. at 48.

130. 42 U.S.C.A. §§ 7651-7651o (West 1995 & Supp. 1998).

131. Leslie Roberts reported that "NAPAP's final integrated assessment, evaluating likely emission reduction scenarios, was released in draft form . . . almost at the moment Congress was passing a bill mandating a 10-million ton reduction in sulfur emissions." Leslie Roberts, *Learning from an Acid Rain Program*, 251 SCIENCE 1302, 1305 (1991); *see also* Rubin et al., *supra* note 129, at 47 (concluding that NAPAP "proved largely irrelevant to the effort to forge the new Clean Air Act").

132. Rubin et al., *supra* note 129, at 48. The policy irrelevance of the NAPAP effort may have also undermined the credibility of those few recommendations that it ultimately did produce because the overall project was perceived as neither comprehensive nor focused. Those who disagreed with the report's findings, for example, were quick to declare the report biased. *See, e.g.*, 136 CONG. REC. H1047 (1990) (daily ed. Mar. 22, 1990) (statement of Rep. Boehlert) ("I was horrified to find out that the original report ignored a number of studies suggesting serious air pollution problems caused by acid rain. . . . Anyone who would suggest that acid rain is not a problem just is not paying attention to what is going on in the United States."); *Air Pollution: Ozone, Acid Rain Cause Extensive Damage to U.S. Crops, Forests, WRI Says in Report*, Env't Rep. (BNA) No. 20, at 1779 (Feb. 6, 1990) (reporting that NAPAP's "preliminary results have underestimated the impact of air pollution on forests and crops"); Cass Peterson, *Few U.S. Lakes Damaged by Acid Rain, Federal Group Says*, WASH. POST, Sept. 17, 1987, at A3 (quoting National Resource Defense Council, which characterized a NAPAP report as "nothing more than political propaganda" and quoting senior attorney Richard Ayres, who "accused the task force of ignoring studies inconsistent with the administration's position, selectively quoting from others and accepting unrealistic projections about emission levels in an effort to demonstrate that 'the problem will go away by itself'"). Those who agreed with the recommendations condemned Congress for acting too quickly in passing the aggressive legislation. *See, e.g.*, 136 CONG. REC. H8605 (daily ed. Oct. 2, 1990) (statement of Rep. Applegate) ("Congress is rushing to judgment far too quickly. . . . Each week more truth and fact comes forth to support this.").

133. A supporter of the recommission of NAPAP beyond the 10-year limit pointed out that at a recent meeting of 700 scientists to prepare the final report:

> Many issues were left unresolved. . . . [indicating] the great need to continue NAPAP beyond its original ten-year mandate. We have before us a clean air bill that would impose strong—and costly—acid rain controls. It is both fiscally and scientifically prudent to continue NAPAP's research into acid rain and the results of our control efforts. Doing so is the only way to enable us to know just what we are getting from our efforts.

136 CONG. REC. S1276 (daily ed. Feb. 20, 1990) (statement of Sen. Moynihan); *see also Acid Rain Program Shifts Gears to Study Effectiveness of Air Act SO2 Limits*, Int'l Env't Daily (BNA) (Jan. 16, 1992). For general criticisms of this congressional response to the NAPAP report, see Comment, *Potential Fall Out from the National Acid Precipitation Assessment Program*, 6 BYU J. PUB. L. 423, 441-42 (1992) ("If the NAPAP has been unable to identify the causes and effects of acid rain, its ability to monitor the effectiveness of the new acid rain controls is doubtful.").

panels it has commissioned to provide guidance on global warming.[134] Daniel Sarewitz concluded from his research of these events:

> Just as the driver of a car, stopping to ask directions, would not be much helped by a sidewalk lecture of the thermodynamics of the internal combustion engine, neither will politicians find that an improved understanding of the intricacies of atmospheric processes can much help them to evaluate policy options for responding to global change.[135]

3. *Other Examples of Congress Misgauging the Limits of Science*

Other patterns of error, albeit much less pervasive, may occur with regard to Congress's appreciation of the limits of science and why these limits exist. Although many scientific uncertainties that plague environmental problem solving cannot be resolved in the near term, some can, but their resolution often requires focused legal direction because of the disinclination of the private sector to gather this information voluntarily. Yet, in a few statutes Congress has failed to gain an adequate appreciation for these entrenched, but preventable, uncertainties and has ultimately developed legislation that mistakenly assumes that the collection of baseline data or basic safety testing will be gathered without congressional action. Congress's failure to understand that market forces will not produce baseline toxicity data on products is perhaps the most troubling example of this type of legisla-

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134. After dedicating considerable sums to studying the problem in a rather undisciplined way, Congress tasked an NAS panel with assisting it in developing research priorities on global warming. *See* 42 U.S.C. § 8911 (1994). The resulting report seemed to overlook the social futility of much of the current research and provided little guidance for the future, other than identifying over a hundred projects with no prioritization scheme. *See* Woodhouse, *supra* note 26, at 147. Edward Woodhouse, a political scientist, has concluded that "[i]nstead of recognizing the inevitability of uncertainty and developing strategies to act in spite of it, [Congress's] greenhouse policy has focused almost exclusively on an (apparently) illusory effort to overcome uncertainty." *Id.* at 148. Daniel Sarewitz reaches a similar conclusion on Congress's global change research agenda, which appears driven by scientifically interesting questions, rather than socially important questions:

> Meanwhile, the global change research agenda concentrates almost entirely on large-scale atmospheric, oceanic, and earth processes. A trivial 1.5 percent of the research budget is devoted to understanding the societal impacts of and human response to climate change. Even less has been allocated to exploring mechanisms for bridging the gap between the information needs of policy makers and the research agenda of scientists. As a consequence, policy makers will find themselves increasingly frustrated by the inability of scientists to provide definitive guidance on global change policy, and scientists will find themselves increasingly exasperated by the scientific illiteracy of politicians who want authoritative answers to seemingly simple questions. Meaningful political and social action will continue to be held hostage to these proceedings.

SAREWITZ, *supra* note 24, at 89; *see also id.* at 180 (explaining that in the "U.S. Global Change Research Program . . . there has been a recognition among numerous policy analysts that the putative political and social goals for this program are largely unrelated to the actual research agenda"); Rubin et al., *supra* note 129, at 50 (observing that most of the research in the government's global climate change research program is "motivated by scientific inquiry or existing programs, not policy issues").

135. SAREWITZ, *supra* note 24, at 86.

tive omission.[136] Because of Congress's inattention, the laws passed to protect society from toxic products not only often fail to require basic toxicity testing,[137] but in some cases could even discourage this testing by using adverse toxicity data as the trigger for regulation.[138] Voluntary toxicity testing is, therefore, potentially rewarded only with additional regulation, while the choice to remain ignorant goes unpunished.

A different illustration of this same type of legislative error comes from Congress's failure to provide for rigorous baseline monitoring of existing water quality in the Clean Water Act. The result of this legislative oversight has been a water quality statute that has produced surprisingly little scientific data upon which to judge the past twenty-five years of regulatory efforts.[139] Several years ago, the Council for

136. For a number of reasons, this baseline toxicity data is unlikely to be encouraged by the marketplace. *See* Clayton P. Gillette & James E. Krier, *Risk, Courts, and Agencies*, U. PA. L. REV. 1027, 1038-40 (1990) (arguing that "[c]ommonly producer firms simply won't *have* good information about risk (often because, as we shall see, they are not stimulated to have it) or, if they do, won't act on it or share it with typically underinformed consumers and employees"); Mary L. Lyndon, *Information Economics and Chemical Toxicity: Designing Laws to Produce and Use Data*, 87 MICH. L. REV. 1795, 1810-17 (1989) (describing market failure in safety testing of chemical products). In addition, safety research in its present form is a "free good." If a manufacturer conducts safety tests and determines that a product is safe, other manufacturers also making that product benefit from this research and yet pay nothing. *See* Applegate, *supra* note 69, at 298-99 (noting that safety information regarding chemicals "is a public good, . . . which reduces to practically nil any return to these persons on investment in research").

137. Indeed, only a subset of drugs, food additives, pesticide products, and a small universe of chemicals are actively regulated by agencies, although in theory existing statutory authorities would allow them to do far more. *See* STEERING COMM. ON IDENTIFICATION OF TOXIC & POTENTIALLY TOXIC CHEMS. FOR CONSIDERATION BY THE NAT'L TOXICOLOGY PROGRAM, NAT'L RESEARCH COUNCIL, TOXICITY TESTING: STRATEGIES TO DETERMINE NEEDS AND PRIORITIES 48, 84-85 (1984) (listing a number of chemicals in various categories, 74% (over 48,000) of which are identified as largely unregulated "chemicals in commerce," and observing that because of more limited regulation, toxicity testing is more sporadic on this large subset of all chemicals); Applegate, *supra* note 69, at 318-32 (proposing refinements to the TSCA to better allow the EPA to narrow the information gap on toxicity of many chemicals).

138. For example, although testing is not required, statutes or regulatory authorities often require manufacturers to disclose information that suggests that a product is hazardous. *See* 15 U.S.C. § 2607(c) (1994) (TSCA) (indicating that the EPA may require industries to keep records of "significant adverse reactions . . . alleged to have been caused" by regulated chemicals); 7 U.S.C. § 136f(a) (1994) (same under FIFRA); 42 U.S.C. § 6924(a)(1) (1994) (same under RCRA); § 9603(d) (same under CERCLA); *see also* Wendy E. Wagner, *Choosing Ignorance in the Manufacture of Toxic Products*, 82 CORNELL L. REV. 773, 788-89 (1997) (outlining how existing regulatory programs may create additional incentives for manufacturers to avoid, rather than to conduct, basic long-term toxicity testing); Woodhouse, *supra* note 26, at 149 (criticizing TSCA for basing priorities in part on exposure data when no program is created or funded to collect this information and suggesting that this failure of TSCA undercuts the success of the resultant program). Tort laws further reinforce, rather than counteract, these incentives. *See* Wagner, *supra*, at 790-96.

139. *See, e.g.*, ROBERT W. ADLER ET AL., THE CLEAN WATER ACT 20 YEARS LATER 33 (1993) (observing that the "[l]ack of federal leadership has resulted in the complete absence of monitoring in some states and in substantial variations in testing methods and closure standards. Only four states use EPA's recommended testing method." (citing 1992 and 1993 NRDC reports)); Houck, *supra* note 4, at 412 (observing that "[e]ven today, after nearly thirty years of effort on this approach to water pollution control, fewer than half the waters of this country are monitored for even the crudest pollutants, and then as infrequently as once a month"). Although

Environmental Quality concluded that this paucity of data "preclude[s] assessing an overall national water quality trend."[140]

A related, but separate, type of legislative error has occurred when the limits of science are widely recognized. In this much more aberrational case, Congress again has failed to gain a comprehensive understanding of those uncertainties that are unlikely to be resolved in the near term and those that may be resolved with legislative attention. The only, or at least the most notable, example of this error is the infamous Delaney Clause of the Food, Drug, and Cosmetic Act.[141] In the process of developing this legislation Congress became so overwhelmed by the dramatic limits of science in determining a no threshold or "safe effects" level for carcinogens that it overreacted and "locked in" existing scientific uncertainties by legislating a flat prohibition on the introduction of *all* carcinogens into food or drug additives.[142] This complete prohibition foreclosed the ability of policymakers to call upon or encourage modest, but nevertheless foreseeable, developments in toxicology that would be able to isolate ex-

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this omission might be the work of lawmakers sympathetic with state fiscs, the lack of controversy regarding such an important omission suggests that it likely was not deliberated carefully or openly.

140. COUNCIL ON ENVTL. QUALITY, ENVIRONMENTAL QUALITY: THE TWENTY-SECOND ANNUAL REPORT OF THE COUNCIL ON ENVIRONMENTAL QUALITY 187 (1992).

141. This same error may also have been committed in Section 109 of the Clean Air Act. It can be inferred rather indirectly that Congress "locked in" the then scientific consensus that widespread air pollutants like ozone and carbon monoxide exerted threshold effects, which in turn made science-based standards more reasonable in an economic sense. To the extent that this assumption is now under question, it also raises some rather important additional concerns regarding Section 109 that go beyond its inherent science-based approach. Standards to protect public health from adverse health effects for nonthreshold pollutants, in theory, should be set at zero. This, however, would end all economic activity as we know it. Congress may have also locked in scientific consensus that relative prioritization of animal and plant species was impossible, even though in retrospect the irreplaceable loss of habitats, coupled with the success of captive breeding, would seem to suggest that some species ought not be protected as vigorously as others. *Cf.* Doremus, *supra* note 8, at 1136-38 (suggesting changes to ESA "strictly science" mandate that roughly provide this sort of de minimis exception authority).

142. *See* 21 U.S.C. §§ 348(c)(3)(A), 379e(b)(5)(B) (1995) (stating that an additive may not be listed as safe if it is found to cause cancer in humans or animals). Note that § 348(c) has been amended by the Food Quality Protection Act to remove this complete prohibition against carcinogens in pesticide residues found in processed food. *See* 21 U.S.C.A. § 321(s) (West Supp. 1998); *see also* Richard A. Merrill, *Congress as Scientists*, ENVTL. FORUM, Jan.-Feb. 1994, at 20-24 (describing how Congress locked in the existing scientific consensus in passing the Delaney Clause in 1958 and detailing a series of subsequent scientific advancements that made the Delaney Clause impractical).

Interestingly, other portions of the Delaney Clause seem to provide evidence of Congress's delegation of duties to implementing agencies that Congress mistakenly believed were scientific in nature, in ways similar to those outlined *supra* in notes 88-94 and accompanying text. *See, e.g.*, Merrill, *supra* note 71, at 73 (observing that "[w]hile the history [of the Delaney Clause] supports FDA's central role in determining whether an additive 'induces cancer,' this is repeatedly characterized as a scientific, rather than a legal, determination"); *id.* at 81 (noting that "statements that FDA was to employ the best science in its assessment of animal experiments are easily found" and that "the issue of what 'induces cancer' means is of the sort that the Agency is empowered to resolve").

tremely low-risk substances.[143] Many, including the National Research Council of the National Academy of Sciences, have argued that the rigid approach of the Delaney Clause was unwise policy because it precluded the FDA from using inevitable advances in risk assessment to at least permit de minimis risks.[144]

C. *Summary*

In sum, Congress's record with regard to environmental lawmaking reveals a consistent pattern of misframing multidisciplinary environmental problems as predominantly or exclusively problems that can be resolved with science. A disturbing number of statutes and environmental programs charge agencies or advisory panels with developing science-based programs when the required scientific information may not be obtainable. Others presume needed baseline data will be collected without legislative incentives and, in rarer cases, neglect to account for foreseeable developments in science that might undercut, however modestly, the existing scientific consensus. The reasons for these recurring congressional blind spots with regard to the limits of science (in contrast to Congress's potentially solid incorporation of positive scientific knowledge) is the subject of the next section.

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143. *See generally* AMES, *supra* note 60, at 130 (citing FDA Commissioner Kennedy in 1978 as conceding that the Delaney Clause type of disputes, like the one involving saccharine, may have been partly avoided "if Congress would regularly review laws that involve technologies that are changing rapidly"); Merrill, *supra* note 71, at 2, 12-41 (outlining the ways in which scientific developments occurring after passage of the Delaney Clause have "frustrated both the Clause's opponents and its defenders," and, as a result, the implementing agency has had to reinterpret the mandate). The Delaney Clause may also be seen as an example of a situation in which Congress actually did understand the limits of science, but overreacted and excluded the information that science provided or would be able to provide in the foreseeable future. This locking in of risk-averse policy judgments that excludes future scientific developments is more worrisome in that it suggests that Congress may pass unsophisticated legislation even when it does comprehend the extent of existing scientific uncertainties. On another level, however, it may be that this type of reaction at least errs on the side of public health explicitly. In contrast, the scientification of policy judgments generally results in policy choices being made that are not well understood or might even be misunderstood. *See infra* notes 296-304 and accompanying text.

144. *See* COMMITTEE ON SCIENTIFIC & REGULATORY ISSUES UNDERLYING PESTICIDE USE PATTERNS & AGRIC. INNOVATION, NATIONAL RESEARCH COUNCIL, REGULATING PESTICIDES IN FOOD: THE DELANEY PARADOX 12-14, 40-43 (1987); Merrill, *supra* note 71, at 2-3 (criticizing the Delaney Clause because of its policy inflexibility); Douglas T. Sheehy, *A* De Minimis *Exception to the Delaney Clause: A Reassessment of* Les v. Reilly, 50 FOOD & DRUG L.J. 257, 260-61 (1995) (same); *see also* Public Citizen v. Young, 831 F.2d 1108, 1122 (D.C. Cir. 1987) (concluding that an agency may not list a color additive as safe, even if the risks to human health are at best "de minimis"); Les v. Reilly, 968 F.2d 985, 990 (9th Cir. 1992) (finding that the EPA's de minimis risk policy for food additives that induce cancer is contrary to provisions of the Delaney Clause). The Delaney Clause has also been criticized because it requires the EPA to ban carcinogenic pesticide residues in processed foods, while allowing the EPA to use a risk-benefit test for carcinogenic residues in raw foods. *See, e.g.*, Regulation of Pesticides in Food: Addressing the Delaney Paradox Policy Statement, 53 Fed. Reg. 41,104 (1988).

III. WHY CONGRESS FRAMES ENVIRONMENTAL PROBLEMS AS IF THEY CAN BE RESOLVED BY SCIENCE

That Congress can, on the one hand, be relatively proficient at finding and following scientific facts and figures and, on the other, be deficient in respecting the limits of scientific knowledge when developing legislation seems initially contradictory. Yet common sense provides a quick and accessible answer. Positive scientific knowledge is politically appealing. Because scientific findings inform the resolution of environmental problems in seemingly objective and respected ways, positive scientific knowledge remains at the forefront of congressional deliberations and usually receives, and ultimately benefits from, congressional airing and adversarial debate. By contrast, scientific uncertainties are generally a political liability, and, therefore, ignorance of the uncertainties is politically rational.[145] Not only are these uncertainties more difficult to define precisely, but they move the debate back to Congress, rather than toward an objective, respected scientific answer. As a result, scientific uncertainties are rarely popular on the Hill.[146]

The in-depth exploration of congressional decisionmaking, detailed in this part, confirms and expands significantly on this commonsense explanation. The adversarial process embodied in most congressional decisionmaking does provide generally reliable quality control on Congress's scientific fact-finding, while offering much less assurance in detecting Congress's misframing errors, except in the most extraordinary circumstances where the unrealistic overreliance on science is conspicuously used as a political tactic to delay legislation. But this is only part of the problem. Misframing errors are also rooted in the motivations and careless omissions of external actors such as the scientific community, in the unrealistic demands of the public at large, and in the analytical gaps that have become a practical reality in current methods of congressional decisionmaking. Understanding and ultimately reforming the pattern of legislative misframing errors requires careful attention to the larger tangle of forces and factors that combine to make it unlikely that federal legislators will notice misframing errors or take measures to correct them.[147]

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145. For a general discussion of rational ignorance in public affairs, see Mancur Olson, *Rational Ignorance, Professional Research, and Politicians' Dilemmas*, *in* KNOWLEDGE, POWER, AND THE CONGRESS 130 (William H. Robinson & Clay H. Wellborn eds., 1991). For a discussion of the greater political saliency of scientific uncertainties during the debates on *whether* to take legislative action, see *supra* note 78.

146. *Cf.* SCHON & REIN, *supra* note 84, at 184 (describing how a "hostile environment" comprised of powerful protagonists is necessary to call attention to the types of frames constructed to define and solve problems). Scientific uncertainties are sometimes politically interesting, however, when partisan motives can be readily attached to a legislator's position with regard to the uncertainties. *See supra* note 78.

147. *See generally infra* notes 305-68 and accompanying text.

To understand why Congress does something, one must first understand why the individual legislators think, debate, and vote the way they do. The prevailing theories of congressional decisionmaking can be roughly summarized in three descriptive (and in some cases normative) models.[148] According to these models, members of Congress base decisions on (1) the unadulterated preferences of the electorate (the "agency" model); (2) public choice motivations; or (3) the legislators' own superior vision of what best serves the public (the Madisonian/Burkean model). The investigation in this part reveals that, despite their differences, each model of congressional behavior can be used to explain why members of Congress rely unrealistically on science when developing environmental legislation, yet excel at identifying and using available positive knowledge.

A. The Legislator as Direct Agent: Popular Democracy

The oldest model of congressional behavior, the popular democracy model, depicts a federal legislator as the direct representative or agent of the people. Although the normative superiority of this model has been generally rejected,[149] it still provides a descriptive representation of some congressional behavior.[150] Congressional decisionmaking sometimes does track the polls, and members of Congress are purported to be extremely attentive to the media.[151] Although this research does not support the conclusion that Congress will always defer to the preferences of the electorate, it does illustrate how important the views of the electorate continue to be to many lawmakers.[152]

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148. *See* JERRY L. MASHAW, GREED, CHAOS, & GOVERNANCE: USING PUBLIC CHOICE TO IMPROVE PUBLIC LAW 38 (1997) (observing that "no one has yet been able to tell us more than that legislators seem to act out of some mix of personal ideology and reelection-oriented self-interest"). There is also a fourth "institutional actor" model that considers congressional decisionmaking from the standpoint of interactions and collaborations. Because this model largely collapses into the others with regard to the misframing error, this model is discussed at the end of the Madisonian discussion. *See infra* notes 268-72 and accompanying text.

149. *See* MASHAW, *supra* note 148, at 201 (observing that popular democracy is made considerably less attractive by voting theory: "If the political process allows anybody to put anything on the table to be voted up or down against any number of alternative proposals, the outcome is likely to be chaotic.").

150. *See, e.g.*, Herbert Hovenkamp, *Legislation, Well-Being, and Public Choice*, 57 U. CHI. L. REV. 63, 89 (1990) (discussing "democratic bias" of legislation where legislators focus on the number of voters rather than the number of dollars and observing that "this democratic bias is important even though it does not control all votes"); *cf.* Dwyer, *supra* note 8, at 243-45 (suggesting that strong popular support for environmental causes helps to explain its strong cost-blind prohibitions).

151. *See generally* STEPHEN HESS, LIVE FROM CAPITOL HILL!: STUDIES OF CONGRESS AND THE MEDIA (1991).

152. Professor Arnold argues that many members of Congress may generally follow this direct agent model when the causal connection between public preferences and legislative outcomes is relatively direct and retrospective evaluation by the electorate is possible. *See* R. DOUGLAS ARNOLD, THE LOGIC OF CONGRESSIONAL ACTION 20-21, 28 (1990) ("The longer the causal chain, the more difficult it is to predict anything about the incidence of costs and benefits at the final stage."). Under such a model of behavior, moreover, federal lawmakers may engage in a potentially elaborate effort to predict electorate preferences for policies that have not yet

With regard to the use of science in developing policy, the legislator acting as a direct agent of (or surrogate for) the average citizen can generally be expected to place considerable faith in science to provide policy guidance or even policy answers to most environmental problems.[153] The reason for this is simple—the public itself appears to place great confidence in the capabilities of science.[154] The direct agent lawmaker accordingly views these problems through the public's metacultural frame, which positions science as the institution best

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received electorate attention. *See id.* at 17 ("For each issue before Congress, legislators need to estimate which of their constituents might someday acquire policy preferences, how those constituents might divide on the issue, and how deeply they might feel about it."). Arnold's theory has interesting implications for the highly complicated body of environmental laws, where it can be argued that the causal chain is extraordinarily attenuated and thus the electorate preferences less important. For example, the passage of a law that sets as its goal the elimination of the discharge of pollutants into navigable waters by 1985, *see* 33 U.S.C. § 1251(a)(1) (1994), and that has set up an extraordinarily detailed state and federal enforcement regime, *see* §§ 1319, 1365, 1367, ultimately cannot be evaluated for its effectiveness, in part, due to the lack of comprehensive and reliable water quality data. *See supra* notes 144-45 and accompanying text. Thus, Congress also has the power to control the information necessary for evaluating its legislative performance and can insulate itself still further from electorate demands.

153. *See, e.g.*, Comment of V, *Environment, Energy, and Economics*, *supra* note 75, at 120 (arguing that "absence of integrated policy in the energy field" is not due to fragmentation of Congress, but instead because "[o]ur legislative process is based on 100 not very wise Senators and 435 not very wise Congressmen reflecting policies that they perceive to be coming from the electorate"); Elliott et al., *supra* note 8, at 328, 336-37 (hypothesizing and then citing an example of how, in the case of environmental lawmaking, "[i]nstead of checking and balancing opposing forces, the separation of powers may generate a system in which lawmakers compete to impress a poorly informed public with the strength of their symbolic commitments"); Fallows, *supra* note 53, at 87 (reporting that several nuclear staffers commented that even when technical information is irrelevant to policy choices, "the public generally views technical expertise favorably and confers greater respect and confidence in the activities of politicians who associate with experts").

Other related problems in environmental law—symbolic legislation and scapegoating—appear also to rely in part on this model. *See* Bradley C. Bobertz, *Legitimizing Pollution Through Pollution Control Laws: Reflections on Scapegoating Theory*, 73 TEX. L. REV. 711, 751 (1995) (observing that "environmental lawmaking may be better understood as a *cultural* phenomenon [highlighting cultural weaknesses] than as merely a legal one"); *see also* Dwyer, *supra* note 8 (discussing the problem of symbolic legislation). For policy circumstances under which legislators may be much less deferential to science and scientists (typically social problems that do not concern the environment), see *supra* note 60.

154. *See* Rae Goodell, *Problems with the Press: Who's Responsible?*, *in* SCIENCE OFF THE PEDESTAL, *supra* note 26, at 31, 35 (noting that "science's public image is . . . too positive" and that the public's expectations of science are "too high"). There is a small percentage of the population that represents an "anti-science" contingent. They believe that science offers little, if anything, to an understanding of the natural world, much less to the resolution of social problems. *See* GERALD HOLTON, SCIENCE AND ANTI-SCIENCE 145-84 (1993) (discussing the antiscience movement). This group currently appears not only to be small in number, but in voice. *See generally* Andrew Lawler, *Selling Science: At What Price?*, 275 SCIENCE 296 (1997) (observing that polls and surveys show significant public support for increased federal funding of biomedical research); *see also infra* notes 157-59. Even though, at present, this devaluation of science is limited, some speculate that a large-scale public rejection of science is looming because of the inability of science to unequivocally declare the "truth." *See, e.g.*, YARON EZRAHI, THE DESCENT OF ICARUS: SCIENCE AND THE TRANSFORMATION OF CONTEMPORARY DEMOCRACY 272 (1990) (observing that the "increasingly visible rift between scientific and common sense knowledge . . . has inevitably devalued science as a cultural resource").

able to cure or at least resolve these complicated social dilemmas.[155] Evidence of this public overconfidence in the capabilities of science to resolve policy issues is provided in several separate bodies of research.[156]

First and most straightforward, the public has indicated in the polls that it prefers scientists to solve environmental problems.[157] Perhaps not coincidentally, the polls also indicate that scientists are held

155. Schon and Rein coin the term "metacultural frames" to refer to constructions of problems that are based on "local expressions of broad, culturally shared systems of belief." SCHON & REIN, *supra* note 84, at 33. These frames, which are essentially ways of seeing a problem, can cause certain perceptions or constructions of social problems to be excluded from consciousness. *See id.* Additionally, these "frames that shape policy positions and underlie controversy are usually tacit, which means that they are exempt from conscious attention and reasoning." *Id.* at 23. Unlike most frames, which cannot be falsified because of the lack of an objective reference point, *see id.* at 30, the metacultural frame that views the cure for the diseased environment to be scientifically determined pollution standards or other quantitative limits is one that can be falsified when the data is absent or the scientific tools are inadequate for the ambitious task.

156. It may be necessary to draw distinctions among the public's trust in "pure" scientific research, in scientists, and in the fruits of scientific-technological innovation. Although there may be some growing misgivings about the latter two categories, the public's respect for scientific research appears very strong. *See* Doremus, *supra* note 8, at 1037-40 (describing public ambivalence to science, but assigning much of the ambivalence to concerns about the risks of new scientific and technological developments or to views of scientists as hired guns).

157. In a public opinion survey conducted in three California cities, lay subjects were questioned concerning the reliability and preferred authority on technological risk of eight sources of information, including government officials, industry officials, and knowledgeable acquaintances. Of the eight sources, the "university scientist" was considered the most reliable, with 50.4% of the subjects considering the "university scientist" as "completely trustworthy," and 47.1% considering the "university scientist" as "somewhat trustworthy." Marc Pilisuk et al., *Public Perception of Technological Risk*, 24 SOC. SCI. J. 403, 407 (1987). The university scientists also ranked at the top with "people living in affected communities" as the "preferred source of influence on decision making," with 96% believing that the university scientists should have "great influence" or "some influence." *Id.* at 408-09. The authors conclude that "[i]t is likely . . . that the reputation of the independent expert is one that will prove useful to the political process and that university scientists will be called on more often to help allay public fears." *Id.* at 411. Jon Miller similarly found that 92% of the attentive lay public interviewed stated that scientists and engineers are the preferred group to set standards for food additives. *See* JON D. MILLER, THE AMERICAN PEOPLE AND SCIENCE POLICY: THE ROLE OF PUBLIC ATTITUDES IN THE POLICY PROCESS 92 (1983); *see also* NATIONAL OPINION RESEARCH CTR., GENERAL SOCIAL SURVEYS, 1972-1991: CUMULATIVE CODEBOOK 197-200 (1991) (reporting that public surveys reveal that when faced with a choice between entrusting decisions to the executive branch of the federal government or to the scientific community, the public prefers the scientific community by a rather wide margin); NATIONAL SCIENCE BD., SCIENCE & ENGINEERING INDICATORS—1993, at 204 fig.7-9 (1993) (reporting a general social survey, which revealed that "the leadership of medical and scientific communities has been among the most trusted in the nation—more so, for example, than the leadership of the Supreme Court. In 1993, approximately 40% of American adults expressed a high level of confidence in the leadership of these communities."); Andrew Lawler, *Support for Science Stays Strong*, 272 SCIENCE 1256, 1256 (1996) (reporting on recent survey in which scientists rank only behind physicians in public esteem); Kristina Petkova & Pepka Boyadjieva, *The Image of the Scientist and Its Function*, 3 PUB. UNDERSTAND. SCI. 215, 215, 222 (1994) (noting that "[m]any leading sociologists of science have pointed out that the scientist is portrayed by society as an almost mythological figure" and concluding, based on an empirical study, that "the image of the scientist has been described in an elevated way with elements of idealization"); Daniel S. Greenberg, *Thumbs Up for Science*, WASH. POST, July 8, 1996, at A15 (reporting on results of polls taken between 1983 and 1995 that reveal the public consistently ranks scientists well ahead of legislators with regard to their "confidence in the people running various institutions").

in highest esteem relative to all other professional groups, with the possible exception of physicians.[158] The public thus may prefer scientists to resolve environmental problems because they are viewed as trustworthy and capable of exercising sound judgment. "It is not just that it would be irrational to ignore the findings of science, but for most people, the methods of science provide the standard for rationality."[159]

Surveys also show that the public has a limited understanding of the scientific enterprise, and as a result, may tend to misunderstand and underestimate the multiple limitations and constraints of science.[160] Studies done in the 1980s and 1990s consistently revealed that approximately ninety percent of the American public lacks a working knowledge of basic science.[161] Moreover, only "about one in five

158. *See* Harvey Brooks, *Some Notes on the Fear and Distrust of Science*, *in* FEAR OF SCIENCE—TRUST IN SCIENCE 97, 98 (Andrei S. Markovits & Karl W. Deutsch eds., 1980) ("Scientists as a profession stand very near the top of the scale in public respect and status. Scientists are for the most part treated with greater deference and respect as Congressional witnesses than almost any other professional group."); Diana Crane, *Science Policy Studies*, *in* A GUIDE TO THE CULTURE OF SCIENCE, TECHNOLOGY, AND MEDICINE 638 (Paul T. Durbin ed., 1984) [hereinafter GUIDE TO CULTURE OF SCIENCE] (describing high confidence in scientists throughout the 1970s); Lawler, *supra* note 157, at 1256 (describing a National Science Foundation poll that found adults ranked "leaders in the scientific community . . . second only to physicians in public esteem"). The public does, however, appear to have somewhat contradictory opinions about scientific information. In a recent survey, 76% of the respondents generally agreed with the statement that "you can find a scientific study that proves just about anything you want to prove," yet 86% admitted that references to a scientific study increased the credibility of a story. CYNTHIA CROSSEN, TAINTED TRUTH: THE MANIPULATION OF FACT IN AMERICA 36 (1994).

159. TRIGG, *supra* note 27, at 174. This high respect for scientists may be further reinforced by mass education. *See* Larson, *supra* note 79, at 56 (arguing that "at higher levels, mass education systems communicate to many more people than does elite education the strong ethic of science 'for science's sake' and the legitimacy of its claims for total autonomy").

160. In a recent survey commissioned by the President's Science Advisor "half the adults questioned did not know that it took one year for the Earth to orbit the Sun." D.A. Bromley, *By the Year 2000: First in the World*, *in* REPORT OF THE FEDERAL COORDINATING COUNCIL FOR SCIENCE, ENGINEERING & TECHNOLOGY (FCCSET), COMMITTEE ON EDUCATION AND HUMAN RESOURCES 8 (1991). In a separate survey conducted by Jon Miller this rather depressing indicator of adult scientific illiteracy is repeated. *See* Jon D. Miller, *The Public Understanding of Science and Technology in the U.S., 1990*, *in* DRAFT REPORT TO THE NATIONAL SCIENCE FOUNDATION 1, 1 (Feb. 1991) (reporting that less than 7% of U.S. adults can be considered scientifically literate by the most generous definition and that only 13% have a minimum level of understanding of the process of science). There is not universal agreement on the implications of these studies, however. Brian Wynne argues persuasively that the surveys themselves are biased and marginalize the public's scientific capabilities far more than is warranted. *See* Wynne, *supra* note 71, at 370 (arguing throughout the chapter that "large-scale surveys of public attitudes toward and understandings of science inevitably build in certain normative assumptions about the public, what is meant by science and scientific knowledge, and about understanding. They may often therefore reinforce the syndrome . . . in which only the public, and not science or scientific culture are problematized"); *see also* Bruce V. Lewenstein, *Science and the Media*, *in* JASANOFF HANDBOOK, *supra* note 8, at 343, 353 (citing studies showing that when a "scientific and technological issue has direct impact on a community, members will quickly and accurately acquire significant amounts of technically sophisticated information").

161. *See* NATIONAL SCIENCE BD., *supra* note 157, at 196 fig.7-2 (showing that only slightly over 10% of adults believed they were informed on science issues); *id.* at 200 (stating approximately 10% of the U.S. population "display a high level of interest" in science, "believe that they are well-informed about it," and "display a pattern of current information consumption"); *id.* at

American adults was able to provide an acceptable definition of a scientific study" and "not more than a third of American adults have a minimal understanding of scientific process."[162] The lay public's misconception of the unlimited capabilities of science is further reinforced by seemingly miraculous advances in technology that receive disproportionate media attention and are often presented in ways that eclipse equally important issues regarding the limitations of that very same technology or scientific research.[163] The public and its lay representatives may understandably expect that if scientists can send a robot to Mars or clone sheep,[164] they can determine what measures need to be taken to make rivers and lakes "fishable and swimmable" and the level at which a particular toxin will present a one in one million risk of cancer.[165]

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209 (concluding that results of 1992 study on public attitudes toward science "point to substantial gaps in the public understanding of environmental science concepts" despite "a high level of public concern about the environment"); NATIONAL SCIENCE BD., SCIENCE INDICATORS 153 (1985) (concluding that when polled, the public reported that 14% considered themselves "very well informed about science," yet an independent measure of scientific literacy placed only 7% of the population in this category).

162. NATIONAL SCIENCE BD., *supra* note 157, at 210.

163. *See, e.g.*, JOHN HORGAN, THE END OF SCIENCE: FACING THE LIMITS OF KNOWLEDGE IN THE TWILIGHT OF THE SCIENTIFIC AGE 245 (1996) (discussing, in the context of the public seeing no "end to science," the "Star Trek factor" that derives from the public's perception of rapid scientific advances that promise such future discoveries as "time travel, teleportation, and parallel universes"); DOROTHY NELKIN, SELLING SCIENCE: HOW THE PRESS COVERS SCIENCE AND TECHNOLOGY 34 (1987) (noting how the press often focuses on the technological frontier of science, conveying a sense "that the new development will give society the magic to cure economic or social ills," but that the press typically leaves out a "clear presentation of the role of technology and a clear assessment of its effects" on society); Lewenstein, *supra* note 160, at 355 (discussing and citing several studies of television coverage of science that usually portray "uncertain outcomes . . . as displays of certainty"). Scientific and social science experts may exacerbate this portrayal of science as providing the answer to everything. *See, e.g.*, SAREWITZ, *supra* note 24, at 160-63 (discussing how social issues like environmental quality "become redefined as questions of costs and benefits—that is, as technical issues that are best resolved by technical experts"); *see also infra* Part III.C.1, notes 205-27.

164. *See* Brian A. Brown, *Cloning: Where's the Outrage?*, WALL ST. J., Feb. 19, 1998, at A22 (discussing social issues surrounding the ability of scientists to clone sheep); Joshua H. Prager, *Life on Mars? We Were on Top of That Big Story 90 Years Ago*, WALL ST. J., Dec. 8, 1997, at B1 (describing a NASA report finding evidence of microbial life on Mars and relating it to similar reports occurring 90 years earlier).

165. *See, e.g.*, 33 U.S.C. § 1251(a)(2) (1994) (stating as the "national goal" that "wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water be achieved"); 42 U.S.C. § 7412(c)(9)(B)(i) (1994) (allowing the EPA to remove a source category from the list promulgated under hazardous air pollutant regulations upon "a determination that no source in the category . . . emits such hazardous air pollutants in quantities which may cause a lifetime risk of cancer greater than one in one million to the individual in the population who is most exposed to emissions of such pollutants from the source"). In some instances the public has gone so far as to vest faith in the capabilities of technology, even when mainstream science has expressed serious doubts about a purported scientific discovery. Laetrile, for example, was purported by a small group of scientists to be a wonder drug for cancer. Despite the opposition of the "American Cancer Society, the American Medical Association, the Food and Drug Administration, and most cancer researchers and oncologists" to the drug because of its unproven effects, half of the state legislatures voted to legalize laetrile. James C. Petersen & Gerald E. Markle, *Controversies in Science and Technology*, *in* SCIENCE OFF THE PEDESTAL, *supra* note 26, at 5, 11.

A general inclination of the public and its congressional agents to turn environmental problems over to scientists may be further fostered by a mentality that "ignorance is bliss" when it comes to considering serious social problems. Professor Dorothy Nelkin, a sociologist, has suggested the public's reliance on science and scientists could be a subconscious effort to avoid confronting social issues by assuming the problems can be resolved with technical solutions: "It is . . . comforting [to the public] to believe that there is definitive, science-based information relevant to understanding and resolving social problems."[166]

Finally, there is some evidence to suggest that an unrealistic overreliance on science occurs because laypersons do not feel competent to participate in discussions of the technical aspects of environmental problems.[167] Because science does inform environmental decisionmaking and because the delineation between positive knowledge and the knowledge gaps can be quite esoteric, the public, and its direct representatives, may not feel that they have the requisite knowledge and skills to competently participate in technical discussions, even if

166. Dorothy Nelkin, *After* Daubert: *The Relevance and Reliability of Genetic Information*, 15 CARDOZO L. REV. 2119, 2126 (1994); *see also* DOROTHY NELKIN & LAURENCE TANCREDI, DANGEROUS DIAGNOSTICS: THE SOCIAL POWER OF BIOLOGICAL INFORMATION 9-10 (1989) (describing society's "actuarial mind-set," which thrives on data and quantitative information, even when the accuracy of diagnostic tests are in doubt and society's parallel "tendency to reduce complex behavior to measurable biological dimensions . . . which [ultimately] medicalize social problems"); Rochelle Cooper Dreyfuss & Dorothy Nelkin, *The Jurisprudence of Genetics*, 45 VAND. L. REV. 313, 338, 345 (1992) ("[I]n its promise of neutrality, predictability, and certainty, science holds extraordinary appeal for the legal system. . . . Biology does not offer a determinative answer, only an easy one."). This avoidance of public controversy may also motivate the public choice legislator who typically flees from reelection-threatening debates. *See infra* notes 197-98 and accompanying text.

Science offers an easy and value-neutral "out" for confronting many of the controversial and very personal realities that emerge from environmental problems. In a recent article, Brad Bobertz makes a somewhat similar argument about the more general human tendency to seek scapegoats for difficult social problems. He concludes that current "environmental legislation presents a striking example of how the law can legitimate an existing state of affairs while simultaneously creating the appearance of reforming it." Bobertz, *supra* note 153, at 715. Delegating the social problems to scientists may put off or eliminate immediate lifestyle changes that would otherwise seem necessary to address current environmental problems.

167. See *infra* note 232 for a reaffirmation of this view by a congressional staffer. The media may add to this sense of lay alienation. "Too often the [media] coverage [of science] is promotional and uncritical, encouraging apathy, a sense of impotence, and the ubiquitous tendency to defer to expertise." NELKIN, *supra* note 163, at 173. The public desire for cultural reaffirmation, rather than transformation, may actually cause the press to cater to the public's vision and reinforce the characterization of science as a truth-seeking enclave largely immune from political pressures. *Cf.* Bobertz, *supra* note 153, at 728-29 (describing journalists' superficial coverage of the Exxon-Valdez oil spill as "tale of a drunken sailor and a dark-hearted company"). For a discussion of the importance of the media to both the general public and members of Congress in particular, see James E. Katz, *Science, Technology, and Congress*, SOCIETY, May-June 1993, at 41, 41-42; *see also* NELKIN, *supra* note 163, at 59 (explaining that an examination of press coverage of cyclamates and saccharine revealed that journalists' "characterization of science perpetuates several popular myths: that science can provide definitive answers about risk, that 'facts' speak for themselves rather than being open to interpretation, and that decisions about what risks are socially acceptable are scientific rather than political judgments").

they understand that, in theory, they should play an important role.[168] Research reveals that people are more inclined to participate in decisionmaking when they are both interested in the issue and feel that they can contribute meaningfully to the decision.[169] If the questions ripe for public debate are perceived to be scientific or technical in nature, laypersons may not know how or where policy input is needed. Until the gaps in scientific knowledge are distinguished from positive scientific knowledge and communicated effectively, the public and its congressional representatives may continue to be disinterested or uninvolved in environmental decisionmaking.[170]

In sum, the tendency of laypersons to expect too much from science and scientists seems to be a deeply ingrained cultural phenomenon. To the extent that members of Congress seek to represent the views of the general electorate, they too will place more reliance on science to resolve pressing policy problems than is realistic or appropriate.

B. The Public Choice Legislator

It is at times difficult to isolate public choice theories as both something unified and something distinct from the other models of congressional behavior.[171] Yet, to the extent that public choice legisla-

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168. *See* NELKIN, *supra* note 163, at 15. As Nelkin observes:

> Science often appears in the press today as an arcane and incomprehensible subject, far from organized common sense. And scientists still appear to be remote but superior wizards, above ordinary people, culturally isolated from the society. . . . Far from enhancing public understanding, such press coverage creates a distance between scientists and the public that, paradoxically, obscures the importance of science and its effect on our daily lives.

Id.

169. *See generally* Mauk Mulder, *Power Equalization Through Participation?*, 16 ADMIN. SCI. Q. 31 (1971).

170. The bitter irony is the self-perpetuating nature of the problem. Because the public tends to entrust too much to science, it becomes increasingly alienated from participating *because* it has erroneously relegated the issues to scientific experts. If the public began with a clearer sense of the limits of science, or the significance of the knowledge gaps, it might feel more competent to participate in the resolution of these pressing social problems.

171. Particularly with regard to the incentives of various outside actors who inform and influence federal legislators, there is a good deal of overlap between the Madisonian legislator's access to information and the public choice legislator's reaction to it. Interest group theories, in fact, are purportedly based on Madisonian concepts. *See* WILLIAM N. ESKRIDGE, JR. & PHILIP P. FRICKEY, CASES AND MATERIALS ON LEGISLATION: STATUTES AND THE CREATION OF PUBLIC POLICY 49 (2d ed. 1995) (observing that "most pluralists claim inspiration from Madison's work"). Interest group or pluralism models, however, form the foundation for much of the public choice literature. *See* MASHAW, *supra* note 148, at 21 (suggesting that public choice theories broadly include a view of public laws that result only from "a particular concatenation of private preferences made politically relevant by the dynamics of self-interested behavior on the part of voters and officials alike"); Gary S. Becker, *A Theory of Competition Among Pressure Groups for Political Influence*, 98 Q.J. ECON. 371, 373-74 ("The basic assumption [of public choice theory] is that taxes, subsidies, regulations, and other political instruments are used to raise the welfare of more influential pressure groups.").

There is also a good deal of overlap between the legislator-as-agent and the public choice legislator. *See, e.g.*, ESKRIDGE & FRICKEY, *supra*, at 55 (explaining that under public choice theory, "a representative faced with a consensual constituency simply votes in accordance with

tors can be distinguished, they are exclusively concerned with winning their battles, which usually includes being reelected.[172] In doing so they may or may not optimize the public good or serve the public's wishes.[173] As one might expect, such an orientation is generally not conducive to developing legislation that openly identifies and adapts to gaps in scientific knowledge. As outlined in fuller detail below, public choice legislators face a number of different reasons to either manipulate or remain rationally ignorant about the knowledge gaps in environmental policymaking.

1. Deliberate Manipulation of Scientific Uncertainties

Scientific uncertainties provide scientifically sophisticated members of Congress splendid opportunities to advance their own political goals without detection. For example, if scientifically sophisticated legislators wish to slow or halt environmental programs, they will simply ensure either that definitive scientific research is a prerequisite to regulatory action or that the agency's regulatory justifications be based on "sound science" or rigorous cost-benefit analysis. Because these scientific tools are incapable of providing such definitive answers, the regulatory process will be stalled, perhaps indefinitely.[174]

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the groups' preferences and keeps the seat 'safe'"). Both will represent the public consensus if it affects election chances, even if that consensus goes against the greater public good as seen by a deliberative, Madisonian policy analyst.

172. For the seminal research that best defines public choice theory, see generally KENNETH JOSEPH ARROW, SOCIAL CHOICE AND INDIVIDUAL VALUES (2d ed. 1963); JAMES M. BUCHANAN & GORDON TULLOCK, THE CALCULUS OF CONSENT: LOGICAL FOUNDATIONS OF CONSTITUTIONAL DEMOCRACY (1962); WILLIAM A. NISKANEN, JR., BUREAUCRACY AND REPRESENTATIVE GOVERNMENT (1971); MANCUR OLSON, JR., THE LOGIC OF COLLECTIVE ACTION: PUBLIC GOODS AND THE THEORY OF GROUPS (1965); GEORGE JOSEPH STIGLER, THE CITIZEN AND THE STATE: ESSAYS ON REGULATION (1975). For detailed arguments that the primary incentive of a legislator is to be reelected, see generally MORRIS P. FIORINA, CONGRESS: KEYSTONE OF THE WASHINGTON ESTABLISHMENT (1977), and DAVID MAYHEW, CONGRESS: THE ELECTORAL CONNECTION (1974). Reinforcing these arguments are empirical studies that confirm the primary importance of reelection, but also note the secondary import of a legislator's own personal or political beliefs and the short-term influence of interest groups. *See, e.g.*, Hovenkamp, *supra* note 150, at 88.

173. Instead, the singular political objective of public choice legislators is to promote policies that minimize political costs and maximize political credits, however that balance is ultimately struck in specific cases. *See* MAYHEW, *supra* note 172, at 49-77 (arguing that rational congressional activities involve "credit claiming"); *cf.* William H. Rodgers, Jr., *The Lesson of the Red Squirrel: Consensus and Betrayal in the Environmental Statutes*, 5 J. CONTEMP. HEALTH L. & POL'Y 161, 171 (1989) (describing various environmental statutes that appear to have resulted from game theory models of congressional decisionmaking and concluding that this behavior "departs from historical visions of contemporary rationality").

174. In the course of the House's passage of H.R. 9 during the 104th Congress, supporters of the bill candidly admitted the delays that would be caused by the bill's research, peer review, and cost-benefit requirements. *See* Bob Benenson, *House Easily Passes Bills to Limit Regulations*, CONG. Q. WKLY. REP. 679, 682 (1995) (quoting Republican Rules Committee Chairman Gerald Solomon as stating that "[f]or years, business and industry have been forced to jump through hoops to satisfy regulators in the bureaucracy. Well, if this legislation becomes law, we are going to turn that around."). For example, under H.R. 9, the agency would have been required to conduct additional substantive analyses in its risk assessments which would have further depleted limited agency time and resources. *See* H.R. 9, 104th Cong. § 414(b)(1) (1995) (mandating

Blame for the inevitable regulatory failure can then be placed on the agencies because the causal connection between a mandate that invests too much stock in science and the agencies' failure to implement that mandate years later can be quite attenuated, particularly if the agencies also perpetuate the myth that science can provide more answers than it in fact can.[175]

Scientifically sophisticated public choice legislators can also exploit the knowledge gaps by converting the uncertainties into a debate over good science. This approach can be used by those on either side of the environmental policy debate. Rather than calling attention to the knowledge gaps, this legislator obfuscates them still further by summoning hand-picked experts to present scientific-sounding arguments that support the legislator's position. In reality the experts'

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that certain government agencies must prepare a risk assessment document including a discussion of conflicts in existing studies and data); H.R. 9 § 415(3) (requiring the agency to compare the risk in question to similar risks, such as skiing and driving a car); H.R. 9 § 415(4) (requiring agencies to include analyses of substitute risks—risks of products that could be substituted for the risk at issue). The substantial peer review requirements incorporated into H.R. 9 for major agency risk assessments would have added still more delays to the standard-setting process for each standard. *See* H.R. 9 § 431(b).

The federal lawmaker's frequent "call for added study" may be another thinly veiled effort to stall legislative action in instances where it should appear clear that scientific study will be unable to resolve the overarching policy questions in the near term. *See, e.g.*, SAREWITZ, *supra* note 24, at 88, 93 (observing that calls for scientific study of problems like global warming forestall the need to make difficult policy decisions and fuel the hope that the problem will "if given enough time, just go away"). Examples of this technique may be found in both the regulatory and congressional arenas. For powerful allegations of federal legislators using this tactic in the global warming debate, see *Rep. Brown's Fringe Science Report*, *supra* note 63, at 13. Brown argues:

> While it may be understandable that laymen like Members of Congress do not understand all the conceptual tools of modern science, we believe that the Subcommittee's [insistence on sound science, which has the effect of paralyzing environmental regulation] in this case was less accidental and more sinister than it may appear at first sight.

Id.; *see also id.* at 3, 9, 14 (similar allegations with supporting footnotes). For a discussion of this parallel phenomenon occurring in the executive branch, see Howard Latin, *Regulatory Failure, Administrative Incentives, and the New Clean Air Act*, 21 ENVTL. L. 1647, 1662 & n.40 (1991) ("[T]here is abundant evidence that administrators [of the EPA under President Reagan] frequently chose to 'study' uncertain issues as a way to avoid resolving them."). This may also lend insight into Congress's questionable decision to commission the NAPAP study described in part II.B.2.

175. *See* Lazarus, *supra* note 5, at 223 (observing that "[a]gency officials can either delay action pending further scientific investigation or act on the basis of limited scientific knowledge. Either response, however, is likely to trigger Congressional criticism"). Not only does the EPA at times fail to make progress in implementing standards, but the progress it does make may be subject to quick criticism. *See id.* at 216 (recounting how Senate overseers of the EPA happily politicized how the EPA had used industry data in registering pesticides under FIFRA, while neglecting (either inadvertently or strategically) to mention that the EPA's "reliance on industry data was the necessary result of unrealistic statutory deadlines and reduced agency budgets").

According to the work of Morris Fiorina and Roger Noll, members of Congress may also perceive that they can act individually to undercut implementation of the statute by creating a complex bureaucracy that only *they* can successfully manipulate for select constituents. *See generally* Morris P. Fiorina & Roger G. Noll, *Voters, Bureaucrats and Legislators: A Rational Choice Perspective on the Growth of Bureaucracy*, 9 J. PUB. ECON. 239 (1978); Morris P. Fiorina & Roger G. Noll, *Voters, Legislators and Bureaucracy: Institutional Design in the Public Sector*, 68 AM. ECON. ASS'N PROC. 256 (1978).

technical arguments are no more than window dressing designed to hide the congressmember's underlying, politically vulnerable, policy preferences.[176] Indeed, veritable armies of lawmakers and their staffs, think tanks, and interest groups may periodically organize not only to plot strategies for implementing ends-oriented goals, but also to carefully package (or "spin") them,[177] at times with a misleading technical wrap.[178] Although this tactic seems dishonest, if all participants engage in such a science charade, it would be an odd, but legitimate, way to debate policy. This is not likely to be the case, however. Instead, it is much more likely that other members of Congress and the public at large are not aware that these battles of the experts pertain not to science, but to differences in opinions and values. As a result, many who have something to offer the debate will be excluded as they patiently wait on the sidelines for a scientific consensus to emerge.

2. *Rational Ignorance of Scientific Uncertainties*

Although a few members of Congress may reap considerable benefits by strategically understating scientific uncertainties, in most cases public choice legislators likely enjoy more political gains by sim-

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176. In his lengthy report criticizing the Subcommittee on Energy and Environment for this misuse of science, Representative Brown made precisely this accusation:

> Subcommittee Members were quite comfortable both in enthusiastically accepting the policy pronouncements of "skeptic" scientists and in demeaning the careful peer-review efforts of traditional scientists. Peer review was almost flippantly dismissed as politically correct tyranny, as opposed to the true scientific breakthroughs generated by the unconventional and skeptical innovator.

Rep. Brown's Fringe Science Report, *supra* note 63, at 11; *see also* BRINT, *supra* note 60, at 136 (observing that "several researchers have found that when the findings of scientific studies do not fit the purposes of top political officials, they are very often suppressed, distorted, or simply ignored"); DAVID COLLINGRIDGE & COLIN REEVE, SCIENCE SPEAKS TO POWER: THE ROLE OF EXPERTS IN POLICY MAKING 34 (1986) (proposing that in some cases "science is used to legitimate or rationalize political choices which have already been taken"); MARK E. RUSHEFSKY, MAKING CANCER POLICY 6 (1986) ("Science, in its regulatory incarnation, is used to forward political goals by all sides in the disputes."); Carol H. Weiss, *Comment*, *in* KNOWLEDGE, POWER, AND THE CONGRESS, *supra* note 145, at 120, 123 (stating that, in her research of Congress and social science, "the most common use of policy research was to support preexisting positions"); Wilson & Anderson, *supra* note 39, at 6 (observing that during the ozone debate of 1996, "policymakers, most of them trained as lawyers, seized whichever of these personal opinions agreed with their own and cited them as the voice of science itself"). In such cases, those alerted to the underlying policy issues will select their own scientists to support their positions, rather than debate the more politically vulnerable value choices openly. Thus, the same adversarial forces that tend to converge on the best available positive science may do little to dispel the notion that science is being manipulated beyond its capabilities.

177. *See* David Grann, *Robespierre of the Right*, NEW REPUBLIC, Oct. 27, 1997, at 20 (describing Conservative Paul Weyrich's organizational meetings and luncheons where political positions are refined and executed).

178. Given the large number of unpreventable gaps in knowledge, proposed legislative strategies to address risk assessment, for example, often take on a suspiciously quantitative form. *See supra* notes 114-20 and accompanying text. It may be doubly convenient that some members of Congress continue to exert some control over the agency through subsequent allocations decisions, *see* Lazarus, *supra* note 1, at 330 (describing how the appropriations process allows Congress to pass proenvironment statutes with proindustry funding levels), and to a lesser extent through the oversight process.

ply remaining rationally ignorant.[179] Thus, although a public choice legislator's decision to remain uninformed about the capabilities and limits of science in developing environmental policy may not be a conscious one, it will almost always be rational given the political costs and benefits involved. This is true for a number of different reasons.

First, and perhaps most obviously, public choice legislators will overrely on science because, as has been discussed, doing so pleases the public and will help them get reelected.[180] According to public choice theory, as long as they are reelected or otherwise rewarded, federal lawmakers will look at science as a political "good fairy." Whether this reliance on science contributes to the greater public good is not a relevant concern.[181]

Public choice legislators may also inappropriately, and often unconsciously, assign problems to science because by doing so they can pass responsibility for making unpopular decisions on to someone else.[182] Even more conveniently, the problems can be directed to an executive branch that may be under the direction of a president from the opposing political party.[183] Congress's use (or abuse) of administrative agencies to bail them out of policy conflicts is one of the widely acknowledged disadvantages of our separation-of-powers form of gov-

179. *See* Olson, *supra* note 145, at 153 (discussing rational ignorance).

180. Because the results of this misframed policy are too complex to be predicted or even traced to a particular legal provision, a public choice legislators' reelection motivation is unlikely to include consideration of the ultimate result of most poorly drafted environmental laws. *See generally* MAYHEW, *supra* note 172; *see also supra* note 152.

181. *See, e.g.*, Larson, *supra* note 79, at 64 ("[T]he regular intervention of scientific-technical experts in the political process lends credence to the claims of professionalism and higher competence made by those who govern and those who advise them."); Olson, *supra* note 145, at 153 (observing that because legislators are elected "mainly by those who are rationally ignorant[,] . . . decent politicians face a dilemma. They can work hard at finding good policies and trying to get them adopted. But this may not serve their career interests").

182. *See* SAREWITZ, *supra* note 24, at 151 ("At heart, the promise of science—of the inevitable tilt toward gain—offers to free politicians from the minefield of political accountability by guaranteeing a brighter future for the voting public."). In a sense, these public choice legislators use this misframing trick to convert highly contentious social *controversies* into politically benign *disagreements* that can be resolved by a more searching examination of the scientific facts. *See* SCHON & REIN, *supra* note 84, at 3-4 (distinguishing between "policy disagreement[s,]" that "refer to disputes in which the parties to contention are able to resolve the questions at the heart of their disputes by examining the facts of the situation," and "controversies," such as those over "crime, welfare, abortion, drugs . . . [which] tend to be intractable, enduring, and seldom finally resolved" by examining the facts).

183. Except when the agencies have been publicly discredited as completely inept or biased by these self-same congressional representatives, the public choice legislators may find delegations of purported scientific tasks a ready escape hatch from controversial policy bombs. Indeed, even when the scientific competency of the agency is doubted publicly, lawmakers may still adhere to unrealistic science delegations but back them up with specific numeric or equivalent standards that come into effect if the agency cannot fulfill the unrealistic mandate. *See, e.g.*, 42 U.S.C. § 6924(g) (1994) (specifying very limited circumstances for land disposal of hazardous wastes if the EPA does not promulgate protective land disposal regulations by specified dates); Dwyer, *supra* note 8, at 265-66 (describing an unpassed amendment proposed in 1983 for an air toxics provision that required the EPA to list specified chemicals as hazardous but, if the agency failed to meet its deadline, automatically listed a number of substances).

ernment.[184] It is also a fundamental problem that plagues much of environmental law. Justice Rehnquist essentially accused Congress of this tactic in his concurrence in the famous *Benzene* case, which involved a challenge to a worker protection standard.[185]

Ironically, delegating controversial policy choices to the agencies under the guise of science may provide public choice legislators with an opportunity to publicly reprimand the agency later for its inevitable failures in implementing the unrealistic statutory mandates. "[B]ureaucrat baiting" or in the environmental world, "EPA bashing"[186] is touted as a popular form of "Capitol Hill recreation."[187] The agency can serve as "every elected official's favorite whipping boy,"[188] explaining why the water is not clean after five years of implementing

184. *See, e.g.*, R. Kent Weaver & Bert A. Rockman, *Assessing the Effects of Institutions*, *in* DO INSTITUTIONS MATTER?: GOVERNMENT CAPABILITIES IN THE UNITED STATES AND ABROAD 1, 11 (R. Kent Weaver & Bert A. Rockman eds., 1993) (observing that one advantage parliamentary systems have over the United States's checks-and-balances system is "greater centralization of accountability"); *see also* ESKRIDGE & FRICKEY, *supra* note 171, at 51 (observing that even when there is a clash of interest groups, "Congress has an incentive to refuse to choose a winner (thereby angering the losers) and instead duck the conflict by delegating the issues to a bureaucracy which is even more prone to interest group manipulation"); MASHAW, *supra* note 148, at 188 (observing that it is well known "[t]hat Congress passes vague and overambitious statutes[,] gives agencies too little resources with which to implement them, and constantly revels in the suggestion of bureaucratic laziness and scullduggery"); Cote, *supra* note 74, at 80 ("[I]f faced with a set of alternatives which are politically explosive, [congressmembers] will look for a technical *excuse* for making a decision—without probing it too deeply—because of the society's universal tendency to view technical solutions as being objectively correct and above politics.").

185. *See* Industrial Union Dep't v. American Petroleum Inst., 448 U.S. 607, 671 (1980) (Rehnquist, J., concurring); *see also* American Textile Mfrs. Inst. v. Donovan, 452 U.S. 490, 543 (1981) (Rehnquist, J., dissenting) (reiterating concern expressed the previous year in his concurrence in the *Benzene* case that the standard-setting mandate in OSHA "exceeds Congress' power to delegate legislative authority to nonelected officials" (citations omitted)). As John Dwyer has also noted with regard to the Delaney Clause and the original toxics pollutant provisions of the Clean Air and Clean Water Acts, "By enacting this type of statute, legislators reap the political benefits . . . [while the] hard issues involved in defining acceptable risk are passed on to the regulatory agency or to the courts." Dwyer, *supra* note 8, at 233. This is a very common observation with regard to the environmental laws. *See also* MELNICK, *supra* note 21, at 253 (speculating that in the Clean Air Act, Congress may have provided a broad mandate precisely in order to be relieved of "the burden of resolving difficult controversies"); PERCIVAL ET AL., *supra* note 1, at 194 ("One of the reasons Congress has delegated such significant responsibility to EPA is Congress's own reluctance to determine precisely who the winners and losers should be in allocating the burden of environmental legislation.").

186. *See* Lazarus, *supra* note 1, at 337 (crediting William D. Ruckleshaus with the term). Both Senator Muskie and Representative John Dingell appeared to benefit professionally from their charismatic roles as agency task masters. *See* Lazarus, *supra* note 5, at 221.

187. MASHAW, *supra* note 148, at 184 (also observing that "[w]hile overpromising, underfunding, and contributing to analytic overkill in its legislation, the Congress has seemed to direct its oversight activities primarily at chastising agencies for the slow pace of their regulatory efforts"); *see* Rabe, *supra* note 8, at 584-85 (detailing Congress's repeated tendency to gain politically from berating the agencies for failed environmental regulations and suggesting that it is, thus, unlikely that even in the near future Congress will gain the capacity to "play a mature, collaborative role with the executive branch"). This may be perceived as an advantage by many members of Congress, regardless of their party affiliation. Indeed, even for those federal lawmakers who share political affiliation with the Chief Executive at the time the law is passed, it might be nice to know that the mandate is there for a future rainy election day.

188. MELNICK, *supra* note 21, at 322.

the noble commands embodied in a 100-page statute, or why one protective standard for ambient air was selected over scientifically plausible, but perhaps more politically popular alternatives.[189] As Professor Mashaw observes:

> The specter of administrative agencies failing to protect the public health and safety, as they have been ordered to do by Congressional legislation, can often capture media attention and promote particular legislators' personal goals. If some suggestion of bad faith or scandal can be added to the agency laxity in the face of an environmental or health crisis, so much the better.[190]

Ignoring the limits of science when developing legislative mandates thus offers legislators a convenient opportunity to ridicule the president.[191]

Also, placing too much reliance on science when developing environmental legislation allows public choice legislators to arrive at noncontroversial solutions to difficult social problems.[192] Rather than

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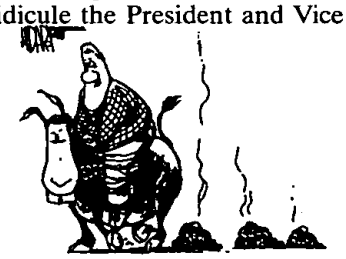
189. *See supra* note 94 and accompanying text.

190. MASHAW, *supra* note 148, at 184. In the specific case of environmental programs, Richard Lazarus observes a similar behavior among members of Congress:

> When EPA failed to meet statutory deadlines, these [Dingell and Florio in the House] and other members of Congress held hearings in which they chastised the agency for neglecting the public trust. Conversely, when EPA made politically unpopular decisions in an effort to comply with its statutory mandates, other members of Congress promptly joined in the public denunciation.

Lazarus, *supra* note 5, at 215 (footnotes omitted).

191. Although there might not have been public choice motivations behind the 1972 enactment of Section 109 of the Clean Air Act, certainly the science-based, cost-blind command to the EPA to set air quality standards, *see supra* notes 88-94 and accompanying text, was used by critics of the administration to ridicule the President and Vice President:



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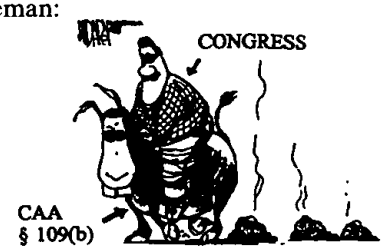
An equally plausible cartoon for this proposed rulemaking, however, could have depicted Congress as the careless horseman:



192. This noncontroversial resolution is apparently very appealing to some federal legislators and their staffs. In a seminar conducted by congressional analysts for the benefit of Congress, one participant relayed a story about a staff aide's effort to identify politically promising avenues for an energy conservation bill. The aide ultimately recommended a ban on decorative outdoor gas lamps. The participant concluded that although such a ban would address less than two percent of the problem, other more useful policy options were off limits. "Many of the

debating competing values, lawmakers can defer (in theory) to the objective research of scientists to resolve thorny environmental controversies.[193] As Professors Guido Calabresi and Philip Bobbitt have noted, "[e]vasion, disguise, temporizing, deception" are all common means society uses to cope with "tragic choices" that demand some form of social suffering in their resolution.[194] Similar to seeking a neutral arbitrator or perhaps even tossing a coin, the "leave it to the scientists" solution is viewed as both intellectually superior and politically safer than resolving issues through painful public debate.[195] Professor Michael Graetz has observed a similar phenomenon in tax law: "Congress today seems to *want* tax policymaking to turn on simple numerical answers, reminiscent of the supercomputer Deep Thought, who in the science fiction classic, *The Hitchhiker's Guide to the Galaxy*, revealed that the answer to the 'great Question of Life, the Universe and Everything' was '42.'"[196]

Delegating responsibility for resolving difficult issues to science also permits the public choice legislator to bypass irksome political debate that might otherwise bog down passage of politically popular legislation.[197] In many instances this quick legislative response could

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people on the Hill simply don't have time to do the analysis they want. So instead they grasp at straws, search among all the analyses that have been done for magical solutions, if you will, like banning outdoor decorative gas lamps." Comment of M, *Environment, Energy, and Economics*, *supra* note 75, at 114, 123. Indeed, a public choice happy ending might be the tendency of Congress to delegate policy deadlocks to the agencies for resolution and then to include a number of proceduralized protections to maximize legitimate forms of public participation and agency accountability. *See infra* notes 328-68 and accompanying text (discussing features of agencies that may make them valuable or even superior policymakers in the standard-setting process provided that they remain sufficiently accountable for these decisions).

193. *See* Charles E. Lindblom, *The Science of "Muddling Through"*, 19 PUB. ADMIN. REV. 79, 83 (1959) (explaining that "[f]or the method of successive limited comparisons, the test is agreement on policy itself, which remains possible even when agreement on values is not").

194. GUIDO CALABRESI & PHILIP BOBBITT, TRAGIC CHOICES 26 (1978).

195. Proenvironment legislators may be pleased to think that the environment will be protected at levels scientists determine to be "safe," even recognizing the uncertainties involved in such a mandate. Tight deadlines and judicial review, in these legislators' minds, are sufficient insurance that the environment will be adequately protected. Members of Congress with opposing interests may see these same mandates as leaving to the agencies a series of impossible tasks that are unlikely to be implemented and that leave the agencies vulnerable to challenge, congressional oversight, and public condemnation. Both parties can claim victory, see the mandate as half-full, and ultimately dodge responsibility by blaming either the majority of Congress or the executive branch.

196. Graetz, *supra* note 73, at 613 (emphasis added) (citation omitted). Graetz continues, "Armed with mathematical answers to both revenue and distributional questions, tax policymakers routinely eschew the difficulties of exercising judgment to strike an appropriate balance among ambiguous and often conflicting normative goals; in the process, they put aside the massive empirical uncertainties they inevitably face." *Id.*

197. *See, e.g.*, Moss, *supra* note 79, at 31 (noting that, in the early years of the environmental laws, environmental problems were at an "acute phase" that required immediate attention and that "[t]here was a political and technical risk in excessive discussion or delay in movement toward a solution"); *cf.* Allen Schick, *Complex Policymaking in the United States Senate*, *in* POLICY ANALYSIS, *supra* note 36, at 4, 18 (arguing that the decrease in specialization by members of Congress increases the time it takes to develop laws because it increases the number of participants and their possible contributions).

be a substantial political benefit, at least during times of perceived public crisis. Finding a short-term fix to a large and complex problem like Love Canal or the Exxon-Valdez oil spill, for example, although perhaps not sound from a broader policy perspective, provides feel-good soundbites for the public choice legislator facing reelection.[198]

Finally, regardless of what public choice legislators take to be in their self-interest, be it peer respect within the House or Senate or advantages in the next election, winning all political battles is critical to success. Positive scientific knowledge provides the armor of credibility that public choice legislators need to go into battle and win. Knowledge gaps, by contrast, expose chinks in this armor, which make it more difficult for the legislators to prevail or gain the respect they seek. As one anonymous congressmember confessed: "The plain fact is we've got to go to the floor and lie to our colleagues—tell them [an environmental program has] a 90-10 chance of succeeding [when we know that it is closer to 50-50]."[199] For these congressional representatives, winning battles takes precedence over being honest about the many unpreventable scientific uncertainties.

C. Madison's Legislator: Representative Democracy

The most optimistic model of congressional behavior[200] and the one that we would expect to do the best job of coping with the numerous challenges posed by science policy problems is Madison's legisla-

198. *See, e.g.*, Comment of Q, *Environment, Energy, and Economics*, *supra* note 75, at 114, 128 (observing that "Congress—and this may be more true of the House than the Senate—basically has a short term viewpoint about some very complex problems"). Even if the controversy cannot be resolved, resolving to study it may be the next best political substitute. Opponents appreciate the delay and advocates have difficulty condemning the value of scientific research. *See* Rodgers, *supra* note 173, at 168 (observing that "[s]tudy provisions are rampant in the environmental laws and they are sustained by a host of tactical aims such as decision-avoidance, information acquisition, experimentation, and even elaborate plots for future action."); *see also supra* note 174.

199. Comment of X, *Environment, Energy, and Economics*, *supra* note 75, at 114, 118; *see also* Comment of M, *id.* at 129 (stating that "to the extent that analysis is useful and important to any committee staff person" it is in the defense of a preordained solution, during the latter stages of legislation).

200. This congressmember, in the view of some, may be not only normatively superior to the other models, but also descriptively superior. *See, e.g.*, ESKRIDGE & FRICKEY, *supra* note 171, at 47 (observing that "[m]any scholars educated under the aegis of the 'legal process' materials emphasized deliberation as an achievable ideal in our representative democracy" and that "[a] substantial political science literature suggests that the legal process (or neo-republican) vision is not unrealistic"). Indeed, Henry Hart and Albert Sacks' endorsement of this legislator is reason enough to take it seriously. *See id.* (citing HENRY HART, JR. & ALBERT SACKS, THE LEGAL PROCESS: BASIC PROBLEMS IN THE MAKING AND APPLICATION OF LAW 154, 695 (William N. Eskridge, Jr. & Philip P. Frickey eds., 1994)). Prominent political scientists and sociologists have also opined that Madison's legislator may be the most accurate descriptive model for how Congress actually operates. *See generally* RICHARD F. FENNO, JR., CONGRESSMEN IN COMMITTEES (1973); STEVEN KELMAN, MAKING PUBLIC POLICY: A HOPEFUL VIEW OF AMERICAN GOVERNMENT 60-66 (1987); ARTHUR MAASS, CONGRESS AND THE COMMON GOOD (1983); RANDALL RIPLEY, CONGRESS: PROCESS AND POLICY, ch. 1 (1975); *cf.* Katz, *supra* note 121, at 429 (opining based on his experience as a staffer that "many members of Congress do wish that they had [objective science] advisors").

tor or a "modern republican" replacement.[201] Madison's legislator responds to the needs of the electorate by filtering those demands and preferences through his experience and superior policymaking expertise. These lawmakers, in Madison's own terms, "refine and enlarge the public views" in order to "best discern the true interest of their country."[202]

Because Madisonian legislators are careful policy analysts, one would expect them to be astutely aware of the limits of science in developing environmental laws. Indeed, some might conclude that Congress's propensity to scientificate environmental policy simply reflects the demise of the Madisonian statesperson in American politics. This assertion must be carefully evaluated, however, because it implies that the solution to the problems identified in this article is simply to ensure that federal lawmakers with higher ideals and greater personal integrity are elected or that incentives after election encourage this sort of integrity. Yet, a detailed analysis of the Madisonian legislator's approach to science policy reveals that even this preeminent statesperson may encounter substantial obstacles to identifying and appreciating the significance of the gaps in scientific knowledge. Indeed, much of the expert information upon which Madisonian legislators rely in developing environmental legislation may fail to help them understand the limitations of science.[203] To the extent these sources of expertise fail in any given case, then, Congress's tendency to scientificate policy choices or otherwise ignore the limits of science may be more of an institutional phenomenon than one tied to the motives or integrity of individuals.[204] The types of ex-

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Both as a descriptive and normative model, Madison's legislator also seems to be more reliable. As a descriptive model, Madison's legislator may be necessary for sound, 20th-century lawmaking. The breathtaking complexity of most environmental problems means that the electorate often has little intelligible to say. *See, e.g.*, Katz, *supra* note 167, at 42 (arguing that "[s]ince most constituents are not familiar with S&T issues, their impact is minimal"); *cf.* ARNOLD, *supra* note 152, at 20-21 (arguing that the causal chain between electorate preferences and legislative outcomes determines the influence of voters). As a normative matter Madison's legislator is also better prepared to make decisions in the tangle of factors that comprise environmental problems. Given what we know about the electorate's scientific competency, the legislator-as-agent seems quite worrisome standing alone as the only available public interest model. *See generally supra* notes 149-70 and accompanying text (discussing lay scientific competency).

201. *See* ESKRIDGE & FRICKEY, *supra* note 171, at 61 (describing "modern 'neo' republicanism" as "a significant tradition in American history" and noting its prominence in *The Federalist Papers*).

202. THE FEDERALIST NO. 10, at 45 (James Madison) (Max Bedoff ed., 1948).

203. These failures also reinforce the inability of the direct agent legislator to understand the dramatic limitations of scientific experimentation described in part III.A and the refusal of the public choice congressmembers to acknowledge these limits in their lawmaking projects described in part III.B.

204. *See also* BIMBER, *supra* note 75, at 23 (observing in study of congressional expert offices that "[t]he degree of politicization of expertise may be more an institutional phenomenon than a product of the preferences of style of politicians, the moral or professional commitment of experts, or an inexorable trend away from neutrality"); KOMESAR, *supra* note 47, at 60 (positing as a general theoretical matter that common academic perceptions that "associate perfect government outcomes with public-interested public officials" may be wrong and that, instead, distor-

pert assistance available to Madisonian legislators, and the possible reasons experts fail to help these lawmakers identify and understand the importance of gaps in scientific knowledge, are discussed below.

1. Inadequate Assistance from Scientists: Interdisciplinary Slippage

Scientists are indispensable sources of information on the limits of science.[205] As discussed previously, because knowledge gaps arise at points where scientific research is unlikely or incapable of being conducted, identifying when knowledge gaps will occur requires an intimate familiarity with the relevant scientific methods. Yet for numerous, powerful reasons, scientists are not likely to provide this sort of information to lay policymakers voluntarily or, at times, even involuntarily.[206] Indeed, the disinclination of scientists to highlight the limits of science appears to rise to the level of a professional norm, originating in the scientists' long-standing commitment to objectivity, their optimism in the infinite capabilities of scientific research, and their desire to protect the future of the scientific enterprise.[207]

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tions in policy and government failures may be institutional phenomena that are "only tenuously related to the motives of the individual participants").

205. *See supra* notes 47-57 and accompanying text.

206. *See* Anderson, *supra* note 85, at 30 (reporting that a U.S. Senator complained that a "discussion by knowledgeable scientists of the earth orbit versus the lunar orbit as the best way to get men to the moon . . . would have helped us better understand the choices before us, the limitations of the alternatives, and the probabilities of success or failure."); Woodhouse, *supra* note 26, at 147-48 (describing the disappointing product of a NAS panel tasked to give Congress guidance on the carbon dioxide assessment program that focused on positive scientific knowledge to the virtual exclusion of highlighting obstacles to resolving the larger policy question presented by the unpreventable limits of science). For a summons to scientists to be more forthcoming in providing mainstream advice to Congress, as well as in policing the prominence of their "fringe scientist" peers, see *Rep. Brown's Fringe Science Report*, *supra* note 63, at 6 (recommending that "the scientific community take much more seriously the responsibility to educate the public and policymakers about the importance of the scientific process and peer review, and to respond to the arguments raised by the scientific 'skeptics' who have taken a highly visible and public role in criticizing mainstream science on these issues").

207. This discussion assumes that "public choice" motivated scientists are few and far between. To the extent that they exist, however, they would generally be expected to oversell the capabilities of science in order to win more research dollars. If both politicians and scientists are seen in public choice terms, the interdisciplinary slippage becomes even worse. *See* SAREWITZ, *supra* note 24, at 87 (arguing that "neither politicians nor mainstream scientists are likely to blow the whistle on the current arrangement [involving misframing policy questions as science] because both derive substantial benefit from it—scientists, who receive generous federal support for research, and politicians, who can claim that they are taking responsible action without having to take any political risks"). In some cases, however, public choice scientists might actually exaggerate the extent of the scientific uncertainties if it suits their own public choice ends. *See* Harvey Brooks, *The Federal Government and the Autonomy of Scholarship*, *in* CONTROVERSIES AND DECISIONS: THE SOCIAL SCIENCES AND PUBLIC POLICY 235, 239 (Charles Frankel ed., 1976) (suggesting that some scientists "exploit uncertainty of evidence in an incompletely researched field to provide different interpretations of the evidence consistent with their policy predilections"); Edward E. David, *White House Science Advising*, *in* SCIENCE AND TECHNOLOGY ADVICE, *supra* note 73, at 104, 106 (noting that a former science advisor to President Nixon asserts that "[i]t is the seeming inability or unwillingness of scientists and engineers to keep the political and technical domains apart that has put science advice to the highest levels of government in the state that it is today").

Undoubtedly, one of the most important reasons scientists fail to delineate the limits of science for policymakers relates to their constant struggle to maximize their objectivity.[208] Because of the long-suspected connection between inherent research biases and active participation in political causes relevant to one's research, most scientists will distance themselves from the political process, at least insofar as it intersects with the results, rather than the funding or freedom, of their research agenda.[209] In fact, participation in the political process and media is not only avoided by many scientists, but it is often expressly discouraged by fellow scientists and the profession as a whole.[210] Even simple matters, such as educating policymakers about the limits of science or helping them frame policy-relevant questions directed to scientists, may be seen as conflicting with the scientist's primary commitment to objectivity, because such activities require both access to and active participation in the political process.[211]

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208. *See, e.g.*, TRIGG, *supra* note 27, at 109 ("One of the prized virtues of science is its objectivity, its apparent willingness to be led by evidence alone and not by prejudice."); Robert K. Merton, *The Normative Structure of Science, in* THE SOCIOLOGY OF SCIENCE 267, 275 (1973) (identifying honesty, objectivity, and disinterestedness as norms constituting the universal "ethos of science").

209. *See, e.g.*, Gieryn, *supra* note 27, at 436 ("Scientists also need to keep the fence on their 'politics' frontier well mended. After all, what makes scientific knowledge useful for politics is not just its content but its putative objectivity or neutrality."); *cf.* Alex C. Michalos, *Philosophy of Science: Historical, Social, and Value Aspects*, *in* GUIDE TO CULTURE OF SCIENCE, *supra* note 158, at 197, 251-53 (observing that many scientists try to limit their social responsibility for research results and arguing that their responsibility should be viewed more broadly). These characteristics have led several commentators to suggest that some researchers exhibit an outward "hostility to democracy" or "politics." *See* LINDBLOM & COHEN, *supra* note 34, at 69.

210. *See, e.g.*, THOMAS S. KUHN, THE STRUCTURE OF SCIENTIFIC REVOLUTIONS 164-65 (1970) (describing as a part of the "initiation" into the scientific community "insulation" from the rest of society); Daniel Melnick et al., *Participation of Biologists in the Formulation of National Science Policy*, 35 FED'N PROC. 1957 (1976) (reporting that the more scientists were involved in politics, the more they were looked down upon by their colleagues). Scientists who seek out or respond to the media apparently receive "pressure" from other scientists to refrain from such activities. *See* Goodell, *supra* note 154, at 35. "The criticism takes various forms, but invariably it includes the ultimate pronouncement that the celebrity scientist is really not a true scientist after all. . . . Apparently, the assumption is that scientists are not capable of maintaining a popular and a professional reputation at the same time." *Id. But see id.* at 37-38 (discussing the founding of the Scientists' Institute for Public Information in 1963, which has as its mission providing an intermediary between science and the public, but noting that its primary support comes from "major publishing and broadcasting companies").

Scientists' fear of being misquoted or publicly embarrassed exacerbates the anonymity that often shrouds both the scientists' experiments and their social implications. *See id.* at 33 (observing that some speculate that scientists' loss of control of the press coverage in the recombinant DNA debate caused scientists to retrench and be "less willing to alert the press, at least to controversial topics, than they were a decade ago"). Dorothy Nelkin recounts in detail scientists' avoidance or very careful control of publicity, often even with regard to the results of studies that have already been published. *See* NELKIN, *supra* note 163, at 154-69.

211. The scientific community may in fact rightly question the ability of politically active or motivated scientists to remain objective in performing research that relates to their larger social concerns. *See, e.g.*, Gardner et al., *supra* note 33, at 901 (calling on fellow psychologists to "withhold the rhetoric of certainty unless we are certain and either restrict our assertions to those matters on which we have certainty or freely acknowledge our doubts"); Arthur Kantrowitz, *The Separation of Facts and Values*, 6 RISK: HEALTH SAFETY & ENV'T 105, 107 (1995) (criticizing Gore for "never mention[ing] the well-known Washington phenomenon that [scientific] wit-

A second reason scientists may not help policymakers identify gaps in scientific knowledge relates to their professional optimism about the capabilities of scientific research. Science enlarges our sphere of knowledge and understanding about the world. That the answers may not come as swiftly as policymakers hoped is not relevant to the scientists' belief in and commitment to the "endless frontier."[212] In conversations with policymakers, then, scientists may fail to highlight the many knowledge gaps that will likely (but not definitely) remain unresolved well into the future, regardless of the best efforts of scientists.[213] After all, it is these very same knowledge gaps that define the challenges to which scientists dedicate their life work.[214] But un-

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nesses [at hearings] who come forward to report problems, and to ask for money to deal with them, will always vastly outnumber those courageous enough to cast doubt on this way of making a living"). Commenting on the role of social scientists in informing policy, Carol Weiss has observed:

> [W]hile social scientists' concern with the utility of social research rests on a belief in its potential as a rational guide to policy, it is likely to be buttressed by (1) interest in the status and rewards that accrue to social science, (2) desire for influence in the corridors of power, and/or (3) reformist zeal to move public policy in the direction of their own beliefs, which are usually economic liberalism and social egalitarianism. They are not disinterested bystanders.

Weiss, *supra* note 24, at 8; *cf.* LINDBLOM & COHEN, supra note 34, at 69 (suggesting that social science researchers may avoid conducting research with private clients because of the "attachment to the greater power associated with the role of independent expert").

The Congressional Fellows Program sponsored by the American Association for the Advancement of Science and other scientific organizations, *see infra* note 236, is a positive step to counteract these socialized norms, although this effort appears to be made in large part to ensure that scientists' needs (such as basic research) are not left out of Congress's deliberations. *See* Michael L. Telson & Albert H. Teich, *Science Advice to the Congress: The Congressional Science and Engineering Fellows Program*, *in* SCIENCE & TECHNOLOGY ADVICE, *supra* note 73, at 447, 447-49 (listing as the primary goals of the Science Fellows Program: to educate Congress about science, to improve scientists' "abilities to affect public policy," and "to make it easier for the general scientific and engineering communities to deliver their messages to Congress more effectively").

212. *See generally* VANNEVAR BUSH, SCIENCE: THE ENDLESS FRONTIER (1960). For a discussion of many scientists' supreme optimism about the capabilities of scientific experimentation, see HORGAN, *supra* note 163, at 227 (reporting on a workshop dedicated to exploring "whether there were [any] limits to science, and if so, whether science could know them"); TRIGG, *supra* note 27, at 172-73 (describing how "[m]any scientists and others believe, . . . not just that science can give some explanation, but that it can explain everything, presumably even the conditions of its own possibility"); *id.* at 180 (recounting physicists' effort to produce a Theory of Everything).

213. In contrast to policymakers, whose needs are often immediate, scientists have far less concern for the time it takes for an "answer" to emerge. That an answer can be found with decades or even centuries of persistence does not lessen the value of the answer, nor is it perceived by the scientific community as less valuable because it takes time. This timeless characteristic of the scientists' search for the truth also conflicts directly with the goals of policymakers who consider the truth to be limited to that set of what *is* known currently or in the immediate future. *See* SHEILA JASANOFF, SCIENCE AT THE BAR: LAW, SCIENCE, AND TECHNOLOGY IN AMERICA 9-11 (1995) (observing a conflict between law and science because "[t]he law, by contrast [with science], must take a position based on the facts at hand, however premature such a decision may appear in the eyes of scientists"); Moss, *supra* note 79, at 34 (observing that "[s]cientific studies have natural times of their own . . . [that] may have to be juxtaposed on entirely different [and more immediate] political decision-making cycles").

214. *See, e.g.*, Jerry Gaston, *Sociology of Science and Technology*, *in* GUIDE TO CULTURE OF SCIENCE, *supra* note 158, at 465, 479 ("The most important role of a scientist is the production of

less the Madisonian legislator is aware of the deeply ingrained professional optimism of his scientist advisors, he may not recognize the resulting tendency of scientists to discount the significance and prevalence of knowledge gaps.

In addition and more pragmatically, scientists may be reluctant to highlight the limits of science because of their reasonable concern that by doing so they could erode support for science.[215] Educating policymakers as to the limits of science not only has important opportunity costs with regard to lobbying for more research funding, it can conflict with it. Erring on the side of assuming that important policy questions can be resolved with scientific experimentation generally means more research funding.[216] Science and scientists also become less powerful

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new knowledge."); *id.* at 481 (discussing how "[s]tudies of scientific productivity help to explain the relationship between role performance and placement within the social stratification system of science"). The scientists' professional axiom of expanding the boundaries of knowledge may also explain why they are generally uninterested in (and, thus, may not call policymakers' attention to) the need to dedicate significant resources to the collection of baseline data related to the environment. *See, e.g.*, SAREWITZ, *supra* note 24, at 98 (observing that "the science community . . . ascribes the greatest intellectual and social prestige to basic or 'pure' research—the source of new knowledge—while viewing the role of applied research and technology development as more concrete, less difficult, and therefore less intrinsically worthy").

215. There is evidence that scientists will target this goal at the expense of clarifying important and socially relevant limitations in this very same research. Dr. Gieryn, a sociologist of science, has documented several examples of scientists' attempts to manipulate the "floating boundary of science" and concludes that there is "a long tradition of political efforts by scientists to defend professional resources already won, and to protect them from future infringements." Thomas F. Gieryn, *Scientific Communication and National Security*, *in* SCIENCE OFF THE PEDESTAL, *supra* note 26, at 79, 91; *see also* Gieryn, *supra* note 52, at 792 (observing as an example that in "the NAS [National Academy of Sciences] Panel on scientific communication and national security, technological fruits are placed 'inside' science when the goal is justification of public support for science, but they are excluded when the goal is protection of the autonomy of scientists from government regulation"); Larson, *supra* note 79, at 63 (describing how scientific consultants in policy settings "bring to the situation conscious or unconscious motives and interests of their own . . . [that advocate] science for science's sake and non-interference from outside sources" (citations omitted)). At least in the early years of the program, some Congressional Science Fellows may have even advanced unacknowledged research biases or conflicts of interest in their work on the Hill. *See* Barry M. Casper, *Scientists on the Hill: Congressional Science Fellows Have Had a Warm Welcome; Now Many of Them Are Part of the Power Structure*, BULL. ATOM. SCI., Nov. 1977, at 8, 11, 12, 13-14 (citing to potential conflicts or activities by fellows to secure significant future funding for pet projects).

216. For example, even though no progress was made in resolving some of the key uncertainties regarding global warming, the studies tripled in number from 1979 to 1985. *See* Woodhouse, *supra* note 26, at 147. Woodhouse concludes that although this dedication of moneys "may be an error for society . . . it has been a boon to geophysical scientists." *Id.*; *cf.* Harvey Brooks, *The Physical Sciences: Bellwether of Science Policy*, *in* SCIENCE AND THE EVOLUTION OF PUBLIC POLICY 105, 129 (James A. Shannon ed., 1973) (observing that scientists do not desire a centralized agency for R&D planning and allocations because such an agency would be more susceptible to "political accidents and personalities in the administration or the Congress"). Even "skeptic" scientists who openly questioned the policy significance of global warming advocated that federal monies continue to be dedicated to this area of research. *See, e.g.*, *Rep. Brown's Fringe Science Report*, *supra* note 63, at 15 (observing that "[i]t is ironic that the 'skeptic' scientists called by the Majority did not, in general, endorse reductions in environmental R&D, particularly climate change R&D").

By contrast, research on the embedded, but preventable, gaps in knowledge, like the collection of baseline data or redundant toxicity testing, is not as desirable to the mainstream scientific community, which in turn may also explain why Congress has missed its import in certain stat-

and research less important once the knowledge gaps become a topic of discussion.[217] A decline in public support for science not only threatens future funding, but could lead to a worrisome marginalization of science.[218] Along these same lines, a principled scientist willing to participate in the political process may conclude that being cautiously optimistic about the capabilities of science is far better than abdicating the role of science advisor to the packs of charlatans and junk scientists eager and willing to provide scientific-sounding answers to all of Congress's questions.[219] Perhaps equally likely, mainstream

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utes. Instead, the type of research scientists encourage is research that pushes the outer limits of knowledge. *See, e.g.*, Coleman, *supra* note 36, at 26 (discussing this "policy research" as being outside the academic's agenda); William H. Rodgers, Jr., *The Seven Statutory Wonders of U.S. Environmental Law: Origins and Morphology*, 27 LOY. L.A. L. REV. 1009, 1018 (1994) (noting that one of the features of "the seven great laws [that Rodgers identifies in the article] is their ability to attract and hold scientific constituencies and to generate scientific questions"). *But see* Houck, *supra* note 4, at 413-14 & n.41 (detailing benefits that laboratories and researchers derive from laws based on human-based risk assessment).

217. Scientists' interest in science policy is generally, and rationally, limited to ensuring the continuation of the scientific enterprise with government funding. *See, e.g.*, Lakoff, *supra* note 76, at 603-08 (describing a "campaign for a statutory national science policy," which appears uniformly to be directed at more coherent R&D spending); Woodhouse, *supra* note 26, at 152 (urging that scientists not be left in environmental policymaking "to define the risks, set the research agenda, and worry about options for mitigating the problem" because they "are likely to do what they know (and like) best: further research"). The same unspoken incentives may also be true of science advisory boards and panels, which in some cases could stand to benefit financially, personally, or as an organization from their involvement in complex problems that receive little oversight from policymaking bodies. *See supra* notes 127-35 and accompanying text (discussing Congress's commission of a NAPAP study); *cf. Three of Four CASAC Chairs Would Not Endorse Proposed PM Standard*, Daily Env't Rep. (BNA), No. 70, at 1 (Apr. 11, 1997) (reporting that "three of four current or former chairmen of the Clean Air Science Advisory Committee . . . cite concerns that [the EPA's] data on fine particulate matter [supporting its particulate air standard] are inadequate" and call on "Congress and federal regulators to implement a $50-million-per-year research effort immediately to gather the information needed").

218. Highlighting knowledge gaps too vigorously presents the risk of digressing into a science-delegitimization campaign under which the pendulum shifts to the opposite extreme and the capabilities of science are marginalized. *See, e.g.*, Sheila Jasanoff, *Research Subpoenas and the Sociology of Knowledge*, LAW & CONTEMP. PROBS., Summer 1996, at 95, 98-100 (describing the communal nature of scientific knowledge and its vulnerability to unwarranted deconstruction by laymen and the legal system). An active education campaign on the limits of science, then, might rightly be viewed as potential professional suicide. Indeed, it could even explain why scientists appear to be aloof and, in some cases, even antagonistic toward the participation of laymen in science policy. *See, e.g.*, SAREWITZ, *supra* note 24, at 52-54, 71-72 (outlining the paternalistic and even condescending position taken by several prominent scientists toward the "scientifically illiterate" public's role in developing science policy). Sociological studies have shown, for example, that some scientists have an "unacknowledged insecurity about recognizing the conditionality of their own knowledge and the prescriptive commitments it embodies." Wynne, *supra* note 71, at 385. "The innumerable attempts by ordinary publics in effect to negotiate what counts as legitimate public knowledge are frequently defined by those anxious elites as 'anti-science.'" *Id.* at 387; *see also* Cozzens & Woodhouse, *supra* note 79, at 545-46 (describing the "subtle denigration of nonprofessional knowledge in the educational system and throughout government interactions").

219. Based on Gieryn's theory of boundary drawing, *supra* note 52, this effort by competent scientists to overpromise the capabilities of science in order to exclude the charlatans and junk scientists from policy debates may be one way to control the costs that these fringe groups exact from the scientific enterprise.

Scientists might also rightly perceive that they will insult federal lawmakers by reminding them of the importance of respecting the limits of science. Particularly if some members of Con-

scientists may already assume that Congress is a hopeless cause and refrain from giving any advice at all because of the fear of negative publicity or unfair professional attacks.[220]

A number of other factors also make it difficult for scientists to establish a positive, symbiotic relationship with Congress. For example, scientists often have difficulty communicating with lay audiences.[221] Consequently, they may think that they are highlighting the limits of science, yet fail to do so in a way that is sufficiently clear or understandable.[222] Scientists, along with other academics and lay publics, may also encounter problems in gaining meaningful access to busy members of Congress and their staffs;[223] a reputable scientist

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gress overdelegate policy problems to science based on public choice motivations, this advice may be viewed quite hostilely by congressmembers and their staffs. Survival as a congressional expert may depend, in part, on refraining from offering advice to questions not asked. *See infra* note 248 and accompanying text.

220. Representative Brown's account of a series of House hearings on environmental issues might have this chilling effect on the participation of reputable scientists in the legislative policymaking process:

> These hearings were aimed at discrediting the environmental movement, the Federal Government, and the science community itself. At best, these assertions of lapses of integrity can be characterized as an investigation into the possible breakdown of scientific integrity (which could not in fact be shown). At worst, they were a mythical distortion with the potential to obscure honest and open debate, to compromise the scientific process, and to cause great damage to human health and the environment.

Rep. Brown's Fringe Science Report, *supra* note 63, at 10; *see also supra* note 218 (detailing the vulnerability of science to unwarranted deconstruction).

221. Likely exacerbating these communication problems is the confusing, or even deafening, noise generated by fringe scientists who offer scientific advice that goes well beyond their data. *See supra* note 211.

222. Scientists' major audience, after all, *is* other scientists. The language used to communicate research results derives from a long socialization process that likely takes for granted the ability of scientific listeners to appreciate the inevitable limits to scientific methods. The need to express these limits when communicating research results to lay audiences may simply not occur to scientists and may be a communication skill that requires conscious effort and, potentially, training. As a result, scientists might find themselves quite unprepared to provide helpful advice to members of Congress on a science policy issue, even with a "Scientists' Guide to Congress" in hand. *See, e.g.*, WILLIAM G. WELLS, JR., WORKING WITH CONGRESS: A PRACTICAL GUIDE FOR SCIENTISTS AND ENGINEERS vii (1996) ("This revised second edition offers scientists and engineers clear, concise advice on how to communicate with lawmakers and their staffs.").

Scientific panels have outlined the limits of science under certain, policy-relevant circumstances. *See generally* NRC, RISK ASSESSMENT, *supra* note 41. *But see* Rebecca Dresser et al., *Breast Implants Revisited: Beyond* Science on Trial, 1997 WIS. L. REV. 705, 757-59 (discussing criticisms of the first National Academy Panel report on DNA evidence for making recommendations on a "ceiling principle" for the use of statistical evidence in court that went beyond the scientific issues that the panel was asked to address). Yet, their communication of answers to problems is accomplished through terminology that admits of uncertainties in ways that are not easily accessed by policymakers. "Default options" rather than knowledge gaps or policy choices signal that the limits of science have been reached—a signal that is likely audible only to other scientists or the most dedicated science policymaker. *See* SCIENCE AND JUDGMENT, *supra* note 50, at 7 ("'[D]efault options' . . . are used in the absence of convincing scientific knowledge on which of several competing models and theories is correct.").

223. Impediments of access may also cause scientists and engineers to be greedy with a legislator's time once they have been tapped for their expertise or to become frustrated and disappointed if their advice becomes slighted or abbreviated. *See generally* Katz, *supra* note 167, at 45, 49 (noting how scientists have, on occasion, expected more time and energy from federal lawmakers than is realistic, and the result is frustration and disappointment on both sides);

anxious to help policymakers understand the limits of science may simply not get their attention.[224] Finally, scientists may not appreciate the implications of "overselling science" when working with lay policymakers, so it may not occur to them to highlight the limits of science.[225] Because science policy teamwork is foreign to many scientists, it is not surprising that they do not fully understand the consequences of their advice and omissions.[226]

Weiss, *supra* note 24, at 14-15 (noting how social scientists commissioned to do research are often "appalled" at an agency's unreceptiveness to their conclusions, even if some legislation is passed). In any case, advice to Congress on specific legislation is unlikely to be forthcoming except for the most important bills. Scientific societies, which are predominantly nonprofit organizations, use their legislative contacts sparingly and rarely, if ever, take part by commenting on specific bills unless their staff or members are called to testify. Personal communication with AAAS staffer (Sept. 1997). In many cases individual scientists, who do not face these constraints, may not have the resources, expertise, or often the access to timely information needed to participate effectively in legislative developments. *See* WELLS, *supra* note 222, at 2 (noting the time and expertise involved in congressional activities and observing that this can distance busy scientists from participating).

224. The academic scientist may face particularly difficult problems in this regard. Based on her research on Congress and social science, for example, Carol Weiss observed that members of Congress and their staffs tended to be more suspicious of advice coming from academics and other "'objective' policy researchers" because "they suspect that everyone has a political bent," but "[w]ith academic analysts, they do not know what values are being advanced and therefore do not know how to compensate for them." Weiss, *supra* note 176, at 121; *cf. Rep. Brown's Fringe Science Report*, *supra* note 63, at 12 (arguing that viewing prevailing scientific consensus and mainstream scientists that subscribe to that consensus as "just another interest group" will cause "small interest groups with greater access [to] have the potential to achieve more than larger interest groups with diminished access").

225. *Cf.* BRINT, *supra* note 60, at 145-47 (discussing the "bounded rationality" of experts and their "characteristic weakness in appreciating the broader social and historical context in which they work"); RAPHAEL SASSOWER, KNOWLEDGE WITHOUT EXPERTISE: ON THE STATUS OF SCIENTISTS 110-11 (1993) (recounting the work of various scholars who observe scientific experts as typically "narrow-minded" and lacking "the ability to coordinate their specialized knowledge . . . with the specialized knowledge of others").

226. Science policy teamwork is necessary for the accurate integration of knowledge gaps into environmental legislation and appears to be present in those expert panels that do excel in delineating the offerings and limitations of science. Without this interdisciplinary teamwork, scientists acting alone may be unable to participate as effectively in reversing Congress's errors. *See* Katz, *supra* note 167, at 44-45 (discussing with examples the difficulties some scientists face in communicating their findings to Congress and how scientists "are not likely to be sensitive to the political aspects and implications of technical information and scientific advice"). For example, surmising ways Congress could improve its policymaking on scientific issues, a senator in 1964 recommended that what "Congress needs most . . . is the advice of the well-rounded 'generalist' who, having a scientific or engineering background, is familiar with the workings of the Federal Government." Anderson, *supra* note 85, at 30; *cf.* Cote, *supra* note 74, at 80 (observing that scientists are often "unable to translate their ideas into language that Congressmen understand"). Lindblom and Cohen have actually expressly called on social scientists to better fit their research with the needs of society, *see* LINDBLOM & COHEN, *supra* note 34, at 93, and have suggested that this effort will require social interaction with social science experts and lay decisionmakers. *See id.* at 101.

There are other, less positive, stereotypes of scientists that, if true, would further exacerbate communication problems between scientists and policymakers. Perhaps the most damning criticism of the scientific community is its alleged disinterest in and lack of respect for the public's contributions to science policy. *See, e.g.*, MILLER, *supra* note 157, at 72 (concluding that science policy leaders (comprised predominantly of scientists) have a lower estimate of the public's understanding of scientific issues than the public itself believes it has); Goodell, *supra* note 154, at 34 (suggesting that "scientists also have a peculiar provincialism about their profession: Scientists

When these characteristics of scientists are set against the behavioral characteristics of Madisonian legislators, a significant source of interdisciplinary slippage is revealed. A Madisonian legislator looks to reputable scientists and other cutting-edge researchers to shed light on complicated policy problems.[227] A scientist by contrast is naturally programmed to answer such difficult questions or at least to remain cautiously optimistic that the scientific enterprise will make headway in providing needed enlightenment on the natural world. As a result, these two groups of highly principled professionals talk past each other when it comes to highlighting the gaps in scientific knowledge. The Madisonian legislator's sincere search for scientific answers and the scientist's equally sincere eagerness to provide them leads to overconfidence in science and a general neglect of science's limits.

2. *Inadequate Assistance from Others*

The interdisciplinary slippage that occurs between scientists and Madisonian legislators with regard to identifying the limits of science does not appear to be counterbalanced by the internal research capabilities of the Madisonian legislator or by input from outside watchdog organizations. The deficiencies of each in identifying the limits of science are addressed in turn.

a. Internal Sources of Scientific Analysis

Within Congress, the Madisonian legislator receives only limited assistance in understanding the limits of science because of deficiencies in the scientific training of federal lawmakers and their staffs. The congressmembers themselves are generally ill prepared, even when striving to fulfill Madison's best aspirations, to appreciate the significant knowledge gaps endemic to environmental policymaking.[228] Their lack of formal scientific training[229] may cause them to discount

know that it takes education and experience to become skilled in their field, but they do not see that the same is true in journalism."); Philip Handler, *In Science, "No Advances Without Risks,"* U.S. NEWS & WORLD REP., Sept. 15, 1980, at 60 (quoting Handler, former president of the National Academy of Sciences, as observing that "most members of the public usually don't know enough about any given complicated technical matter to make meaningful informal judgments," and science policy decisions should be left to the "knowledgeable wise men [of science]").

227. *See generally* KEITH KREHBIEL, INFORMATION AND LEGISLATIVE ORGANIZATION (1991) (using rational models of politics to conclude that the utility of information, including technical information, derives from its capacity to reduce uncertainty).

228. *See, e.g.*, Fallows, *supra* note 53, at 6 (observing that "[f]ew members of Congress have the specialized knowledge in technical fields that would allow them to know the answers to such technical questions [as raised in nuclear disputes]. . . . For issues outside their personal knowledge, they must solicit information or assistance from other sources.").

229. *See, e.g.*, Pete V. Domenici, *Science and the U.S. Senate*, *in* SCIENCE AND TECHNOLOGY ADVICE, *supra* note 73, at 405, 405 (observing that "today [1988], sixty-five of our 100 Senators were trained as lawyers" and that "[w]ith all this talent, one broad discipline is missing. Not a single member of today's United States Senate is a scientist. The closest we come is our civil engineer (Senator Evans of Washington) and our astronaut (Senator Glenn of Ohio)."); Kathy

or ignore the limits of science unless the limits are made evident by using common sense or reading the newspaper.[230] Institutionally, moreover, they may lack either the time[231] or incentive[232] to concern themselves with ensuring that the limits of science are clearly and accurately delineated. Indeed, recent history suggests that Madisonian legislators may consider debating the limits of science to be the antithesis of the role they ought to play as financier and motivator of scientific research and technology development.[233]

Sawyer, *Gore's Scientific Approach to GOP Cuts,* WASH. POST, Feb. 28, 1996, at A17 (citing Vice President Gore's tally that the House and Senate combined contained a scarcity of scientists, consisting of only six scientists, two engineers, and one science teacher).

230. *Cf.* LINDBLOM & COHEN, *supra* note 34, at 14-17 (suggesting that "ordinary knowledge" generally suffices as an adequate knowledge base for making policy decisions); Weiss, *supra* note 176, at 120 (observing that "[m]embers and staff [of Congress] tend to pay particular attention to the media, [in part] because the media serve Congress as a proxy for public opinion").

231. A diligent member of Congress will face a back-breaking workload and a resultant need to reach decisions rapidly. Under such pressure, analytical blind spots are bound to develop on policy issues where there are no proponents or where the issues are too muddled or esoteric to decipher. *See, e.g.*, Schick, *supra* note 197, at 16 (concluding that federal lawmakers have little "leisure" time to work on complex legislative matters, with membership averaging 14.2 subcommittees per congressmember in 1976); Comment of N, *Environment, Energy, and Economics*, *supra* note 75, at 121 ("Something like 86 members of the Senate say their schedules are driving them up the wall. . . . [T]his is a very bad way to live if one wants to act rationally and think problems through thoroughly.").

232. The technical components of environmental problems may be viewed by the Madisonian legislator as more appropriately resolved by administrative agencies. At least some science policy staff have indicated that *they* believe that scientific advice is not terribly necessary for Congress because "Congress does not make technical decisions. Congress develops policy." Fallows, *supra* note 53, at 83. Indeed, this is the fundamental justification for the regulatory state.

233. Over the past 50 years, science and technology issues have frequently been merged by congressmembers and viewed predominantly as "technology" issues—how to split an atom, to code the human genome, to develop a range of technologies that preserve our status as an international trade leader. *See, e.g.*, Domenici, *supra* note 229, at 407 (discussing, in the context of preserving international competitiveness on science and technology, "[t]wo huge, exciting issues [that] confront mankind. . . . The first is superconductivity. The second is the human genome."). In an effort to reach these goals, Congress has often proudly proclaimed itself as motivator and financier, a role accomplished primarily through technology-forcing laws and purportedly beneficent research programs. *See, e.g.*, Anderson, *supra* note 85, at 31 (citing, with pride, Congress's success, in 1964, at "spurr[ing] momentous decisions, in the face of inconclusive advice of experts" such as proceeding with the hydrogen bomb and with weapons using large quantities of fissionable materials, the development of a nuclear submarine fleet, and the development of power reactors). Weak empirical evidence of this observation also derives from the fact that all of the six members of Congress participating in a chapter of essays on science and technology advice to Congress each began with (or, in Roe's case, included in) their contribution a discussion on the importance of encouraging science and technology in an age of intense international competitiveness. *See, e.g.*, Emilio Q. Daddario, *Reflections on Science, Technology and Congress, in* SCIENCE AND TECHNOLOGY ADVICE, *supra* note 73, at 400, 400 (arguing that "[t]he present concern about American productivity and the nation's ability to compete in a world that has become so rapidly globalized has initiated a period of self-examination" about science and technology); Dominici, *supra* note 229, at 405-06 ("I am convinced America can strengthen our competitiveness far more effectively by unleashing our vast scientific knowledge than by passing a dozen new trade laws."); Don Fuqua, *Federal Investment in Science and Technology: Priorities for Tomorrow, in* SCIENCE AND TECHNOLOGY ADVICE, *supra* note 73, at 409, 414 (emphasizing in his comments, to the exclusion of other issues, the import of scientific and technological development to "a nation's socio-economic well-being, if not its very survival" and arguing that technology requires a "sufficient force" to drive it, like legislated research programs); Bill Green,

For a number of reasons, congressional staff, although considerably greater in numbers and in expertise relative to members of Congress, may also miss many critical opportunities to highlight the limits of science and its relevance to environmental policymaking.[234] First, persons with advanced scientific training are in a noticeable minority on both committee and personal staffs,[235] and they appear to have

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Science and Technology Advice and Education: A Long-Term View, *in* SCIENCE AND TECHNOLOGY ADVICE, *supra* note 73, at 420, 420 ("[T]he space program and international trade are examples of arenas in which the federal government needs solid, honest and long-range scientific knowledge."); John Kerry, *Science Advice, Government, Education and the Economy*, *in* SCIENCE AND TECHNOLOGY ADVICE, *supra* note 73, at 431, 431 ("There is no more critical issue for the future of this nation than the question of how we maintain our tradition of excellence in science and technology, and thus our ability to compete in world markets in the . . . new international economy."); Robert A. Roe, *Science and Technology Advice for the President and Congress: The Need for a New Perspective*, *in* SCIENCE AND TECHNOLOGY ADVICE, *supra* note 73, at 435, 439-40 (noting the centrality of "science and technology . . . [in] almost every important issue facing the nation," including "trade balance" and the "new global economy/global marketplace"). This congressional view, both of science and of the role of Congress in relation to it, might understandably permeate all encounters with science.

234. Interestingly, however, the staff members themselves may not feel this scientific pinch quite so much or, at least, might not admit to it. In at least one study done in the late 1970s, most staff members appeared to feel fully competent to handle technical issues without scientific training. *See* Fallows, *supra* note 53, at 85 (reporting that in interviews with staff aides, "[n]early ninety percent of the nonscientific staff . . . find technical training relatively unimportant" even when the issue is technically complex). *Cf. id.* at 86 (explaining that, in interviews with a few professional staff that do *not* have advanced scientific training, the staff admitted that they felt intimidated by technical information and experts and had trouble sorting out the better of conflicting scientific arguments). If there is a disparity between congressmembers' view of the need for scientific training and the staff's view, and if the staff are doing a good deal of the foundational research and analysis, then this may either mean that members of Congress do not trust their staffs as much as they should on these issues or that the staff members are overconfident. Research into this possible disparity could prove very illuminating.

The absence of staff scientists, standing alone, does not necessarily foreclose sound and well-researched policymaking. But because knowledge gaps are esoteric and because their identification requires great familiarity with science, even a nonscientific staff that is dedicated to an open and searching fact-finding process may overlook the knowledge gaps, while collecting a relatively complete body of relevant positive scientific knowledge. *See supra* notes 47-57 and accompanying text.

235. The number of scientists on congressional staffs was undoubtedly lowest during the formative period of the environmental laws (the early 1970s). *See, e.g.*, Casper, *supra* note 215, at 8-9 (reporting that "[w]hen the 93rd Congress opened in 1973, there were only two PhD [sic] scientists on the permanent congressional staff and only a handful of staffers with any significant scientific background," although in 1977 there were "more than 50 PhD [sic] scientists and engineers on the Hill"). Despite improvements over the past 20 years, there is still a very limited number of scientists on personal or committee staffs, or at least quite a few less than the federal legislators themselves say they believe is adequate. *See, e.g.*, Abelson, *supra* note 73, at 398 (reporting that "[r]equests by Congressmen for [science] Fellows exceed supply by a factor of five"). Susan Fallows reported that in the period from 1977 to 1979 "[o]nly five percent of the overall staff population [of committees and personal staff in both houses of Congress] had advanced scientific training." Fallows, *supra* note 53, at 57. Many of these scientists were concentrated in science policy committees or the personal staff of those committee members. Energy staffers, for example, were comprised of 40% scientists, most of them (60%) serving committees. *See id.* at 56-59 & tbl.III-2. These numbers are corroborated in a relative sense by more recent (1990) reports on the proportion of scientific staffers serving specialized committees. *See, e.g.*, Abelson, *supra* note 73, at 396 (observing that "[a] major center of scientific and engineering expertise for the House of Representatives is the staff of the Committee on Science, Space and Technology. Out of a total of 80 staffers, about a third have advanced degrees in science or engineering.").

shorter tenures on the Hill.[236] Second, because scientific staff members must play multiple roles and have limited time,[237] even the most valued and informed staff expert may not recognize the importance of the knowledge gaps or be introduced to a legislative development early enough to guide it in a helpful way.[238] Finally, because the number of staff is limited and legislative developments have become more divided between committees,[239] it is possible that even if staff

236. In 1980, Fallows observed that "the mean duration of Hill service for scientists [serving on nuclear issues] was 2.7 years, compared to 4.6 years for nonscientists." Fallows, *supra* note 53, at 61. She went on to observe that this shorter service period of staff scientists could exacerbate their limited numbers by also impairing their Hill sophistication, experience, and continuity on major legislative developments. Unfortunately, this is the only study found comparing service terms between scientific and nonscientific staff, and it is neither published nor analyzed statistically. Some staff scientists are also serving through the one-year congressional fellowship program, making their tenure even shorter. *See, e.g.*, Abelson, *supra* note 73, at 396-97 (observing that "about thirty Congressional Fellows that are selected by and supported financially by various scientific and engineering societies" are "[s]prinkled among the many offices on Capitol Hill").

237. *See, e.g.*, Fallows, *supra* note 53, at 68-75 & tbls.III-5, III-6 (identifying multiple roles energy staffers play and placing many positive knowledge-related tasks, such as gathering information and clarifying and evaluating technical merits, at top and others, that might involve more knowledge-gap related analysis like drafting legislation and advising, near the bottom of their list of activities). *But see id.* at 74, 77 (noting that the Senate staff often function much more actively in providing advice and guidance on legislative matters, as well as information, because there are only 100 members and an equivalent number of legislative matters to consider).

238. In fact, some of these other roles that scientific staff must often fill—for example, enhancing the credibility of one or more members of Congress—may conflict with the role of policy analyst. In any case, these multiple roles compete for the staffers' limited time and attention. *See id.* at 86 (reporting that some scientific staff believed their purpose is not so much to improve legislative products as it is "to establish credibility in the eyes of people who interact with the legislator and his staff"). Thus, like the Madisonian legislator, expert staff may find themselves so valuable that many opportunities for their input are necessarily missed. Additionally, some scientific staff may simply not be trusted. A staff member, however expert, who does not have this trust finds little opportunity to advance different or conflicting policy analyses. Because committee staff are hired on a partisan basis, moreover, their advice may not always be trusted by committee members of the opposing stripe. *See generally id.* at 64-67 (elaborating in detail on the nature of the senior member-committee staff bond); Harrison W. Fox & Susan Webb Hammond, *Congressional Staffs and Congressional Change*, *in* LEGISLATIVE STAFFING: A COMPARATIVE PERSPECTIVE 122 (James J. Heaphey & Alan P. Balutis eds., 1975) (observing a strong sense of party affiliation between committee staff and those hiring them). *Cf.* Comment by X, in *Environment, Energy, and Economics*, *supra* note 75, at 117 (accusing congressional staff in general of being partisan in their views and, hence, reacting negatively to objective analysts as "the wild card thrown on the table after the hand has been dealt"). Gaining access to expert committee staff is also not always easy for all members of the committee. In her study of scientific staff serving on nuclear issues, for example, Fallows found that "committee staffers provide a special resource for senior committee members—one that is less accessible to other members on the committee. . . . If a junior member wants to have reliable access to independent information or analysis, he may have to build it up on his own staff." Fallows, *supra* note 53, at 64.

239. Fragmented and overlapping jurisdictions of congressional committees and subcommittees are common and increase legislative errors because of the failure of any one committee to take full responsibility for a policy area. House committees have been partially consolidated recently, but this division nevertheless remains a problem. *Cf.* Lazarus, *supra* note 1, at 339-40 (observing that in 1991, before the committees were consolidated, "[e]leven standing House committees, nine standing Senate committees and up to one hundred of their subcommittees currently share environmental jurisdiction" (footnotes omitted)); Schick, *supra* note 197, at 15 (describing how the Energy Research and Development Administration is subject to the juris-

have the time and are trusted, they may not be in the right place at the right time to effectively influence legislation.[240]

More formal internal mechanisms for gathering advice—calling on one of the congressional research services[241] or holding a hearing[242]—also appear to emphasize fact-finding (or the gathering of positive scientific knowledge) rather than the identification and isolation of scientific uncertainties. This results, in part, because formal methods of information collection are generally dominated by a congressmember's (or staffer's) own inquiries and perceptions of the relevant questions.[243] As a result, if congressional-level officials do not ask for

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diction of several dozen congressional committees and concluding that fragmentation can cause a lack of cohesiveness and comprehensiveness in Congress's understanding and reaction to the issues). This divided committee jurisdiction also complicates the ability of legislators to become specialists. *See* Lazarus, *supra* note 1, at 357 (observing that fragmented jurisdictions of congressional committees make it "extremely difficult, if not impossible, for any one committee to undertake a broad, coordinated look at a complex problem"); *id.* at 359-60 (describing how decentralization impeded ability to reach agreement on Superfund reauthorization and on 1990 amendments to Clean Air Act); Schick, *supra* note 197, at 16 (noting that because of workload, necessary increased delegations to staff, and other pressures it is "harder and harder for beleaguered Senators" to become expert-specialists on certain policy areas, as well as to reach agreement).

But fragmented jurisdictions may be somewhat of a mixed blessing. One political scientist has carefully shown how, through the decentralization of power, these fractionated jurisdictions may actually preserve and reward the neutrality of scientific advice. *See* BIMBER, *supra* note 75, at 97-98 (concluding that "[i]n Congress, decentralization of power has made a low degree of politicization on the part of captive experts functional for survival. Congressional agencies like OTA are rewarded for being perceived as depoliticized, and they tend to adopt some form of a strategy of neutrality in response").

240. *See, e.g.*, Fallows, *supra* note 53, at 92 (reporting that based on her interviews with 43 energy staffers, "committee staffers in both chambers turn to other committees less often" and "[o]nly a few take advantage of the fact that committee jurisdictions overlap with their own in order to gather missing data"). Rarely can one or two well-informed staff members (or congressmembers) take charge of an issue if it has some political saliency and is subject to more than one committee or subcommittee jurisdiction. Turf wars may also develop, which further complicate and undermine thorough policy analysis. *See id.* (observing, based on interviews, that "most staffers indicate that in instances of overlap, committees jealously guard their own jurisdiction and resist attempts to share resources as important as information").

241. *See* Abelson, *supra* note 73, at 397 (touting the expertise of the Science Policy Research Division of the Congressional Research Service, which "has a professional staff of thirty-seven who are expert in a wide range of scientific and engineering disciplines").

242. Hearings, unlike the open free-for-alls common in administrative decisionmaking, are based largely on experts and questions that federal legislators (and their staff) consider relevant to the issue. For example, testimony and testifying experts are almost always predetermined by congressional staff, and the contributions at hearings are generally limited by information the staff has collected or deems important. *See generally* Wendy M. Rogovin, *The Politics of Facts: The Illusion of Certainty*, 46 HASTINGS L.J. 1723, 1744 (1995) (describing hearings as "elaborate and somewhat bizarre re-creation[s] of [Congress's parallel process of] informal fact finding [sic]").

243. Scientific staff, experts at hearings, and highly expert adjunct bodies like the former OTA or the NAS are utilized most often when Congress feels that their assistance will be helpful. *See* Abelson, *supra* note 73, at 397 (describing the helpfulness of the Science Policy Research Division of the Congressional Research Service (CRS), but limiting the discussion to the apparently primary role of these experts in responding to a variety of types of congressional requests for information). Although these experts, as well as scientists testifying at a congressional hearing, may have the opportunity to interject information regarding the limits of science, despite legislators' failure to inquire about those limits, this will necessitate that those testifying also

specific assistance in understanding the limits of science, this assistance is unlikely to be offered.[244] Limitations in time and resources[245] or an incomplete understanding of Congress's larger policy needs may

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appreciate the importance of highlighting the limits of science. For a number of reasons, this appreciation could be lacking in most testifying experts. *See supra* notes 205-21 and accompanying text. They may also be reluctant for fear of less forthright experts or non-Madisonian legislators who may attempt to deconstruct the testimony. *See supra* notes 171-99 and accompanying text; *see also* Nichols, *supra* note 78, at 94 (reporting that the adversarial approach of legislative hearings may "ask the wrong questions, put key social issues on a pseudo-technical basis, and thereby undermine the confidence of everyone"). With this said, however, it seems possible that more informal, information-gathering hearings should be capable of improving Congress's understanding of the limits of science.

244. Depending on the expert office, "asking" for advice is also not always easy. Although the Congressional Research Service (CRS) does provide some scientific/technical advice on individual request, its work is widely diffused among disciplines and issues, making it difficult for it to dedicate resources to prepare a full report. *See* BIMBER, *supra* note 75, at 80 (describing the broad nature of the CRS's services and characterizing it as "a Grand Central Station of information, where a ceaseless schedule of questions arrive and are routed to the appropriate experts"). The more academic and technically oriented counterpart among Congress's captive experts, the now defunct Office of Technology, could provide these more comprehensive reports, but its work was not only slow, *see id.* at 34 (describing average OTA study as taking two years), but it had to be commissioned by "a written request from a committee chair to the agency director or board." *Id.* at 33; *see also id.* at 28 (discussing Congress's rationale for the limited availability of OTA advice); AMES, *supra* note 60, at 174 (describing the difficulty of commissioning an OTA study and how, as a result, "considerable power over whether an assessment is done has fallen to committee or subcommittee chairmen who either serve on, or have friends on, the OTA board"). Although the OTA did produce some important environmental reports, *see, e.g.*, OTA, ACID RAIN AND TRANSPORTED POLLUTANTS (1984); OTA, CATCHING OUR BREATH: NEXT STEPS FOR REDUCING URBAN OZONE (1989), relatively little of its work appeared to be related to environmental matters. *See* BIMBER, *supra* note 75, at 34 tbl.4 (listing the "top 10 committee clients for OTA, 1980-95" with Senate Environment and Public Works falling in seventh place and with 19 requests comprising less than 6% of the total requests).

The OTA has also been accused of not communicating speedily or well, which could have further reduced the impact of its message. *See* Fallows, *supra* note 53, at 89 tbl.IV-1 (reporting, based on interviews with 43 nuclear staff, that only 37% mentioned the OTA as useful, as compared to 60% mentioning the Congressional Research Service, 46% mentioning the G.A.O., and 92% mentioning executive agencies); *id.* at 95 (reporting, based on interviews, that "[f]ew staffers had come in contact with [the OTA's] work since it began operations in 1974. Only half the committee staffers reported referring to OTA reports as a source of information. Among this group, nearly everyone perceived its analyses as irrelevant, dated, subjective, or lacking usefulness for some other reason."); *see also* Comment of Schick, *Environment, Energy, and Economics*, *supra* note 75, at 128 (discussing how Congress "needs analysis translated into a form that is germane to legislation" and suggesting that four other congressional agencies can do a better job in that regard); Comment of R, *id.* at 130 (observing that the "OTA, in my judgment, moves like a dinosaur. It takes them eight months to get geared up to do something that you've got to decide upon tomorrow. On a short term [sic] basis, they don't have any input.").

It is also to be expected that these same formal processes, particularly hearings, prove to be of lesser value to the staff as a source of technical information. In an interview of 43 energy staffers, expert testimony at hearings was mentioned almost the least frequently as a source of information (by 35% of the staffers). The only source that was cited even less often were layman constituents (by 21% of the staffers). *See* Fallows, *supra* note 53, at 89 tbl.IV-1.

245. Expert support organizations generally face daunting workloads and deadlines. *See, e.g.*, Abelson, *supra* note 73, at 397 (observing that the 37-person Science Policy Research Division of the CRS "turn[s] out 100-200 reports a year with a median of 20 pages" and "respond[s] to some requests with one- to two-page memos totalling about 500 a year" and that these documents "are prepared with a fast response time"). As a result, they necessarily have little time to provide extra advice on big picture issues like the capabilities and limitations of available scientific information.

also exacerbate the failure of internal experts to come forward to discuss the limits of science.[246] For example, internal experts or experts called in hearings who are aware of Congress's unrealistic overreliance on science may assume that this reliance on science does little harm to the final legislative products.[247] Even if these internal experts realize the policy relevance of identifying knowledge gaps and are able to utilize a rare opportunity to take the initiative in identifying these gaps, they may still find themselves disinclined to provide guidance for fear of congressional reprisal for overstepping their bounds.[248]

b. External Watchdogs

Much information that reaches Congress arrives not through active search techniques, but passively through interested parties, such as the executive branch and interest groups.[249] These parties are considered by some to be among the most important features of Congress's adversarial approach to developing legislation.[250] Yet, these

246. *See supra* notes 205-21 and accompanying text.

247. Because the scientific staff will likely take the lead on such issues within captive expert organizations, they may be particularly complacent about Congress's overconfidence in science. *See supra* notes 205-21 and accompanying text.

248. It seems to be well known by congressional expert agencies that they are supposed to be "on tap, not on top." BIMBER, *supra* note 75, at 28 (quoting Rep. Jack Brooks). Captive experts like the OTA apparently found that boldly defining their own research agenda proved threatening to Congress and ultimately to their own survival. *See id.* at 60-68 (describing the OTA's "strategy of neutrality"). The OTA, Congressional Research Service (CRS), and Congressional Budget Office (CBO) carry this still further and resist offering policy recommendations in the hope that their reports will offer something for everyone. *See id.* at 66, 82, 85-86 (describing OTA, CRS, and CBO policies respectively, and noting that in the CRS "[a] reviewing office . . . is dedicated to checking outgoing reports for balance and neutrality before they are delivered to a legislator or committee"); *see also id.* at 91 (describing the General Accounting Office's (GAO's) practice (alone among congressional support agencies) of providing policy recommendations, which has lead to predictable "criticism from legislators who object to its recommendations").

249. *See* Michael D. Cohen et al., *A Garbage Can Model of Organizational Choice*, 17 ADMIN. SCI. Q. 1 (1972) (describing a "garbage can model" of decisionmaking in which problems and alternatives present themselves almost randomly, with the outcome reflecting this unorganized process). More value-neutral think tanks have exerted little meaningful influence on science policy, although this may be changing. *See generally* CARNEGIE COMM'N, SCIENCE, TECHNOLOGY, AND CONGRESS: ORGANIZATIONAL AND PROCEDURAL REFORMS (1994); CARNEGIE COMM'N, SCIENCE, TECHNOLOGY, AND CONGRESS: EXPERT ADVICE AND THE DECISION-MAKING PROCESS (1993).

250. Professor Lindblom has argued that "[w]ithout claiming that every interest has a sufficiently powerful watchdog, it can be argued that our system often can assure a more comprehensive regard for the values of whole society than any attempt at intellectual comprehensiveness." Lindblom, *supra* note 193, at 85. Even the best Madisonian legislator must, by necessity, rely heavily on an adversarial process of decisionmaking, which seems ideally suited for airing conflicting opinions and for ultimately ensuring the factual accuracy of policymaking. *See, e.g.*, Comment of M, *Environment, Energy, and Economics*, *supra* note 75, at 119-20 (arguing that "the greatest strength [in terms of policymaking] of the Senate and House as institutions is their adversarial atmosphere" and warning that expert panels should not supplant this means of making decisions); Domenici, *supra* note 229, at 406 (describing an incident where Senator Domenici and staffers noted that the conclusions of a scientific study relied on by the EPA were much broader than single tests done at a single plant and arguing that based on his experience "Con-

watchdog groups are also unlikely to identify gaps in scientific knowledge. Except in those limited circumstances where the policy consequences of overdependence on science are clear, direct, and immediate, in fact, these watchdogs may actually benefit from Congress's tendency to scientificate environmental policy choices.[251]

The executive branch, for its part, wields great influence over the legislative process,[252] but typically fails to help highlight the prevalence of knowledge gaps in environmental policymaking. This may be due in part to poor utilization[253] or possible biases[254] of White House

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gress usually does pretty well in evaluating science . . . [and sifting] out the logical conclusions"). But, it can also lead to serious errors of omission when the facts or positions are difficult for members of Congress and their staffs to discern or understand and/or when there are no stakeholders for particular positions or factual realities. *See, e.g.*, KREHBIEL, *supra* note 227, at 76-103 (discussing the incentives members of Congress have for seeking out information and how constituency or self-interest produces most policy-relevant information); Lakoff, *supra* note 76, at 599 (observing that Congress tends to be "especially sensitive to the interests and needs of particular constituencies . . . [and that this] forces them to spend a good deal of their time providing services to constituents"); Lindblom, *supra* note 193, at 81 (describing the "muddling" process likely used by policymakers to solve complex problems, which raises the likelihood that important possible policy outcomes, alternatives, and/or affected values will be neglected); *cf.* Rogovin, *supra* note 242, at 1742-43 (observing that "Congress has no formal or legal obligation to engage in any fact finding prior to the passage of legislation").

251. When overreliance on science has obvious and immediate consequences—such as in the case of global warming where "good science" means legislative delays—interest groups may prove more valuable in educating Congress about unpreventable scientific uncertainties that arise in environmental problem solving. Even then, however, the interest groups may find it more advantageous to adhere to the extreme predictions on either side of the debate, rather than attempt to characterize and explain the pockets of scientific uncertainty that require policy choices. *Cf.* GOTS, *supra* note 53, at 251 (recounting in detail the Alar scare and explaining that the differences between risk predictions used by environmental and industry groups were the result of "numerous and often irreconcilable assumptions underlying their respective risk assessments").

252. Because the president is charged with implementing the laws and has the option to veto them, he takes a keen interest in legislative developments. *See* Lakoff, *supra* note 76, at 594 (observing that "the reality" of executive/legislative branch relations is that "members of the legislature have been virtually coopted into the executive"). *But see id.* at 597 (concluding that Congress has not "been entirely subservient to the executive in matters involving science and technology"). Indeed, the president initiates a good number of bills through friends on the Hill and in some circumstances is best suited to develop legislative proposals. *See* R. RIPLEY & G. FRANKLIN, CONGRESS, THE BUREAUCRACY, AND PUBLIC POLICY 55-60 (3d ed. 1987) (describing the close relationship between Congress and agencies); Terry Moe & Scott Wilson, *Presidents and the Politics of Structure*, LAW & CONTEMP. PROBS., Spring 1994, at 1, 3 (1994). Administrative agencies also provide an almost continuous source of information to Congress, both voluntarily and on demand. *See, e.g.*, Fallows, *supra* note 53, at 90 (reporting, based on interviews of energy staffers, that "congressional staffers most frequently mentioned administrative agencies as the key source of information. They use it on a day-to-day basis to get quick bits of information."); Lazarus, *supra* note 5, at 212 (describing the tremendous number of hearings, reports, and other contacts Congress makes with the EPA each year and estimating that the EPA officials appear before Congress between 92 and 213 times a year).

253. Despite its large army of agency scientists, the executive branch may not be positioned to utilize them effectively in originating and commenting on legislation. *See generally* William D. Carey, *Science Policy: USA and USSR, in* SCIENCE AND TECHNOLOGY ADVICE, *supra* note 73, at 83, 85 (bemoaning the "limp muscles of science policy arrangements at the Presidential level"); J. William Hirzy, *The Other Voice from EPA: The Role of the Headquarters Professionals' Union*, 20 Env't L. Rep. (Envtl. L. Inst.) 10,057, 10,057 (Feb. 1990) (reporting that the scientific side of the EPA has become both subordinate and subservient to the legal side). *See also* Lazarus, *supra* note 1, at 362, 370 (reporting that the EPA's decisionmaking process is encumbered by large

or agency scientists. Equally likely, however, is the possibility that the executive branch perceives more gains than losses from Congress's mistakes.[255] Mandates that depend unrealistically on science for their

numbers of interested staff from various offices and suggesting that this might cause conflict and disorganization in formulating policy positions); *id.* at 355-56 (reporting on the large demands on agency resources and the limited time left for agencies to formulate policies). Legislative proposals that originate in the executive branch are generally developed by a team of lawyers, most of whom are located in the White House or at high levels in agencies. *See id.* at 354-55 (observing that "lawyers in the EPA General Counsel's Office have become increasingly influential on matters of agency policy. . . . Technical expertise is devalued, and opportunities for public education are missed."); *see also* Sheila Jasanoff, *Risk, Uncertainty, and the Legal Process*, *in* SCIENCE OFF THE PEDESTAL, *supra* note 26, at 41, 50 (reporting that in 1984, "seven out of EPA's eight acting and permanent administrators had been lawyers"). In most cases, these influential officials are unlikely to be proficient in science and its limits. As a result, the knowledge gaps may receive inadequate attention, even from the president, during the formative period of legislative development. In any case, even if agency or White House personnel did identify Congress's failure to account for important pockets of negative knowledge, it is not clear that the president would always, or even frequently, choose to take on this esoteric battle given the competing, and often more politically salient concerns with Congress's legislative efforts. The executive branch can fail to identify the knowledge gaps for the same reasons that the Madisonian, public choice, and direct agent legislators fail in this regard.

254. Bruce Bimber suggests that internal incentives within the executive branch may cause the science advice received by this branch to be more biased than that offered by the captive experts on which Congress relies: "In the Executive Office of the President . . . experts . . . are likely to be sanctioned for displaying a lack of commitment and rewarded for providing expertise designed to further a focused set of political interests." BIMBER, *supra* note 75, at 7; *see also* Terry M. Moe, *The Politicized Presidency*, *in* THE NEW DIRECTION IN AMERICAN POLITICS 235 (John E. Chubb & Paul E. Peterson eds., 1985). Thus, even when agencies overcome the many practical and institutional obstacles and publicly highlight the prevalence and import of knowledge gaps to environmental legislation, it is possible that the Madisonian legislators may discount the agencies' advice because of perceived biases resulting from their loyalty to the president's larger policy agenda. *Cf.* Comment of R, *Environment, Energy, and Economics*, *supra* note 75, at 130 (observing that the executive branch should improve its responsiveness to congressional requests and insinuating that, at times, executive officials do not provide balanced or honest information). One of the original purposes of the OTA, in fact, was to provide Congress with information from a source independent from the executive agencies. *See* STAFF OF SENATE COMM. ON RULES & ADMIN., 92D CONG., TECHNOLOGY ASSESSMENT FOR THE CONGRESS 44 (Comm. Print 1972); *see also* BIMBER, *supra* note 75, at 40-49 (describing the primary role of OTA as helping Congress see biases in executive branch technical positions); Fallows, *supra* note 53, at 91 (reporting, based on interviews with nuclear staffers in congressional committees, that they "expect bureaucrats to glean potentially damaging data, leaving only the information they perceive to be neutral or advantageous to their agency's interest.").

255. Although presidents have not always taken advantage of the power relegated to them through a dysfunctional mandate, there are many examples of the EPA using this administrative discretion to craft regulations that met the executive branch's larger policy agenda. *See, e.g.*, JONATHAN LASH ET AL., A SEASON OF SPOILS: THE REAGAN ADMINISTRATION'S ATTACK ON THE ENVIRONMENT 149 (1984) ("Scientists critical of the shift [to "good science" under Reagan] called it a 'covert' attempt to radically revise and soften regulations."); RUSHEFSKY, *supra* note 176, at 175 (describing the "political use of science" during Reagan administration); Ashford et al., *supra* note 42, at 328 (describing the EPA's decision to not regulate formaldehyde under Reagan as one reached "long before any 'decisionmaking process' had been completed"); *see also* COLLINGRIDGE & REEVE, *supra* note 176, at 34 (proposing that in some cases "science is used to legitimate or rationalize political choices which have already been taken"); TED GREENWOOD, KNOWLEDGE AND DISCRETION IN GOVERNMENT REGULATION 255 (1984) ("Regulatory agencies sometimes select a strategy before examining relevant scientific and engineering knowledge, then tailor their risk assessments and analyses to be consistent with that choice."). *See generally* Wagner, *supra* note 7, at 1644-50 (providing examples of the premeditated science charade of agencies). To the extent that an individual agency or the White House wishes to

implementation delegate considerable discretion, and hence power, to the executive branch.[256] Indeed, the agency may for related and other reasons already be engaging in its own science charade.[257]

Interest groups[258] will tend to have little influence on Madisonian legislators because these congressmembers seek out reliable and

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maximize its policymaking authority, then, misrepresenting the capabilities of science, or at least failing to point out important knowledge gaps, will enlarge this sphere of power.

It is also possible that agency staff themselves have more to lose than to gain from the vigilant (and often unrewarded) review of legislative proposals that misframe environmental problems as scientific ones. In contrast to the president and his appointees, long-term agency staff are able to maintain themselves through unreasonable delegations, particularly those that assume that scientist-technocrats will be able to provide more policy-relevant answers than are actually possible. Professors Lindblom and Cohen, for example, have observed that "government agencies are again and again assigned (by the legislature or by superior agencies) responsibilities beyond any person's or organization's known competence. They do not typically resist these assignments because they are funded and maintained for their efforts, not for their results." LINDBLOM & COHEN, *supra* note 34, at 86; *see also* GREENWOOD, *supra*, at 191 (observing that "a professional's influence within an agency often derives from the presumption of expertise in a particular field," which can cause agency experts to represent that conclusions are based on scientific knowledge or judgment, even if they are not); Peter H. Schuck, *Legal Complexity: Some Causes, Consequences, and Cures*, 42 DUKE L.J. 1, 31 (1992) (observing that "technical rules promote agency autonomy. Being more opaque to the generalist institutions like Congress and the media that seek to influence it, such rules make agencies more difficult to control and help obscure their pursuit of controversial policies." (footnote omitted)). As discussed in part IV, however, this power does not come without long-term costs.

256. For example, during congressional deliberations over the infamous Delaney Clause of the Food, Drug, and Cosmetic Act in 1950, the implementing agency, the Department of Health, Education, and Welfare (HEW), initially opposed the blanket prohibition on carcinogens in food additives and advocated, instead, that the HEW should be given authority to make individual safety determinations on all food additives (a reliance on science that would be unrealistic, *see supra* notes 86-120 and accompanying text). The HEW ultimately acquiesced to the Delaney Clause when the Delaney Clause was "revised to confirm FDA's scientific discretion in interpreting the results of animal tests." Merrill, *supra* note 71, at 1-2. A variety of authors have confirmed the tremendous range of uncertainties inherent in toxic risk assessment, which leaves the risk assessor with considerable discretion. *See, e.g.*, MELNICK, *supra* note 21, at 239 (describing broad discretion given to the EPA in setting standards for criteria air pollutants: "If the EPA sets excessively stringent standards, billions of dollars of unnecessary control costs will be imposed on the economy. If standards are too lenient, then the health of thousands of individuals will suffer."); Latin, *supra* note 69, at 95 ("It is important to stress that thousands of lives and billions of dollars in regulatory costs may depend on an agency's choice of controversial risk-assessment principles."). Similar sorts of assurances appear to have been provided to Congress by public land managers during deliberations on the Endangered Species Act. These managers maintained that optimum sustainable populations of threatened or endangered species could be determined scientifically, even though this clearly was not, and still is not, the case. *See* Doremus, *supra* note 8, at 1048 n.100.

257. *See generally* Wagner, *supra* note 7. Agencies themselves are already guilty of understating the gaps in scientific knowledge and overstating the scientific grounding of environmental policies or positions. The threat of judicial review, internal oversight by agencies like the OMB, and even self-interested power grabs by individual agency officials may cause the agency or officials to perpetuate the myth that science is the dominant or sole basis for the agency's regulatory programs. *See id.* at 1650-73. These forces may simply be so pervasive that agencies as a cultural/professional matter adhere to this science charade, regardless of whether it is against their long-term interests to do so.

258. Interest groups are often viewed as necessary intermediaries who fill the void between electorate understanding of the quality of the laws and their representatives who draft or vote on them. Interest groups may also act as "market facilitators" who "communicate the desires of a defined group of voters to those drafting legislation." Hovenkamp, *supra* note 150, at 104-05.

value-neutral expertise.[259] Thus, to the extent that interest groups call attention to knowledge gaps—most likely to deflate the unwelcome scientific projections of their opponents—the Madisonian legislator may heavily discount or even ignore this information.[260] As a rule, however, interest groups may more frequently perceive an advantage in the scientification of environmental policy, because such legislation typically delegates unaddressed policy issues to administrative agencies, and interest groups purportedly view these agencies as substantially easier to influence than Congress.[261] In addition, once policy issues are laid bare, interest groups are forced to openly acknowledge the economic or health-related costs of their public positions. They may prefer the unintelligible language of science over these honest, but painful, public disclosures.[262] Finally, interest groups likely recognize that resorting to scientific arguments increases the costs of participating in environmental policymaking, which, in turn, reduces the number of participants and increases the power of those remaining at

259. Political scientists have confirmed that members of Congress in general are wary of technical arguments made by interest groups and afford them less credence than objective advice. *See supra* note 75 and accompanying text. *But see supra* note 224 (describing congressmembers' suspicion of "objective" advice because they do not know how to evaluate it).

260. *See* KOMESAR, *supra* note 47, at 83 (observing that the general public, "faced with complex issues and limited incentives to independently investigate[,] may be manipulated or misled [by interest groups] into supporting positions that are detrimental to them").

261. *See* MASHAW, *supra* note 148, at 35 (discussing theorists' prediction that interest groups will seek broad delegations of authority to agencies). Experience has proven that the policy outcome of even the most conservative, science-based mandate is unpredictable and depends predominantly on decisions made by the implementing agency. In the case of the toxic air pollutants provision, for example, the statutory mandate threatened by its plain language the potential for severe social and economic dislocation. *See* Dwyer, *supra* note 8, at 240-41 (discussing the widespread social and economic consequences threatened by the original section 112 (toxic air pollutants provision) of the Clean Air Act). Yet, this mandate was so politically unrealistic that the EPA ultimately resisted doing anything. *See id.* at 278-80 (observing how the EPA, which is definitely not a "captured" agency, nevertheless resisted implementing the air pollutants provision through "paralysis by analysis" because of the mandate's incredible stringency). Thus, the industry undisputedly benefited the most during the 20-year history of a mandate that promised that the public would be protected from all toxic air pollution, regardless of the cost of regulation.

262. Highlighting knowledge gaps may ultimately work to polarize membership. Values also are difficult to argue when pitted against other values, like economic concerns. Framing debates as ones over positive knowledge or "good science" is, therefore, easier for interest groups to control and is more likely to be successful. *Cf.* Greenwood, *supra* note 35, at 95 (observing that "[t]o discredit an agency . . . interest groups of whatever stripe cannot merely complain in public that the agency acted contrary to their preferences. Such complaints would be discounted readily as advocacy by all except those who share the critic's interests or policy preferences."). Positive knowledge also appeals to the general public who often comprise the membership of at least the more public-spirited interest groups. *See supra* notes 149-70 and accompanying text.

the table.[263] This puts interest groups that scientificate environmental policy at a distinct competitive advantage.[264]

3. *The Enlightened Madisonian Legislator and Institutional Theory*

In some cases, a Madisonian legislator may overcome all of these obstacles and gain a full appreciation of the limits of science.[265] Yet this federal lawmaker may still fail to identify and adjust to the scientific knowledge gaps when drafting legislation because of the larger institutional context within which he operates.[266] In most cases, these enlightened members of Congress may simply assume the tendency of their colleagues to delegate scientifically unrealistic assignments to an agency or expert panel is, on balance, harmless.[267] A mandate that requires the EPA to base pollution standards on levels scientifically determined to be sufficient to protect the public health, for example, may, in their view, be naive but ultimately workable. In making this assumption, they may overlook the nonintuitive costs, including the possibility of agency paralysis or distorted emphasis on technical argu-

263. Interest groups are generally expected to be more influential when the issues are highly technical and the visibility of the debate is low. *See* KAY LEHMAN SCHLOZMAN & JOHN T. TIERNEY, ORGANIZED INTERESTS AND AMERICAN DEMOCRACY 317 (1986). Because positive knowledge is scientific information, while knowledge gaps must be resolved by commonly held values, understating the import of the knowledge gaps offers a way to limit participation by increasing access costs. This may also provide side benefits to individual advocates by enshrouding them with a veil of expertise.

264. *See, e.g.*, Cozzens & Woodhouse, *supra* note 79, at 547 (noting that the "debates over abortion, creationism, and animal rights . . . illustrate that various American publics are willing to retrieve the definition of key aspects of their lives and cultures from the experts, when enough is seen to be at stake" (citations omitted)).

265. There are certainly examples of individual members of Congress berating their colleagues for assuming that science will come forward with immediate answers to pressing environmental problems when there is great scientific evidence to the contrary. *See, e.g.*, *Rep. Brown's Fringe Science Report*, *supra* note 63, at 14 (arguing that "[t]here is no 'scientific' way to decide how to make the difficult tradeoffs among uncertainties, costs, benefits, and risks inherent in any policy action. . . . It is therefore meaningless to say, as some environmental policy critics have, that certain *policy* decisions are 'unscientific.'").

266. *See* SCHON & REIN, *supra* note 84, at 184. Institutional theory assumes that legislators act in more anticipatory ways, responding to one another in an effort to ensure their own ends, values, or other goals are maximized. *See generally* PETER C. ORDESHOOK, A POLITICAL THEORY PRIMER (1992); WILLIAM H. RIKER & PETER C. ORDESHOOK, AN INTRODUCTION TO POSITIVE POLITICAL THEORY (1973). An overly simplistic description of this competing model of congressional behavior is that members of Congress behave in a way to reach win-win solutions with other members of Congress. In applying institutional theory to this analysis, in fact, this enlightened Madisonian legislator is the only congressional model worthy of consideration as he is the only remaining protagonist who may find a reason to question the unrealistic science frame that his colleagues have constructed to resolve environmental problems.

267. In the debates over global warming, by contrast, scientific uncertainties are much more politically salient because of the inevitable delay associated with the position that "sound science" establishing the severity of the problem should be a precondition to legislation. *See, e.g.*, *Rep. Brown's Fringe Science Report*, *supra* note 63, at 14 (pointing out the inescapability of scientific uncertainties in the global warming debate and arguing that federal lawmakers who ignore this are merely trying to paralyze any industrial regulation under the cover of "sound science").

ments at the expense of democratic deliberations, that result from mandates that overrely on science.[268]

These scientifically enlightened members of Congress, assuming they are in the considerable minority, may also perceive that the costs of following up on their concerns regarding Congress's overreliance on science will be high. Responding to their colleagues' pleas for "good science" with elaborate tutorials on the limited capabilities of scientific experimentation in all but the most urgent policymaking circumstances[269] may be viewed as a losing proposition by even the most idealistic Madisonian legislator. Particularly in a culture where technical references and quantitative predictions seem to win votes from fellow congressional representatives as well as the public, urging a better appreciation for technical uncertainties may be viewed as a battle not worth fighting.

D. Summary

In sum, regardless of the model of congressional decisionmaking one adopts, it appears that individual members of Congress and Congress collectively will tend to scientificate environmental policy decisions. This analysis not only explains why congressional overreliance on science is so prevalent, but it is also critical in determining how best to reform this problem. Before discussing reform, however, it is necessary to first review the implications of Congress's overreliance on science and to consider whether reform is, in fact, needed.

IV. Adverse Consequences of Congressional Overreliance on Science

Although it is no small accomplishment for Congress to legislatively address controversial environmental issues, a variety of significant costs are imposed on society when environmental laws that place an unrealistic overreliance on science for their implementation are passed.[270] Some of these adverse consequences are detailed below.

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268. *See generally infra* notes 270-305 and accompanying text.

269. *See supra* note 267.

270. These costs would likely have been considerably lower if alternative legislative approaches had been adopted that placed more realistic demands on science. *See supra* notes 82-84 and accompanying text. Even the crude technology-based standards for pollution control are promulgated more quickly and do not suffer from the severe deliberative weaknesses that afflict their science-based counterparts. *See, e.g.*, Wagner, *supra* note 7, at 1692-95 (describing benefits and weaknesses of technology-based standards in relation to science-based standards). Yet even if the total social costs of scientificated mandates ultimately turned out to be lower than the costs incurred in using alternative legislative approaches with regard to resolving a particular environmental problem, the identification of specific costs associated with scientificated mandates is a necessary first step in determining the superiority of alternate approaches. *Cf. infra* notes 306-13 and accompanying text.

A. Lost Costs

Congress may not admit or even fully recognize that a series of legislative and regulatory inefficiencies result from its failure to account for the limits of science in developing environmental legislation. These unnecessary or lost costs include the costs of developing environmental regulatory programs that are ultimately rejected, as well as the lost costs associated with agencies' and industries' efforts to implement and navigate these unrealistic mandates.[271]

Most obviously, substantial costs are incurred when Congress abandons a science-based regulatory approach to controlling pollution and adopts in its place a more science-blind approach. For example, in amendments to the toxics provisions of both the Clean Water Act and Clean Air Act, Congress essentially conceded that a science-based legislative approach was ill conceived given the prevalence of scientific uncertainties.[272] Had Congress acquainted itself with the limits of science in advance, it could have not only avoided the political embarrassment of having to admit the science-intensive approach was not sound,[273] but it could have saved the countless resources the EPA and many states expended in their ill-fated efforts to implement and enforce these nonfunctional environmental programs.[274] Indeed, about the only benefit resulting from the EPA's doomed attempts to implement the toxics programs under these statutes was the painful reminder that science is of only limited usefulness in protecting the

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271. *See* Gabriel Kolko, *Intelligence and the Myth of Capitalist Rationality in the United States*, 44 SCI. & SOC. 130, 154 (1980) (arguing that "[t]he technical and ideological cadres that purvey intelligence, rather than becoming a source of rationality and integration, burden the already insupportable complexity of the system with worthless data"). Other lost costs occur as Congress misallocates or overfinances policy-related scientific research that is unlikely to produce the hoped-for answers. For example, because of the natural variability of the earth's climate, the absence of solid historical climate records, and various other factors, some global warming research is unlikely to produce helpful social results (at least in the near term). Although research on global warming tripled in a six-year period beginning in 1979, for example, virtually no progress was made in advancing understanding of the greenhouse effect. *See* Woodhouse, *supra* note 26, at 147. This does not mean that the research is meaningless or unhelpful. It could mean, however, that its usefulness for policymaking may be disappointing.

272. *See supra* notes 82-83 and accompanying text.

273. Undoubtedly, the resources Congress dedicated, first to reaching the flawed mandates and, second (and more importantly) to correcting them, could also have been put to more productive uses. *Cf.* Lazarus, *supra* note 1, at 360 (detailing the monumental effort required to reauthorize CERCLA).

274. The total compliance costs of the EPA's programs are estimated by the GAO at $86 billion a year. *See* S. REP. NO. 101-262, at 15 (1990). Even with the modest assumption that the EPA's own administrative costs are one-tenth of one percent of this figure for the creation and early implementation of a major program, for example, an air toxics program, these lost costs still amount to $10 million per year (in today's dollars). Considering the tremendous information costs—resources expended by states implementing the law, regulated parties that must or do follow legislative developments, public interest groups involved in the regulatory proceedings—the costs are undoubtedly much higher, particularly for programs that become so complex or dysfunctional that they are ultimately abandoned.

public from toxic pollution, a reminder that appears to have been quickly forgotten.[275]

Less tangible, but in the long run perhaps more significant, are the complexity costs that are incurred when laws are poorly drafted. Both regulators and the regulated must spend considerable time and energy understanding poorly constructed legislation.[276] Moreover, legal uncertainties created by ill-conceived legislation increase the likelihood of disputes, which, in turn, may breed disputes over disputes and ultimately more laws and regulations. "Complicated laws also increase the likelihood of noncompliance, undermining the attainment of environmental goals and creating pressures for extending deadlines and raising permissible emission levels—a pattern endemic in environmental law."[277]

B. Transformation Costs

In addition to the lost costs associated with changing or coping with ill-conceived legislation are the often enormous costs associated with changing the status quo—referred to by economists and political scientists as "transformation costs."[278] Indeed, these transformation costs can be so high that on balance society is sometimes better off continuing to muddle through with inferior rules.[279] Professor Elinor

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275. *See supra* notes 78-144 and accompanying text.

276. Eric Orts has introduced the term "juridification," which means "proliferation of law," to the environmental law literature to describe the "great undigestible masses of statutes about the environment." Orts, *supra* note 6, at 1239-40. Although Orts uses the term to refer to command-and-control approaches to regulation that result in a series of increasingly detailed orders, it would seem to apply equally well to legislation that is ill suited for accomplishing its stated goals and that requires revisions and lengthy clarifications by the implementing agency, by sympathetic courts, or by Congress itself.

277. Bobertz, *supra* note 153, at 742-43 (footnotes omitted); *see also* Marianne Lavelle, *Environmental Vise: Law, Compliance*, NAT'L L.J., Aug. 30, 1993, at S1 (reporting that only 30% of attorneys believe that full compliance with state and federal environmental laws is possible).

278. For an early discussion of transformation costs, see generally BUCHANAN & TULLOCK, *supra* note 172 (isolating and discussing various individual and collective costs involved in reaching decisions). The economic notion of "path dependence," where traits of a prior generation or state of affairs are retained in one or more subsequent generations even though they are no longer the best option, also may overlap in part with this concept of transformation costs. *See, e.g.*, Mark J. Roe, *Chaos and Evolution in Law and Economics*, 109 HARV. L. REV. 641, 643 (1996) (describing path dependence in the context of law). The notion of "path dependance" in the courts' and legislatures' continued adherence to maladaptive laws is discussed in M.B.W. Sinclair, *The Use of Evolution Theory in Law*, 64 U. DET. L. REV. 451, 455 (1987).

279. *See, e.g.*, ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION 198-202, 202 (1990) (describing transformation costs and highlighting how "[p]rior decisions may open up some future options for development, and close out others"); *see also* Bobertz, *supra* note 153, at 750-51 (lamenting that "[w]ith billions of dollars at stake and more than twenty years of adjustments to the original system, maintenance of that system, with all its flaws, is by far the preferred alternative to thoroughgoing reform for more of the system's participants"). Professor William Rodgers has also noted this statutory inertia: "Legislative pronouncements . . . can become sunk into channels that limit the plasticity of future directional changes. Some parts of the package, indeed, give every sign of being unchangeable or very nearly so." 3 WILLIAM H. RODGERS, JR., ENVIRONMENTAL LAW: PESTICIDES AND TOXIC SUBSTANCES § 5.2, at 23 (1988); *see also* 1 *id.* preface, § 3.7.

Ostrom makes this point when she writes that "status quo rules . . . have a privileged procedural position. Past institutional choices open up some paths and foreclose others to future development."[280]

Transformation costs are high largely because a known, but imperfect, status quo is often preferred to an uncertain, but potentially better, future. Under this "better the devil you know" theory, some stakeholders (particularly the regulated) who may have resisted the actual passage of a particular environmental regulatory program become vigorous opponents of reform because they have learned to navigate and even exploit its loopholes.[281] In fact, the more unduly complicated the regulatory approach, the more dedicated to the status quo these existing stakeholders can become.[282] Even regulators and compliance attorneys, who might in theory be expected to prefer more focused and effective legislative approaches, often find their own power and professional future tethered to the significant (but from their perspective well-understood) imperfections of congressional mandates that place too much reliance on science.[283]

Transformation costs are also high because turning an existing regulatory program in a new direction requires investing in new ways of thinking about environmental issues.[284] Certainly, costs must be incurred to explain and differentiate the new regulatory approach from the old. More importantly, because existing regulatory programs typically bring with them traditions in staffing and departmentalization that take on a life of their own,[285] even policymakers with the best intentions may find themselves unable to break away from existing

280. OSTROM, *supra* note 279, at 202.

281. *See, e.g., id.* ("Status quo operational rules always protect some individuals and expose others. A proposed change in these rules must be supported by a set of individuals large enough to have the authority to change them."); *cf. id.* at 198-202 (stating that transformation costs increase with the number of decisionmakers and the extent of the processes necessary to effectuate change); PERCIVAL ET AL., *supra* note 1, at 829 (citing literature on industry and regulator resistance to market-based approaches to pollution control and observing that industry resistance may result in part because "industry may prefer the system they know").

282. *See, e.g.*, Schuck, *supra* note 255, at 26 (observing that the beneficiaries of complex laws include "groups that are relatively well equipped to cope with complexity and for whom complexity can create a competitive advantage").

283. *See id.* at 31 ("For every new regulatory program or legal complexity, there is a set of corporate officials whose jobs and occupational advancement depend upon understanding, complying with, and managing it."); *see also* Boris I. Bittker, *James S. Eustice*, 45 TAX L. REV. 1 (1989) (humorously referring to tendency of tax lawyers to perpetuate complexity for personal and financial reasons).

284. *See, e.g.*, BRUCE A. ACKERMAN & WILLIAM T. HASSLER, CLEAN COAL/DIRTY AIR 42-58 (1981) (describing how Congress's focus on technological fixes led to increased environmental degradation while quicker and easier fixes like low sulfur coal were overlooked); Lazarus, *supra* note 1, at 355-56 (observing that congressional oversight and litigation can consume as much as 90% of agency resources and bemoaning how these drains deprive the agency of time needed for the thoughtful development of policies).

285. *See, e.g.*, Lazarus, *supra* note 1, at 362 (describing the considerable inertia that has formed around an early administrative decision to organize EPA offices according to the media (air, water, etc.) they regulate, rather than a clearly preferable, functional approach (according to enforcement, monitoring, etc.)).

ways of doing things.[286] As a result, legislative reforms may be perpetually delayed until needed changes take place in the regulatory agencies.

Not surprisingly, in contrast to many other types of environmental law reforms that can be corrected through incremental amendments and regulatory modifications, an entirely new regulatory approach is often needed to address problems with laws that place too much reliance on science. Statutory revisions often entail revolutionary rather than evolutionary amendments.[287] Indeed, in the few instances where a scientifically ill-conceived program has ultimately been amended, the program was changed only after the costs and public concern reached almost epic proportions. The Air Toxics Program, which required twenty years of failure before Congress acted, was changed as the result of a crisis—Congress suddenly realized that only seven air toxic standards had been promulgated by the agency and that hundreds of other air toxins were being emitted in large quantities without regulatory oversight.[288] The Delaney Clause lived to be forty-something before it was even partly amended to reflect "modern" scientific theories already several decades old.[289] In other in-

286. As John Dwyer has observed, "[b]y making promises that cannot be kept, and by leaving no middle ground for accommodation, the legislature [in unrealistic mandates] makes it more difficult to reach a political compromise . . . that would produce a functional regulatory program." Dwyer, *supra* note 8, at 234. More abstract, but equally insightful, is Professor Lindblom's observation in his famous "Muddling Through" article that decisionmakers tend to think incrementally about reform, a process which he calls the "method of successive limited comparisons." *See* Lindblom, *supra* note 193, at 83. In this process the policy decisionmaker considers competing policies "that differ in relatively small degree from policies presently in effect. Such a limitation immediately reduces the number of alternatives to be investigated and also drastically simplifies the character of the investigation of each." *Id.* at 84; *cf.* OSTROM, *supra* note 279, at 199-200 (describing incremental changes as typically having much lower transformation costs and offering the opportunity to "gain experience concerning the costs of changing the rules . . . before attempting changes that will require substantial transformation costs").

287. Incremental adjustments are often not available to correct an ill-fated overreliance on science; rather, the statute must be essentially rewritten to adopt a completely different basis for regulation. Thus, speaking of environmental law and regulation as "evolving" may generalize too broadly. Some aspects of the laws, such as the gradual adoption of nonpoint source pollution programs or the strengthening of the water quality backup program under the Clean Water Act, *see, e.g.*, 33 U.S.C. §§ 1288, 1314(f) (1994), can be accomplished incrementally, with strengthening amendments that periodically improve upon prior approaches. By contrast, in instances in which Congress chooses an unrealistic, science-intensive approach to regulating pollution or toxic substances, major statutory revisions are likely required. *Cf.* OSTROM, *supra* note 279, at 200 n.8 ("Because the process of governing affects the future costs of governing, these processes are recursive. Decisions made within a structure will affect that structure in the future.").

288. *See infra* note 292 and accompanying text.

289. The Delaney Clause in Section 409 of the FDCA that applied to pesticide residues in processed food, 21 U.S.C. § 348(c)(3)(A) (1994), was amended in 1996 to require essentially a cost-benefit balancing test with regard to the risks of the residues (a doubtful improvement, *see supra* notes 86-120 and accompanying text). *See* 21 U.S.C. § 321(s) (Supp. 1996) (amending the Delaney Clause essentially by changing the definition of "food additive"); *see also* Bauer, *supra* note 115, at 1386-88 (describing the 1996 amendment). Identical Delaney Clauses written into sections of the FDCA regulating color additives in animals' drugs and food still have not been amended. *See* 21 U.S.C. §§ 379e(b)(5)(B), 360b(d)(1)(I). Much of the 40-year longevity of the Delaney Clause seems to be due to the entrenched stakeholders that fought change. *See also*

stances, where Congress has avoided or substantially postponed amending poorly functioning science-based programs (for example the toxic substance control laws), the stakeholders appear to have become so heavily invested in the status quo that they consistently defeat the passage of more effective reforms.[290]

C. *Opportunity Costs*

Significant opportunity costs such as unintended delays in environmental and public health protection are inflicted on society while the agencies struggle, at times hopelessly, to implement a scientifically unrealistic mandate.[291] For example, a number of cancers and other adverse health effects resulting from air toxins undoubtedly would have been prevented had the EPA been able to expeditiously promulgate protective air standards.[292] In this case, an authorizing mandate

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Bauer, *supra* note 115, at 1382-86 (describing the history of congressional efforts to reform the Delaney Clause). As Richard Merrill has observed, "Congress not only adopted a clear but unwise rule for regulating carcinogenic additives; it has since displayed no capacity to come to grips with the serious practical problems that the current law creates." Merrill, *supra* note 71, at 87; *see also id.* at 67 (quoting Chairman Harris of a House Committee that was considering a Delaney Clause for color additives, who noted with concern the flaws in the Delaney Clause but concluded that now that it is part of the law, "to throw out the Delaney amendment would create so much fear in the minds of the American people in their reaction against industry that it might be pretty bad"); Dwyer, *supra* note 8, at 234 (observing that "[e]nvironmental groups take the legislation's promise of a risk-free environment at face value and tend to refuse to compromise the 'rights' inherent in such promises.").

290. *See, e.g.*, 3 RODGERS, *supra* note 279, at 28-29 (discussing several entrenched "entitlements policies favoring the users and makers of pesticides" in FIFRA); *id.* § 6.2, at 377 (noting the stability of the TSCA with regard to amendments and speculating that it could be attributed to the fact that it "has been little used [against regulated entities] and, thus, has not loosed the strong forces of selection and change that accompany an active and aggressive administration").

291. This of course assumes that when Congress passes an environmental law with ambitious goals for the environment and public health, it collectively intends that statute to be implemented expeditiously. Yet in the case of mandates that place unrealistic demands on science, delays and even regulatory paralysis are common. *See generally* Dwyer, *supra* note 8, at 234, 259 (observing that the common agency response to an unrealistic mandate is to "resist implementation" and that "[a]s a result, the agency adopts very few standards" and later observing that the EPA itself referred to this tactic to explain prolonged delays in its implementation of the air toxics mandate); Lazarus, *supra* note 1, at 324-28 (describing missed deadlines in major environmental statutes and the current time-frame for the EPA's review of pesticides and toxic products, which spans several decades into the new millennium). Further dragging down implementation of a poorly formulated mandate that overrelies on science is the Russian roulette of judicial review and the constant oversight hearings on regulations that are too slow in coming, too lax, or too stringent. *See also* MASHAW, *supra* note 148, at 188 ("Congress's power to hassle administrators and to claim credit with constituents for intervening with the bureaucracy is legendary, but there is virtually no hard data on the degree to which this external political force is a major impediment to effective rulemaking.").

292. For example, from the date of listing to the promulgation of final standards, the EPA averaged almost four years each for six of the seven toxic air standards. Four of the seven standards were promulgated under legal pressure. *See* OTA, BACKGROUND PAPER, *supra* note 113, at 106 (discussing seven air toxic standards promulgated by the EPA and extraordinary delays associated with them); U.S. CONGRESS, GENERAL ACCOUNTING OFFICE, DELAYS IN EPA'S REGULATION OF HAZARDOUS AIR POLLUTANTS i (1983) (noting that four of 37 hazardous substances identified for possible regulation in 1977 had been regulated by 1983). The small number of standards actually promulgated stands in stark contrast to the number of substances that were identified by the government as needing regulation. By 1976, the EPA had identified 43 toxic air

that required an unrealistic overreliance on science was identified by Congress and commentators to be the prime cause of the EPA's regulatory paralysis.[293]

Unnecessary delays arising in the implementation of unrealistic congressional mandates may also foreclose superior policy options. As debates over scientific issues relating to old growth forests and the Spotted Owl dragged on, the unmanaged harvesting that proceeded during the interim closed off some of the most attractive options for achieving peaceful coexistence between environmental and timber interests.[294] Stephen Yaffee argues that in the case of the Spotted Owl, the resulting social compromises may have been more devastating precisely because policymakers did not come to terms earlier with the fact that unpreventable knowledge gaps existed and that value choices were needed to resolve the controversy.[295]

D. Accountability and Deliberation Costs

Finally, Congress's overreliance on science when developing environmental legislation hinders democratic deliberation on important issues. Some may disregard the importance of such deliberations, arguing that sound-bite politics has largely displaced valuable public debate,[296] and thus a few added impediments to democratic dialogue are not terribly serious. For the more optimistic readers, however, it is

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pollutants in need of regulation under the Clean Air Act. *See* CROSS, *supra* note 113, at 105. By 1990 Congress had legislatively identified at least 189 toxins that required such standards and ultimately abandoned science and resorted to technology-based standards. *See* 42 U.S.C. § 7412(b) (1994). For an effort to quantify the health effects resulting from these sorts of regulatory delays in setting adequate standards, see William J. Nicholson & Philip J. Landrigan, *Quantitative Assessment of Lives Lost Due to Delay in the Regulation of Occupational Exposures to Benzene*, 82 ENVTL. HEALTH PERSP. 185, 185 (1989) (reporting that from 1978 to 1987 between 30 to 490 excess leukemia deaths occurred from occupational exposure to benzene concentrations of greater than one ppm).

293. *See, e.g.*, CROSS, *supra* note 113, at 104-07; Phillip D. Reed, *The Trial of Hazardous Air Pollution Regulation*, 16 Envtl. L. Rep. (Envtl. L. Inst.) 10,066 (Mar. 1986); *see also supra* note 83 and accompanying text.

294. *See* YAFFEE, *supra* note 23, at 192, 201 (describing how delay in decisionmaking with regard to Spotted Owl led to a "shrinking set of options, as suitable habitat was degraded or diminished by harvest activities. . . . As time went by, it got tougher to find a solution, not easier.").

295. Instead, each party to the controversy continued to seek scientific answers that were unlikely to materialize. *See id.* at 170-74, 177 (discussing the problematic nature of manifold scientific uncertainties present in determining fate of the Spotted Owl that prevented firm grounding of decisions and ultimately served to delay decisions).

296. *See* AL GORE, EARTH IN THE BALANCE: ECOLOGY AND THE HUMAN SPIRIT 168 (1992) (lamenting that "[i]mpressions and affect have become the coin of our political realm. Skillful 'visual rhetoric' has become as important as logic, knowledge, or experience in determining a candidate's success"); *see also* Frank B. Cross, *The Public Role in Risk Control*, 24 ENVTL. L. 887, 949-55 (1994); Richard B. Stewart, *Madison's Nightmare*, 57 U. CHI. L. REV. 335, 340-42 (1990) (arguing the public is unable to participate meaningfully); Cass R. Sunstein, *Democratizing America Through Law*, 25 SUFFOLK U. L. REV. 949, 958 (1991) (arguing the inability of general public to participate meaningfully in regulatory decisions).

worthwhile to recount the significant adverse effects on democratic deliberation that result from Congress's overreliance on science.

First and foremost, the scientification of environmental policy precludes public and even congressional input on critical social problems.[297] Congress's deference to science masks the fact that value judgments must be made when scientific knowledge gaps exist and that these value judgments should be informed by public debate. Moreover, in some cases, deferring to science may be a political ploy on the part of a few savvy legislators. In such cases, democratic values are clearly compromised as many legislators defer, simply as a result of their scientific ignorance, to the concealed policy choices of a few.[298]

Additionally, when the need for meaningful policy debates are foreclosed by Congress's excessive reliance on science, legislation that could have been more comprehensive had the policy options been more openly considered becomes distorted and incomplete.[299] For example, distributional inequities may be more likely to arise when policy assumptions have not been expressed, because those making the undisclosed value judgments are not made aware of the concerns and

297. *See* Bobertz, *supra* note 153, at 743 (observing that "[c]reating barriers to public understanding of, and involvement in, environmental law frustrates the theoretical virtues of democratic self-rule and also engenders a problem of more practical import—a spirit of confusion and anger that characterizes most public encounters with environmental problems and the laws erected to correct them"); Larson, *supra* note 79, at 68 (arguing that "politics cannot be the preserve of experts or professionals" and that "an active and confident citizenry" should make the ultimate policy decisions); Lazarus, *supra* note 1, at 354 (discussing the tendency of current institutional structures to "polarize" debate at the expense of "candid dialogue"); *see also* Graetz, *supra* note 73, at 680 (arguing that Congress's overemphasis on complex revenue estimates and distributional policies is "extremely costly to sensible tax policy" as it obscures the important policy decisions that should be made by Congress). Delegation by apathy or disinterest may be considered acceptable by some, *see, e.g.*, Lawrence B. Mohr, *Authority in Organizations: On the Reconciliation of Democracy and Expertise*, 4 J. PUB. ADMIN. RES. & THEORY 49, 60 (1994) (suggesting a "voluntarist model" of organization democracy in which "a person has a low desire for influence on a certain matter, and simply abides by decisions made by others"), but only when they understand the nature and ramifications of the choices that they are delegating.

298. *See supra* notes 174-83 and accompanying text (describing the strategic behavior of public choice legislators).

299. In the development of American policies for nuclear development and control, for example, public participation was of critical import in "bringing about a reexamination of the problem definitions undergirding American policies." Randy J. Rydell, *Solving Political Problems of Nuclear Technology: The Role of Public Participation, in* CITIZEN PARTICIPATION IN SCIENCE POLICY 182, 193 (James C. Petersen ed., 1984). In addressing biomedical issues, greater involvement of citizens in decisionmaking "usually resulted in more comprehensive consideration of issues, greater attention to potential risks and possible alternatives, and a more realistic assessment of likely benefits." Diana Dutton, *The Impact of Public Participation in Biomedical Policy: Evidence from Four Case Studies, in id.* at 171; *see also* BRINT, *supra* note 60, at 145-47 (discussing the bounded rationality of experts that makes them poor substitutes for the general public in the development of public policy); Mary G. Kweit & Robert W. Kweit, *The Politics of Policy Analysis: The Role of Citizen Participation in Analytic Decision Making, in* CITIZEN PARTICIPATION IN PUBLIC DECISION MAKING 19, 29 (Jack DeSario & Stuart Langton eds., 1987) ("[C]itizen participation has a role to play in common policy analytic techniques by supplying decision makers with more comprehensive information on the potential impacts of policies and the valuation of those impacts.").

perceptions of minority or other unrepresented groups.[300] This can also lead to public backlash against some scientificated policies and programs. The periodic unraveling of important environmental programs, like the EPA's program requiring inspection and maintenance of automobile emissions in ozone nonattainment areas, results in part from the lack of public debate about this important environmental program.[301]

Moreover, as the electorate becomes more alienated, not only from the laws but from the implementing agencies' seemingly dysfunctional regulatory programs, their faith in the agencies deteriorates.

> By making promises that cannot be kept, and thus forcing EPA to reformulate public policy, Congress indirectly undermined public confidence in the Agency's competence and good faith. Both those who want stricter regulation and those who oppose regulatory controls will see the Agency as a paper tiger whose cajoling, promises, and threats . . . are not to be taken seriously.[302]

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300. *See, e.g.*, James Flynn et al., *Gender, Race, and Perception of Environmental Health Risks*, 14 RISK ANAL. 1101 (1994) (reporting results of a national survey that reveal differences in gender and race with regard to perceptions of risk, with the most striking difference being that between white males, who perceived risks as much smaller, and all other groups.) Enhanced participation of minority groups in environmental decisionmaking is one of the most consistent recommendations for correcting possible distributional inequities. *See generally* Richard J. Lazarus, *The Meaning and Promotion of Environmental Justice*, 5 MD. J. CONTEMP. LEGAL ISSUES 1 (1994) (setting forth concrete reforms to environmental programs that are generally designed to increase attention to distributional inequities).

301. As Professor McGarity observed with regard to this controversy:

> EPA was foolhardy to take the position initially that it could simply order the states to enact, implement, and enforce regulatory programs dictated by a federal bureaucracy. This extreme stance, which rested on the rather weak argument that a state's highways were indirect sources of automobile pollutants, undermined fledgling state agencies, alienated the courts, armed anti-regulatory politicians with horror stories, and ultimately caused even the agency's allies to run for cover.

Thomas O. McGarity, *Regulating Commuters to Clear the Air: Some Difficulties in Implementing a National Program at the Local Level*, 27 PAC. L.J. 1521, 1620 (1996); *cf.* Larson, *supra* note 79, at 66 (recounting that "[e]vidence shows that the level of public mobilization in controversies around technical issues is increased by disputes among experts"). For more general discussions of the importance of public understanding and support for the stability of environmental programs, see Harvey Brooks, *The Resolution of Technically Intensive Public Policy Disputes*, SCI. TECH. & HUM. VALUES, Winter 1984, at 46 ("[P]ublic participation . . . confers political legitimacy on the policy choices that are made and secures public acceptance and cooperation in the actual implementation of these choices."); Ellison Folk, *Public Participation in the Superfund Cleanup Process*, 18 ECOLOGY L.Q. 173, 179-80 (arguing that public participation may lend legitimacy to government decisions and citing as an example the import of public participation in understanding and supporting Superfund cleanup decisions); Susan Wiltshire, *Public Participation in Department of Energy High-Level Waste Management Programs*, 53 TENN. L. REV. 541, 552 (1986) ("[A]mong the benefits an agency can expect from effective public participation are improved decisionmaking, reduced uncertainty when planning is based on an accurate assessment of public concerns and possible opposition, increased credibility and legitimacy, and a final product that is more likely to be acceptable.").

302. Dwyer, *supra* note 8, at 281-82; *see also* MASHAW, *supra* note 148, at 184 (observing that "congressional bureaucrat baiting has tended to delegitimate the administrative process politically and to further hamper the agency rulemaking process"); Lazarus, *supra* note 1, at 350-51 (discussing how unrealistic institutional demands on the EPA have led to unfair criticisms of the agency, including a "myth of scientific incompetence"); *cf.* Nelkin, *supra* note 75, at 48 (observing, based on a case study, that "the fact that there was disagreement among experts confirmed

The agency may also suffer if, as a result of increased pubic disapproval, staff morale drops, inappropriate challenges to the agency's competence are made, and valuable staff leave the agency.[303] Remaining staff may be dissuaded from engaging in creative problem solving for fear their efforts will be condemned by the public and perhaps by Congress.[304]

V. REFORM

The difficulties Congress faces in addressing important, but elusive, gaps in scientific knowledge are substantial. Congress and the electorate are not likely to be aware that the failure to identify these knowledge gaps has important policy implications, much less be aware of the marked limits of science. Equally distressing, individual members of Congress may benefit personally and professionally from this widespread ignorance. Scientists, on the other hand, are unlikely to highlight policy-relevant gaps in scientific knowledge for a wholly different set of deeply entrenched reasons. As a result, the experts remain silent, while the lay people who do not understand the limits of science and its importance to developing sound policy continue to place more reliance on science than is appropriate.[305]

It is possible, however, that despite its imperfections the current state of environmental lawmaking is still better than the alternatives.[306] Because environmental problems often bring quality of life

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the fears of the community and directed attention to what they felt was an arbitrary decisionmaking procedure in which expertise was used to mask questions of political priorities").

303. *See, e.g.*, Lazarus, *supra* note 1, at 353 (discussing how undeserved public criticism causes "agency demoralization" at agencies such as the EPA in which staff are often idealistic advocates of the public and how this can lead to rapid turnover and difficulties with retention of talented staff).

304. *See, e.g.*, Lazarus, *supra* note 5, at 229 (suggesting that "[t]he mere anticipation of congressional criticism [of the EPA] is often enough to dissuade agency decisionmaking, including experimentation with new approaches to environmental problems"). Misuse of science may also cause reputable scientists to retreat from environmental policy projects. Those scientists who remain may be the least able to provide accurate assessments of the limits of science. *See, e.g.*, Nichols, *supra* note 78, at 95 (observing that as political debates splintered the R&D community in the 1970s, "more scientists and engineers simply backed away from governmental policymaking [and that] . . . with fewer independently credible technical advisors . . . [t]he public therefore became even more confused and wondered whether honest technical judgment counted at all").

305. This negative circularity logically leads to scientists determining most, if not all, science policy matters. *Cf.* Lakoff, *supra* note 76, at 607 ("[S]cience and technology have become instruments of public policy, science policy must be thought of not as an independent, but as a dependent, variable of other public policy.").

306. Although some have posited a somewhat different argument that environmental laws may gradually "evolve" to codify more successful regulatory programs, for the reasons stated in part IV.C this does not appear to be the case with Congress's habitual scientification of environmental policy choices. Because these errors generally cannot be corrected incrementally, their reform is more costly, more significant, and may be akin to putting "wings on the hippopotamus." RODGERS, *supra* note 279, § 5.2, at 23. Perhaps more importantly, there is little indication that this evolution away from the scientification of environmental policymaking is occurring. Despite a few notable efforts by Congress to abandon failed statutory programs that unrealistically overrelied on science for their implementation, *see supra* notes 83-84 and accompanying

issues and decisions about future generations into stark contrast with immediate monetary interests, resolving environmental issues often requires unpleasant or even tragic decisions that involve painful personal or societal sacrifice. Dealing with these issues openly and honestly is extremely difficult. As a result, if these decisions are not made under the guise of science, they may be made in other equally deceptive ways. For example, economic analysis might be used to obfuscate the central issues, or underlying policy compromises might be hidden in a tangle of unintelligible bureaucratic requirements. Either approach masks the underlying social decisions in a way that is no more open and honest than disguising the central issues through scientification.[307] Moreover, one might argue that, because there is no easy way to resolve these social problems, an open and honest debate might result in deadlock, which prevents any progress from being made in addressing environmental problems.[308] Indeed, achieving any solution to complex social problems, however flawed, is no small accomplishment.[309] At least disguising these problems as technical puzzles that

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text; *see also* Michael P. Vandenbergh, *An Alternative to Ready, Fire, Aim: A New Framework to Link Environmental Targets in Environmental Law*, 85 KY. L.J. 803, 855-56, 859 n.234 (1997) (listing voluntary and market-based programs for pollution control that are not unrealistically science intensive), legislative amendments and bills over the past decade, in large part, continue this tendency toward overreliance on science. *See supra* notes 86-120 and accompanying text. The possibility that scientification of environmental policymaking is nearly a permanent political fixture is further supported by the many benefits that this form of deception bestows on members of Congress and society at large. The evolutionary theory thus appears unlikely to correct this particular problem.

307. In their book, *Tragic Choices*, Professors Calabresi and Bobbitt suggest that public decisionmaking regarding these tragic choices likely cycles through a series of approaches that "may limit the destructive impact of tragic choices by choosing to mix approaches over time." CALABRESI & BOBBITT, *supra* note 194, at 196. "Since the values endangered by any given approach vary, a society which wishes to reject none of them can, by moving, with desperate grace, from one approach to another, reaffirm the most threatened basic value and thereby seek to assure that its function as an underpinning of the society is not permanently lost." *Id.* at 198. Examples provided in the book, however, suggest that there can be some incremental narrowing and, at times, even closure on tragic choices. *See id.* at 158-67 (describing the conscription in the United States that has evolved with regard to policies for hiring substitutes to serve in place of draftees); *id.* at 190 (seeming to conclude from their own examples that various societies "ultimately" seemed to find a stable way to deal with the "allocation dilemma" for artificial kidneys).

308. *See id.* at 186-89 (discussing public attack against Seattle God Committee's effort at open decisionmaking with regard to allocation of artificial kidneys and speculating that this attack might suggest the "dangers of thinking too clearly in this area" because the public cannot tolerate such painful decisions regarding who and how many will live and die).

309. *See* MASHAW, *supra* note 148, at 14 (describing how Arrow Theorem and ordinary experience reveal the difficulties in selecting among three or more alternative solutions to a policy problem); Schick, *supra* note 197, at 8 (describing the difficulty in arriving at majority support for a single law addressing a complex problem because of the increased number of opportunities for conflict); *cf.* Dwyer, *supra* note 8, at 309-10 (describing complicated and numerous interest groups that typically participate in social regulation). By some accounts, the vast complexity of environmental problems makes them more difficult to resolve than other social problems because they "leave little room for maneuvering or trade-offs. Solutions rather than providing something for each interest group may entail the denial of something to each group—a tactic that the government has usually been able to pull off only in times of severe crisis." Comment by X, *Environment, Energy, and Economics*, *supra* note 75, at 115. Additionally, this tenuous compromise may actually serve some positive public purpose even when public choice incentives

scientists can solve ensures some resolution to the legislative debate that resonates with public preferences.[310] When viewed in this light, the benefits of the scientification of environmental policymaking are hard to ignore.

Yet, the initial appeal of being complacent with regard to Congress's scientification of environmental policymaking becomes less compelling when one examines examples of legislation that do not exhibit this overdependence.[311] The public support and relative success of laws like the acid rain provisions in the 1990 Clean Air Act amendments, the technology-based requirements for pollution control, and source-specific pollution reduction programs are legislative testaments to the feasibility of successful environmental programs based on a realistic use of science, despite the need to explicitly resolve differing values about environmental protection and industry responsibility.[312] The remainder of this part argues that the current scientification of policymaking is not necessarily the best choice among imperfect alternatives and that its reform is worth careful consideration.[313]

The following subsections propose two reforms designed to correct Congress's misframing errors, one operating from within and the other from without Congress. The first, internal reform targets the Madisonian legislator through education. Although other members of Congress may not welcome this enlightenment, if effective it could produce important internal pressure on all legislators to reframe environmental laws in more realistic, multidisciplinary terms. The second, complimentary reform, takes a more indirect approach that engages the agencies and the courts in the reframing work. The enormous

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motivate the individual legislator. "Adopting policies that provide largely symbolic gratifications for demands may achieve little of substance in the immediate case but constitute nonetheless a positive reinforcement for the demands themselves and the legitimation of a governmental role in dealing with these demands." Dwyer, *supra* note 8, at 249 (quoting James Q. Wilson, *The Politics of Regulation*, *in* SOCIAL RESPONSIBILITY AND THE BUSINESS PREDICAMENT 135, 146 (J. McKie ed., 1974)).

310. Yet, the deadlock may in some cases simply be transferred to the administrative agency. The unrealistic science-intensive mandate for setting air toxics resulted in protective standards for seven toxins over a 20-year period. *See supra* note 292. Although seven standards may be better than no standards, it is not clear that Congress would not have acted sooner had it, in fact, been alerted to this huge void in air pollution prevention. *See* 136 CONG. REC. S17,234 (daily ed. Oct. 26, 1990) (statement of Sen. Baucus) ("This new approach is desperately needed to overcome the inertia that plagued the health-based standards in current law."). The public, as well as Congress and perhaps the executive branch, may in many cases be lulled into complacency by a strong statutory mandate that is not implemented in practice. Frank legislative gridlock may be a more honest, and ultimately more productive way to force resolution of the difficult social problem. *Cf.* Wagner, *supra* note 138, at 810 n.135 (discussing how the complexity of regulatory, tort, and market systems that lead to undertesting of toxic product safety likely escapes public understanding and may be perpetuated precisely for that reason).

311. *See also* Larson, *supra* note 79, at 67 (arguing that "[u]nchallenged expert power" does provide a way out of public crisis but one that is antidemocratic and that leads to forms of governing that "ultimately discourage their citizens' intelligent participation in public affairs").

312. *See supra* note 84 and accompanying text. *See generally* Vandenbergh, *supra* note 306.

313. *See* Lindblom, *supra* note 193, at 88 (observing that muddling through as a decision-making process is sometimes capable of improvement in specific situations).

complexity of environmental problems, coupled with the multiple obstacles and challenges involved in forcing Congress to break the science frame on its own, make such parallel reform efforts an important part of any comprehensive effort to counteract this serious and pervasive problem in the environmental laws.

A. Better Education of Legislators and Their Staffs

Although the misframing problem that is present in a number of environmental laws is not a pure accident, neither is it likely the sole result of sinister political manipulations. The multiple reasons for Congress's incomplete understanding of the limits of science and their significance to environmental policymaking suggest that analytical oversights and information slippage share the blame for the current state of environmental law. With regard to this series of causes, then, the most obvious and direct way to reform Congress's scientification of environmental policy is to educate legislators and their staffs about the zigzag pattern of science and knowledge gaps and its importance to sound environmental lawmaking.[314] Certainly some members of Congress, particularly those whose decisionmaking behavior is best described by the public choice model, might not welcome this education. Over time, however, as federal lawmakers who are willing to be educated become more knowledgeable about the limits of science,[315] it will be increasingly difficult for members of Congress to remain blissfully ignorant of the knowledge gaps or for scientifically sophisticated legislators to exploit the ignorance of their colleagues. Thus, curing some of the disabilities of the Madisonian legislator may exert important counterpressure on other causes, such as public choice motivations.

The education of congressmembers can be accomplished in several ways.[316] The most expeditious, but also the most unrealistic method is to make lawmakers aware of the problems by widely publicizing the consequences of their errors and ultimately generating

314. Public education regarding the methods and limits of science should also be a priority. The American Association for the Advancement of Science (AAAS), for example, has just initiated a "Science for Life" project that will build on and ultimately disseminate curricula for middle school students that instructs them on the basic link between laboratory science experiments and science policy. *See, e.g.*, SCIENCE FOR LIFE: A PROJECT OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (1998) (brochure available from the AAAS); *cf.* Lazarus, *supra* note 1, at 372-73 (discussing the importance of promoting environmental literacy among the general public).

315. Several prominent scholars have expressed their belief that, in fact, a number of these Madisonian legislators exist. *See supra* note 200.

316. Given the multiple ways that members of Congress are informed about policy issues, a multifaceted education campaign would seem necessary. *See* Katz, *supra* note 121, at 441-42 (asserting that "[t]he dispersed and diffused composition of Congress does not lend itself to singular proposals or arrangements" and recommending several "levels" at which Congress can receive the needed advice, including regular, individualized contacts with scientists; maintenance of a strong, broad committee staff; and the use of advisory experts and hearings to solicit scientific information and perspectives).

public pressure for change. This adverse publicity may force Congress and possibly society at large to recognize that the science frame currently used to view and resolve many environmental problems is unrealistic.[317] Given the relatively esoteric nature of the issues, however, even the most dedicated reformer may balk at the practical difficulties associated with carrying out this strategy.[318]

A second, more realistic way to improve Congress's use of science in environmental lawmaking is to educate legislators in a less adversarial way, using bipartisan primers and academic studies, conducting casual meetings and conferences, and encouraging collaborations between policy academics and members of Congress and their staffs.[319] Increasing the awareness of even a few members of Congress

317. *See, e.g.*, SCHON & REIN, *supra* note 84, at 184.

318. The executive branch, if it became interested, might be very effective in calling the media's and public's attention to Congress's failing. The executive branch could become interested in this deficiency for political reasons or simply because it tends to inherit impossible statutory directives that adversely affect the agencies' (and, hence, the president's) public image. Although the president may indirectly enjoy more policymaking authority from erroneous, science-based mandates, in many ways these poorly conceived mandates serve only to complicate and distort his regulatory powers. *See* Woodhouse, *supra* note 26, at 150 (concluding that statutory mandates that place unrealistic reliance on science leave the agency vulnerable to suit for being either too harsh or too lenient).

Moreover, the executive branch with its army of scientists is certainly well equipped to take on science policy battles with Congress. *Cf.* Lakoff, *supra* note 76, at 609 (recommending that the executive branch create an office independent of the OMB that would serve as a general advisor on science policy). The executive branch also makes ample use of expert panels such as the NAS and has already embarked on an analogous science policy project with an expert bioethics advisory commission. *See* Exec. Order No. 12,975, 60 Fed. Reg. 52,063 (1995); *see also* Alexander M. Capron, *An Egg Takes Flight: The Once and Future Life of the National Bioethics Advisory Commission*, 7 KENNEDY INST. ETHICS J. 63 (1997) (article by the Chair of the National Bioethics Advisory Commission describing its activities and what is necessary for it to succeed). In fact, congressional scholars have recommended more generally that one of the best paths to legislative reform is to "concentrate on finding organizational devices to encourage the executive to plan ahead in such a way as to represent the kind of values Congress favors." James A. Robinson, *Decision Making in Congress, in* CONGRESS: THE FIRST BRANCH 292 (Alfred de Grazia ed., 1966). The White House, through these expert and largely detached expert agency units, can thus become both the educator and the informal overseer of the legislative process.

319. Some of these recommendations have some basis in past experience. A potentially pathbreaking effort aimed at improving communication between scientists, industry, and policymakers (including members of Congress) involved a private-public partnership convened by a consulting group, Science and Policy Associates, on the uncertainties at issue in global warming. After the decisionmakers identified their most pressing questions regarding climate change, the scientists and social scientists endeavored to answer their questions, including highlighting major uncertainties that were unlikely to be resolved in the short term. *See* SCIENCE & POLICY ASSOC., INC., JOINT CLIMATE PROJECT TO ADDRESS DECISION MAKERS' UNCERTAINTIES: REPORT OF FINDINGS 1-2 (1992) (discussing the approach and participants). Interestingly, in their sessions the decisionmakers placed great emphasis on gaining a better understanding of the limits of science. *See id.* at 30-31 (explaining that decisionmakers called on researchers to better identify uncertainties arising in four separate contexts). Although the scientific responses were often enlightening, in some instances they were much less helpful. This seemed to occur either because the scientists avoided the uncertainties, *see id.* at 38 (explaining that scientists in one panel agreed that "scientists need to communicate what is *known* about climate change, rather than only focusing on uncertainties"), or because the scientists explained the uncertainties in technical terms that were confusing to decisionmakers. *See id.* at 41 (identifying major uncertainties in the following hypertechnical manner: "Assuming the usual extrapolations of current anthropogenic trace gas emissions, the magnitude of predicted change is mainly determined by the degree of

on these issues might lead them to take some modest action to address the problem by, for example, commissioning one or more prominent panels[320] to report on the precise contributions that science can and

effectiveness of various feedback processes in the hydrological cycle. . . ."). The conveners concluded that similar efforts should be undertaken in the future and offered recommendations on how this could best be accomplished. *See id.* at 83-85.

Some nonprofits have also endeavored to provide more general, bipartisan advice on the use of technical information in policymaking. *See, e.g.*, CARNEGIE COMM'N, SCIENCE, TECHNOLOGY, AND CONGRESS: ORGANIZATIONAL AND PROCEDURAL REFORMS (1994); CARNEGIE COMM'N, SCIENCE, TECHNOLOGY, AND CONGRESS: EXPERT ADVICE AND THE DECISION-MAKING PROCESS (1991). In their book advocating that policymakers reinspect their often unarticulated policy frames for viewing social problems, Professors Schon and Rein propose detailed recommendations on how to create better collaboration between policymakers and academics engaged in public policy research. *See* SCHON & REIN, *supra* note 84, at 193-200.

320. In their analysis of NAPAP and the global climate change research program, Rubin et al. advocate essentially the same sort of reform proposal, which they call an "integrated assessment," that attempts to "bridge" the knowledge of the scientific community to the needs of the policy community. *See* Rubin et al., *supra* note 129, at 51 (calling for "integrated assessments" on policy questions that have a scientific component; these assessments will "survey the state of current knowledge regarding climate change and . . . reach scientifically informed judgments about what we know and don't know, what the key uncertainties are, and where new research could aid the policy process most effectively"). Rubin et al. also suggest that two identical assessments be undertaken simultaneously, one conducted by universities and nonprofit groups and the other conducted by the government because "[i]ntegrated assessments are too important to be left to a single group." *Id.* at 53. While there would undoubtedly be significant benefits from their two-track recommendation, additional analysis is needed to determine when and how parallel reports can be conducted in a cost-effective way.

Any of a number of organizations are qualified to produce these science policy templates, including well-respected in-house and advisory organizations like the Congressional Research Service (CRS), the American Association for Advancement of Science (AAAS), and the National Academy of Sciences (NAS). *See* BIMBER, *supra* note 75, at 15 (asserting the general objectivity of NAS); Ashton B. Carter, *A New Era in Science Advising, in* SCIENCE & TECHNOLOGY ADVICE, *supra* note 73, at 88-89 (referring to the National Research Council (of NAS) as having an established track record of providing good analyses); Rubin et al., *supra* note 129, at 54 (advocating the involvement of the NAS and professional societies, such as the AAAS, in conducting and commenting on integrated assessments). *But see* PHILIP BOFFEY, THE BRAIN BANK OF AMERICA 245 (1975) (arguing that many NAS reports are "mediocre or flawed by bias or subservience to the funding agencies"). Fortunately, federal lawmakers and their staffs should not encounter difficulties locating neutral, respected experts. Congress's own captive experts, like the CRS, would appear to fit the bill. According to Professor Bimber's study of the nature of captive expert advice to Congress, internal congressional research services will, in most cases, respond to requests for expert assistance with competent and neutral advice. *See* BIMBER, *supra* note 75, at 98 (concluding that "[p]erhaps the most positive conclusion one can draw from OTA's relatively short relationship with Congress is that captive organizations of experts can provide depoliticized expertise—if institutional arrangements reward it"). Bimber posits that it is the institutional goal of survival that promotes this dedication to neutrality: "[A]n institution [like Congress] with a highly pluralistic distribution of power tends to reward experts who provide broadly applicable, politically uncommitted expertise. In Congress, experts are likely to be sanctioned for displaying favoritism and rewarded for signalling neutrality." *Id.* at 7. Bimber concludes that "despite its reputation for being too highly politicized to be conducive to responsible policy expertise, Congress is actually quite successful at producing neutrally competent advisors. In fact it is better equipped than the executive branch to inform policy debates with balanced expert views." *Id.*; *see also id.* at 15, 82-83 (describing the respected objectivity of NAS and CRS respectively). Sadly, the recently eliminated OTA may have been best suited to perform this function, although there is no evidence that it actually did assist Congress in separating science from policy choices. *See id.* at 51 (observing that by the mid-1980s "OTA received credit for being a 'dispassionate, nonpartisan player.' The agency was cited for having earned 'widespread trust' on Capital Hill." (footnotes omitted)). The OTA was eliminated in a largely symbolic effort to balance the budget. *See supra* note 121.

cannot make toward resolving an environmental problem.[321] Experience has shown that outside expert panels may be more able to provide such information than internal congressional experts or experts from within the executive branch.[322] The recent creation of an external expert panel to elucidate the ways in which science can and cannot provide policy-relevant information to understanding the global warming problem, in fact, provides a promising first experiment along these lines that should be monitored carefully over the next few years.[323]

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321. *See* Rubin et al., *supra* note 129, at 54 (recommending "key senators or House committee chairmen" as sponsors of government-directed, integrated assessments that are conducted on specific policy problems and that clearly identify uncertainties and highlight promising avenues for further research). There is a possibility that scientists will not always succeed in reaching agreement on such scientific uncertainties. The seemingly easy success of the NAS in providing very helpful guidelines to delineate the knowledge gaps arising in carcinogenic risk assessments, however, is promising. *See supra* notes 42-46 and accompanying text. It also seems possible that tasking an expert science policy group with mapping one or more of the zigzag patterns that undergird environmental problems could at least result in a list of subquestions that arise in resolving the larger inquiry, as well as in highlighting those for which experiments have been run successfully.

The study produced by this expert body could also vary considerably in scope from a brief summary in memo form to a full-blown, several volume treatise. The subject could range from identifying all provisions in a single bill that erroneously overrely on science to discussing the capabilities of science more generally as an advanced blueprint for environment or health-related policymaking. Regardless of the scope, size, and author, this scientific advice should clearly delineate what science does know from what it does not know and what pertinent information is likely to be revealed in the future. *Cf.* Graetz, *supra* note 73, at 614 (recommending that Congress be provided with qualitative information about tax alternatives, as well as about the reliability of various estimates and the "range of likely outcomes"). This is a challenge made more daunting because most efforts to communicate scientific information have focused on its attributes rather than on its limits. For example, Congress tasked an NAS panel with advising them on how the ongoing U.S. government carbon dioxide assessment program should be modified so as to be of increased utility in providing information and recommendations. *See, e.g.*, Woodhouse, *supra* note 26, at 147. In response, the NAS panel issued a report that primarily synthesized existing research and knowledge and produced a list of over 100 desirable research projects, with no instructions on how to prioritize or divide the work among countries. *See id.*

Care also should be taken to ensure that reputable scientists and science policy experts jointly participate and make an advanced commitment to present an objective separation, as best they can, of the positive knowledge and knowledge gaps. The deliberative sessions may best be kept confidential, or partly confidential. *See, e.g.*, Nichols, *supra* note 78, at 95-96 (explaining that a measure of confidentiality may be necessary to keep deliberations focused and to postpone publicity that tends to cause issues to become more urgent and hurries solutions). This commitment, coupled with the exclusive mandate to the panel to delineate knowledge gaps, should protect against detrimental overreaching by this elite group. Initial direction on the capabilities of science would also intrude only very little on the Senate's commitment to deciding matters democratically, with "100 members with 100 different points of view." Comment of M, *Environment, Energy, and Economics, supra* note 75, at 119; Comment of S, *id.* at 131 (extolling the adversarial, chaotic decisionmaking approach of Congress and arguing that "the idea of the leadership formulating policy on a regular basis is bad").

322. *See supra* notes 251-57 and accompanying text (describing Congress's dislike or suspicion of executive branch expert advice and interest group expert advice respectively).

323. *See* SAREWITZ, *supra* note 24, at 179-81 (proposing the formation of "small, independent, satellite policy institutes" that would act as "honest brokers" in ensuring compatibility between the research community and policymakers and citing as a possible model the "Joint Climate Project to Address Decision Makers' Uncertainties"). In fact, this advice could even be institutionalized by establishing a single or rotating panel of science policy experts who are asked to comment on the reasonableness of a mandate prior to its implementation. *See* Lazarus, *supra*

A third and equally powerful cure for congressional ignorance (or feigned ignorance) about the scientification problem is for the scientific community, possibly through an organization like the American Association for the Advancement of Science (AAAS),[324] to play a

note 5, at 234 (suggesting this same proposal (with the OTA or the GAO providing the advice) with regard to reviewing the reasonableness of statutory deadlines).

Congress might also create grants for external groups to assist in mapping scientific uncertainties. *See* Katz, *supra* note 167, at 48 ("What is required . . . is showing a clear link between S&T advice and the rewards that may be garnered from successful entrepreneurship."). Such incentives could include dedicating grants to the effort; placing particularly helpful interest group representatives on task forces; calling these experts to testify at congressional hearings; and acknowledging them with appreciation in the legislative history.

To the extent that scientists may be acting in public choice fashion, for example, these incentives for external groups to highlight knowledge gaps may be an especially important addendum to the reform. An expectation that interest groups might completely fill this analytical void may be naive, however. *See generally supra* notes 231-66 and accompanying text. Interest groups motivated exclusively by public welfare concerns might face the best reasons to dedicate their energies to policing Congress's overreliance on science. Yet, even these interest groups—assuming that they would prioritize this goal—may experience internal conflicts with other positions that they consider as maximizing public welfare. Environmental groups might sense that turning over value issues to Congress will cause the groups to lose considerable ground in protecting the environment. Acknowledging the uncertainties in global warming predictions, they may rightly suspect, feeds into the procrastinating, high discount rate, of the general public and could cheat future generations. Adopting a paternalistic stand, by resorting to scientific sounding assumptions rather than confronting distortions in public values head-on, they might reason, is likely to prove more beneficial to the public. Industry leaders, to the extent they consider their positions to seek maximization of the public welfare, might take the reverse stand on the public's distorted perceptions of risk—a stand that also has support in the psychology and risk communication literature, as well as in some statutes like the Delaney Clause. *See* Paul Slovic et al., *Facts Versus Fears: Understanding Perceived Risk, in* JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES 463, 467 (Daniel Kahneman et al. eds., 1982) (reporting that the public typically overestimates the frequency of death resulting from cancers and other "dramatic and sensational" causes). Industry might fear that the public's risk aversity of cancer will lead to overly stringent regulatory programs. Finally, scientists, although best able to highlight the limits of science, will likely do so—if at all—in a highly conservative way. Real fears about the wholesale deconstruction of science could silence professional societies as well as scientists themselves. *See supra* notes 205-21 and accompanying text. Thus, while a concerned interest group could, in theory, make great strides towards disclosing the adverse consequences of overreliance on science, it seems that few, if any, groups will have sufficient incentives to do so unless externally motivated.

324. The American Association for the Advancement of Science (AAAS) has been quite active on this front by funding and coordinating one-year fellowships for scientists to serve as staff on congressional committees, subcommittees, or on personal staff, *see* WELLS, *supra* note 222, at 100 (describing AAAS involvement in Congressional Fellows Program); by disseminating a newsletter of Science and Congress, *see generally* SCI. & TECH. IN CONG., Dec. 1997; by chairing a diverse number of projects that address the interface between science and Congress, *see* AAAS & ABA, *Agenda Book for National Conference of Lawyers and Scientists—1997-1998* (on file with author) (listing projects undertaken by AAAS); and by publishing letters, articles, and books on the subject through the AAAS press. *See* WELLS, *supra* note 222. The National Academy of Sciences has responded to congressional requests for assistance and has been a highly regarded participant and educational force in the science-law interface, predominantly through its commissioned reports on specific problems. *See* NRC, RISK ASSESSMENT, *supra* note 41; SCIENCE AND JUDGMENT, *supra* note 50; *see also* BIMBER, *supra* note 75, at 15 (noting that the "National Academy of Sciences . . . has developed a reputation for independence and political disinterestedness"). Finally, even some national and international professional organizations, such as the Society for Risk Analysis (SRA), have sponsored workshops and other educational functions for members of Congress, staff, and other policymakers that are dedicated to explaining the processes and limits of science. *See Money, Time Wasted Because Congress Does Not Grasp Limits of Science*, ENVTL. HEALTH LETTER, Dec. 1997, at 163 (referring to statement

leadership role in educating Congress, as well as their own scientist members, about the dangers of an unrealistic overreliance on science in developing environmental policy.[325] Through this dialogue with Congress, the scientific community might not only strengthen Congress's understanding of positive scientific knowledge, but might also highlight the limits of knowledge as a positive side effect of explaining what science does know.[326] Until the scientific community perceives that real, immediate dangers will result from Congress's misframing errors, however, their role in addressing this problem can be expected to remain, at best, indirect.[327]

B. The Judicial Backstop

Practical difficulties associated with ensuring that Congress gains a greater appreciation for the limits of science when developing environmental legislation make parallel reform efforts directed at the

made by Gail Charnley, SRA president-elect, regarding regular meetings held by a committee of SRA to educate congressional staff on risk-related issues).

325. AAAS recently initiated a court-appointed expert program for assisting the judiciary in addressing a related set of issues. *See Breyer Cautiously Endorses Use of Neutral Experts*, WASH. POST, Feb. 17, 1998, at A2 (reporting on Breyer's endorsement of an AAAS pilot project to help federal judges find neutral court-appointed experts).

326. An adjustment in professional ethics may ultimately be required if scientists are to be expected to police the boundary between positive scientific knowledge and knowledge gaps. *See* Cozzens & Woodhouse, *supra* note 79, at 550 (discussing and citing literature calling for "scientists and their institutions to reinvigorate their commitments to public responsibility" in relation to the public and public policy); Dorothy Nelkin, *Changing Images of Science: New Pressures on Old Stereotypes*, 14 PROGRAM IN PUBLIC CONCEPTIONS OF SCIENCE NEWSL., Jan. 1976, at 21, 23 (observing that "unlike physicians, or those in professional practice, scientists share no well-formulated set of norms to govern their relationship outside the scientific community" and that, as a result, there are internal contradictions and dilemmas that many scientists involved in public policy face). Several prominent science policy scholars have advocated that scientists dedicate more attention to explicating the scientific uncertainties that arise in the resolution of overarching science policy questions. *See* Kantrowitz, *supra* note 211, at 109 (making an impassioned plea calling on fellow scientists to develop "an institution dedicated to separating what science knows from what it wants"); Howard Raiffa, *Science and Policy: Their Separation and Integration in Risk Analysis*, 36 AM. STATISTICIAN 225, 230 (1982) (calling on scientists involved in policy issues to "foster a tradition of openness and honesty in reporting" and to be clear about when they cannot make scientific pronouncements that bear on a particular policy problem). Few have offered guidance with regard to steps scientists should take to ensure that policymakers understand these limits of science, however. To address this deficiency, influential organizations like AAAS and NAS could develop detailed consensus documents that encourage scientists to improve understanding of the science-nonscience boundary without sacrificing other important professional values.

327. As described in part III.C.1, the multiple, embedded points of interdisciplinary slippage between the scientific community and Congress make this type of advice unlikely to arise voluntarily, even with congressional urging. For recent congressional pleas for this type of advice from the scientific community, see *Rep. Brown's Fringe Science Report*, *supra* note 63, at 20 (observing that "an adequate rebuttal" to the alleged abandonment of peer review by certain members of Congress "cannot be made effectively within the rapid-fire political process in which congressional oversight is carried out. The scientific community must develop new mechanisms to engage these arguments as a general and ongoing task, not one that is carried out once or twice a year in a hearing.").

courts advisable.[328] Because the courts come to the process late and their actions are generally limited to often narrow or even distorted disputes over environmental policy, they are not well positioned to correct systemic problems in congressional decisionmaking.[329] Nonetheless, if public choice motivations or scientific illiteracy prove too difficult to combat, the courts may be the institution of last resort for improving congressional policymaking, at least with regard to the quality of final legislative outputs.[330] At the very least, the court reform is a necessary supplement to congressional reeducation initiatives.

Currently, rather than correcting or at least remaining neutral, courts tend to exacerbate Congress's tendency to overrely on science by requiring agencies to support rulemakings with substantial evidence.[331] This requirement may lead agencies to implement mandates

328. The courts, for their part, may also act to exacerbate the unrealistic scientific demands imposed on agencies by these mandates. *See* Wagner, *supra* note 7, at 1661-67 (citing cases and literature on the subject).

329. It is important to note, however, that the courts appear to play a large role in overseeing the EPA's rulemakings. Approximately 85% of the EPA's regulations are challenged in the courts through the judicial review process. *See* STEPHEN G. BREYER & RICHARD B. STEWART, ADMINISTRATIVE LAW AND REGULATORY POLICY: PROBLEMS, TEXT, AND CASES 607 (3d ed. 1992) (explaining that for major EPA rules "there is an 85 percent chance of subsequent court litigation"); *see also supra* note 4. *But see* Cary Coglianese, *Assessing Consensus: The Promise and Performance of Negotiated Rulemaking*, 46 DUKE L.J. 1255, 1295-1300 (1997) (investigating whether this 80% to 85% review statistic is valid and concluding that the number of rulemakings challenged is in fact much lower, regardless of which type(s) of agency activities are being considered). Thus, one comparative institutional disadvantage of the courts—the "threshold costs of litigation," which might otherwise raise the costs of access to this institutional decisionmaker beyond what the general public (through interest groups) is capable of paying—does not appear at first glance to be a very serious disability. *See* KOMESAR, *supra* note 47, at 128 (listing as one of the disadvantages of courts as institutional decisionmakers the costs of access and the possibility that these costs will "keep the courts from a given social issue or from large sets of social issues").

330. In a comparative institutional sense, the courts may be free of at least some of the public choice biases and information distortions that plague Congress with regard to respecting the limits of science. Therefore, the courts have some distinct institutional advantages with respect to this particular problem. *See* KOMESAR, *supra* note 47, at 141 (observing that as between courts and the political process as institutional decisionmakers, the political process has the advantage of "integrat[ing] far more information but with a more significant risk of bias. . . . The adjudicative process hears and considers less, but is more evenhanded in what it hears and considers."); *id.* at 150 (recommending as factors for consideration in comparing the decisionmaking capabilities of courts, political process, and the markets that the "comparative advantage" of courts exists "only when the balance of bias, competence, and scale favors that substitution").

331. *See* Administrative Procedures Act, 5 U.S.C. § 706(2)(E) (1994); Universal Camera Corp. v. NLRB, 340 U.S. 474, 487-88 (1951) (providing a definition of the substantial evidence standard); *see also* Public Citizen Health Research Group v. Tyson, 796 F.2d 1479, 1507 (D.C. Cir. 1986) (finding OSHA's rationale for not issuing short-term exposure limit for ethylene oxide was not supported by substantial evidence); Asbestos Info. Ass'n v. OSHA, 727 F.2d 415, 424-26 (5th Cir. 1984) (staying enforcement of emergency temporary standard for asbestos because of the lack of substantial evidence to support OSHA's conclusion that risk was "grave" or standard was "necessary"); Gulf South Insulation v. Consumer Prod. Safety Comm'n, 701 F.2d 1137, 1149 (5th Cir. 1983) (finding complaints and study relied on by Consumer Product Safety Commission did not provide substantial evidence to support rule); MELNICK, *supra* note 21, at 356 (observing that reviewing courts have focused "their review on the quality of the scientific evidence supporting the EPA's standards"). Justice Scalia highlights the demands courts have placed on agen-

in a science- or data-intensive way that can be very much at odds with the realities of scientific experimentation and available information and that only serves to reinforce Congress's comparable errors at the legislative level. Therefore, a reform directed at the judiciary must work to correct the courts' current reinforcement of Congress's misframing problem and must also encourage the courts to assist in the reframing effort by reading these misframed mandates broadly enough to permit agencies to correct them when doing so is essential to carrying out the legislative mission. Both the agencies and the courts, working together in this way, may be of great assistance in repairing the worst of the misframed mandates and informing Congress of its framing errors without encroaching on the legislature's policymaking responsibilities.

1. The Proposal

In this judicial backstop reform, courts should be reinstructed, preferably in an amendment to the Administrative Procedures Act (APA),[332] to defer to agencies' science and policy determinations even when the statutory mandate appears to limit the agency predominantly to science or quantitative findings. This added deference would be provided only after the agency establishes that existing science is inadequate to fulfill Congress's charge and that Congress intended the statute to be functional.

The court-centered reform thus requires two clarifications to the current approach to judicial review of agency rulemakings. First, courts must abandon their requirement that the agency produce substantial evidence to support a rulemaking if the agency can prove that this evidence is not available because of a gap in scientific knowledge. Obviously, if the science is missing because of research limitations or even inadequate research funds, the courts should not insist that this evidence be produced.

Second, the courts must defer to creative administrative interpretations of statutory mandates if the agency establishes that such an interpretation is necessary because pervasive scientific uncertainties would otherwise thwart a statute's implementation. Accordingly, the agency must identify the limits of science, explain the reasons for these limitations, and outline the resulting policy choices. If the agency does this, however, the court should defer to the agency's pol-

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cies in providing support for rulemakings: "[Reviewing courts require] that the agency publish and permit the public to comment on all data and studies on which it intends significantly to rely, and that the agency justify the rule in detail and respond to all substantial objections raised by the public comments." Antonin Scalia, *Back to Basics: Making Law Without Making Rules*, REGULATION, July-Aug. 1981, at 25, 26.

332. *See* Wagner, *supra* note 7, at 1712 (proposing language of an amendment that would roughly accomplish the objectives outlined in this section).

icy and scientific findings, unless they appear wholly insupportable based on a review of the administrative record.

The courts' resulting role in emphasizing process and transparency, rather than overseeing the agencies' substantive results—provided they fall within the permissible policy space left to the agency by Congress in the authorizing statute—is fully consistent with current conceptions of the appropriate role of judicial review.[333] *Chevron* requires courts to provide agencies with bounded deference when a statute is ambiguous, and certainly a statute is ambiguous if it seems (inadvertently) to require agencies to do the scientifically impossible.[334] This reformed approach to judicial review also comports with

333. *See* McGarity, *supra* note 13, at 1454 (recommending that the courts do a better job exercising self-restraint in their substantive review of agency rulemaking and, if that fails, recommending an amendment to the Administrative Procedures Act to "reduce the stringency of judicial review by amending the APA to change the scope of review for informal rulemaking"); *see also* Richard J. Pierce, Jr., *Two Problems in Administrative Law: Political Polarity on the District of Columbia Circuit and Judicial Deterrence of Agency Rulemaking*, 1988 DUKE L.J. 300, 327-28 (proposing, as reform of inconsistent and overreaching judicial review, strong Supreme Court precedent reminding reviewing courts to give agency policy judgments deference); Administrative Conference of the U.S., *Recommendation 93-4, Improving the Environment for Agency Rulemaking* 4, 8 (Dec. 9, 1993), *excerpted in* 59 Fed. Reg. 4669 app. at 4670 (1994) (recommending searching judicial review only of the range of an agency's legally permissible choices (statutory, policy, and factual) and deference to the agency if its ultimate justification falls somewhere within this range of permissible choices).

This process-oriented approach also avoids other obvious institutional disabilities of the courts—their narrow view of any particular social problem as a result of the case-adjudication method, and their general lack of accountability and perhaps representativeness for the public at large. *See* KOMESAR, *supra* note 47, at 141 (observing that one of the institutional disabilities of courts is that "the adjudicative process . . . separates judges from a great deal of information about the desires and needs of the public" and, as a result, judges "can carry a severely distorted view of public needs").

334. *See* Chevron U.S.A., Inc. v. Natural Resources Defense Council, Inc., 467 U.S. 837 (1984) (holding that courts should give deference to agency interpretations of statutory provisions except when they are contrary to unambiguous statutory commands); Robert Rabin, *Federal Regulation in Historic Perspective*, 38 STAN. L. REV. 1189, 1311-12 (discussing the watershed case Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council, Inc., 435 U.S. 519 (1978), in which the Court mandated greater judicial deference to agency decisions that abandoned a "right answer" approach in favor of a "best efforts" approach that seeks only "assurance of good faith consideration of the issues by the regulator rather than demanding a pristine search for truth"). An amendment to the APA codifying this deference approach could also, in theory, be passed if the majority of federal legislators behaved in Madisonian fashion with regard to these knowledge gaps. Congress may resist providing agencies with this greater deference, however. *See* MASHAW, *supra* note 148, at 176 (arguing that "[t]o the extent that the Congress has seriously debated any general change in the scope of judicial review of rulemaking, it has largely sought to make review more penetrating, not more deferential").

It does not appear that these basic principles embodied in *Chevron* are always followed, however. When it comes to interpreting Congress's science-based mandates, for example, some courts have not been willing to consider the scientific impossibility of the mandate as a factor in determining whether the statute is vague or the agencies' program reasonable. *See* Lead Indus. Ass'n v. EPA, 647 F.2d 1130, 1148 (D.C. Cir. 1980) (finding the EPA may not consider economic and technological feasibility in setting ambient air quality standards under section 109); Natural Resources Defense Council v. EPA, 824 F.2d 1146, 1163-66 (D.C. Cir. 1987) (stating that the EPA must first determine risk levels using science before taking available technologies into account); Hercules, Inc. v. EPA, 598 F.2d 91, 112 (D.C. Cir. 1978) (holding that "Congress enacted section 112 [of Clean Air Act] . . . without provision for considerations of feasibility"); *see also supra* note 331. Because this is most likely attributable to the courts' own underappreciation of

existing principles of statutory construction. It is a long-settled canon of statutory interpretation that statutes be read to preserve their functionality, and a statute is certainly not functional if it places unrealistic expectations on science for its implementation.[335]

This more sophisticated approach to judicial review may not prevent Congress from placing too much reliance on science when developing environmental legislation, but it could reduce many of the costs associated with Congress's overreliance on science by providing the agencies still greater latitude to repair misframed environmental programs early in their lifetime.[336] Providing agencies with the freedom to repair these programs under limited circumstances also takes advantage of the historical fact that agencies have proven themselves capable of interpreting unrealistic mandates in creative and functional ways and have sometimes done so even without the judiciary's blessing.[337] Giving greater deference to agencies' efforts to "functionalize" problematic science-intensive mandates might even result in *better* policy outcomes than requiring Congress to correct its own errors.[338]

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the limits of science, enlightenment seems, fortunately, to be the best antidote. Requiring agencies to map the zigzag would be the first step towards educating the courts in this regard.

335. Thus, if two alternate interpretations are possible and one would make the statute nonfunctional, the alternative, more functional interpretation should be adopted. Of course, if there is evidence that Congress *intended* the statute to be nonfunctional, then the analysis would be different. *See* WILLIAM N. ESKRIDGE, JR., DYNAMIC STATUTORY INTERPRETATION 323-28, app. 3 (1994) (listing as a textualist canon that plain meaning determines the result unless it leads to an absurd result and listing as a statute-based canon a de minimis exception to a statutory rule, so long as it does not undermine statutory policy); Cass R. Sunstein, *Interpreting Statutes in the Regulatory State*, 103 HARV. L. REV. 405, 482 (1989) ("Aggressive construction [of statutes] is entirely legitimate if there is no affirmative evidence that the legislature intended the result").

336. *See supra* notes 270-304 and accompanying text.

337. The agencies' ability to improve mandates through the implementation process is evidenced by the FDA's courageous efforts to implement the Delaney Clause, *see, e.g.*, Merrill, *supra* note 71, at 88 (concluding that the FDA's "success in the face of such statutory precision [as the Delaney Clause] should convince drafters of the futility of efforts to cabin administrative power through positive law"); the EPA's revisions of the Clean Water Act toxics provision, *see* Hall, *supra* note 83, at 519-25; RCRA's toxics provision, *see* Hazardous Waste Treatment Council v. EPA, 886 F.2d 355, 363 (D.C. Cir. 1989) (holding that "EPA's catalog of the uncertainties inherent in the alternative approach using [health-based] screening levels supports the reasonableness of its reliance upon BDAT [Best Demonstrated Available Technology] instead"); the Clean Air toxics provision, *see generally* Dwyer, *supra* note 8, at 251-57 (describing the EPA's approach to air toxins before the court struck it down and Congress ultimately amended the statute); and now the EPA's effort to diminish the adverse effects of CERCLA on the purchase and redevelopment of brownfields. *See generally* Jonathan D. Weiss, *The Clinton Administration's Brownfields Initiative*, *in* BROWNFIELDS: A COMPREHENSIVE GUIDE TO REDEVELOPING CONTAMINATED PROPERTY, *supra* note 113, at 41.

338. *See, e.g.*, MASHAW, *supra* note 148, at 204 (observing that "interpretation or implementation can be understood as a power to participate actively in an ongoing process of constructing legislative meaning, rather than as a power to subvert legislative preferences in favor of those of either the judiciary or the executive branch"); Dwyer, *supra* note 8, at 235-36 (presenting an overview of his argument that the EPA should reformulate unrealistic mandates); *id.* at 267 (including as evidence the greater ability of agencies to revise regulatory policies as the need arises, while Congress is more likely to be encumbered by "unrelated political conflicts"); *id.* at 284 (arguing that agencies are responsive (or more responsive) to majoritarian preferences, particularly when they tend to shift); Lazarus, *supra* note 1, at 357-58 (outlining a number of reasons for "questioning the wisdom of exacting judicial review of EPA decisions"); Merrill, *supra* note

Professor Jerry Mashaw has persuasively argued that in some policy settings (which would seem to include the science-law conflicts at issue here) agencies may be at least as democratically accessible as Congress;[339] better at fact-finding and consensus-building;[340] and subject to superior legal checks and balances.[341] In contrast to Congress, agencies also have much greater flexibility to adapt rules to new information, policy back-talk (the inevitable real world occurrences that are not squarely anticipated in complex policymaking), and changes in science.[342] Thus, there is good reason to be optimistic about the benefits that will result from providing agencies with greater latitude to correct mandates that overrely on science for their implementation.

Judicial review that permits agencies latitude to repair misframed mandates would also seem capable of improving the institutional performance of both Congress and the agencies in addressing future environmental problems. Agencies would be publicly commended for implementing scientifically unrealistic mandates in a way that preserves the statutes' functionality[343] and, therefore, might be quicker to repair mandates that are otherwise destined for regulatory failure.[344]

71, at 88 (suggesting, at the end of a description of the FDA's attempt to reconcile the Delaney Clause with developing science, that the agency's program was more successful than the one Congress designed). *But see* SCHOENBROD, *supra* note 69, at 111-14 (concluding that agency decisionmaking subject to Administrative Procedures Act requirements does not provide sufficient mechanisms for full public participation; legislating policy is a far better alternative). Indeed, the history of a number of Congress's poorly drafted science-based mandates ended in only partial failure due to administrative efforts to redefine the statutory mandate. *See supra* note 337 and accompanying text; *see also* Dwyer, *supra* note 8, at 251, 251-57 (detailing how, before it was struck down by the courts, the EPA "candidly informed Congress and the public that its standard-setting criteria included implementation costs and technological feasibility," in spite of the fact that the mandate was a science-based, cost-blind one that required the agency to base regulatory levels on those sufficient to protect public health).

339. *See, e.g.*, MASHAW, *supra* note 148, at 208 (arguing that "[w]hile agency policy discretion has generally been viewed as a constitutionally problematic form of delegated legislative judgment, it can also be understood as solving certain pathologies in the legislative process (preeminently logrolling) and as reinforcing issue-oriented presidential politics").

340. *See id.* at 156 (arguing that in situations where there are likely to be very different perceptions of relevant facts, "delegation to experts becomes a form of consensus building that, far from taking decisions out of politics, seeks to give political choice a form in which potential collective agreement can be discovered and its benefits realized").

341. *See id.* at 157 (arguing that to the extent some sort of authoritativeness is sought in law, judicial review of administrative decisions provides a process far better than the legislative process; "[d]elegating authority to administrators thus reinforces checks for both procedural and substantive legality that might otherwise be missing.").

342. *See, e.g.*, SCHON & REIN, *supra* note 84, at 171-72 (describing the need for frame reflection in policy design and how "[m]embers of a designing system should reflect on the meanings that underlie policy back talk in order to detect unanticipated design flaws or opportunities"). In this setting, the agencies are also an external discussant, so there is less risk that Congress can co-opt the agency's policy recommendations or threaten its future survival in any permanent way. *See supra* note 248 (discussing how Congress's captive experts like the CRS refrain from providing policy advice in order to survive the heated bipartisan climate on the Hill).

343. The courts have also been frequently accused of cramping regulatory innovations. *See, e.g.*, Dwyer, *supra* note 8, at 236 (arguing that in the case of the original section 112 of the Clean Air Act "[j]udicial intervention denied the Agency the opportunity to create a functional regulatory program and advanced few, if any, of Congress' substantive goals").

344. *See supra* note 337.

Coincidentally, giving greater deference to creative agency interpretations of statutory mandates that might otherwise be read to require the agency to do the scientifically impossible will assist the agencies in avoiding some (but not all) of the incentives to engage in their own science charade.[345] In addition, giving judicial deference to agency interpretations of unrealistic mandates might put pressure on Congress to get the statute right the first time. Once Congress recognizes that its errors become subject to judicial notice and that these errors provide the executive branch with considerable policy discretion, it may conclude that the scientification of environmental legislation is a practice that should not continue.[346]

2. *Responding to Critics*

A reform that sanctions, indeed even encourages, greater policymaking by agencies and more sophisticated review of the agencies' scientific analysis by the judiciary will be quick to draw criticism from a number of different quarters. Closer examination of these concerns reveals that although the proposed reform is far from perfect, under the harsh light of critical attack, it still appears to be the best candidate among alternatives.

The first and probably the most fervent denunciation of this judicial backstop proposal will probably come from those advocating reinvigoration of the nondelegation doctrine.[347] These scholars will likely argue that the Constitution requires that legislators, rather than unaccountable bureaucrats, make these difficult policy decisions. If anything, they will argue, the courts should invalidate misframed mandates under the nondelegation doctrine because they provide agencies with *too much* rather than too little policymaking latitude.[348] As the reforms outlined in part V.A propose, the most desirable

345. *Cf.* Dwyer, *supra* note 8, at 304 (arguing that literal judicial review of symbolic mandates could cause the agency to "disguise its decisionmaking and suppress informed public policy debate (and judicial review) of agency standards"). A prior article describes this pervasive practice and its multiple causes. Although unrealistic mandates were rarely a prerequisite to this strategy, they certainly did not encourage more open policy-drafting. *See* Wagner, *supra* note 7, at 1667-69. Moreover, calling the judiciary's attention to Congress's tendency to place overconfidence in science might check the courts' own similar tendencies as well. This, in turn, could improve the state of administrative decisionmaking and judicial review more generally.

346. *Cf.* Dwyer, *supra* note 8, at 285-87, 302-04 (concluding that for several reasons literal implementation of a poorly devised statutory mandate may not be the best means of improving policy or Congress's future statute-drafting efforts); Graetz, *supra* note 73, at 677 ("[B]y supplying decisionmakers with complex additional numerical information and, at the same time, by identifying uncertainties in the numbers provided to them, lawmakers would be hindered in their ability to tie legislative decisions to easy summations of revenue estimates.").

347. *See* SCHOENBROD, *supra* note 69, at 13-19.

348. *See* Industrial Union Dep't v. American Petroleum Inst., 448 U.S. 607, 646 (1980) (observing that if Congress did *not* intend that the Secretary be allowed to quantify risks as a precondition to promulgating OSHA standards, "the statute would make such a 'sweeping delegation of legislative power' that it might be unconstitutional under the Court's reasoning in A.L.A. Schecter Poultry Corp. v. United States") (Stevens, J., writing for the plurality); *see also id.* at 671-713 (discussing the appropriateness of a nondelegation challenge to OSHA for im-

course for improved environmental lawmaking *is* for Congress to take the lead in approaching its lawmaking tasks with greater appreciation for the limits of science. Yet, the corollary argument that the courts should actually *require* this under threat of invalidating statutes through the nondelegation doctrine will almost certainly exacerbate, rather than correct, this particular science-framing problem.

Putting to one side the historical disinclination of courts to use the nondelegation doctrine aggressively,[349] the most obvious problem with applying the nondelegation doctrine to misframed mandates is that it would likely lead either to invalidation of all (or nearly all) misframed mandates or none of them.[350] It is difficult to see how either alternative constitutes a desirable reform of the present situation or would serve to lower the overall costs of the current state of environmental lawmaking.[351] Even if the courts were able to draw lines in the sand and preserve some misframed mandates while invalidating others, the elevated role of the courts could actually tilt the balance of power further toward the courts and away from Congress (a result nondelegation proponents would presumably not want).[352] Within Congress, moreover, the doctrine will likely advantage public choice legislators at the expense of the Madisonian statesperson.[353]

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proper delegation of policymaking authority) (Rehnquist, J., concurring). *See generally* SCHOENBROD, *supra* note 69.

349. The courts have not used this power in 70 years, despite some arguably good opportunities. *See, e.g.*, Touby v. United States, 500 U.S. 160, 165 (1991) ("So long as Congress 'lay[s] down by legislative act an intelligible principle to which the person or body authorized to [act] is directed to conform, such legislative action is not a forbidden delegation of legislative power.'" (quoting J.W. Hampton, Jr., & Co. v. United States, 276 U.S. 394, 409 (1928))).

350. The courts most likely will decline to invalidate misframed science mandates because they appear to delegate only technical decisions to the agencies. *See, e.g.*, Lead Indus. Ass'n v. EPA, 647 F.2d 1130, 1148 (D.C. Cir. 1980) (precluding the EPA from considering economic and technological feasibility in setting air quality standards because the mandate requires that the agency rely only on scientific considerations). The opinions would, therefore, only reinforce the misframing problem.

Alternatively, if the courts do consider the enormous scientific uncertainties embedded in the standard-setting endeavor, they would find it necessary to invalidate virtually every major environmental provision discussed in part II.B because of the inevitable and significant policy delegations contained within science-based mandates.

351. *See supra* Part IV, notes 270-304.

352. The power of courts would be elevated by enabling them to make substantive decisions about when a mandate does or does not unconstitutionally delegate policy choices to an agency. *See, e.g.*, Peter H. Schuck, Non-Solution to a Non-Problem: Comments on David Schoenbrod's Paper, Conference draft 3/98, at 1 (observing that "if the Supreme Court were to resurrect the nondelegation doctrine . . . it would vastly increase federal judges' power over American life and would correspondingly weaken the authority of what we quaintly call the 'political' branches").

The agencies, for their part, might also even enjoy more policy-making discretion by controlling the interpretation of their mandates. In cases where the policy discretion is welcome, they could simply conceal policy choices under mandates they interpret as "technical." *See* Wagner, *supra* note 7, at 1628-50 (describing the agencies' current proclivity to engage in the science charade). When the discretion or the statute itself is unwelcome, they can hasten its demise by exaggerating the extent of the necessary policy choices.

353. Sophisticated public choice officials will greet with glee the opportunity to infuse statutes with subtle unconstitutional delegations that their interest group constituencies can later use to invalidate the statute. *Cf.* Johnathan L. Entin, *Congress, The President, and the Separation of*

Practical realities further call into question the desirability of using the courts to invalidate, rather than broaden, the agencies' policy space within misframed mandates. Federal legislators will find that for policymaking on complex social issues, like the environment, it is nearly impossible to identify and then make all necessary policy choices in a single piece of legislation.[354] Even if Congress could satisfactorily identify all of the policy issues of significance, it is doubtful that a majority of members could agree on the proper resolution of these issues in a single piece of legislation.[355] It is equally doubtful

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Powers: Rethinking the Value of Litigation, 43 ADMIN. L. REV., Winter 1991, at 31, 43 (recounting how the House Democrats who opposed the Gramm-Rudman-Hollings Act "supported specific provisions that they believed would make a constitutional challenge to the statute more likely to succeed"). *See generally* Fiorina & Noll, *supra* note 175 (describing how members of Congress include in legislation complex provisions that are intended to benefit their constituents during the implementation process). The only losers under the nondelegation doctrine approach would seem to be the Madisonian legislators and their publics, who must now search even harder through more confusing interest group, public choice congressmember, and agency positions and a tangle of case law enforcing the doctrine in a variety of very different legal and policy settings. *See, e.g.*, Schuck, *supra* note 352, at 9 (suggesting that "[b]y magnifying the uncertainty surrounding the legislative process, the doctrine would further increase the strategic opportunities of politicians and organized interests that desire to enact, block, or delay new legislation").

354. *See, e.g.*, Sharyn O'Halloran, *The Politics of Delegation*, CARDOZO L. REV. (forthcoming 1998) (observing that many of Congress's delegations occur when the issues include technical factors and require considerable expertise and arguing that this division of the workload is politically efficient and "makes representative government possible in an era where legislators are constantly faced with complex policy choices"); Schuck, *supra* note 352, at 2 (observing that the great problem in the political system "is that social complexity has made it far more difficult for legislators to accurately predict the consequences of their choices" and concluding that this fact "may imply the need for greater delegation, not less"); *see also* KELMAN, *supra* note 200, at 56-57 (describing the extraordinarily limited time of congressmembers and their staffs to research policy issues and the resulting tendency of Congress to resort to vague statutory language instead of making specific decisions in the laws themselves). Indeed, the legislative complications encountered both in anticipating and responding to judicial invalidations of statutes under the doctrine will most certainly slow if not stop the process of environmental lawmaking, a result that could well be contrary to the wishes of the general public. *See also* Schuck, *supra* note 352, at 9 (discussing the inevitable legislative inertia that would result from strengthening the nondelegation doctrine). In addition, the already overburdened agencies and courts would be besieged with a whole new category of nondelegation doctrine challenges, a drain that, standing alone, likely cancels the marginal improvements that would result from such a cost-intensive, adversarial approach to legislation drafting. *See also id.* at 8-10 (identifying other adverse consequences of strengthening the nondelegation doctrine, including shifting considerable power to the federal courts and away from Congress).

A variety of academics of policy design have underscored the necessarily incremental and highly interactive nature of policymaking on complex social problems, a quality that precludes their resolution in a single legislative effort or even in an effort that is revisited every five to ten years. *See* SCHON & REIN, *supra* note 84, at 167 (explaining that complex problem solving is, instead, a design process that involves an iterative process in which the "designer's continuing inquiry should incorporate the observed effects of her moves as she reformulates both her problem and her solutions in order to take fuller account of the observed complexity of the situation and its gradually discovered field of values and interests"). *See also* Schuck, *supra* note 352, at 4-5 (observing that the agency level, as opposed to the congressional level, is where the parties can interact more iteratively with the policymakers and where the "remote effects [of a law] that ripple through a complex, opaque society" can be explored and addressed). *See generally* Lindblom, *supra* note 193 (discussing "muddling through" and incremental decisionmaking as dominant strategies for resolving complex problems).

355. *See, e.g.*, Jerry L. Mashaw, *Prodelegation: Why Administrators Should Make Political Decisions*, 1 J.L. ECON. & ORG. 81, 82 (1985) (arguing that vague mandates of policy authority

that in doing so they could successfully exclude the agency from making these choices or finding discretion between the lines.[356] But, perhaps most importantly, even if members of Congress successfully surmount all decisionmaking obstacles, it is not at all clear that their policy decisions will be made in a way that is democratically superior to the existing agency-Congress dialogue of oversight and amendments.[357] Particularly in the area of environmental law, where there are so many policy choices woven together, many of which are not at all transparent, it is fair to question legislators' ability to comprehend and to act openly on these policy choices.[358]

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to agencies are better than no action). In the reform proposed in part V.A, Congress is able to pick and choose those aspects of a policy problem it wishes to resolve. Delegations may still be made to an agency for difficult decisions, but the mandates resulting from congressional enlightenment and dedication to correct the misframing problem should at least leave the agency sufficient policy space within which it can effectively resolve environmental problems without feeling that it is stepping outside the scientificated statutory mandate.

356. *See* MASHAW, *supra* note 148, at 154 (observing that "[s]queezing discretion out of a statutory-administrative system is, indeed, so difficult that one is tempted to posit a 'Law of Conservation of Administrative Discretion.'").

357. Nondelegation doctrine proponents place considerable emphasis on Congress's allegedly superior democratic accountability relative to agencies. *See, e.g.*, SCHOENBROD, *supra* note 69, at 119-21, 129-31 (arguing that public participation in environmental policymaking would be greatly enhanced if Congress, rather than agencies, made the decisions). Unfortunately, it is not at all clear what this congressional democratic accountability is and how one measures it relative to agency accountability. *See generally* Dan M. Kahan, *Democracy Schmemocracy*, CARDOZO L. REV. (forthcoming 1998) (arguing that "democracy" is "an empty standard for judging the desirability or constitutionality of the delegation schemes . . . because democracy is an essentially contested concept: there is not just one but rather a plurality of competing conceptions of democracy, each of which emphasizes a different good commonly associated with democratic political regimes"); Schuck, *supra* note 352, at 3-4 (discussing the "normative tradeoffs" involved in assessing the political responsibility of the legislature); Letter from Peter Strauss, Betts Professor, Columbia University School of Law, to Marci Hamilton, Professor, Cardozo School of Law (Feb. 18, 1998) (on file with author) (observing that the price of greater congressional decisionmaking is "legislation so cumbersome and complex that no one knows what's in it when they vote on it").

358. Accessing members of Congress can be much more difficult than communicating lay concerns to bureaucrats. *See supra* note 261 (citing literature that suggests that interest groups find the agencies more accessible and accountable and for that reason prefer them as decisionmakers); *see also* Schuck, *supra* note 352, at 4 (observing that costs of access are lower for agencies than for Congress and that as a result the "agency is a more meaningful site for public participation than Congress"). Agency decisionmaking is also more constrained by the threat of judicial review and congressional oversight, which potentially make it more democratically accessible than Congress's decisionmaking. Finally, Congress is the penultimate authority, and it remains free to amend, reverse, financially constrain, or publicly chide agency decisions. *See* William N. Eskridge, Jr., *Overriding Supreme Court Statutory Interpretation Decisions*, 101 YALE L.J. 331, 378 (1991) (discussing how Congress does at times override Supreme Court interpretations and how that, in turn, can impact the Supreme Court's statutory analysis); *see also* Schuck, *supra* note 352, at 5-7 (outlining measures Congress can take in constraining agency discretion). In fact, this legislature-agency dialogue may be even more productive once agencies have expended considerable effort outlining the ways in which science does and does not guide their rulemakings. *Cf.* Kahan, *supra* note 357, at 9 (2/17 draft on file with author) (observing that "*[t]oo much* legislative accountability, the civic republican view suggests, can disserve certain democratic goods and experiences; when that's so, it perfects democracy for elected representatives to delegate some of their power to agencies structured to respect those goods and experiences"). Although Congress's participation in this conversation might be delayed, its manifold

A second, major concern with regard to the proposed reform is whether the courts have the scientific competence to implement the reform satisfactorily. The response to these concerns is not disagreement but, rather, a comparative institutional analysis.[359] The competency of courts to oversee agencies' scientific findings is most assuredly not always impressive.[360] But, the proposed reform avoids some past pitfalls by improving the nature and clarity of directions given to both agencies and courts. Under the proposed judicial backstop reform, agencies are instructed to serve as the primary governmental expert. The only added requirement is that in doing so the agencies must clearly explain why a science-intensive mandate may be nonfunctional and hence vague if interpreted narrowly. The agency would accomplish this by clearly identifying the points at which scientific expertise cannot currently inform decisionmaking and the policy choices that must be made instead. Courts are thus limited to ensuring that the agencies have adequately complied with this "support and explain" requirement.[361]

A third and related criticism of the proposal will likely question increased reliance on the courts to correct systemic failures in Congress's lawmaking because of the courts' demonstrated political biases in applying what should be objective procedural rules in reviewing agency rulemakings.[362] Because the courts are much less accountable

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opportunities to intervene and ultimately control the policy outcome leaves its alleged superior accountability intact.

Common sense further reinforces the conclusion that for complex policymaking, the public will have more diverse avenues to access a collaboration between Congress and the agency than to Congress alone. This is especially true if the agency has been instructed under threat of judicial review to identify and explain the various scientific uncertainties that punctuate its decisionmaking. The executive branch power also serves as a looming threat that can work to improve Congress's lawmaking. Were it not for the executive branch, for example, Congress may have been much more unconcerned about developing its own cadre of scientific experts to assist it in its policymaking. *See supra* note 257 (describing the origins of the OTA that resulted in part from Congress's efforts to keep up with the expertise of the executive branch).

359. *See generally* KOMESAR, *supra* note 47 (advocating that in proposing legal reforms, reformers employ a "comparative institutional analysis" that compares specific institutions' attributes and deficiencies against one another, rather than simply employ a "singular institutional analysis").

360. *See* Davis, *supra* note 12, at 86, 92, 98 (discussing inconsistent judicial review of agency risk assessments); *see also* Gulf S. Insulation v. United States Consumer Prod. Safety Comm'n, 701 F.2d 1137, 1146 (5th Cir. 1983); Ashford et al., *supra* note 42, at 363-68 (critiquing the court's review of science in *Gulf South*).

361. The courts' process-based inquiry could be further assisted by reference materials, such as those provided by the Federal Judicial Center, *see infra* note 363, that outline the manner and types of explanations that agencies should be providing. These reference materials would clarify the different types of knowledge gaps and whether or how they can best be resolved.

362. *See* Pierce, *supra* note 333, at 303-07. The tendency of D.C. Circuit judges to misuse procedural requirements as a mechanism for "selectively" invalidating those agency regulations the judges find politically unpalatable has even been supported by several empirical studies. *See* Richard L. Revesz, *Environmental Regulation, Ideology, and the D.C. Circuit*, 83 VA. L. REV. 1717, 1717 (1997) (concluding that a judge's ideology does impact judicial decisionmaking, especially in reviewing agency rulemakings under the process-based requirements); Emerson H. Tiller, *Controlling Policy by Controlling Process: Judicial Influence on Regulatory Decision-mak-*

than Congress, political biases in the courts' review of agency rulemakings have worrisome implications for this judicial backstop reform. Yet, the literature documenting the D.C. Circuit's politicized review of agency rulemakings also suggests that nuanced refinements to judicial review are likely to improve the situation. Refinements could include, for example, much more specific guidance to the courts, perhaps in the form of universal checklists of common scientific uncertainties or on the level of technical explanation that agencies should be providing in rulemakings,[363] and more active Supreme Court review of cases involving challenges to agencies' interpretations of vague mandates or to their compliance with APA procedures.[364] In any case, even if the appellate courts do continue to invalidate agency rules in a biased fashion, it is not at all clear that, as a result, agencies will abandon following clearly delineated process requirements.[365] Indeed, if an agency does abandon detailed process requirements, it is only further increasing the risk of having its rulemakings invalidated.

Ultimately, however, the capabilities of this judicial backstop reform to improve matters may devolve into nothing more than a comparative institutional argument. Set against the analysis of why Congress tends to misframe mandates advanced in part III and similar pervasive failings of agencies discussed elsewhere,[366] it appears that there are simply no better institutional options.[367] Whether the costs of Congress's errors will exceed the benefits derived from counteract-

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ing, 14 J.L. ECON. & ORG. 114, 114 (1998) (same). This criticism also significantly undercuts nondelegation doctrine proponents' faith in the judiciary to make objective decisions about the constitutional status of statutes, particularly when the guidelines for determining delegation violations are unformulated.

363. *See* Revesz, *supra* note 362, at 1731 (positing as one explanation for biased or "selective deference" by D.C. Circuit judges in reviewing challenges to the agency's adherence to process requirements under the APA that the rules governing these requirements are "more malleable than for statutory challenges"). If guidelines were prepared for the courts, they could be legislatively directed (prepared by Congress directly or through the establishment of an expert panel like the National Academy of Sciences) or prepared by the Federal Judicial Center. In fact, the Federal Judicial Center has been quite effective in preparing these types of lists and handbooks for related technical issues. *See, e.g.*, FEDERAL JUDICIAL CTR., REFERENCE MANUAL ON SCIENTIFIC EVIDENCE (1994).

364. *See* Revesz, *supra* note 362, at 1767-68 (concluding based on empirical analysis that "judges act more ideologically when their decisions are unlikely to be reviewed by a higher authority (such as when they involve fact-bound, procedural challenges) than when such review is more probable (as is the case with respect to statutory challenges)"). Richard Revesz also suggests, based on his study of the D.C. Circuit, that it may be possible to eliminate some of the problems of biased judicial review by vesting the authority to review regulations in all circuits rather than just the D.C. Circuit. *See id.* at 1771.

365. *See id.* at 1769-70 (raising but not resolving the question of whether "hard look" review and/or related stringent procedural requirements will encourage the agency to follow such rules absent even-handed enforcement by the courts).

366. *See supra* note 7.

367. *See* KOMESAR, *supra* note 47, at 124-25 (describing courts' greater independence and even-handedness relative to political institutions and markets because of life tenure, limits on ex parte contact, and other factors).

ing the misframing problem can ultimately be determined only from the hindsight of modest experimentation.[368]

VI. CONCLUSION

Many of the most significant failings of environmental law can be traced to Congress's tendency to develop legislation and programs that rely too heavily on science. Laws that require the scientifically impossible undercut the effectiveness and, at times, even the implementability of environmental legislation, with attendant regulatory inefficiencies and delays in public health and environmental protection. Despite these adverse consequences, however, in recent bills and legislation Congress continues to demand more from science than it is capable of producing. Indeed, models of basic congressional decisionmaking reveal deeply ingrained behavior patterns that cause members of Congress to regularly neglect, ignore, or deliberately manipulate the scientific uncertainties that are commonplace in environmental problem solving. Nonetheless, some reform is possible. Focused initiatives by individual legislators or scientists, and greater attention to the problem by the courts could begin to counteract Congress's overreliance on science when developing environmental legislation.

368. This type of minor adjustment to the nature of judicial review essentially makes explicit what some courts already appear to be doing. *See supra* note 337.