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Paradoxical Perils of the Precautionary Principle

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Few principles are better ensconced in the law and philosophy of environmentalism than is the "precautionary principle." The precautionary principle simply reflects the classic adage: Better safe than sorry. The principle suggests that government should take precautions to protect public health and the environment, even in the absence of clear evidence of harm and notwithstanding the costs of such action.[1] The appeal of the principle makes it a candidate for consensus, among a public otherwise deeply divided about environmental policies.[2] The precautionary principle is not only a mantra of the green movement but also is fundamentally appealing to the "anxious millions who think it might often be better to be safe than sorry."[3] The theory can be traced back to Rachel Carson's *Silent Spring*, the environmentalist bible that warned against human tampering with nature with particular reference to pesticides.[4] Yet in this Article I will maintain that the precau-

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1. *See, e.g.*, Gregory D. Fullem, *The Precautionary Principle: Environmental Protection in the Face of Scientific Uncertainty*, 31 WILLAMETTE L. REV. 495, 497-98 (1995) (reporting that "the principle asserts that regulators and decision makers should act in anticipation of environmental harm, without regard to the certainty of the scientific information pertaining to the risk of harm"); Lothar Gundling, *The Status in International Law of the Principle of Precautionary Action*, 5 INT'L J. ESTUARINE & COASTAL L. 23, 26 (1990) (declaring that precautionary principle "requires action even if risks are not yet certain but only probable, or, even less, not excluded").

2. *See* Zygmunt J.B. Plater, *Facing a Time of Counter-Revolution — The Kepone Incident and a Review of First Principles*, 29 U. RICH. L. REV. 657, 695 (1995); *see also* Fullem, *supra* note 1, at 499 (referring to "growing espousal of the principle by policy makers, scientists, and legal commentators alike"); *id.* at 500 (observing that "the precautionary principle is being incorporated into environmental law and policy at an ever-escalating rate").

3. *Environmentalism: Risking the Earth*, ECONOMIST, Sept. 16, 1995, at 99; *see also* Bradford C. Mank, *Superfund Contractors and Agency Capture*, 2 N.Y.U. ENVTL. L.J. 34, 80 (1993) (observing that "the public generally chooses to err on the side of safety"); Amy Montemarano, *The Delaney Paradox Resurfaces: Regulating Pesticides as Food Additives under Federal Law*, 25 RUTGERS L.J. 433, 455 (1994) (suggesting that it "is far better to err on the side of safety than to 'force the public to play Russian roulette each time it eats'").

4. *See* Zygmunt J.B. Plater, *From the Beginning, a Fundamental Shift of Paradigms: A Theory and Short History of Environmental Law*, 27 LOY. L.A. L. REV. 981, 1000 (1994)

tionary principle is deeply perverse in its implications for the environment and human welfare.

Under different names, the precepts of the precautionary principle consistently reappear in environmental policy. For example, some have compared the risk of scientific false positives in environmental law (costing money) with the cost of scientific false negatives (costing lives) and argued that the greater consequences of false negatives mean that scientific uncertainty should become a basis for environmental protection regulation or other governmental action.[5] The classic formulation of this principle was produced by Talbot Page in 1978.[6] He suggested that a false negative could cost lives, while a false positive, such as banning a truly harmless chemical, would have only economic consequences, and probably minor ones at that.[7] Given the asymmetry in the consequences of error, Page urged that we err on the side of preventing false negatives at the expense of some false positives. Yet his claimed asymmetry of consequences was essentially asserted without proof.[8]

(tracing precautionary principle as outgrowth of Rachel Carson's paradigm). The origin of the phrase apparently lies in a 1965 committee of German administrators. Alex Milne, *The Perils of Green Pessimism*, NEW SCIENTIST, June 12, 1993, at 34. Ms. Carson's text remains compelling today, though "nothing Carson forecast in *Silent Spring* came to pass." GREGG EASTERBROOK, A MOMENT ON THE EARTH 80 (1995). Indeed, "the unintentional harm arising from the activities of environmental alarmists" has been called "Carsonogenic harm." William M. London, *Priorities, Dollars and Sense*, 7:4 PRIORITIES 3, 4 (1995).

5. *See* Sidney Shapiro, *Keeping the Baby and Throwing Out the Bathwater: Justice Breyer's Critique of Regulation*, 8 ADMIN. L.J. 721, 732 (1995) (discussing uncertainty in regulatory decisionmaking). Shapiro argues:

> When a regulator makes a decision under conditions of uncertainty, there are two possible types of error. The regulator can overregulate a risk that turns out to be insignificant or the regulator can underregulate a risk that turns out to be significant. If the regulator erroneously underregulates, the burden of this mistake falls on those individuals who are injured or killed, and their families. If a regulator erroneously overregulates, the burden of this mistake falls on the regulated industry which will pay for regulation that is not needed. This result, however, is fairer than setting the burden of uncertainty about a risk on potential victims.

Id. at 732; *see also* Donald T. Hornstein, *Reclaiming Environmental Law: A Normative Critique of Comparative Risk Analysis*, 92 COLUM. L. REV. 562, 641 (1992) (suggesting that "the danger of false positives . . . [is] far less serious than the danger of false negatives").

6. Talbot Page, *A Generic View of Toxic Chemicals and Similar Risks*, 7 ECOLOGY L.Q. 207 (1978).

7. *Id.* at 219-20.

8. *See* Frank B. Cross, *The Public Role in Risk Control*, 24 ENVTL. L. 887, 941 (1994) (discussing basis and effects of precautionary principle). I wrote that:

> It is often asserted that in environmental regulation it is better to risk false positives (unnecessary regulation) than false negatives (failure to regulate actual

Another manifestation of the precautionary principle is found in the suggestion that new chemicals and other human activities should bear the burden of proof before they are allowed.[9] As espoused by some, the precautionary principle requires "proof of harmlessness" before an activity is allowed.[10] The burden shifting is applied in California's Proposition 65 requirements of warning.[11] This concept also appears strongly in the United Nations' *World Charter for Nature*, which declares that when "potential adverse effects are not fully understood, the activities should not proceed."[12]

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problems). It is thought that a false negative may be catastrophic, while a false positive will only waste a little money. In fact, false positives may present a much greater threat to health than false negatives.

Id. The primary point of the present Article is to demonstrate this fact.

9. *See* Brian Wynee & Sue Mayer, *How Science Fails the Environment*, NEW SCIENTIST, June 5, 1993, at 32 (declaiming that "precautionary principle demands that the environment must not be left to show harm before action is taken," so the "burden of proof is shifted from those seeking to protect the environment to the polluter"); *see also* Alana M. Fuierer, *The Anti-Chlorine Campaign in the Great Lakes: Should Chlorinated Compounds Be Guilty Until Proven Innocent*, 43 BUFF. L. REV. 181 (1995).

10. *See* Milne, *supra* note 4 (discussing difficulty in proving negative). This establishes quite a high standard, as the author elaborates:

> Wittgenstein and Bertrand Russell once sat on a couch together and tried to prove that there was not a hippopotamus in the room. In the end they had to get down on their knees and look under the sofa. . . . If Wittgenstein and Russell cannot do it without effort, it is because it cannot be done, and no scientist has ever wasted a minute in the attempt.

Id. It is a scientific aphorism that you cannot prove a negative. *See, e.g.*, Junius C. McElveen, Jr. & Chris Amantea, *Legislating Risk Assessment*, 63 U. CIN. L. REV. 1553, 1561 (1995) (observing that if "the burden of proof is put on the party alleging that the chemical is safe — that it presents no risk — that party will lose, because their is no way to prove a negative").

11. *See* William S. Pease, *Identifying Chemical Hazards for Regulation: The Scientific Basis and Regulatory Scope of California's Proposition 65 List of Carcinogens and Reproductive Toxicants*, 3 RISK 127 (1992). Pease observes:

> Proposition 65 shifts the burden of proof in the regulatory process from government to industry. Use of chemicals known to cause cancer or reproductive toxicity is no longer considered "innocent" until proven "guilty" of harming public health by governmental agencies. . . . Exemptions from these requirements are allowed only if the business responsible for an exposure or discharge can demonstrate that the amount of chemical in question poses "no significant risk."

Id. at 127-28.

12. *World Charter for Nature*, G.A. Res. 37/7, U.N. GAOR, 37th Sess., Supp. No. 51, at section (II)(11)(b), U.N. Doc. A/Res/37/7 (1992), *reprinted in* 22 INT'L LEGAL MATERIALS 455, 458 (1983).

Environmentalists' disdain for scientific evidence has been justified on the grounds that it nudges society toward such a shift in the burden of proof.[13]

The precautionary principle has recently assumed added prominence with the growth of international environmental concern. The 1992 Rio Declaration of the U.N. Conference on the Environment explicitly declared that "[i]n order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities."[14] Some "express statement of a precautionary principle is found in the Treaty of Rome, as amended by the Treaty on European Union, as well as in other international instruments adopted in the intervening twenty years."[15] The principle is prominent in international consideration of policies regarding climate change.[16] The precautionary principle has become linked with the fundamental international principle of sustainable development.[17] Precaution is "rapidly assuming a central role in international environmental law."[18] The

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13. *See* Sylvia N. Tesh, *Environmentalism, Pre-Environmentalism, and Public Policy*, 26 POL'Y SCI. 1, 15 (1993) (claiming that "grassroots environmental groups, by attributing their diseases to pollution regardless of the scientific evidence, will continue to reflect and promote environmental principles, edging the movement along").

14. United Nations Conference on Environment and Development: Rio Declaration on Environment and Development, June 14, 1992, Principle 15, *reprinted in* 31 INT'L LEGAL MATERIALS 874, 879 (1992). The Principle states that "lack of full scientific certainty" shall not serve as a barrier to environmental regulation. *Id.*

15. David A. Wirth, *The Rio Declaration on Environment and Development: Two Steps Forward and One Back, or Vice Versa?*, 29 GA. L. REV. 599, 634 (1995). The author further notes that "[e]laboration of the principle has occurred with special particularity in the context of marine pollution," and that "[p]recautionary approaches have also received considerable attention in the policy debate on global climate change." *See also* James E. Hickey, Jr. & Vern R. Walker, *Refining the Precautionary Principle in International Environmental Law*, 14 VA. ENVTL. L.J. 42 (1995). At a recent conference of European environmental ministers on hazardous substances, the chemical industry argued that regulation should be grounded in risk assessment, but the ministers chose instead to rely upon the precautionary principle. *See Ministers Target Near-Zero Emissions, Stand Firm on Mercury Cell Phaseout*, CHEM. WEEK, June 21, 1995, at 15.

16. *See* Fullem, *supra* note 1, at 504 (finding that "[i]nternational delegates confronting the issue of global warming have also embraced the precautionary approach"); *see also supra* notes 14-15 (discussing international community's embrace of precautionary principle).

17. *See* Richard B. Howarth, *Sustainability Under Uncertainty: A Deontological Approach*, 71 LAND ECON. 417 (1995). This article provides an unusually rigorous defense of the precautionary principle, both philosophically and through economic modeling.

18. Naomi Roht-Arriaza, *Precaution, Participation, and the "Greening" of International Trade Law*, 7 J. ENVTL. L. & LITIG. 57, 60 (1992). The author catalogues a number of treaties and international conferences that have embraced the precautionary principle. *Id.* at 60-62; *see also* Fullem, *supra* note 1, at 502-08; Gundling, *supra* note 1; Plater, *supra* note 2, at 1000 n.73 (reporting that precautionary principle has become "major international

principle may have significant protectionist repercussions for world trade.[19]

Aspects of the precautionary principle pervade domestic environmental and public health law as well. The Delaney Clause, which prohibits all food additives that have been shown to induce cancer in any animal species, is but one prominent example.[20] Under the Clause, it matters not that the animal test is a poor surrogate for human risk or that the human risk is miniscule.[21] Food and Drug Administration (FDA) approval conditions for new drugs reflect Page's fear of false negative errors.[22] In fact, the concept of "margin of safety" is found throughout our environmental laws.[23] The meaning of margin of safety for a non-threshold pollutant is murky, but the concept clearly embraces the precautionary principle's devotion to erring on the side of safety. The feasibility-based standards found elsewhere in environmental law likewise represent a reflection of the precautionary principle.[24] The Superfund process is even structurally designed to emphasize

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policy norm"); Bernard A. Weintraub, *Science, International Environmental Regulation, and the Precautionary Principle: Setting Standards and Defining Terms*, 1 N.Y.U. ENVTL. L.J. 173 (1992).

19. *See* Don Mayer & David Hoch, *International Environmental Protection and the GATT: The Tuna/Dolphin Controversy*, 31 AM. BUS. L.J. 187, 234-35 (1993) (citing conflicts between precautionary principle and General Agreement on Tariffs and Trade (GATT)); Roht-Arriaza, *supra* note 18, at 62 (describing how GATT "violates . . . the precautionary approach").

20. 21 U.S.C. § 348(c)(3)(A) (1994).

21. *See* Les v. Reilly, 968 F.2d 985 (9th Cir. 1992) (stressing that Delaney Clause must be interpreted literally, without regard to conceptions of sensible policymaking), *cert. denied*, 113 S. Ct. 1361 (1993). This decision has been criticized as a misuse of the precautionary principle, as the "court's strict interpretation of the clause may cause greater harm to public health than the risk posed by the negligibly carcinogenic pesticides at issue in the case." Douglas T. Sheehy, *A* De Minimis *Exception to the Delaney Clause: A Reassessment of* Les v. Reilly, 50 FOOD DRUG COSM. L.J. 257, 258 (1995).

22. *See* HENRY GRABOWSKI & JOHN VERNON, THE REGULATION OF PHARMACEUTICALS: BALANCING THE BENEFITS AND RISKS 10 (1983) (declaring that "mandate to the FDA is drawn in very narrow terms — to protect consumers against unsafe or ineffective drugs (that is, to avoid type–2 [false negative] errors)" with "no corresponding mandate to avoid type–1 [false positive] errors or to compel equal concern with new drug innovation and improved medical therapy").

23. The National Ambient Air Quality Standards are to be set "allowing an adequate margin of safety." 42 U.S.C. § 7409(b)(1) (1994). Standards for hazardous air pollutants are to provide an "ample margin of safety." *Id.* § 7412(b). Water pollution standards for toxic pollutants likewise are to provide an "ample margin of safety." 33 U.S.C. § 1317(a)(4) (1994).

24. *See* Kenneth M. Murchison, *Environmental Law in Australia and the United States: A Comparative Approach*, 22 B.C. ENVTL. AFF. L. REV. 503, 530 (1995) (noting that feasibility-based standards are consistent with precautionary principle and that such standards are

the precautionary principle.[25] Aaron Wildavsky observed that the "canon of 'decide in favor of safety,' sometimes known as the 'precautionary principle,' pervades analysis and action in all risk issues."[26]

The courts also have uncritically embraced the precautionary principle. Perhaps the first critical circuit court opinion under the Clean Air Act emphasized the need (and "common sense") of taking affirmative action in the presence of uncertainty about environmental effects.[27] In a decision rejecting the use of cost or technological feasibility considerations in setting National Ambient Air Quality Standards, the United States Court of Appeals for the District of Columbia Circuit stressed that the objective of the Clean Air Act was "to err on the side of caution."[28] Even in the Supreme Court's *Benzene* decision, a setback for the Occupational Safety and Health Administration's effort to rely on the precautionary principle, the Court emphasized that risk assessment for hazardous substances "is free to use conservative assumptions in interpreting the data with respect to carcinogens, risking error on the side of overprotection rather than underprotection."[29]

Agencies administering environmental and public health laws have responded to these directions and have applied the precautionary principle in rulemaking. The cautionary statutory directions are probably unnecessary because precaution is induced by structural incentives within the bureaucracy itself.[30] For whatever reason, "agency estimates of health risks

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found in Clean Air Act, Clean Water Act, and Resource Conservation and Recovery Act).

25. *See* Mank, *supra* note 3, at 80 (1993) (reporting that "[s]tructural incentives within the Superfund process seem to encourage EPA to require more protective approaches: it is the PRPs that are supposed to pay, and the public generally chooses to err on the side of safety").

26. AARON WILDAVSKY, BUT IS IT TRUE? 8 (1995).

27. Ethyl Corp. v. EPA, 541 F.2d 1, 24-25 (D.C. Cir.), *cert. denied*, 426 U.S. 941 (1976).

28. Lead Indus. Ass'n v. EPA, 647 F.2d 1130, 1155 (D.C. Cir.), *cert. denied*, 449 U.S. 1042 (1980).

29. Industrial Union Dep't, AFL-CIO v. American Petroleum Inst., 448 U.S. 607, 656 (1980) (plurality opinion).

30. *See* Sam Kazman, *Deadly Overcaution: FDA's Drug Approval Process*, 1 J. REG. & SOC. COSTS 31, 36 (1990) [hereinafter Kazman, *Deadly Overcaution*] (observing that overcaution is "a problem that is inherent in the agency's political nature," because administrators are more likely to be sanctioned for false negative than false positive). Former FDA Commissioner Alexander Schmidt stated that throughout all of FDA's history he was "unable to find a single instance where a congressional committee investigated the failure of FDA to approve a new drug," while hearings to criticize such an approval were "so frequent that we aren't able to count them." *Id.* at 37. He concluded that the congressional pressure for disapproval was "intense." *Id.; see also* STEPHEN BREYER, BREAKING THE VICIOUS CIRCLE 41 (1993) (observing that "hearings are far more likely to mean criticism for leniency than for strictness"). A survey of "dozens of oversight hearings on health and safety" found that "all but four featured

tend to be worst-case or upper bound."[31] The Environmental Protection Agency (EPA) incorporates a number of conservative assumptions in its assessment of risks.[32] A recent survey referred to how "most regulatory attempts to standardize assessment methods have introduced several levels of conservatism because such assessments have, for the sake of public safety, been structured to over-estimate true risks" and cited ten recent scientific articles to this effect.[33] While risk assessments are commonly criticized as overly conservative, defenders of the prevailing assessment methods have risen to claim that the EPA's methods overstate risk by *only* seven times.[34] The D.C. Circuit recently took note of the EPA's "blanket, highly conservative assumptions" in regulation.[35]

When agencies extrapolate from animal tests in carcinogen risk assessments, they may overstate the true risk of human health by a factor of more than 100 and perhaps as much as infinity.[36] While much of the discussion

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criticisms that agencies had been too lax." R. Shep Melnick, *The Politics of Benefit-Cost Analysis, in* VALUING HEALTH RISKS, COSTS, AND BENEFITS FOR ENVIRONMENTAL DECISION MAKING 23, 32 (P. Brett Hammond & Rob Coppock eds., 1990). "One FDA official remarked that no one was going to blame him for slow approval of a beneficial drug, but he would be blamed for approving the next thalidomide." W. KIP VISCUSI, FATAL TRADE-OFFS 273 (1992). These incentives to caution are supplemented by the innate interest of agencies in enhancing their political power. *See* Sam Kazman, *Death by Regulation*, REGULATION, Fall 1991, at 18, 18 [hereinafter Kazman, *Death by Regulation*] (observing that government agencies will act to increase their influence "even when increased political power comes at the direct expense of the public safety the agency is charged with promoting").

31. DANIEL J. FIORINO, MAKING ENVIRONMENTAL POLICY 113 (1995).

32. *See* EPA Guidelines for Carcinogen Risk Assessment, 51 Fed. Reg. 33,992, 33,993-94 (1986) (discussing basis for EPA's guidelines for carcinogen risk assessment).

33. Dennis J. Paustenbach, *Retrospective on U.S. Health Risk Assessment: How Others Can Benefit*, 6 RISK 283, 287 & n.17 (1995).

34. Adam M. Finkel, *A Second Opinion on an Environmental Misdiagnosis: The Risky Prescriptions of* Breaking the Vicious Circle, 3 N.Y.U. ENVTL. L. REV. 295, 349 (1995). Finkel has been the leading legal respondent to the claim that risk assessment is overly conservative. *See, e.g.*, Adam M. Finkel, *Is Risk Assessment Really Too Conservative? Revising the Revisionists*, 14 COLUM. J. ENVTL. L. 427 (1989). A factor of seven is far less than the claims of a thousand-fold overestimation of risk, but a seven-fold overestimation is nonetheless quite significant.

35. Leather Indus. of Am., Inc. v. EPA, 40 F.3d 392, 403 (D.C. Cir. 1994).

36. Philip H. Abelson, *Commentary: Exaggerated Risks of Chemicals*, 48 J. CLINICAL EPIDEMIOLOGY 173, 175 (1995). Abelson, a former president of the National Academy of Sciences (NAS), catalogues many of the features that cause overestimation of risk, including the use of inbred animal subjects, the application of maximum tolerated doses, the assumption that rate and mode of administration do not matter, and the failure to consider pharmacokinetic differences among species. *Id.* at 174-77. Similar criticisms can be found in Dennis J. Paustenbach, *Health Risk Assessment: Opportunities and Pitfalls*, 14 COLUM. J.

of risk assessment's conservatism focuses on extrapolation from animal studies,[37] the most remarkable precaution often exists in exposure assessments. These may presume the existence of "naked, dirt-eating farmers" near waste sites[38] or children who consume remarkable quantities of dirt.[39]

When setting standards for Superfund cleanups, very conservative assumptions are common, driving remediation to extensive measures.[40] As is the case with regulatory actions, the EPA uses "far-fetched exposure scenarios" to increase the apparent risk.[41] The agency confesses that its carcinogen profiles for risk calculation provide "an upper bound estimate of cancer risks."[42] At one site, the government insisted that the ground "be sufficiently clean that a person could consume six teaspoonsful of its soil every year for 70 years without risk."[43]

ENVTL. L. 379 (1989). Stephen Breyer likewise noted that risk assessments "overstate risks by factors of a thousand or even a million or more." BREYER, *supra* note 30, at 47.

37. *See* OFFICE OF MANAGEMENT & BUDGET, REGULATORY PROGRAM OF THE UNITED STATES GOVERNMENT 14 (Apr. 1, 1990 - Mar. 31, 1991) (complaining of excessive conservatism in agency risk assessments and focusing on several conservative assumptions in conduct of animal bioassays and extrapolation of those studies to humans).

38. John S. Applegate, *A Beginning and Not an End in Itself: The Role of Risk Assessment in Environmental Decision-Making*, 63 U. CIN. L. REV. 1643, 1654 (1995). The exposure model used for risk assessment at a waste site near Cincinnati calculated the risk for a resident farmer who has full-body exposure to the soil plus some incidental consumption of soil. The author drolly notes that "such individuals are a rarity in southwestern Ohio," but explains that the assessment assumption was used "precisely because its conservatism provided a margin of safety." *Id.*

39. *See* BREYER, *supra* note 30, at 12 (referring to waste site where millions of dollars were spent to protect "non-existent dirt-eating children"). A recent risk assessment for municipal waste incinerators assumed that a "child could eat as much as about one small spoonful of dirt each day, that his house was down-wind of the stack, that he ate fish from a pond near the incinerator, that his fish consumption was at the 95th percentile level, that he drank contaminated water from the pond, that he ate food grown primarily from the family garden, and that he drank milk from a cow which grazed on forage at the farm." Paustenbach, *supra* note 33, at 310. The assessment also assumed that he did so for his entire seventy year life. *Id.*

40. The director of the Center for Disease Control's Center for Environmental Health blamed the EPA's "exaggerated risk models" for the costly and disruptive relocation of those living near the Superfund site at Times Beach, Missouri, though subsequent evidence demonstrated that little risk was present. WILDAVSKY, *supra* note 26, at 122.

41. *Id.* at 167; *see also id.* at 168 (quoting EPA assessment manual which directs assumption that "exposure occurs 24 hours per day for the entire period that contamination is present").

42. *Id.* at 170. A study of several cleanup actions found that "[i]n each instance this worst-case conception of risk guided EPA decisions about the degree of cleanup necessary." *Id.* at 184.

43. EASTERBROOK, *supra* note 4, at 603.

The concept of the precautionary principle has received very little criticism, perhaps because it is presented as a matter of simple common sense.[44] What criticism exists takes the principle's advocates to task for ignoring the monetary costs of environmental regulation. The critics thus object that the "flaw in such playing-it-safe is that it replaces environmental risk with risks to jobs and wealth, which environmentalists often loftily ignore."[45] The critics typically emphasize the financial costs attendant to embracing the precautionary principle.

While there is a measure of truth in the economic disapproval of reliance upon the precautionary principle, the criticism grounded in cost consideration is limited and rhetorically quite unpersuasive. The appealing underpinning of the precautionary principle is the belief that economic gain should not justify taking risks with public health and safety or general environmental welfare. Juxtaposed against human life and health, dollars seem relatively unimportant. Even the critics of the precautionary principle thus have allowed the debate to be framed in terms very favorable to the principle. As Wildavsky notes:

> The precautionary principle is a marvelous piece of rhetoric. It places the speaker on the side of the citizen — I am acting for your health — and portrays opponents of the contemplated ban or regulation as indifferent or hostile to the public's health. . . . The rhetoric seems to present a choice between health and money or even suggest health with no loss whatsoever, for a tangential presumption is that industry will find a better and a cheaper as well as safe way.[46]

Rhetorical appeal, however, is not the same as wisdom.

The precautionary principle can be attacked as an uncertain decision rule.[47] The truly fatal flaw of the precautionary principle, ignored by almost

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44. *See* Fullem, *supra* note 1, at 521 (reporting "inexorabl[e] link" between "[c]ommon sense and the precautionary principle"). This stands in contrast to science, which requires proof and "is not a common-sense activity." Milne, *supra* note 4.

45. *Environmentalism Runs Riot*, ECONOMIST, Aug. 8, 1992, at 11.

46. WILDAVSKY, *supra* note 26, at 428.

47. If uncertainty justifies regulation, there remains the question of how much regulation should ensue. The precautionary principle seems to call for the elimination of uncertainty, reducing any risk to zero. Yet a zero risk approach is both functionally impossible and practically disastrous. *See* FRANK B. CROSS, ENVIRONMENTALLY INDUCED CANCER AND THE LAW 70-73 (1989) (discussing how pursuit of zero risk is economically disastrous, physically impossible, and politically counterproductive). If the zero risk approach is not adopted, as it cannot be, the precautionary principle does not tell us how much uncertainty or risk should be allowed by a regulation. For this same reason, the approach cannot state that a given, uncertain risk rises to the level that would warrant regulation. Some of the adverse consequences of this effect are discussed below in Section II(A).

all the commentators, is the unsupported presumption that an action aimed at public health protection cannot possibly have negative effects on public health.[48] Yet these unanticipated adverse effects are demonstrably common, as illustrated below. Because the precautionary principle counsels for action against even those uncertain hazards that might be nonexistent, the presence of real adverse health effects consequent to that action means that the regulation will often cause more health harm than good.[49] H.W. Lewis refers to this as the "delusion of conservatism" and notes that efforts to strengthen the wings of commercial aircraft in the interest of safety would make the airplanes less safe, as they become heavier and less maneuverable.[50] The more that government strives to eliminate the last bit of potential risk, the greater the danger of adverse consequences: "[A]s we try to squeeze out more and more risk, the pressure leading to side effects may grow."[51]

This apparent incoherence does not render the precautionary principle practically meaningless, however. As a realistic matter, any environmental regulatory dispute will admit of a range of politically feasible outcomes. The true pragmatic importance of the precautionary principle is its use to argue for the most restrictive of the possible regulatory approaches.

48. *Id.* at 428 (noting that rhetoric of precautionary principle "assum[es] also that there are no health detriments from the proposed regulation").

49. *See* JOHN D. GRAHAM & JONATHAN B. WIENER, RISK VERSUS RISK: TRADE-OFFS IN PROTECTING HEALTH AND THE ENVIRONMENT (1995) (arguing that regulation under precautionary principle can do more harm than good). Graham and Wiener note that as we have "conquered many of the most obvious and easily preventable risks," future risk reduction efforts will have a greater tendency "toward countervailing risks." *Id.* at 12; *see also* Ronald Bailey, *Prologue*, *in* THE *TRUE* STATE OF THE PLANET 1, 5 (Ronald Bailey ed., 1995) (urging that "following the precautionary principle can lead to greater environmental degradation"). The remainder of this Article demonstrates how this counterintuitive claim is often true.

50. *See* H.W. LEWIS, TECHNOLOGICAL RISK 113 (1990) (discussing how overemphasis of strong airplane wings would make planes less safe rather than more). The airplane wings case is not an isolated, unrepresentative example. Lewis goes on to say that:

> Buildings that are rigidly enforced to have adequate strength to deal with earthquakes will fail where more flexible ones won't. . . . Excessive testing of vital emergency diesel generators at nuclear power plants, to assure their availability in time of need, is wearing them out. If the airlines didn't fly in bad weather, more people would drive, which is riskier. Reluctance to accept medical x-rays, for fear of radiation, can leave serious diseases undiagnosed. . . . If astronauts (another real case) are forced to practice for all conceivable emergencies, they will be less well prepared for those few that are more likely.

Id. at 116.

51. GRAHAM & WIENER, *supra* note 49, at 12. The authors also note that "as we address ever small target risks, the importance of countervailing risks *relative* to the target risks is likely to increase." *Id.*

Applied fully and logically, the precautionary principle would cannibalize itself and potentially obliterate all environmental regulation. Environmentalists would apply the principle to chemicals and industries, but why not apply it to the environmental regulations themselves? According to the burden of proof approach, advocates of regulation would be required to demonstrate to a certainty the absence of counterproductive effects on health resulting from the effects of the regulation itself. The practical consequences of regulation are so uncertain that advocates typically could not meet this burden, and the precautionary principle would preclude further regulation.

At this point, devotees of the precautionary principle surely will object to such use of the principle, claiming that we "know" adverse health effects from pollution are common, while adverse health effects from public health regulation are presumed to be rare.[52] This is a key factual claim that I will set out to disprove in the remainder of this Article. If it is true that environmental and public health regulations frequently produce health or other environmental harms, the basis for the precautionary principle collapses. In this case, the principle itself would counsel against adopting environmental regulations.

The first section of this Article reviews the physical risks attendant to environmental regulations. These risks may arise in a variety of ways. The three main sources of risk analyzed are the risks from alternatives to the controlled substance or practice, the health benefits foregone from the regulation of products or activities, and the risks created by the remediation measures themselves. The section provides a considerable number of examples demonstrating the prevalence of risk trade-offs that can render protective effects hazardous in themselves.

The second section considers indirect risks attendant to the precautionary principle, above and beyond the inescapable direct physical harms. First, the precautionary principle skews prioritization of government efforts to reduce risk. The consequence is less risk reduction than otherwise could occur. Moreover, the skewing of priorities will contribute to an unfair distribution of environmental risk, as in the case of "environmental racism." Second, the precautionary principle creates indirect health risks through its wealth effects. As noted above, the contrast of health and money has been employed to justify the precautionary principle, but adherents have overlooked the health benefits of income. A significant economic cost may result in significant health risks.

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52. *See* Frank B. Cross, *When Environmental Regulations Kill*, 22 ECOLOGY L.Q. 729, 730 (1995) (describing discussion of adverse consequences but noting that "most assumed that the counterproductive effects of regulation were rare").

The third section addresses an alternative to the precautionary principle. The principle is grounded in the limitations and uncertainties of scientific knowledge. While these limitations are undeniable, they do not call for an artificial decision rule that ignores the science, such as the precautionary principle. Rather, policymakers should confront the scientific uncertainty and act prudently in accord with the best possible scientific understanding. This approach may sometimes call for precaution, but only after considering the potentially substantial risks attendant to precaution.[53] The proposed policy might itself be considered a form of the precautionary principle, though in vastly expanded form, with better recognition of the full consequences of regulatory action.

I do not propose a wholly reactionary case for government doing nothing in support of public health and the environment. Public health policy is not a Newtonian world in which every action must produce an opposite and equal reaction. In reality, some government actions are "risk-superior" and improve overall health,[54] while other well-meaning actions actually make problems worse. I simply call for a thoughtful policy to distinguish between these situations. Present applications of the precautionary principle, however, make such distinctions impossible and promote even perverse policies.

I. Physical Risks of the Precautionary Principle

Much environmental law and regulation unfortunately reflects a rather one-dimensional deontological focus. Public and regulatory attention centers on a specific perceived problem (say, DDT) that is considered to cause some type of harm, often to public health. The common demand is to eliminate the problem, such as by banning the objectionable product. Seldom do the nonfinancial consequences of the prohibition receive much attention. Addressing these consequences would serve to complicate an otherwise simple and appealing political issue. Yet failure to attend to these consequences may render the action counterproductive, causing more health harm than good. This section considers the ways in which action may be counterproductive and catalogues a significant number of supporting cases.

The risks resulting from regulation are a manifestation of the law of unintended consequences, as expounded by Robert Merton, Reinhold Niebuhr, and many others. Well-meaning efforts to achieve some goal may have perverse side effects that actually undermine the goal. This risk is well-

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53. As Breyer observes, "regulators should investigate carefully in order to avoid actions that kill more people than they save." BREYER, *supra* note 30, at 65.

54. *See* GRAHAM & WIENER, *supra* note 49, at 3 (defining "risk-superior" alternative as one that involves "reducing overall risk rather than trading one kind of risk for another").

known in other fields, such as in medicine, where it is known as iatrogenesis or side effects, and in the military, where it is known as collateral damage. Consider the situation on a small island off Hawaii, historically used as a United States military chemical weapons repository. These weapons must now be destroyed under federal law. Incineration is the only available means of destruction, but environmental groups have frustrated efforts to incinerate the weapons due to the presence of some risk from airborne pollution. Avoidance of a small and uncertain risk from incinerator air pollution, however, has left literal time bombs on the island that "pose an imminent danger" from the leakage of chemical weapons or even from explosion.[55] In this case, the adverse consequences of *not* incinerating are rather obvious. The consequences of most protective government regulations are much less apparent, but they may nevertheless prove to be quite substantial, as this section will attempt to demonstrate.

A. Risks from Alternatives

In a free market, product sales and other commercial activities exist because of some market demand. A decision to ban the product or activity does not eliminate the demand for its uses. As a consequence, producers and consumers typically will shift from the banned or regulated entity to some alternative product or activity.[56] This shift plainly reveals the potential health risks of precaution. If the alternative activity is more hazardous than the original, the regulation will cause more harm than it cures. And efforts to regulate the alternative will only yield another alternative, which may or may not be preferable from a health standpoint. This scenario was played out in the case of artificial sweeteners.

A family of sweeteners called cyclamates was removed from the market in the late 1960s, when evidence arose regarding their potential carcinogenic-

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55. Stephen J. Driscoll, *Environmental Private Actions: Are Special Interest Groups Hobbling Comprehensive Programs Without "Standing" Themselves?*, 24 RUTGERS L.J. 469, 473-74 (1993) (summarizing chemical weapons problem). A similar example has arisen in the continental United States. Families in Anniston, Alabama have opposed government efforts to incinerate chemical weapons, out of fear of exposure to their children. Yet "thousands of drums" have been sitting at the local army depot, "gradually corroding." EASTERBROOK, *supra* note 4, at 620. The risk of leaks "from these old shells are far more likely than from the high-tech new incinerator." *Id.*

56. *See* Ralph L. Keeney, *Understanding Life-Threatening Risks*, 15 RISK ANALYSIS 627, 628 (1995) (observing that "elimination of any one alternative de facto means the selection of another, and any selected alternative will always have its risks"). This new source of risk is commonly ignored, as "people have a tendency to compare the active choice of an alternative to an unspecified alternative assumed to have zero risk." *Id.*

ity.[57] Saccharin rushed in to meet the market demand for artificial sweetening. The FDA then proposed to ban saccharin because of evidence of carcinogenicity. Congress, which overturned the ban, let saccharin off with a warning.[58] Saccharin was probably riskier than cyclamates.[59] The saccharin warning may have deterred some purchasers and encouraged consumers to shift to aspartame, which has its own health questions.[60] Moreover, any restriction on artificial sweeteners "may increase consumption of sugar, with attendant risks of weight gain in some consumers and particular risks for diabetics."[61]

The risk of alternatives is obvious in the case of regulating electric power generation.[62] Every large-scale source of electrical power presents

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57. *See* Cyclamate; Denial of Petition, 41 Fed. Reg. 43,754, 43,754-55 (1976). The ban was based on a study that "raised questions as to cyclamate's possible carcinogenicity." Frederick H. Degnan & W. Gary Flamm, *Living With and Reforming the Delaney Clause*, 50 FOOD DRUG COSM. L.J. 235, 240 (1995). The ban was sustained the following year because cyclamate's manufacturers could not establish the safety of the substance. *Id.* At the time, the "[FDA] Commissioner readily acknowledged that these [data] did not prove that cyclamate was a carcinogen." *Id.* This is a classic application of the precautionary principle. Some years later, the NAS reported that "cyclamate was not a carcinogen." *Id.*

58. The FDA's proposed ban on saccharin was based in part on the Delaney Clause. *See* Food Additives Permitted in Food for Human Consumption or in Contact With Food on an Interim Basis Pending Additional Study: Saccharin and Its Salts, 42 Fed. Reg. 1461, 1461-62 (1977) (discussing basis for general ban on saccharine). A considerable public outcry ensued. *See* Richard Cooper, *Saccharin — Of Risk and Democracy*, 40 FOOD DRUG COSM. L.J. 34 (1985) (summarizing public complaints about removing saccharin from market). Congress responded with the Saccharin Study and Labeling Act, Pub. L. No. 95-203, 91 Stat. 1452 (1977) (amended 1980, 1981, and 1983), which placed a moratorium on any ban of saccharin and provided for labeling about the risk. *See generally* William B. Schultz, *The Bitter Aftertaste of Saccharin*, 40 FOOD DRUG COSM. L.J. 66 (1985) (summarizing reasons for and reviewing nature of congressional intervention).

59. *See* PETER ASCH, CONSUMER SAFETY REGULATION 119 (1988) (suggesting that "the cyclamate ban, by contributing to increased saccharin consumption, may have had a net carcinogenic effect"); Paulette L. Stenzel, *Right-to-Know Provisions of California's Proposition 65: The Naivete of the Delaney Clause Revisited*, 15 HARV. ENVTL. L. REV. 493, 519 (1991) (stating that "strong evidence shows that saccharin has a higher carcinogenic potential than cyclamates"); Edward W. Warren & Gary E. Marchant, *"More Good than Harm": A First Principle for Environmental Agencies and Reviewing Courts*, 20 ECOLOGY L.Q. 379, 389 (1993) (reporting that "the banning of cyclamates resulted in greater use of saccharin, which scientists now believe to be a more potent carcinogen than cyclamates").

60. *See* LEWIS, *supra* note 50, at 152 (noting that aspartame had "health hazards of its own but no known evidence of carcinogenicity").

61. GRAHAM & WIENER, *supra* note 49, at 14.

62. *See* Clayton P. Gillette & James E. Krier, *Risk, Courts, and Agencies*, 138 U. PA. L. REV. 1027, 1032 (1990) (reporting that "conventional centralized power plants are

some risks to human health. Coal-fired generation is a source of air pollution that presents a direct risk to human health, and the carbon dioxide it produces contributes to global warming. The mining and shipping of coal also entails material risks to health. Other fossil fuels are cleaner but produce their own air pollution from combustion by-products. Nuclear power has well-known risks that include the possibility of reactor accidents and the problems of nuclear waste disposal.

Given the omnipresence of risk, the precautionary principle tells us little about the preferred source of power. The precautionary principle is not employed so comprehensively, however, but typically arises in the context of a specific regulation of a particular power source. Thus, the precautionary principle will be invoked in Nuclear Regulatory Commission regulatory attention to nuclear power plant risks. Advocates will argue that stricter rules are necessary, given the importance of safety and uncertainty of risk. They will not consider the possibility that stricter rules may cause power generators to shift to some other source of power, such as fossil fuel combustion, and the precautionary principle will not be applied with respect to the consequent risks of fossil fuels.

The trade-offs among power sources will occur, however, even if they are not recognized by regulators and interest groups. When protests prevented the construction of a nuclear power plant at Shoreham, New York, the Long Island Lighting Company replaced the lost power with fossil fuel-fired generation.[63] Power not generated by one source must come from another, and the alternative source inevitably carries its own risks. Some might argue that the answer is a reduction in power consumption, yet conservation carries its own risks, as discussed below.[64]

If a public health regulation of nuclear power causes a shift to fossil fuels, the health cost may be considerable. The first rigorous comparison of health risks from electric power production was performed by Herbert Inhaber for the Canadian Atomic Energy Control Board.[65] He estimated that the mortality from a single coal-fired plant could range from 50 to 1600 deaths, but that a nuclear power plant might be expected to cause only 2.5

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probably safer than wood stoves, perhaps safer than alternative decentralized power sources (such as solar), perhaps safer, even, than energy conservation (insulation is not free of danger) — with nuclear power the least risky of all in the view of a considerable number of experts").

63. Peter Passell, *The American Sense of Peril: A Stifling Cost of Modern Life*, N.Y. TIMES, May 8, 1989, at D12.

64. *See infra* notes 78-82 and accompanying text (discussing health risks generated by some conservation efforts).

65. HERBERT INHABER, ENERGY RISK ASSESSMENT (1982).

to 15 deaths.[66] Hence, causing a shift from a nuclear plant to a coal plant would cause at least three times more mortality, and possibly thousands more deaths. Inhaber was followed by a study by J.H. Fremlin, who calculated that oil and coal power generation would cause over fifty deaths for each power unit of ten gigawatt-years, while natural gas and nuclear power would cause less than one.[67] One scientist argued that "every time a coal burning plant is built instead of a nuclear plant, something like 1000 extra Americans are condemned to an early death."[68]

These studies were criticized as being unduly favorable to nuclear power, and the authors had an open connection with the nuclear industry. The less challengeable National Academy of Sciences (NAS) performed its own study and came to comparable conclusions. According to the NAS, a single coal plant could be expected to cause from five to fifty-five deaths, while a nuclear power plant of comparable size would cause less than one.[69] The most recent major study was performed by the Pace University Center for Environmental Legal Studies and led by former Democratic Congressman Richard Ottinger.[70] Rather than simply comparing deaths, the Pace study sought to quantify economically all the environmental costs of power production, including losses associated with climate change. The costs varied by type of plant, but for existing coal plants the cost was more than twice that of a nuclear plant, and oil-fired generation was no better.[71] Moreover, the Pace study was rigged against nuclear power. While the environmental costs of fossil fuel production were limited to air pollution, excluding occupational and transportation accidents, the Pace study included occupational mortality in its estimates of nuclear costs.[72] The costs for nuclear power were also

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66. *Id.* at 352. Oil plants were nearly as bad as coal generation, causing 20 to 1400 deaths. Natural gas, by contrast, was the safest of all, producing only one to four expected deaths. *Id.*

67. J.H. FREMLIN, POWER PRODUCTION: WHAT ARE THE RISKS? 198 (1989).

68. Bernard L. Cohen, *Perspectives on the Cost Effectiveness of Life Saving*, *in* RATIONAL READINGS ON ENVIRONMENTAL CONCERNS 461, 467 (Jay Lehr ed., 1992).

69. Christoph Hohenemser et al., *Nuclear Power*, *in* PERILOUS PROGRESS: MANAGING THE HAZARDS OF TECHNOLOGY 219, 222-23 (Robert W. Kates et al. eds., 1984).

70. PACE UNIV. CTR. FOR ENVTL. LEGAL STUDIES, ENVIRONMENTAL COSTS OF ELECTRICITY (1991).

71. Costs per kilowatt-hour for existing coal plants were 6.8 cents, though other forms of coal generation ranged from 2.8 to 4.5 cents. *Id.* at 31. Oil externality costs ranged from 3 to 7.9 cents per kilowatt-hour. *Id.* at 32. Nuclear power plant costs were 2.91 cents per kilowatt-hour. *Id.* at 34.

72. *Compare id.* at 371 (estimate for coal units, which considers only airborne emissions of four pollutants) *with id.* at 371-75 (estimate for nuclear units including occupational health costs).

inflated by the questionable judgment of using the Soviet Chernobyl accident to extrapolate U.S. costs, but Pace did not even consider the consequences of accidents at fossil fuel plants.[73]

The risk of harm from obstructing nuclear power is even more striking when one considers specific types of harms. For example, many fail to appreciate that the routine radioactive emissions associated with coal and oil plants are *higher* than those allowed from equivalent nuclear reactors.[74] Long-lived nuclear wastes are particularly feared by the public, but one study found that the wastes produced by coal burning, or even solar power, presented a much greater public health threat than the wastes from a nuclear power plant.[75] Americans likewise fear a nuclear accident but may be unaware that:

> [T]he likelihood of a severe accident leading to a given number of acute fatalities per unit of electricity produced is around 3 orders of magnitude higher in the case of fossil fuel energy cycles than in that of the nuclear cycle based on the type of light water reactors in operation in the western world.[76]

The accident at the Three Mile Island reactor was hyped extensively in the media, but studies after the accident found that those living near the plant actually suffered fewer cancer deaths than would be expected.[77]

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73. *Id.* at 378-84 (discussing nuclear accidents based on Chernobyl). The Pace Center for Environmental Legal Studies concedes that the extrapolation is "somewhat speculative." *Id.* at 381.

74. *See* Hohenemser et al., *supra* note 69, at 220 (coal); CROSS, *supra* note 47, at 30 (coal); EASTERBROOK, *supra* note 4, at 494 (oil). This effect occurs because the fossil fuels contain radioactive particles that are released when burned.

75. Bernard L. Cohen, *Risk Analyses of Buried Wastes from Electricity Generation, in* THE RISK ASSESSMENT OF ENVIRONMENTAL AND HUMAN HEALTH HAZARDS: A TEXTBOOK OF CASE STUDIES 561, 573 (Dennis J. Paustenbach ed., 1989) [hereinafter THE RISK ASSESSMENT OF ENVIRONMENTAL AND HUMAN HEALTH HAZARDS]. The construction of photovoltaic cells "requires toxic materials from cadmium to hydrofluoric acid," which, "together with the large maintenance problem involved in keeping the collectors, mirrors, lenses, and solar cells free from dust, greasy films, and snow, combines to make solar power one of the least safe ways to generate electricity." DIXY L. RAY & LOU GUZZO, TRASHING THE PLANET 130-31 (1990). In addition to the Cohen study above, this conclusion was also reached by Samuel McCracken. SAMUEL MCCRACKEN, THE WAR AGAINST THE ATOM 86-87 (1982). Most of these risks would be suffered by workers rather than the general population. *See* Deroy Murdock, *Eco-Dilemmas: How "Green" Policies Hurt Mother Nature*, 7 ETHNIC NEWSWATCH, Oct. 31, 1995, at 27 (reporting how solar and wind power destroy considerable number of natural habitats and how solar power produces toxic pollution).

76. Andrew Fritzsche, *Severe Accidents: Can They Occur Only in the Nuclear Production of Electricity?*, 12 RISK ANALYSIS 327, 329 (1992).

77. MELVIN A. BENARDE, OUR PRECARIOUS HABITAT 365 (1989).

The best data appear to indicate that nuclear power is distinctly safer than fossil fuel power generation, but the case against the precautionary principle need not rely upon this factual finding. Rather, the case requires only the obvious conclusion that some sources are relatively riskier than others. Perhaps nuclear power is more hazardous than coal power. If so, applying the precautionary principle when regulating coal generation could increase the overall risks through a shift to nuclear power. The precautionary principle is a poor guide to regulation when hazardous alternatives may exist.

Those in favor of regulation may seek an escape hatch in the form of energy conservation, which might be considered consistent with the precautionary principle. The typical answer to this contention is that conservation can only reduce, not eliminate, the need for power plants. The remaining power plants should be as safe as possible. A more compelling answer is typically overlooked — energy conservation measures may cause death at a rate exceeding that of hazardous power sources.

The most significant source of energy conservation, particularly for electricity, has been the weatherization programs that prevent the loss of heating or cooling through building insulation. The beneficial retention of heat is accompanied by the retention of all forms of indoor pollutants. A build up in indoor radon consequent to weatherization has been implicated in as many as twenty thousand cancer deaths each year.[78] Weatherization also furthers the concentration of volatile organic compounds, particulates, and other pollutants. Because indoor levels of these substances are typically higher than outdoor levels, conservation may well cause more deaths than the outdoor pollution from oil or coal burning.[79] Even an apparently benign maneuver, such as planting shade trees to reduce air conditioning use, will increase the growth of mold spores that cause considerable incidence of disease.[80] The Pace study found that a shift to more efficient appliances could increase emissions of chlorofluorocarbons,[81] and efforts to shift electricity usage to off-peak hours could have the practical effect of increasing air pollution.[82] Not all conservation measures are themselves deadly, but the above catalogue of risks instructs that such measures are not inevitably safe either. A shift to greater conservation could increase mortality and morbidity.

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78. FRANK B. CROSS, LEGAL RESPONSES TO INDOOR AIR POLLUTION 6 (1990).
79. *Id.* at 51-60.
80. *Id.* at 62.
81. *See* PACE UNIV. CTR. FOR ENVTL. LEGAL STUDIES, *supra* note 70, at 491-98.
82. *Id.* at 499-505.

For a time, environmentalists argued that we should "split wood, not atoms." They contended that returning to more traditional energy sources, such as woodburning, would be a safe replacement for electrical power. In fact, a major shift to personal woodburning for home fuel could have been an environmental catastrophe. The quantity of wood required for a broad scale replacement of electricity could have denuded our nation's forests, with attendant harms to a variety of species. More significantly, the burning of wood is very hazardous to human health. When some began to shift to woodburning, the EPA had to set air pollution standards for woodstoves, which had become the source of fifteen percent of airborne particulates, including serious carcinogens.[83] Furthermore, woodstoves became a major source of accidents, causing home fires and hundreds of deaths each year.[84] Some environmentalists applied the precautionary principle to large, centralized power plants and correspondingly favored a shift to an old-fashioned, traditional form of heating, which happened to be far more hazardous than the large power plants.

The consequences of error resulting from an unwise selection of power sources due to the precautionary principle is magnified many times over in poorer nations. Many residents of these nations lack electricity and rely upon wood or dung fires for home fuel. These sources produce considerable outdoor smoke and a literally choking level of indoor air pollution. Residents of these nations breathe in air pollution levels more than ten times those found in the United States.[85] The World Bank estimates that this indoor air pollution kills four *million* children every year from acute respiratory disease.[86] In addition, half of all adult women in developing countries

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83. *See* EPA Standards of Performance for New Stationary Sources; New Residential Wood Heaters, 53 Fed. Reg. 5860, 5860-926 (1988) (codified at 40 C.F.R. pt. 60 (1996)); *see also* EASTERBROOK, *supra* note 4, at 581 (pointing out that "highest airborne particulate pollution reading ever recorded in the United States came not in Cleveland or Pittsburgh but in the trendy community of Klamath Falls, Oregon, where the elite heat with wood to be natural").

84. ROSS E. CHEIT, SETTING SAFETY STANDARDS: REGULATION IN THE PUBLIC AND PRIVATE SECTORS 82 (1990).

85. Gregg Easterbrook, *Forget PCBs. Radon. Alar.*, N.Y. TIMES, Sept. 11, 1994, (Magazine), at 62. Indoor particulate concentrations measured in New Guinea, Kenya, India, and Nepal were as much as 50 times higher than the U.S. standard for ambient exposures. *See* David C. Christiani, *Urban and Transboundary Air Pollution: Human Health Consequences*, *in* CRITICAL CONDITION: HUMAN HEALTH AND THE ENVIRONMENT 13, 19 (Eric Chivian et al. eds., 1993).

86. THE WORLD BANK, WORLD DEVELOPMENT REPORT 1992: DEVELOPMENT AND THE ENVIRONMENT 52; *see also* EASTERBROOK, *supra* note 4, at 314 (suggesting that "three million Third World children died preventable deaths in 1991 from acute respiratory distress

suffer from chronic heart or lung diseases due to the pollution from biomass burning.[87]

The indoor air pollution abattoir affecting poor countries could be ameliorated through the development of large power plants or hydroelectric dams that produce electricity to replace indoor burning. Tragically, "Western environmental lobbies oppose nearly all new central energy production facilities for the developing world, especially hydroelectric plants."[88] The precautionary concern for habitats or the health consequences of power plants translates into a mortal enormity for the poor children of developing nations. The wood burning obviously contributes to serious deforestation problems in these nations as well. Perpetuation of traditional sources of fuel in poorer nations causes more deaths and obstructs economic progress.[89]

Another source of risk from alternatives exists in pesticide regulation. After Rachel Carson's warning, the public grew concerned about the environmental and health effects of DDT and other long-lasting pesticides. The public concern eventually translated into government action, which forced the category of organochloride pesticides off the market. This group of pesticides was replaced by those in the organophosphate family, such as malathion, diazinon, and dichlorvos.

Carson and others criticized organochlorides for being environmentally long-lasting, and the organophosphates did have a shorter active life. However, the organophosphates are more acutely toxic in their short life, and are even related to forms of nerve gas. The switch had the effect of transforming a highly uncertain, long run risk from organochlorines into a more certain, immediate, and significant risk of toxicity from the organophosphates.[90] This risk is felt primarily by the farmworkers involved in the

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brought on by living in unventilated huts where heating and cooking was done with wood or even dung, causing smoke damage to the lungs"). These deaths could have been avoided with greater electrification. *Id.*

87. THE WORLD BANK, WORLD DEVELOPMENT REPORT 1993: INVESTING IN HEALTH 92.

88. Easterbrook, *supra* note 85, at 62; *see also* EASTERBROOK, *supra* note 4, at 583 (observing that "[w]hile the Western environmental community shows little interest in such issues as dung-smoke pollution, it is devoting intense energies to stopping developing-world hydroelectricity").

89. A recent study shows how societal advancement to more centralized, higher grades of energy resources is closely linked with economic growth. Douglas B. Reynolds, *Energy Grades and Economic Growth*, 19 J. ENERGY DEV. 245 (1996).

90. *See* WILDAVSKY, *supra* note 26, at 58 (noting that "organophosphate insecticides, such as the parathions, . . . are hundreds of times more toxic to man than DDT").

application of the pesticides,[91] although children are also at risk.[92] The shift to organophosphates "caused incidents of serious poisoning among unsuspecting workers and farmers who had been accustomed to handling the relatively nontoxic DDT."[93] While deaths and injuries in most jobs have decreased over the years, the number of accidental pesticide poisonings increased by fourteen percent over the decade following the DDT ban.[94] The President of NAS reproached the public by declaring that the "predicted death or blinding by parathion of dozens of Americans last summer must rest on the consciences of every car owner whose bumper sticker urged a total ban on DDT."[95] To employ the anecdotal approach common to antipesticide campaigns, consider the case of Clarence Lee Boyette. He was informed that use of DDT to control a worm infestation on his tobacco crop would preclude his receiving government price supports; he therefore used a brand of parathion, which subsequently killed his youngest son.[96] The prohibition of DDT also had some adverse consequences to the environment.[97]

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91. *See, e.g.*, Stephen Ciesielski, *Pesticide Risk Assessment and Reduction Among Migrant Farmworkers in North Carolina*, 106 PUB. HEALTH REP. 207 (1991) (reporting that "[m]ost of the pesticides used in agriculture . . . are organophosphates applied to crops picked by migrant farmworkers"). The organophosphate pesticides can affect the nervous system, causing "breathing impairment, blurred vision" and "a variety of neurologic and cognitive deficits." *Id.*

92. *See, e.g.*, Robert J. Ziener & Charles M. Ginsburg, *Organophosphate and Carbamate Poisoning in Infants and Children*, 81 PEDIATRICS 121 (1988).

93. GRAHAM & WIENER, *supra* note 49, at 174.

94. Harlan Austin et al., *A Prospective Follow Up Study of Cancer Mortality in Relation to Serum DDT*, 79 AM. J. PUB. HEALTH 43 (1989); *see also* WILDAVSKY, *supra* note 26, at 73 ("As DDT was phased out and organophosphates were used more, mortalities increased sharply. In 1972 estimates of the number of deaths jumped to 118 for the first half of the year alone."). The failure to consider the risks of DDT replacements "cost several hundred lives." *Id.* at 80.

95. RICHARD L. STROUP & JOHN C. GOODMAN, MAKING THE WORLD LESS SAFE: THE UNHEALTHY TREND IN HEALTH, SAFETY, AND ENVIRONMENTAL REGULATION 4 (1989) (quoting President of NAS reproaching those who supported ban of DDT); *see also* GRAHAM & WIENER, *supra* note 49, at 189 (reporting that "beneficiaries of reduced residue and persistence — consumers and wildlife — may be enjoying the benefits of a risk transfer to farm workers").

96. WILDAVSKY, *supra* note 26, at 72.

97. *See id.* at 58 (discussing adverse environmental effects of DDT ban). Wildavsky reports that shortly after the banning of DDT, tussock moths invaded and began killing Douglas firs in the Northwest to such a degree that the EPA had to temporarily permit the use of DDT on infested forests in Washington, Oregon, Idaho, and Montana. In addition, the use of DDT substitutes wiped out 83,000 California bee hives. RITA GRAY BEATTY, THE DDT MYTH: TRIUMPH OF THE AMATEURS 130 (1973). The banning of DDT may have

Environmental laws often shift risks to workers. The constituency for most environmental action consists of relatively well-to-do white collar workers who show relatively little concern for occupational risks in blue-collar jobs.[98] There is a general tendency that "reducing public risk often means creating occupational risk" as exposures are shifted.[99] This shift may be an inevitable consequence of regulation, politically if not physically.[100] Existing patterns of precaution exert a systematic push of risks toward disadvantaged groups in society.[101] Even organic farmers use sulfur and other "natural" pesticides that are the source of "many worker poisonings."[102]

Many environmentalists recognize the risk of alternative pesticides and therefore advocate the avoidance of pesticides altogether, much like they seek energy conservation as a substitute for electric power production.[103] The typical response to calls for pesticide elimination is practical and financial — growers argue that eliminating pesticides would have serious adverse effects on the availability and price of food.[104] This is true, as

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helped bird species, but even here the evidence is quite uncertain. WILDAVSKY, *supra* note 26, at 65-67 (suggesting that DDT may have caused decline in bird populations but extent is unknown).

98. Environmental policy tends to focus on the perceived problems of the affluent. In consequence, "economically and politically oppressed groups in this country [have seen] environmental reforms being used to direct social and economic resources away from problems of the poor toward priorities of the affluent." ROBERT D. BULLARD, DUMPING IN DIXIE: RACE, CLASS AND ENVIRONMENTAL QUALITY 137 (1989).

99. Chris Whipple, *Nonpessimistic Risk Assessment and De Minimis Risk as Risk Management Tools*, *in* THE RISK ASSESSMENT OF ENVIRONMENTAL AND HUMAN HEALTH HAZARDS, *supra* note 75, at 1105, 1109. The author cites an example of how controls on radioactive effluents in power plants significantly increased radiation exposure of workers. *Id.* In another example, "EPA standards on grain dust emissions caused several major grain elevator explosions." Cross, *supra* note 8, at 943.

100. *See* Keeney, *supra* note 56, at 629 (observing that "selection of an alternative leads to a redistribution of risks not to zero risk").

101. *See, e.g.*, Cross, *supra* note 8, at 925-26.

102. HARVARD CTR. FOR RISK ANALYSIS, RISK IN PERSPECTIVE, March 1995, at 1; *see* Leonard P. Gianessi, *Use of Pesticides in the United States*, *in* PESTICIDE RESIDUES AND FOOD SAFETY 24, 28 (B.G. Tweedy et al. eds., 1991) (observing that organic growers use pesticides such as sulfur).

103. The practicality of this approach is open to question. For many fruits and vegetables, there is no good alternative to synthetic pesticides. While progress is being made in genetic engineering, "these new varieties will probably lower rather than eliminate the need for pesticides." NATIONAL ACADEMY OF SCIENCES, REGULATING PESTICIDES IN FOOD 9 (1987).

104. *See, e.g.*, Julie Corliss, *The Delaney Clause: Too Much of a Good Thing?*, 85 J. NAT'L CANCER INST. 600, 601 (1993) (citing position of Professor Manfred Kroger that "the

discussed below,[105] but an even more compelling, direct rejoinder would note that the abolition of synthetic pesticides could increase the risk to human health.

Chemical pesticides supplant or counteract natural carcinogens that may be far more deadly than the synthetics. Stephen Breyer observed that "a regulator does not, or cannot easily, take account of offsetting consumer behavior as, for example, when a farmer, deprived of his small-cancer-risk artificial pesticide, grows a new, hardier crop variety that contains more 'natural' pesticides which may be equally or more carcinogenic."[106] Efforts to breed a pest-free potato yielded a tuber so full of natural pesticides that it was acutely poisonous to humans,[107] and efforts to create a naturally insect-resistant form of celery, averting the need for synthetic pesticides, produced a plant with eight times more psoralens, a naturally occurring carcinogen.[108] In general, attempts to restrict "the use of potentially toxic synthetic chemical pesticides may induce farmers to use plants bred to harbor pest-resistant properties; the plants' pesticides may be more toxic than the regulated synthetic pesticides."[109] In "the absence of protective fungicides, plants in self-defense create phytoalexins, some of which are toxic to humans and induce carcinomas in rodents."[110]

To some, the concept of natural pesticides or carcinogens seems discordant; they presume that it is artificial petrochemicals that are risky.[111] Scientific research, however, has demonstrated that many natural substances

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benefits of pesticides, which help ensure widely available and affordable fruits and vegetables, justify their use").

105. *See infra* notes 197-202 and accompanying text (discussing estimated price increases for beneficial fruits and vegetables if pesticides were banned).

106. BREYER, *supra* note 30, at 23 (1994).

107. MICHAEL FUMENTO, SCIENCE UNDER SIEGE: BALANCING TECHNOLOGY AND THE ENVIRONMENT 66 (1993).

108. Jane Brody, *Strong Views on Origins of Cancer*, N.Y. TIMES, July 5, 1995, at B9; *see also* FUMENTO, *supra* note 107, at 66.

109. GRAHAM & WIENER, *supra* note 49, at 16. The authors cite the example of cassava root, as well as the celery and potato cases already mentioned. *See also* C. Robert Taylor, Economic Impacts and Environmental and Food Safety Trade-Offs of Pesticide Use Reduction on Fruits and Vegetables 18 (1995) (unpublished research paper, Auburn Dep't of Agric. Econ. and Rural Soc.) (suggesting that "there would be adverse indirect food safety consequences of severely restricting or banning pesticide use in terms of increased contamination by fungal products and by phytoalexins created in self-defense by plants").

110. Philip H. Abelson, *Adequate Supplies of Fruits and Vegetables*, 266 SCIENCE 1303, 1303 (Nov. 25, 1994).

111. *See* Tesh, *supra* note 13, at 11 (observing that "[e]nvironmentalism . . . assigns political significance only to pollution resulting from human activity").

cause cancer and are far more prevalent and deadly than are the synthetic pesticides. This should not be too surprising — arsenic, for example, is a natural constituent in plants.[112] Dr. Bruce Ames of the University of California has found that Americans consume about ten thousand times the load of natural pesticides as they do of those that are man-made.[113] The quantity of natural carcinogens in a single cup of coffee is roughly "equivalent to the total amount of pesticide residues an average person would take into his or her body in a year."[114] Existing natural carcinogens may be unavoidable and unregulatable, but that fact does not make a case for substituting natural carcinogens for synthetic pesticides. Pesticides may reduce natural carcinogen exposure. Ames, a widely respected biochemist and molecular biologist, has flatly stated that "pesticides lower the cancer rate."[115] When daminozide (trade named Alar) was prohibited after a great public outcry, the result was an increase in public exposure to the higher

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112. *See* EASTERBROOK, *supra* note 4, at 83. Tobacco contains nicotine because that substance kills or deters insects and animals that otherwise might feed on tobacco leaves. *Id.*

113. Bruce Ames et al., *Ranking Possible Carcinogenic Hazards*, 236 SCIENCE 271, 272 (Apr. 17, 1987). These natural carcinogens are "virtually everywhere" and found "in almost all fruits and vegetables, including apples, bananas, broccoli, brussels sprouts, cabbage, mushrooms, and oranges." WILDAVSKY, *supra* note 26, at 60. Not only are natural carcinogens present, they are comparably hazardous. *See* BENARDE, *supra* note 77, at 71 (noting that "few synthetic chemicals equal the potency and human toxicity of naturally occurring products"). Easterbrook writes that:

> All-natural bread would be listed as containing formaldehyde, the ultimate preservative. All-natural peanut butter would be listed as containing aflatoxins, a family of potent fungal poisons. All-natural apple juice would be listed as containing as many as 137 natural "volatiles," organic compounds that are primary ingredients in urban smog; three are known rodent carcinogens. Various foods ingested daily would be listed as containing on a purely natural basis arsenic, heterocyclic amines (a rodent carcinogen group), lead, and other scrumptious stuff . . . when given to lab animals, vitamin A appears powerfully carcinogenic.

EASTERBROOK, *supra* note 4, at 116.

114. WILDAVSKY, *supra* note 26, at 266. This is not to suggest that coffee is highly dangerous because it is not. The comparison simply demonstrates how low the risk is from synthetic pesticides and the potential increase caused by a switch to natural pesticides. "As for the idea that the human body copes well with natural carcinogens but badly with synthetics, there is no supporting evidence. The body is a non-discriminatory equal opportunity ingestor to which a chemical is a chemical is a chemical." *Id.* We have not had enough generations for human evolution to establish an immunity to natural substances. This is obvious from the continued carcinogenic effect of a substance such as radiation, which is natural and to which humans have been exposed for their entire history.

115. Brody, *supra* note 108, at B5 (quoting Dr. Bruce Ames).

carcinogenic risk of mycotoxins in molds on apples.[116] Given the very small exposure to man-made pesticides,[117] the chance of worsening risks through their prohibition is apparent. The levels of natural carcinogens "may increase dramatically in plants damaged by insects or fungi."[118]

The perverse effect of the precautionary principle can be more specifically illustrated by reference to ethylene dibromide (EDB). EDB was used primarily to control the development of molds on grain and other foods. Concern over the potential carcinogenic risk of EDB led to a public scare over "killer muffins," and the government therefore banned the fungicide. As it happens, "EDB is the safest known way to combat molds, which produce some of the most potent carcinogens in all of nature."[119] One of these molds, aflatoxin, is estimated to be one thousand times more carcinogenic than EDB.[120] The EPA never considered the trade-off of risk, and "it

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116. *See* Bruce N. Ames & Lois S. Gold, *Environmental Pollution and Cancer: Some Misconceptions*, *in* RATIONAL READINGS ON ENVIRONMENTAL CONCERNS, *supra* note 68, at 165 (observing that "[s]ince Alar produces healthier apples that stay on the trees, Alar-treated fruit is less susceptible to molds"); Joseph D. Rosen, *Much Ado About Alar*, ISSUES SCI. & TECH., Fall 1990, at 89 (stressing that organic apples may "contain high levels of carcinogenic mycotoxins").

In addition, Alar's strengthening of the fruit's bond with the tree protected the apples from insect pests, and the prohibition on Alar required greater use of "much harsher insecticides." Warren T. Brookes, *The Wasteful Pursuit of Zero Risk*, FORBES, Apr. 30, 1990, at 162; *see also* WILDAVSKY, *supra* note 26, at 220 (reporting that without Alar's prevention of fruit drop, apples have to be treated against ground pests, so that ban on daminozide "may undermine efforts to decrease the total use of chemicals"); WALLACE KAUFMAN, NO TURNING BACK 80 (1994) (stating that elimination of Alar required 70 percent increase in use of other, harsher pesticides); Gianessi, *supra* note 102, at 29 (observing that Alar was crucial to Integrated Pest Management programs so that banning Alar caused unquantified increase in use of other pesticides).

117. Even with existing pesticide applications, a majority of foods have no residues. *See* Pasquale Lombardo & Norma J. Yess, *The Food and Drug Administration Program on Pesticide Residues in Food*, *in* PESTICIDE RESIDUES AND FOOD SAFETY, *supra* note 102, at 162, 165 (noting that 58% of samples had no residues). Indeed, "dietary intakes of pesticides are usually less than 1% of the Acceptable Daily Intakes (ADIs) established by the United Nations' Food and Agriculture Organization and the World Health Organization." *Id.* at 166. A study of average dietary residue levels for a pesticide used on many crops (chlorothalonil) found that the average residues were less than 0.2% of the already protective tolerance level set by government. Gary L. Eilrich, *Tracking the Fate of Residues from the Farm Gate to the Table*, *in* PESTICIDE RESIDUES AND FOOD SAFETY, *supra* note 102, at 202, 211.

118. Fred R. Shank et al., *Evolving Food Safety*, *in* PESTICIDE RESIDUES AND FOOD SAFETY, *supra* note 102, at 297, 299-300.

119. STROUP & GOODMAN, *supra* note 95, at 2.

120. Richard Wilson, *Summary and Analysis*, 16 ENVTL. L. REP. 10,226 (1986); *see also* GRAHAM & WIENER, *supra* note 49, at 13 (noting that "ban on the fungicide EDB

is quite possible that the public was exposed to a much higher risk through aflatoxin than EDB would have presented."[121] There were alternative pesticides to protect against the molds, but the banning of EDB caused a shift to fungicides that required greater quantities in application, greater worker exposure, and greater hazard to those exposed workers.[122] The EDB ban was "based on overblown fears of consumer carcinogenicity and an underestimate of the risks to pesticide applicators who would be forced to use more carcinogenic substitutes."[123]

While electric power production and pesticides offer the best documented examples of risks from alternatives to banned or regulated products, the principle has broader application. One manner in which the general principle operates is in the retention of old risks, rather than exposure to new risks. The precautionary principle tends to be primarily applied to new sources of risk because we have been accustomed to living with old risks and are therefore less threatened by them. This conservative approach to new risks, however, almost certainly increases the overall harm to public health.

The prohibition or restriction of a new facility through the precautionary principle has the effect of perpetuating reliance on old facilities. This is counterproductive because new products and facilities are almost universally safer than existing ones. There is "hardly a product in use today — a car, plane, boiler, municipal water system, drug, vaccine or hypodermic syringe — that is not many times safer than its counterpart of a generation or even a decade ago."[124] The history of energy production shows that "[n]ew technologies that entered the marketplace substantially increased the efficiency of all types of combustion equipment, reducing the amount of

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removed its cancer risk, but in turn may have left on grains and nuts a fungus that promotes aflatoxins more carcinogenic than the fungicide").

121. GRAHAM & WIENER, *supra* note 49, at 187; *see also* BREYER, *supra* note 30, at 17 (noting that ban on EDB "could lead farmers to switch to other, more dangerous fumigants instead, or lead them to fumigate their crops less well, leaving more mold residues, which bring with them an increased cancer risk from aflatoxin").

122. AARON WILDAVSKY, SEARCHING FOR SAFETY 202 (1988). The alternative fumigant apparently presented even greater risks to workers. *See* William R. Havender, *EDB and the Marigold Option*, REGULATION, Jan./Feb. 1984, at 13, 16 (discussing risks to workers from alternative fumigant).

123. Donald T. Hornstein, *Paradigms, Process and Politics: Risk and Regulatory Design*, *in* WORST THINGS FIRST? THE DEBATE OVER RISK-BASED NATIONAL PRIORITIES 147, 160 (Adam Finkel & Dominic Golding eds., 1994) [hereinafter WORST THINGS FIRST?].

124. Peter Huber, *Safety and the Second Best: The Hazards of Public Risk Management in the Courts*, 85 COLUM. L. REV. 277, 298 (1985).

soot produced and fuel burned for a given amount of usable energy."[125] Cass Sunstein has observed that "[t]o regulate new risks in the interest of health and safety is to perpetuate old ones, and thus to reduce health and safety."[126]

Notwithstanding this general principle, environmental law repeatedly employs the precautionary principle with respect to new risk sources. The Clean Air Act, for example, provides for new source performance standards that impose higher pollution control requirements on new and modified sources of pollution.[127] On its face, stricter standards might seem to contribute to pollution reduction. The costs added to new sources discourage their development, however, and consequently perpetuate the use of older sources. Since the Clean Air Act, U.S. electrical generating plants are aging: "[I]n 1970 only two percent of U.S. electric generating capacity was more than thirty years old; it is predicted that by 2000 the average age will be thirty years."[128] One study found that the stricter new source standards for electric power generating facilities actually caused a twenty percent increase in total airborne emissions because of the perpetuation of old plants.[129] Any restrictions on new technologies are likely to increase relative risks.[130]

Similar problems resulted from the Act's placing strict controls on emissions from new automobiles. The control devices had a substantial positive effect on new car emissions, but also significantly increased the

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125. Indur M. Goklany, *Richer Is Cleaner: Long Term Trends in Global Air Quality*, *in* THE *TRUE* STATE OF THE PLANET, *supra* note 49, at 339, 347. Goklany stresses that "[c]leaner energy sources, such as natural gas, oil, and electricity were becoming increasingly available as substitutes for coal and wood in homes, businesses, and industries." *Id.*

126. CASS SUNSTEIN, AFTER THE RIGHTS REVOLUTION 106 (1990).

127. 42 U.S.C. § 7411 (1994).

128. BEN BOLCH & HAROLD LYONS, APOCALYPSE NOT 23 (1993).

129. BRUCE YANDLE, THE POLITICAL LIMITS OF ENVIRONMENTAL REGULATION 88-89 (1989).

130. *See* Jatin Nathwani & Jan Narveson, *Three Principles for Managing Risk in the Public Interest*, 15 RISK ANALYSIS 615, 616 (1995) (discussing positive effects of new technology despite new risks). Nathwani and Narveson write:

> New technologies, while they carry some risks with them, also *reduce* risk; indeed, that is the normal effect of technology. The automobile, for example, kills thousands per year, and injures even more. Yet its effect on the whole is to *increase* life expectancy and health. The automobile speeding the stricken patient to a hospital saves many more lives by getting there in time than it loses by being involved in an accident on the way. The motor vehicles that deliver our food before it rots promote our health, despite the occasional accident.

Id.

price of new cars and reduced the turnover in the stock of automobiles. As a result, there are more old cars on the road, and these older autos are a primary source of urban air pollution. Before emission control regulations in 1978, about fourteen percent of cars were more than ten years old; by 1982, about twenty-four percent of cars were ten or more years of age.[131] The costs attendant to regulation have prolonged the life of old cars that pollute more and tend to be more unsafe to drive. In this case, the initial new car regulation may have produced a net benefit — the reduction in new car pollution more than counterbalanced the increase from greater numbers of old cars. However, placing more and more restrictions on new cars out of an excess of precaution could well become counterproductive. The entire program might have been more effective had the shift to old cars been recognized from the outset.

Current demands for a shift to emission-free electric cars may well represent a precautionary action that causes more harm than good. The removal of lead from gasoline is a major environmental success story with great benefits causing no apparent significant countervailing risks. The introduction of electric cars, ostensibly for pollution prevention, could more than destroy the benefit of the leaded gasoline regulation. Electric cars require lead acid batteries to run.[132] This lead must be mined, smelted, and disposed of or recycled. At every step of the process, some lead will be released into the environment. The researchers calculated that a 1998 model electric car would release sixty times more lead for each kilometer of use than the old, leaded gasoline cars.[133] Even taking a best case scenario of lead control indicates that the electric cars would have five times the emissions of leaded gasoline vehicles.[134] Thus, the precautionary effort to eliminate all direct auto emissions will increase emissions of a more hazardous pollutant — lead. Of course, the emissions of lead will primarily occur in different places: near smelters or recyclers, rather than city streets.

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131. ROBERT CRANDALL ET AL., REGULATING THE AUTOMOBILE 96 (1986).

132. *See* Lester B. Lave et al., *Environmental Implications of Electric Cars*, 268 SCIENCE 993, 993-95 (May 19, 1995) (discussing electric car technology and its environmental effects). Some alternative battery technologies are becoming available, but these also require the use of toxic heavy metals, such as nickel and cadmium. *Id.* The Executive Director of the Electric Vehicle Association has emphasized that first-generation cars will inevitably have lead acid batteries, but environmentalists note that the alternative heavy metal technologies are also risky. *See* Peter Passell, *Lead-Based Battery Used in Electric Car May Pose Hazards*, N.Y. TIMES, May 9, 1995, at A1. The risks from other sources are more uncertain, but the very fact of the government mandate "puts a premium on using the most conservative technological option," lead acid batteries.

133. Lave et al., *supra* note 132, at 995.

134. *Id.*

In the process, the risk is not only increased, but shifted generally to poorer populations who must live closer to industrial facilities.[135]

The potential tragedy of electric cars is amplified because the prospective air pollution benefits from emission-free vehicles are largely vaporous. Electric cars do not avoid fossil fuel combustion, they simply shift its locus from internal combustion engines to electric power generating facilities. The net effect of this shift is debatable, but there is good reason to think that total emissions may increase due to a shift to electric vehicles.[136] Studies suggest that the increase in sulfur dioxide emissions from a shift to electric cars could be as little as 17% or as much as 2100%.[137] New cars are already so clean, thanks to past regulation, that any benefit from new electric vehicles will inevitably be quite small.[138] While new electric power plants must also meet stricter standards, their total pollution rate remains higher than that for new cars.[139] A compulsory shift to electric cars will also drive up the price of all vehicles, exacerbating old car pollution,[140] as discussed above. Finally, electric vehicles present unique safety risks that have not been considered closely.[141]

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135. *See* Robert D. Bullard, *Unequal Environmental Protection: Incorporating Environmental Justice in Decision Making*, *in* WORST THINGS FIRST?, *supra* note 123, at 237, 245-48 (discussing proximity of poor and minority groups to lead smelting operations).

136. The *Rocky Mountain News* editorialized that "if electric cars actually did catch on, much busier coal-fired utility plants would pump enough additional sulfur oxide into the air to more than make up for the pollutants that went away." ROCKY MOUNTAIN NEWS, Jan. 10, 1996, at 39A.

137. Eric Peters, *The False Promise of Electric Cars*, 78 CONSUMERS' RES. MAG., Aug. 1995, at 10.

138. According to research in California, the cleanest fifty percent of the cars tested emitted only three percent of total air pollution. Rick Henderson, *Dirty Driving: Donald Stedman and the EPA's Sins of Emission*, POLICY REVIEW, Spring 1992, at 56. A chemistry professor suggested that most new cars are "as clean as me breathing." *Id.*; *see also* Peters, *supra* note 137 (noting that automobiles are no longer primary or even secondary cause of urban smog).

139. *See, e.g.*, Kathleen Noble, *Electric Car No Panacea*, GOVERNING MAG., Oct. 5, 1992, at 6 (declaring that "gasoline and alcohol fuels both burn much cleaner than the fossil fuels used by most power plants, even if power plants are using state-of-the-art scrubbing technology").

140. *See* Murdock, *supra* note 75 (reporting that "[h]igher prices for both electrical and gas-fueled cars" will cause "older, higher-emitting vehicles to be kept longer and driven more"); Peters, *supra* note 137 (suggesting that electric car mandate could produce increase of more than $500 in price of conventional vehicles).

141. *See* Peters, *supra* note 137 (citing General Accounting Office report suggesting that electric vehicles threaten "high voltage electric shock, fire and [exposure to] toxic gases" in addition to general safety risks attendant to automobile accidents).

Another perverse program for automobile emission reduction is the use of gasohol as an alternative fuel. In contrast to gasoline, ethanol has some benefits, but also is more volatile and correspondingly increases emissions of hydrocarbons, volatile organic compounds, and nitrogen oxides, which are harmful in themselves and contribute to urban ozone problems.[142] A switch to ethanol also would increase emissions of certain carcinogens[143] and add to global warming emissions.[144] The ethanol case is more a story of corporate rent-seeking than use of the precautionary principle, but it provides an additional example of how control measures may cause more harm than good.

The Toxic Substances Control Act provides another story of a risky shift to older products. When the EPA sets strict standards for the introduction of new chemicals, placing upon them the burden of proof of safety, the effect is the prolongation of the use of existing chemical products. This unfortunately results "in both higher costs *and* increased risks: higher costs because economic progress is delayed; increased risks because the new products that would replace existing ones may be inherently less risky than the latter."[145] A strict safety requirement that is inconsistently applied between old and new risks will inescapably reduce safety by preserving a greater role for old products.

The old versus new risk problem arises in pesticide regulation. Many traditional pesticides that were registered before and during the 1960s are carcinogenic but were not subject to the rigors of modern testing.[146] Suppose that a new pesticide was presented for registration, and this new pesticide had some weak evidence of carcinogenicity. The NAS has warned that "[e]ven though approving the new chemical may reduce dietary cancer risk because it would displace more potent, approved oncogens, the EPA probably would maintain the status quo."[147] Analogously, the EPA proba-

142. Jonathan Adler, *Clean Fuels, Dirty Air*, *in* ENVIRONMENTAL POLITICS: PUBLIC COSTS, PRIVATE REWARDS 19, 23 (Michael S. Greve & Fred L. Smith, Jr., eds. 1992).

143. *Id.*

144. FUMENTO, *supra* note 107, at 323.

145. Michael Shapiro, *Toxic Substances Policy*, *in* PUBLIC POLICIES FOR ENVIRONMENTAL PROTECTION 195, 232-33 (Paul R. Portney ed., 1990).

146. *See* Sheehy, *supra* note 21, at 278 (observing that "it is widely suspected that many old pesticides are carcinogenic" but remain widely used). Yet, "[n]ewer, safer, but minimally carcinogenic pesticides, on the other hand, are banned from use by the Delaney Clause." *Id.*

147. NATIONAL ACADEMY OF SCIENCES, *supra* note 103, at 42. This risk is not just hypothetical, as the authors observe that "[e]xamples of this scenario can also be found in actions now pending before the EPA." *Id.*

bly could not cancel the old hazardous pesticide without evidence of a reasonably effective substitute, and the rigorous requirements for new pesticide approval could preclude the availability of such a substitute.[148] Precaution about new pesticides may simply perpetuate greater hazards from older chemicals.[149]

The new source bias is a common problem in public health law and regulation. Precaution is particularly applied to new sources, as "new technologies are feared . . . while very hazardous existing technologies are not so feared."[150] Yet, this precautionary bias is pervasively counterproductive. John Graham and Jonathan Wiener observe that "regulations that apply only to new cars . . . pesticides . . . medicines, and industrial technology have had the perverse effect of keeping more hazardous older products in use longer."[151] Inevitably, the selective application of the precautionary principle will cause more public health harm than benefit.

Another risk from alternatives arose from undue precaution about hazardous waste exposures. The EPA closed a number of wells in Northern California due to the discovery of trace amounts of trichloroethylene in the groundwater used by the wells. Closing the wells caused the owners to seek other water sources, and in "all but two cases, the cancer risk from California tap water was greater than the risks from the water in the wells that were closed."[152] No well had a greater risk than drinking "an equal volume of cola, beer, or wine."[153] The government likewise closed wells

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148. *Id.* at 43. The NAS suggests that under this scenario "[h]uman cancer risk would rise, not fall." *Id.* at 42; *see also* GRAHAM & WIENER, *supra* note 49, at 184 ("When EPA sets a tolerance for a new compound, it must consider only the risk of the new pesticide as compared to the ADI or acceptable cancer risk and implicitly ignore the risks associated with older pesticides already on the market. Yet older pesticides are often more toxic and less carefully tailored to pest-specific impact than are the new compounds that have been developed in accordance with modern toxicological testing protocols.").

149. *See* Sheehy, *supra* note 21, at 278 (finding that "the Delaney Clause prevents the replacement of older, more dangerous pesticides with newer, less dangerous pesticides"). Ironically, some of these more hazardous older pesticides are used by organic farmers. *See supra* note 102 and accompanying text (discussing natural, but highly hazardous, pesticides used by organic farmers).

150. Cross, *supra* note 8, at 924.

151. GRAHAM & WIENER, *supra* note 49, at 241.

152. STROUP & GOODMAN, *supra* note 95, at 2. The authors note that in two cases the California tap water was 50 times riskier than the water from the closed wells. *Id.*; *see also* Bruce N. Ames et al., *Ranking Possible Carcinogens: One Approach to Risk Management*, *in* THE RISK ASSESSMENT OF ENVIRONMENTAL AND HUMAN HEALTH HAZARDS, *supra* note 75, at 1082, 1086 (noting that only two of thirty-five wells closed presented greater risk than tap water).

153. Ames et al., *supra* note 152, at 1086.

in Woburn, Massachusetts that had fewer carcinogenic substances than normal tap water.[154] The unilateral application of the precautionary principle called for closing down the wells at the slightest hint of risk without consideration of the relative risk from alternative drinking sources.

B. Foregone Benefits

Another important unforeseen cost of environmental regulation is the loss of health benefits from the regulated substance or activity. Like the risks of alternatives, the health benefits of activities are commonly ignored when regulation is contemplated. Industry advocates make sure that regulators consider the economic costs of rulemaking, but the health benefits do not always get such an audience. Yet, the health benefits of products and activities are often substantial, and ignoring these benefits can produce hazardous regulation.

A good example of potentially foregone benefits is chlorine. Various chlorine-based compounds, such as chlorofluorocarbons and PCBs, have been implicated as environmental hazards. Scientific evidence has mounted to suggest that the chlorination of public water supplies contributes to the development of carcinogenic trihalomethanes and consequent risk to all those drinking from the water supplies.[155] These and other discoveries have moved many environmentalists, including those in Greenpeace, to propose a complete ban on chlorine, without respect to the particular compound or usage.[156]

While various chlorinated compounds present some risk, the value of a ban is scientifically dubious.[157] Moreover, a ban could create substantial

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154. *See* Jay H. Lehr, *Toxicological Risk Assessment Distortions*, *in* RATIONAL READINGS ON ENVIRONMENTAL CONCERNS, *supra* note 68, at 673, 681.

155. *See* Kenneth P. Cantor et al., *Bladder Cancer, Drinking Water Source, and Tap Water Consumption: A Case-Control Study*, 79 J. NAT'L CANCER INST. 1269, 1269 (1987) (discussing evidence of risk of trihalomethane exposure); Kenny S. Crump & Harry A. Guess, *Drinking Water and Cancer: Review of Recent Epidemiological Findings and Assessment of Risks*, 3 ANN. REV. PUB. HEALTH 339, 339-56 (1982) (same); *see also* Proposed Rules: EPA Drinking Water; National Primary Drinking Water Regulations: Disinfectants and Disinfection Byproducts, 59 Fed. Reg. 38,668, 38,670-73 (1994); BENARDE, *supra* note 77, at 465-68 (summarizing evidence of carcinogenicity but characterizing association as weak).

156. *See* Ivan Amato, *The Crusade Against Chlorine*, 261 SCIENCE 152 (July 9, 1993). Fuierer, *supra* note 9; William Leiss, *"Down and Dirty": The Use and Abuse of Public Trust in Risk Communication*, 15 RISK ANALYSIS 685, 687 (1995) (referring to Greenpeace campaign for complete phase-out of chlorine compounds).

157. *See* Meryl H. Karol, *Toxicologic Principles Do Not Support the Banning of Chlorine*, 1994 FUNDAMENTAL & APPLIED TOXICOL. 1, 1-2 (1995) (reporting conclusions of Society of Toxicology that ban was irresponsible and unscientific). A one thousand page review of the evidence on chlorination, organochlorines, and other compounds came to a similar

health risks. A ban on water chlorination would cause far greater mortality from waterborne bacteria than any deaths caused by trihalomethanes or other disinfection by-products. Chlorination has not extinguished all risk from waterborne illness, but the process has eliminated some of the greatest risks, including cholera and typhus. According to the World Health Organization (WHO), over nine million people around the world die because their water is *not* chlorinated.[158] When Peru responded to the chlorine scare by halting the chlorination of their water supply, thousands died of cholera.[159] Not only would the elimination of chlorination increase overall risk, it would shift the remaining risks to especially vulnerable populations, because "waterborne disease can be especially devastating to the elderly and those with immune system deficiencies such as AIDS."[160] The alternatives to chlorination are not equally effective and may carry their own public health risks.[161] In addition to the benefits of water chlorination, chlorine is also a component in many pharmaceuticals employed to treat problems like coronary heart disease and cancer.[162] Polyvinyl chloride (PVC) may not appear to provide such direct health benefits, but its prohibition could require increased use of highly hazardous lead in pipes as well as increased pollution from the manufacture of iron.[163] PVC's fire retardant properties may also have saved many

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conclusion. The various articles are found in part 2 of 20 REG. TOXICOL. PHARMACOL. (Aug. 1994).

158. Kenneth Smith, *The Media's War on Essential Chemicals: Targeting Chlorine*, 6:2 PRIORITIES 6, 8 (1994).

159. *See* Christopher Anderson, *Cholera Epidemic Traced to Risk Miscalculation*, NATURE, Nov. 28, 1991, at 255; James Brooke, *Cholera Kills 1100 in Peru and Marches On, Reaching the Brazilian Border*, N.Y. TIMES, Apr. 19, 1991, at A3; R.I. Glass et al., *Epidemic Cholera in the Americas*, 256 SCIENCE 1524, 1524-25 (June 12, 1992); *see also* AMERICAN COUNCIL ON SCIENCE & HEALTH, CHLORINE & HEALTH 6 (Aug. 1995).

160. GRAHAM & WIENER, *supra* note 49, at 125.

161. *See id.* at 139 (observing that primary alternative — ozonation — does not control virological regrowth as well as chlorination and that ozone manufacturing requires additional energy use, with its own polluting consequences); *id.* at 140 (pointing out that alternatives to chlorine also form organic by-products that have been implicated in disease causation); *see also* AMERICAN COUNCIL ON SCIENCE & HEALTH, *supra* note 159, at 6 (reporting that ozone provides less effective guard against disease and that "there is no assurance that ozone's by-products, including bromate (an animal carcinogen) will be any less toxic than by-products produced during chlorination").

162. Smith, *supra* note 158, at 10-11. These include the only antibiotic currently effective against hospital staph infections, a newly discovered natural anticancer marine sponge metabolite, a DDT derivative used to treat inoperable adrenal cancer, and the leading drug for treatment of testicular cancer. *Id.*

163. *See* AMERICAN COUNCIL ON SCIENCE & HEALTH, *supra* note 159, at 8 (noting that "emissions from the iron pipe manufacture would cause more serious environmental

lives over the past few decades.[164] Banning chlorine would threaten all these substantial benefits.

Fluoridation provides an episode of foregone benefits due to precautionary local regulations. About forty percent of American people live in areas where the water contains relatively little fluoride, and where none is added.[165] This is attributable to "dire predictions for public health because fluorides are poisonous" and the political power of "anti-technology forces."[166] The levels of fluoride added to water are low enough to present no risk and to offer a substantial reduction in dental caries. Yet precautionary public fears fail to consider the benefits and dwell upon the remote hint of a possibility of a risk.[167]

One of the best documented examples of foregone health benefits from precautionary government safety regulation involves FDA requirements for the introduction of new drugs. The FDA will permit such introduction only after manufacturers have demonstrated the safety and efficacy of their new drugs through a series of rigorous tests. These requirements were provoked in part by public concern over the thalidomide tragedy, in which the introduction of a new drug in Europe apparently caused severe birth defects.[168] The restrictions in the United States have the effect of delaying or preventing the introduction of new drugs.[169] This is the genesis of what has become known as the "drug lag" in the United States.[170] FDA regulation

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problems than are caused by emissions from PVC pipe production" and that PVC provides "noncorroding, lead-free pipe and connections for potable water supplies").

164. *See id.* at 9 (reporting that "use of PVC in building materials is partly responsible for the fact that the U.S. death rate from fire has decreased from 76 per million population in the 1940s, when most construction and decorative products were made of 'natural' materials, to 29 per million in the 1980s, by which time PVC had replaced natural materials in many applications").

165. LEWIS, *supra* note 50, at 41.

166. *Id.* at 40-41.

167. As an interesting sidebar, Representative James Delaney, the author of the famous clause, was an "ardent anti-fluoridationist." LEWIS, *supra* note 50, at 147.

168. *See generally* HARVEY TEFF & COLIN R. MUNRO, THALIDOMIDE: THE LEGAL AFTERMATH (1976) (reviewing history of how thalidomide used by pregnant women resulted in thousands of birth defects cases).

169. *See* WILLIAM WARDELL & LOUIS LASAGNA, REGULATION AND DRUG DEVELOPMENT 98 (1975) (observing that "beneficial new drugs are introduced more quickly and in greater numbers in Britain"); William M. Wardell, *A Close Inspection of the 'Calm Look'*, 239 JAMA 2004, 2007 (1978) (reporting study that for nine major therapeutic areas, 43 drugs were introduced in Great Britain and only 14 new drugs were introduced in U.S.).

170. *See, e.g.*, Kenneth I. Kaitin et al., *The Drug Lag: An Update of New Drug Introductions in the United States and in the United Kingdom, 1977 through 1987*, 46 CLIN. PHARMACOL. & THERAPEUTICS 121 (1989) (presenting quantitative evidence of drug lag).

of new drugs became particularly controversial when it delayed access to AIDS treatments,[171] although it remains uncertain whether this graphic episode of costs of precaution will translate into any broader reform.[172]

Delaying or preventing the introduction of new drugs almost definitionally involves foregone health benefits because health benefits are the purpose of the drugs. Of course, no one wants to induce unnecessary thalidomide tragedies, but the great precaution regarding that possibility has tragically caused substantial health harm. Democratic Representative James Scheuer of New York charged that the FDA "is contributing to the needless suffering and death of thousands of Americans because it is denying life-enhancing and life-saving drugs available elsewhere."[173] The FDA's restrictions on the use of beta-blockers reportedly "set back cardiovascular therapy in this country by years."[174] The FDA Commissioner even conceded that the FDA had delayed the introduction of one drug with the potential to save seventeen thousand lives each year.[175] Delay of a drug to prevent bleeding gastric ulcers may have cost in excess of eight thousand lives annually.[176] A two-year delay of another drug offering thrombolytic therapy for heart attacks may have cost twenty-two thousand lives.[177] Moreover, the strict standards for new drugs are not applied to old drugs, so failure to approve a new pharmaceutical out of great precaution may simply prolong the use of a more harmful, older product.[178] This history

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171. Steven R. Salbu, *Regulation of Drug Treatments for HIV and AIDS: A Contractarian Model of Access* 11 YALE J. REG. 401, 410-11 (1994) (discussing pressure put on FDA by AIDS victims and other interested parties to speed up drug approval process).

172. *See* Kazman, *Death by Regulation, supra* note 30, at 19. Kazman noted that the "AIDS crisis has produced some incremental changes because it is the first time that drug lag's potential victims have organized themselves into a powerful political constituency." *Id.* However, "it is still unclear whether the AIDS-inspired reforms, such as liberalized distribution of drugs before full approval and more lenient standards for test data, will be significantly utilized." *Id.*

173. *See* John Kelly, *Bridging America's Drug Gap*, N.Y. TIMES, Sept. 13, 1981, (Magazine), at 99-100. The article goes on to detail the story of a doctor who lost a patient to the drug lag. He reports that "[s]he was a sturdy, healthy-appearing black woman and so she [remained] at the time of her death when she turned to her husband, gasped and fell to the floor dead." *Id.* at 101. She suffered from Prinzmetal angina, which was treatable by a new drug available in England and Germany, but denied to U.S. patients for lack of FDA approval. *Id.*

174. Wardell, *supra* note 169, at 2010.

175. JOHN URQUHART & KLAUS HEILMAN, RISK WATCH 118 (1984) (quoting FDA Commissioner Arthur Hayes).

176. Kazman, *Deadly Overcaution*, *supra* note 30, at 43.

177. *Id.* at 44.

178. WARDELL & LASAGNA, *supra* note 169, at 100 (reporting on study of adverse drug

does not mean that the United States should allow new drugs to be marketed without any screening, but does demonstrate that application of the precautionary principle to potential risks of new drugs will cause more mortality and morbidity than it prevents. One of the drugs cited by FDA advocates, practolol, was kept off the market because of toxicity concerns without regard to the far greater benefits the drug could provide to heart patients.[179] Precautionary fears of possible risk from new drugs may well have cost thousands of premature deaths.

Pesticides offer another case of significant foregone benefits as a consequence of regulation. The Natural Resources Defense Council and the television program *60 Minutes* teamed up to spread fears of Alar, a growth hormone used on apples.[180] The resultant media-fed fear was considerable. In the wake of this scare, "millions of consumers stopped buying apples and apple products,"[181] and apples were withdrawn from school lunchrooms.[182] Yet the risk from Alar was somewhere between miniscule and nonexistent,[183] and by foregoing apple consumption, consumers lost health benefits

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reactions in New Zealand — where there are fewer restrictions than U.S. — which found that older drugs caused most of fatalities, and newer drugs were relatively safer).

179. *See* GRABOWSKI & VERNON, *supra* note 22, at 44, 46 (noting that despite practolol's "known toxicity," it has "an extremely high benefit-to-risk ratio when used to prevent heart attacks and coronary death"). The authors suggest that use of the drug could prevent more than 10,000 deaths per year in the United States. *Id.*

180. *See* WILDAVSKY, *supra* note 26, at 202-04 (summarizing nature of media campaign against Alar). The entire effort was part of a "skillfully organized public relations campaign." *Id.* at 204. Even Meryl Streep was called in to publicize the asserted threat, and Alar was eventually proscribed by the EPA. *Id.*

181. Rosen, *supra* note 116, at 85.

182. 135 CONG. REC. E2237 (daily ed. June 21, 1989) (remarks of Rep. Hamilton) (reporting that "apples were removed from many school lunchrooms . . . and some families poured apple juice down the drain").

183. The World Health Organization (WHO) concluded that Alar was not carcinogenic. *See, e.g.,* Eliot Marshall, *A Is for Apple, Alar and . . . Alarmist?*, 254 SCIENCE 20, 20 (Oct. 4, 1991). The EPA's own Scientific Advisory Panel (SAP) rejected the agency's proposed ban on daminozide, concluding that the data were insufficient to demonstrate carcinogenicity. *See* WILDAVSKY, *supra* note 26, at 211 (quoting SAP's conclusion that data were "inadequate to perform a qualitative risk assessment" on potential carcinogenicity of substance, much less quantitative risk assessment on relative degree of risk). An expert panel appointed by the British government concluded that prevailing exposures to Alar posed "no risk to health." *Id.* at 214. The EPA continues to maintain that Alar presents a risk of cancer, but did eventually reduce its risk estimate by about half. *See* Marshall, *supra*, at 21. The journal editorialized that "a clearly dubious report about possible carcinogenicity by a special interest group was hyped by a news organization without the most simple checks on its reliability or documentation." Daniel Koshland, *Credibility in Science and the Press*, 254 SCIENCE 629, 629 (Nov. 1, 1991); *see also* Kenneth W. Weinstein, *When*

including protection from heart disease and cancer.[184]

Controversies over pesticide use commonly result in foregone health benefits from consumption of foods. Democratic Representative Lee Hamilton lamented that consumers have reduced "consumption of fresh produce because of pesticide worries," even though "increasing consumption of fruits and vegetables can help reduce the risk of some cancers, with benefits far outweighing possible cancer risks from the pesticides."[185] It is simply not wise to counsel consumers *not* to eat their spinach, although some environmentalists do precisely that. The actual risk from pesticide residues on food is quite small.

The risk of foregone health benefits from fruit and vegetable consumption is demonstrated in a recent report by the Environmental Working Group (EWG), which cautioned consumers to avoid such products as strawberries, bell peppers, and spinach, due to pesticide residues.[186] The forty-five page report by EWG takes note of the health benefits of these food products and recommends substitutes.[187] The recommendation of substitutes shows some responsibility, but is plainly insufficient. First, many consumers will hear only the word about the products with the highest pesticide residues and may never get the message about the need to substitute. Second, consumers may resist substitution — those who like spinach may not care for brussels sprouts or other alternatives. Third, the substitutes may not provide all the benefits of the products cautioned against. Strawberries may offer greater health benefits than the alternatives.[188] Spinach

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Pesticides Go Public: Regulating Pesticides by Media after Alar, *in* PESTICIDE RESIDUES AND FOOD SAFETY, *supra* note 102, at 277, 281 (reporting that "[f]ormer Surgeon General C. Everett Koop, John Weisburger of the American Health Foundation, former FDA Commissioner Dr. Frank E. Young, the Director of the California Department of Health Services, the Institute of Food Technologists, Dr. Bruce Ames of the University of California, and others expressed the view that the consumption of apples with Alar was safe and that the trace amounts found in apples were toxicologically insignificant").

184. *See* JEAN CARPER, FOOD PHARMACY 114-17 (1988) (surveying research on health benefits of apple consumption).

185. Remarks of Rep. Hamilton, *supra* note 182, at E2237.

186. *See* Environmental Working Group, *A Shopper's Guide to Pesticides in Produce* (Nov. 1995). This report is available by mail or at <http://www.ewg.org/pub/home/Reports/Shoppers/Shoppers.html>. Environmental Working Group's (EWG's) home page is at <http://www.ewg.org>.

187. *Id.* at 26. The substitutes recommended for strawberries include blueberries, raspberries, oranges, watermelon, and other fruits. Recommended substitutes for spinach included broccoli, brussels sprouts, romaine lettuce, or asparagus. *Id.*

188. *See* CARPER, *supra* note 184, at 283 (reporting that "strawberries capped a list of eight foods most linked to lower rates of cancer deaths among a group of 1271 elderly

is a uniquely healthy food, offering more benefits than its substitutes.[189] EWG also counsels against eating Chilean grapes, "a rich storehouse of antioxidant, anticancer compounds,"[190] but only substitutes U.S. grapes when in season (apparently they would forego the health benefits for six months of the year).[191] EWG cautions against apples, suggesting that just about any fruit or vegetable would be more nutritious, but this ignores many health benefits of apple consumption.[192] In exchange for all these health benefits, EWG does not even identify the benefits of pesticide avoidance. The report contains a very elaborate comparison of pesticide residues on various products,[193] but nowhere attempts to estimate the magnitude of risk from these residues.[194] A table in the report acknowledges that the residues are extremely low, in the parts per billion or even parts per hundred billion range.[195] The report additionally ignores the finding that "[f]ruits that are inadequately protected against pests have also

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Americans in New Jersey").

189. *See* Environmental Working Group, *supra* note 186, at 26 (acknowledging that spinach provides anticarcinogenic lutein that is "not abundant in these substitutes"). Spinach contains "about four times more beta carotene and three times more lutein than broccoli." JEAN CARPER, FOOD — YOUR MIRACLE MEDICINE 474 (1993). Spinach also contains more beta carotene than raw carrots, and "spinach's panoply of other carotenoids may possess anticancer activity, and may be even more responsible than beta carotene for spinach's splendid showing in population surveys of cancer-preventive foods." CARPER, *supra* note 184, at 279.

190. CARPER, *supra* note 189, at 481.

191. *See* Environmental Working Group, *supra* note 186, at 26 (recommending consumption of U.S. grapes only from May to December to avoid pesticide residues).

192. *See id.* at 27 (apparently considering only vitamin C content and carotenoids as health benefits). Apples offer other valuable constituents: "Whole fresh apples may help ward off cancer because they are shot through with caffeic or chlorogenic acid, which blocks cancer formation in lab animals dosed with potent carcinogens." CARPER, *supra* note 184, at 117. Apples may also lower cholesterol. *Id.* at 474.

193. Environmental Working Group, *supra* note 186, at 29-41.

194. EWG notes that consumers have "a right to know how slim the knowledge base really is when it comes to predicting the true risks of pesticides and pesticide combinations on human health." *Id.* at 29. This is another invocation of the precautionary principle — if we do not know the answer, avoid the product. Yet one must wonder why consumers should forego fruits and vegetables that fight cancer, according to a substantial knowledge base, simply because a slim knowledge base exists about the risk from those products.

195. *Id.* at 13. The most hazardous of the pesticides, parathion, was found in average residue at only two parts per hundred billion. *Id.* Even these estimates of miniscule exposure may overstate the risk. One recent study of eight carcinogenic pesticides "found that actual human exposures in food had been overestimated by factors of 99,000 to 463,000." HARVARD CTR. FOR RISK ANALYSIS, RISK IN PERSPECTIVE, Mar. 1995, at 1.

been shown to have lower nutritional value (e.g., less vitamin C in apples) than are fruits that are protected by pesticides."[196]

While the foregone benefits from food consumption are generally traced to consumer fears of pesticides, government regulation can have a similar consequence. Scientists from the National Cancer Institute warned that a strict interpretation of the Delaney Clause could increase risk because "[b]y outlawing pesticides and making it more difficult to grow fruits and vegetables, prices would rise and demand could fall for foods that have been shown to prevent cancer, such as broccoli and carrots."[197] The anticipated banning of thirty-five additional pesticides under that law is anticipated to cost $1.2 billion, which will be passed on to consumers.[198] Elementary economics informs us that reduced supply and higher cost will yield reduced consumption of fruits and vegetables that can play a major role in cancer prevention[199] and other forms of health enhancement.[200] An economic study concluded that the total elimination of pesticide use on fruits and vegetables would increase prices from 11% (fresh vegetables) to 52.5% (fresh fruits) and reduce consumption by a significant amount.[201]

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196. HARVARD CTR. FOR RISK ANALYSIS, *supra* note 195, at 2.

197. Sheehy, *supra* note 21, at 275 n.191.

198. *Id.* at 275-76.

199. *See* Gladys Block et al., *Fruit, Vegetables, and Cancer Prevention: A Review of the Epidemiological Evidence*, 18 NUTRITION & CANCER 1, 20 (1992) (reporting that "the evidence of an association between fruit and vegetable consumption and cancer prevention is exceptionally strong and consistent"). Research finds a protective effect against cancers of the lung, larynx, mouth, esophagus, stomach, colon, rectum, bladder, pancreas, cervix, ovaries, and breast. Sheehy, *supra* note 21, at 276-77 and sources cited therein.

200. *See* HARVARD CTR. FOR RISK ANALYSIS, *supra* note 195, at 2 (observing that banning pesticides would most hurt poor by raising food prices). The authors note that:

> A recent study in the journal *Science* indicated that the increase in food prices from bans of pesticides could be quite substantial. For poor families and households on fixed incomes, higher food prices increase the risk of malnutrition and its associated illnesses. In short, banning numerous pesticides may have the same effect on poor people as reducing their food stamp payments!

Id.

201. *See* Taylor, *supra* note 109, at 15 (finding 12.2% reduction in fresh vegetable consumption, 14.7% reduction in frozen vegetable consumption, 10.4% reduction in canned vegetable consumption, 25.5% reduction in fresh fruit consumption, 26% decrease in frozen fruit consumption, and 22.9% reduction in dried fruit consumption). In some respects, these average reductions actually underestimate the importance of pesticides to food production. In some cases, pesticides are not critical to production in the normal year, but the option to use the chemicals is essential to respond to atypical conditions. *See* Gianessi, *supra* note 102, at 26 (noting that only one percent of Illinois soybeans need pesticide treatment in typical year but 1988 drought conditions caused particular pest infestation that required

Moreover, the banning of pesticides can actually obstruct Integrated Pest Management programs aimed at reducing overall chemical usage, thereby increasing net agrichemical application.[202]

DDT presents a prominent case of substantial foregone benefits from regulation. While an EPA hearing examiner found no good scientific evidence of public health risk from DDT,[203] the substance was banned by the agency, in part because of its environmental persistence and apparent threat to wildlife. The adverse consequences for farm workers were observed above, but the DDT ban also produced serious foregone benefits on an international scale. Countries around the globe had used DDT to eradicate or at least control insect-borne diseases, particularly malaria. These countries followed U.S. action in prohibiting or restricting the use of DDT. At the time of the ban, malaria "was close to being eradicated."[204] Malaria experienced a resurgence after DDT was banned and currently causes millions of

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treatment of 40 percent of crop). Farmers are increasingly seeking to cut back on the use of pesticides (which, after all, cost money) and are tailoring usage to only necessary conditions. *Id.* at 26-27.

202. Patrick Weddle, *Pesticide-Free Tree Fruit Crops: Can We Meet Consumer Demands?*, *in* PESTICIDE RESIDUES AND FOOD SAFETY, *supra* note 102, at 58, 63 (reporting that "[s]ingle issue legislative and regulatory efforts aimed at restricting the use of pesticides at the national and state levels have created vacuums that may actually be increasing the reliance on pesticides and other petrochemical inputs"). Weddle notes that pest "resistance management" is a crucial component of an Integrated Pest Management system so that "to reduce reliance on pesticides, practitioners will, paradoxically, need the appropriate uses of a broad selection of pesticidal products." *Id.*

203. *See* Richard F. Sanford, *Environmentalism and the Assault on Reason*, *in* RATIONAL READINGS ON ENVIRONMENTAL CONCERNS, *supra* note 68, at 16-17 (observing that court-appointed hearings examiner and "independent scientists" found no justification for ban, but Administrator William Ruckelshaus proceeded with action anyway). The background to the DDT ban is discussed in Environmental Defense Fund, Inc. v. Ruckelshaus, 439 F.2d 584 (D.C. Cir. 1971). The original studies suggesting that DDT might cause cancer were tainted by contamination with the known powerful carcinogen, aflatoxin. WILDAVSKY, *supra* note 26, at 416. Other than the aflatoxin-contamination study, no other study had found DDT to be such an animal carcinogen. *Id.* at 416, 424. Long after the ban, some evidence arose that DDT might cause breast cancer, and this research received considerable press attention. However, follow-up research suggested that the initial correlation was spurious and that there was no connection between DDT and cancer. *See* Austin, *supra* note 94, at 43 (1989) (finding no connection between DDT and cancer); *see also* Liess, *supra* note 156, at 688 (observing that studies "do not indicate an association between breast cancer and serum organochlorines"). Moreover, the study that suggested that DDT might be linked with higher levels of breast cancer actually found that PCBs appeared to have a protective effect that reduced breast cancer incidence. *See generally* Stephen S. Sternberg, *DDT and Breast Cancer*, 86 J. NAT'L CANCER INST. 1094 (1994).

204. Sanford, *supra* note 203, at 20.

deaths each year throughout the world.[205] This mortal enormity is at least partially attributable to the decision to prohibit the use of DDT.[206] In this case, the United States has been fortunate to feel few of the foregone health benefits from DDT use, but the worldwide impact was immense. Other pesticides also offer substantial health benefits through disease control.[207]

The banning of DDT also had significant adverse effects on natural habitat preservation. Use of DDT had made the eradication of the gypsy moth in the eastern United States "imminent."[208] After the pesticide's prohibition, the moth "staged a spectacular comeback," as biological control efforts were ineffective.[209] The moth "defoliated 13 million acres of prime woodland across the Northeast, primarily in New Hampshire, Massachusetts, Connecticut, New York, New Jersey, and Pennsylvania."[210] In other words, banning DDT resulted in substantial deforestation.

Pesticide use has other significant environmental benefits not considered by critics. Use of these chemicals is crucial for high-yield agriculture, at least for the near future. The Council for Agricultural Science and Technology estimated that crop production would decline by 30% in the absence of such pesticides.[211] These figures are disputed, of course, because many argue that sustainable agriculture, using more traditional farming techniques, could provide ample food.[212] Even if they are correct, such low input

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205. RAY & GUZZO, *supra* note 75, at 17. The authors noted that DDT reduced malaria cases in Sri Lanka from 2.8 million to only 17, but incidence grew back to about 2.5 million after the ban. *Id.* at 69. They also quote Dr. Samuel Simmons, chief of the technology branch of the Communicable Disease Center of the U.S. Public Health Service to the effect that the "total value of DDT to mankind is inestimable" in "protection from infectious diseases and pestiferous insects or indirectly by better nutrition, cleaner food, and increased disease resistance." *Id.* at 69-70.

206. *See* GRAHAM & WIENER, *supra* note 49, at 174.

207. *See* BENARDE, *supra* note 77, at 145 (observing that "[b]efore chemical insecticides were introduced, hundreds of thousands of people died each year from a host of insect-borne diseases").

208. *Id.* at 155.

209. *Id.*

210. *Id.* at 154.

211. *See* John Picket, *Safer Insecticides: Development and Use*, CHEMISTRY & INDUSTRY, Jan. 6, 1992, at 25.

212. Some may challenge the benefits of pesticides on the grounds that the insect targets will develop a resistance to the chemicals and render applications ineffective in the long-term. While there is some truth in the concern over resistance, it is often overstated. *See, e.g.*, EASTERBROOK, *supra* note 4, at 79 (noting that "while some pest species have developed a vexing resistance to man's chemicals, most have not; the resistant portion may be far less than one percent"). Even when targets develop resistance, the pesticide may provide substantial short-run benefits.

techniques require far more land to produce the same amount of food. Axiomatically, lower yields per acre require more acres for the same total production. This is evident from current experience with organically grown produce.[213] In turn, greater land use means increased destruction of natural habitats. Therefore, "[f]or those of us who wish to preserve the planet's diversity of species, high-tech, chemically-assisted agriculture is an environmentalist's best friend."[214] If we returned to the crop yields that existed without the use of fertilizer and pesticides, maintaining total production levels would mean "plowing down the land equivalent of North America in addition to South America," so that "high-yield farming is saving 10 million square miles of wildlife habitat right now."[215] It is also noteworthy that "traditional and organic farmers suffer the highest rates of soil erosion per ton of food output," while use of herbicides with reduced tillage can cut soil erosion from fifty to ninety-eight percent.[216] None of this makes the case for apotheosizing pesticides or striving to maximize chemical use. Pesticides cost money, and farmers therefore have an appropriate incentive to reduce their use as much as possible, within production constraints. The importance of recognizing the benefits of

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213. *See* Dennis Avery, *Saving the Planet with Pesticides: Increasing Food Supplies While Preserving the Earth's Biodiversity*, *in* THE *TRUE* STATE OF THE PLANET, *supra* note 49, at 49, 70 (noting reductions in yield and reporting that organic yields for carrots declined 40%); Ronald Bailey, *Rebuttal*, GARBAGE, Fall 1994, at 51 (observing that "a recent survey of seven European countries, where organic farming is widespread, finds that organic yields are typically just two-thirds of those achieved by using modern agrochemicals, e.g., wheat (65%), potatoes (60%), sunflowers (70%)); F.L. McEwen, *Food Production — The Challenge for Pesticides*, 28 BIOSCIENCE 773, 776 (1978) (suggesting that "were it not for pesticides, crops such as apples and most of our tender fruits and many vegetables, including onions and cold crops, would not be available in quantity, and the price would be excessively high"); David Pimentel et al., *Benefits and Costs of Pesticide Use in U.S. Food Production*, 28 BIOSCIENCE 772, 772 (1978) (comparing yields and finding substantial benefits to insecticide use).

214. Ronald Bailey, *Once and Future Farming Environmentalists Who Want To Preserve Wildlands from the Farmer's Plow As We Feed a Burgeoning Human Population Should Reconsider an Old Enemy: Chemical-Based Agriculture*, GARBAGE, Fall 1994, at 42; Bailey, *supra* note 49, at 5 (observing that if "poor countries do not adopt modern high-yield agriculture, for example, then their impoverished farmers will be forced by hunger to level millions of square miles of wildlands").

215. Avery, *supra* note 213, at 72. Norman Borlaug, the 1970 Nobel laureate, stated that without high-yield agriculture, "[e]ither people would have starved or the increases in food output would have been realized by drastic expansion of acres under cultivation — losses of pristine land 100 times greater than all losses to urban and suburban expansion combined." *Quoted in* EASTERBROOK, *supra* note 4, at 13.

216. Avery, *supra* note 213, at 74.

pesticide use is to caution against presumptive application of the precautionary principle to pesticide risks without considering lost benefits.

Food additive regulation presents another case of foregone benefits. Few have much positive to say about artificial additives, which are perceived as potentially risky and trivially beneficial.[217] Yet, additives such as preservatives definitionally prevent spoilage with attendant savings in food quantity and disease prevention. Nitrites used in curing bacon and other meats became controversial as a cause of cancer, but the additives were used to prevent botulism, a fatal disease.[218] Additives may have other benefits as well; some of the preservatives added to food happen to be antioxidants that actually prevent the development of intestinal cancers, yet these benefits are unappreciated. Although the risk from food additives is immaterial, public fears have caused abandonment of some additives such as BHA and BHT. Yet, "[s]ome cancer epidemiologists believe that the decline in the human death rate from stomach cancer since the 1940s — when the widespread use of BHA and BHT began — may actually in part be a result of the increased use of these two additives."[219] Animal studies have confirmed this beneficial effect of the additives, finding that BHA and BHT may also prevent colon cancer[220] and breast cancer.[221] This occurs because the additives sequester and control the formation of free oxygen radicals, which have been implicated as a source of cancer. Such "dietary control of oxygen radical damage could add, on average, five or more years to our life."[222] When nitrites and nitrates

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217. *See, e.g.*, Sheehy, *supra* note 21, at 269 (discussing legislative history and finding that "Congress considered color additives of questionable value").

218. *See* U.S. GENERAL ACCOUNTING OFFICE, DOES NITRITE CAUSE CANCER? CONCERNS ABOUT THE VALIDITY OF FDA-SPONSORED STUDY DELAY ANSWER 9 (Jan. 31, 1980). Moreover, the elimination of nitrites and nitrates from cured meats would not even significantly reduce human exposure to these potentially toxic substances. About 80% of human consumption of nitrates comes from natural constituents in vegetables. BENARDE, *supra* note 77, at 71.

219. Fredrick J. Stare, *Perceptions of Food Safety Issues in the United States*, *in* RATIONAL READINGS IN ENVIRONMENTAL CONCERNS, *supra* note 68, at 522, 526; *see also* Huber, *supra* note 124, at 297 (stating that "there is growing evidence that some antioxidant preservatives inhibit the formation of certain active natural carcinogens, and so may actually contribute to the decline in mortality from stomach cancer").

220. Bandaru Reddy et al., *Effect of Various Levels of Dietary Butylated Hydroxyanisole on Methylazoxymethyl Acetate-Induced Colon Carcinogenesis in CF1 Mice*, 71 J. NAT'L CANCER INST. 1200 (1983).

221. L.A. Cohen et al., *Inhibition of Chemically Induced Mammary Carcinogens in Rates by Long-Term Exposure to Butylated Hydroxytoluene*, 76 J. NAT'L CANCER INST. 721 (1986).

222. BENARDE, *supra* note 77, at 84.

themselves were subjected to further study based on evidence of their carcinogenicity, the research found that low levels of exposure appeared to *protect* humans from cancer.[223] Selenium additives were banned thirty years ago under the Delaney Clause in light of animal tests revealing carcinogenicity, but selenium now appears to have a net effect as an anticarcinogen.[224] Just as an environmental mindset rejects the concept of natural carcinogens, it may find inconceivable the prospect that a synthetic chemical might *prevent* cancer. Yet, the same animal studies relied on to diagnose carcinogenic properties of chemicals often demonstrate a protective effect for studied chemicals.[225] Notwithstanding this finding, the precautionary principle is applied to prohibit food additives based on even a remote risk of harm, while we remain oblivious to associated foregone health benefits of the additives.

Another serious case of foregone benefits resulting from consumer fear involves food irradiation. Microbial contamination of food with camplylobacter, salmonella, and other pathogens is a serious public health problem, causing hundreds of thousands of food poisoning cases every year.[226] Perhaps nine thousand Americans die annually from such foodborne diseases.[227] Irradiating foods like raw chicken can prevent many of these cases.[228] Widespread use of food irradiation has been blocked, however, by environmentalists and food safety activists who stress the

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223. *See id.* at 73 (summarizing results of research by Oxford's Imperial Cancer Research Fund). The researchers found less gastric mortality among those with higher nitrate/nitrite levels of saliva. They concluded that "nitrates or something associated with them exert a protective effect" on gastric cancers. *Id.*

224. *See generally* James E. Oldfield, *The Two Faces of Selenium*, 117 J. NUTRITION 2002 (1987) (discussing selenium's positive and negative effects).

225. Thomas S. Davies & Alastair Munro, *The Rodent Carcinogenicity Bioassay Produces a Similar Frequency of Tumor Increases and Decreases: Implications for Risk Assessment*, 20 REG. TOXICOL. PHARMACOL. 281 (1994). This survey of studies conducted by the National Toxicology Program between 1990 and 1993 found that two-thirds of the studied chemicals showed increases in some tumors and over 80% of the studies showed decreases in tumors. Two significant points emerge: First, many chemicals appear to decrease cancer, at least at some sites. Second, the same chemical may both increase and decrease tumors. This considerably complicates application of the precautionary principle.

226. *See* Ronald Krystynak, *Control of Microbial Pathogens in Poultry by Irradiation: Issues Related to Risks and Benefits*, *in* NEW RISKS: ISSUES AND MANAGEMENT 111, 114 (Louis A. Cox, Jr. & Paolo F. Ricci eds., 1990); *see also* BENARDE, *supra* note 77, at 35-63 (discussing health risks from microbial food poisoning).

227. Philip R. Lee, *Irradiation To Prevent Foodborne Illness*, 272 JAMA 261, 261 (1994).

228. *Id.*

possibility of health risks from irradiation, even if unproven.[229] Food irradiation has been used in thirty-seven countries for a number of years with no adverse health effects, according to the WHO.[230] Yet this evidence is no answer to the precautionary principle, which requires only a hint of a risk of a harm. Of course, this approach ignores the demonstrably greater health benefits from irradiation and the risks from any alternatives to irradiation.[231]

Another flurry of precautionary concern arose over food additives for cows. The industry administered the hormone diethylstilbestrol (DES) to cattle to stimulate weight gain or to increase milk production. DES became controversial when research demonstrated that its use as a human drug caused cancer in succeeding generations. With respect to cattle feed, however, "no evidence showed that the levels of DES present in edible tissue could actually cause cancer," but the FDA Commissioner prohibited such use after "requiring that manufacturers show that such residues were safe."[232] The ban on DES had the effect of increasing the feed required for each animal by seven to twelve percent and lengthening the time required in the feedlot.[233] These increases resulting from the ban of DES withdrew grain from direct human consumption and raised the cost of beef. Environmentalists who resist giving other hormones to dairy cows to increase milk production ignore the prospect that "lower milk prices would have a much more powerful health effect on poverty-sensitive poor children."[234] Increased efficiency provided by the hormones again would

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229. *See* Michael Fumento, *Irradiation: A Winning Recipe for Wholesome Beef*, 6:2 PRIORITIES 37, 37-39 (1994).

230. *Id.* at 38-39; *see also* Ari Byrnjolfsson, *Wholesomeness of Irradiated Foods: A Review*, 7 J. FOOD SAFETY 107, 120 (1985) (concluding that animal studies at many laboratories and radiation chemistry data demonstrate that food irradiation is not harmful). In the United States, astronauts routinely eat irradiated food. *See* Lee, *supra* note 227. The American Medical Association's Council on Scientific Affairs has also concluded that irradiation is a safe and effective process that increases the safety of food.

231. *See* Fumento, *supra* note 229, at 39 (observing that alternative means of food preservation, including smoking, pickling, and salting have been linked to higher death rates and cancer of esophagus).

232. *See* Degnan & Flamm, *supra* note 57, at 243. There was hardly a case to be made for any risk from DES fed to livestock, because "DES is excreted in the feces, unchanged chemically, which means that it does not remain in the tissue as residue." BENARDE, *supra* note 77, at 84.

233. LESTER B. LAVE, THE STRATEGY OF SOCIAL REGULATION 77-78 (1981).

234. KAUFMAN, *supra* note 116, at 155. The hormone in question, BST, "produced no evidence of even mild carcinogenicity" in years of animal trials and "break[s] down in the stomach into harmless constituent chemicals." EASTERBROOK, *supra* note 4, at 119.

help protect natural habitats.[235]

Another general health risk arising from one-sided use of the precautionary principle arises from hormesis. Hormesis occurs when a substance presenting a mortality risk at high levels of exposure actually protects against death or disease at low levels of exposure. The concept suggests that reducing high levels of exposure to hazardous substances will be beneficial, but attempts to eliminate all exposure would be counterproductive. Unfortunately, the precautionary principle suggests that all reductions should be encouraged and elimination of exposure the goal.

Evidence of hormesis first arose in the context of radiation exposures. Studies in animals and among Japanese survivors of the atomic bomb seemed to indicate that those with relatively low radiation exposure actually lived longer than wholly unexposed populations.[236] Other studies of radiation exposure have confirmed this effect.[237] While much of the research has centered on radiation effects, a number of other studies have found a hormetic effect for exposures to chemicals. Hormesis has been identified for many regulated substances, including various pesticides,

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The American Academy of Pediatrics declared BST safe because it showed no adverse health effects after a decade of testing. *Id.*

235. *See* EASTERBROOK, *supra* note 4, at 391 (reporting that "[t]hrough increased productivity hundreds of thousands of acres of dairy land have been returned to nature in New York in the last half century, offsetting urban expansion even in that overdeveloped state").

236. Harold Boxenbaum et al., *Hormesis, Gompertz Functions, and Risk Assessment*, 19 DRUG METABOLISM REVIEWS 195 (1988) (summarizing some studies of radiation hormesis); M.K. Loken & L.E. Feinendegen, *Radiation Hormesis: Its Emerging Significance in Medical Practice*, 28 INVESTIGATORY RADIOLOGY 446 (1993) (same). The data are not limited to the natural experiment resulting from the bombing. Ray and Guzzo write that:

> [S]imilar results keep accumulating. In 1980; Professor T.D. Luckey published the conclusions from 1,239 separate studies of many investigators involving living things from cell cultures and bacteria to plans (800 references) and animals (200 references) of many different species exposed to varying amounts of ionizing radiation of all types. He reports that the results are consistent: There is a threshold or cutoff point below which ionizing radiation is either harmless or beneficial. Luckey concluded that ionizing radiation is generally stimulating in low doses; that low doses give accelerated development, increased resistance to disease, greater reproductivity, and longer life span . . . .

RAY & GUZZO, *supra* note 75, at 111.

237. *See* BENARDE, *supra* note 77, at 391 (reporting that "ample evidence supports the idea that low doses of whole-body radiation reduce tumor induction," such as evidence that "low doses of radiation administered to mice resulted in a five-fold reduction in the incidence of leukemia").

PCBs, heavy metals, and chlorinated hydrocarbons.[238] One review of scientific studies on both animals and humans from 1974 to 1987 found twenty-nine studies that demonstrated hormetic effects.[239] Research has shown a hormetic effect from exposure to low levels of trichloroethylene, a common hazardous constituent of waste sites, yet Superfund cleanups have sought to erase all traces of trichloroethylene from these sites.[240]

Hormesis turns the precautionary principle and many current regulatory approaches upon their heads. The precautionary linear models used by agencies for extrapolating risks simply assume no hormetic effect and assume that low levels carry a risk relative to the proportion of exposure. If very high exposures, such as maximum tolerated doses, cause harm, the model assumes without demonstration that much lower doses are also hazardous. Yet hormesis indicates that high levels may be harmful while low levels are beneficial. The precautionary principle and linear risk assessment extrapolation would require striving to eliminate the beneficial lower doses as well. The evidence for hormesis may not be so strong as to justify increasing human exposures to low level radiation, but it should be sufficient to dejustify expensive efforts to reduce such exposures.

The existence of hormesis is not indisputable. The difficulties of producing conclusive research at such low exposure levels confounds certainty. The precautionary principle might counsel that we ignore hormesis given this uncertainty. Such a one-sided application of the precautionary principle would be remarkably illogical, however. The quantitative risk assessments that suggest there are health risks at low levels are highly uncertain and share the same limitations as the hormesis studies. An examination of the data suggests some uncertainty about the presence of health benefits from low exposures and uncertainty about the presence of health risks at such exposures. A choice to emphasize the uncertain health risks while ignoring the uncertain health benefits reflects some agenda other than public health protection.

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238. *See* Edward Calabrese et al., *The Occurrence of Chemically Induced Hormesis*, 52 HEALTH PHYSICS 531 (1987) (reviewing studies of chemical hormesis); Edward Calabrese & L.A. Baldwin, *Possible Examples of Chemical Hormesis in a Previously Published Study*, 13 J. APPLIED TOX. 169 (1993) (same).

239. J. Michael Davis & David L. Svendsgaard, *U-Shaped Dose Response Curves: Their Occurrence and Implications for Risk Assessment*, 30 J. TOXICOL. & ENVTL. HEALTH 71 (1990).

240. Teruo Nagaya et al., *Subclinical and Reversible Hepatic Effects of Occupational Exposure to Trichloroethylene*, 74 INT'L ARCHIVE OCCUPATIONAL & ENVTL. HEALTH 561 (1993).

C. *Risks of Remediation*

Harm may be caused directly by the implementation of the environmental regulation itself. Measures taken to prevent a risk inadvertently may increase the level of that same risk. Consider the wings of an airplane. Obviously, these wings need to be strong, but only up to a point. Efforts to continue to add strength to the wings can make a plane less safe by adding weight and hindering maneuverability.[241] Beyond a certain point, added precautions reduce overall safety.

Additional risks from remediation have recurred in environmental and public health protection. Efforts to remove indoor asbestos-containing products provide an example of such counterproductive controls. A public panic arose from the discovery of asbestos in buildings such as schools. The precautionary principle is particularly compelling with regard to children, and the panic produced demands to compel the removal of all asbestos-containing products from schools and some other buildings. There is little doubt that breathing asbestos fibers can be distinctly hazardous to health, causing cancer and other fatal lung diseases.

The mere presence of asbestos-containing materials in buildings, however, did not necessarily create a risk. The actual exposure level in most public buildings, including schools, that contained asbestos was very low — about 0.0001 fibers per milliliter of air.[242] This is about the same concentration that is found outdoors,[243] suggesting that the indoor materials may not have been independently responsible for any exposure and therefore not responsible for any risk. Rather than rely on the measurements and risk assessments, however, schools employed the precautionary principle to remove the asbestos-containing materials without regard to actual risk.

In many cases, removal of asbestos-containing materials was foolish and created a health risk. Asbestos fibers are only hazardous when floating in the air and breathed in. Asbestos contained behind a wall or ceiling cannot be breathed. Removal operations disrupted this asbestos and exposed it to the air. Removal eliminated the bulky asbestos-containing products but could not capture every miniscule fiber that flaked off.

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241. LEWIS, *supra* note 50, at 113.

242. *See* HEALTH EFFECTS INST., ASBESTOS IN PUBLIC AND COMMERCIAL BUILDINGS 4-81 (1991).

243. A recent survey found that "fiber concentrations from recent studies in buildings are comparable to levels in the outdoor air, a point surely relevant to assessing the health risk of asbestos in buildings." B.T. Mossman, et al., *Asbestos: Scientific Development and Implications for Public Policy*, 247 SCIENCE 294, 299 (Jan. 19, 1990).

Many of these fibers settled to the floor. When students returned to the building, they disrupted the fibers that settled to the floor, and these fibers became resuspended in the air.[244] Removal operations shifted asbestos fibers into the breathable air. Studies consistently found that exposures to asbestos were *higher* after removal than they had been before.[245] The asbestos removal also created some additional risk for the workers involved in the removal process.

Much like asbestos, lead is an undeniably hazardous substance, yet efforts at its removal can increase the hazards it presents. A study of the Massachusetts Department of Public Health's Childhood Lead Poisoning Prevention Program found that the "process of deleading lead-painted buildings may cause a substantial increase in ambient lead levels."[246] Other studies have come to a similar conclusion.[247] Removal also creates dangerous lead exposure levels among workers and even their children.[248] The potential hazards of lead paint removal do not dejustify all efforts at removal,[249] but the risks caution for carefully targeted action, not blind pursuit of the precautionary principle.

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244. The National Institute of Building Sciences observed that "whether the removal process involves wet or dry disruption of the in-place asbestos, data shows that a substantial quantity becomes resuspended and recirculated throughout the building." Michael Fumento, *The Asbestos Rip-Off*, AM. SPECTATOR, Oct. 1989, at 21, 25.

245. *See* Frank B. Cross, *Asbestos in Schools: A Remonstrance Against Panic*, 11 COL. J. ENVTL. L. 73, 92 (1986). Dr. Robert Sawyer of Yale suggested that the one-sided perception of hazard caused the "stampeding of local school administrators into . . . a chaotic situation that can actually increase the hazard presented by asbestos-bearing products." *Quoted in id.* at 89; *see also* LEWIS, *supra* note 50, at 167 (emphasizing that "expert consensus is that the best thing that can be done for the children is to leave the stuff alone unless it is exposed and friable, not to release it into the atmosphere in a clumsy effort to get rid of it").

246. Yona Amitai et al., *Residential Deleading: Effects on the Blood Lead Levels of Lead-Poisoned Children*, 88 PEDIATRICS 893, 896 (1991).

247. Susan Rey-Alvarez & Theresa Menke-Hargrave, *Deleading Dilemma: Pitfall in Management of Childhood Lead Poisoning*, 79 PEDIATRICS 214 (1987); M. Rabinowitz et al., *Home Refinishing, Lead Paint and Infant Blood Lead Levels*, 75 AM. J. PUB. HEALTH 403 (1985); Ellen Ruppel Shell, *An Element of Doubt*, ATLANTIC MONTHLY, Dec. 1995, at 38. Shell summarizes the research of others and finds that lead removal can produce substantial increases in lead dust levels in the house and "a subsequent spike in blood lead levels." *Id.*

248. *See generally* R.G. Feldman, *Urban Lead Mining: Lead Intoxication Among Deleaders*, 298 NEW ENG. J. MED. 1143 (1978); E.L. Baker et al., *Lead Poisoning in Children of Lead Workers*, 296 NEW ENG. J. MED. 260 (1977).

249. The studies cited in the preceding footnotes generally conclude that deleading is beneficial so long as it is done carefully and occupants vacate the house until the process is complete. These steps may be ignored, however, absent a recognition of countervailing risks.

A similar risk can arise from remediation of hazardous waste sites. The presence of hazardous substances creates an understandable concern for those living nearby. Realistically, however, the waste site may pose little or no risk because the hazardous substances are well-contained on site. Forty academic scientists embarked upon a major epidemiologic study of mortality and morbidity associated with hazardous waste sites and found that, with one exception, the evidence of an association with disease was "weak."[250] Love Canal in New York was the paramount case of unsafe hazardous waste disposal, but studies have found that "no illness, not even a cold, can properly be attributed to living next to Love Canal."[251]

Cleanup operations at a hazardous waste site, conversely, may create considerable risk. One source of risk is to the cleanup workers because "the accidental fatality risk from cleanup [for a typical site] appears to be several times larger than the health risk from not cleaning up."[252] These risks are often ignored, even though "cleanup at a single site . . . may involve thousands of man-hours of work with heavy earth-moving equipment, as well as worker exposure to the risks of toxic chemicals and automobile commuting."[253] One study calculated that the Superfund cleanups taken by 1994 had caused an estimated 720 deaths associated with removal and remediation.[254] Other regulations also typically require construction or other manufacturing that will cause an increase in worker deaths.[255] Given the relatively low risks associated with the undisturbed sites, it seems likely that cleanups in a number of cases have caused more mortal-

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250. EXECUTIVE SCIENTIFIC PANEL OF UNIVERSITIES ASSOCIATED FOR RESEARCH AND EDUCATION IN PATHOLOGY, HEALTH ASPECTS OF THE DISPOSAL OF WASTE CHEMICALS 344 (Joe Grisham ed., 1986). The Executive Scientific Panel of Universities Associated for Research and Education in Pathology concluded that "none of the investigations has provided sufficient evidence to support the hypothesis that a causal link exists between exposure to chemicals at a disposal site and latent or delayed adverse health effects in the general populace." *Id.* at 246. An independent investigation of the studies likewise found that the only studies showing positive effects were "weak or inconclusive." Gary M. Marsh & Richard J. Caplan, *Evaluating Health Effects of Exposure at Hazardous Waste Sites: A Review of the State-of-the-Art, with Recommendations for Future Research*, *in* HEALTH EFFECTS FROM HAZARDOUS WASTES 3, 65 (Julian B. Andelman & Dwight W. Underhill eds., 1987).

251. WILDAVSKY, *supra* note 26, at 152.

252. GRAHAM & WIENER, *supra* note 49, at 16.

253. W. Kip Viscusi & Richard J. Zeckhauser, *The Fatality and Injury Costs of Expenditures*, 8 J. RISK UNCERTAINTY 19, 19 (1994).

254. W. Kip Viscusi, *Risk-Risk Analysis*, 8 J. RISK UNCERTAINTY 1, 3 (1994).

255. *See* Viscusi & Zeckhauser, *supra* note 253, at 33 (calculating relative risk in different industries, based on dollar expenditures). For example, for each $689 million in construction expenditures induced by a regulation, one worker is likely to die. *Id.*

ity than they have averted, yet the risks of remediation are commonly ignored in the pursuit of precaution.[256] Furthermore, the more exhaustive the cleanup effort, perhaps out of concern for dirt-eating children or farmers, the greater the risk of fatalities to workers.[257]

The transportation of hazardous waste in cleanup operations also creates health risks. When hazardous substances are removed from a site, they are typically transported to a modern, state-of-the-art disposal facility. This requires some form of shipping the wastes, with the attendant possibility of accidental release. One study found that the transportation of waste alone may create a health risk fourteen times greater than the health benefits of remediation.[258] Another study found that the series of shipments necessary to move the waste from a particular disposal site probably would yield from one to three transportation spills of the waste, with uncertain but possibly significant health consequences.[259]

The cleanup of a hazardous waste site near Cincinnati, known as the Fernald site and regarded as particularly hazardous, yielded an instructive study of remediation risks. In cleanup considerations at many sites, the risks to cleanup workers are not even considered,[260] but the Fernald committee considered a range of remediation risks. The committee found a considerable (four in one thousand) cancer risk to cleanup workers and a probable loss of several lives in connection with offsite waste transportation.[261] The Fernald Citizen's Task Force ultimately rejected the most

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256. *Id.* at 19 (noting that "[c]reated risks tend to be ignored completely when new expenditures are principally designed for risk reduction, as with the production and installation of pollution-control equipment or the cleanup of Superfund sites").

257. *See* HARVARD CTR. FOR RISK ANALYSIS, RISK IN PERSPECTIVE, Sept. 1995, at 3 (summarizing presentation of Dr. Curtis Travis of Oak Ridge National Laboratory whose "key finding is that worker fatality risks tend to increase as the desired levels of cleanup increase, since more soil excavation, solidification, and transportation is required to make the site cleaner").

258. Thomas Mar et al., *Physical Injury Risk Versus Risk from Hazardous Waste Remediation: A Case History*, 17 REG. TOX. & PHARMACOL. 130, 134 (1993).

259. Susan Brett et al., *Assessment of the Public Health Risks Associated with the Proposed Excavation of a Hazardous Waste Site, in* THE RISK ASSESSMENT OF ENVIRONMENTAL AND HUMAN HEALTH HAZARDS, *supra* note 75, at 427, 446.

260. *See* HARVARD CTR. FOR RISK ANALYSIS, *supra* note 257, at 3 (summarizing presentation of Alan Krupnick of Resources for the Future who observed that in "the official 'Records of Decisions' at many sites, the possibility of dangers to remediation workers are not even mentioned").

261. Fernald Citizens Task Force, *Recommendations on Remediation Levels, Waste Disposition, Priorities, and Future Use*, app. E, at 17-18 (June 1995). The Committee also found that "serious ecological damage . . . would occur from widespread excavation." *Id.* at 33. The process could rob square miles of "vital top soil, mature trees, and vegetation."

precautionary cleanup alternative, because it "would not only be expensive, but would also necessitate disposal of the soil elsewhere and would entail construction risks to the remediation workers."[262] The most protective approach also "posed the risk of disturbing contamination that was otherwise fairly immobile."[263] While the avoidance of mechanistic precaution was wise, even the more moderate alternative selected may have caused more deaths.

Those living near the site may also suffer increased risk from cleanup operations. Thoroughly cleaning up a waste disposal site involves digging and consequent disruption of hazardous substances, a disruption that may introduce new sources of human exposure to the substances. There is an "increased potential for chemical exposure of surrounding populations that is inherent with remedial activities."[264] One evaluation of a specific hazardous waste site cleanup found that individuals living nearby would be exposed to a higher level of airborne chemicals from the cleanup than the exposure that existed prior to cleanup.[265] A federal court took cognizance that the installation of certain wells in the course of a Superfund site cleanup could perversely cause hazardous substance contamination to spread to an underground aquifer, thereby increasing the environmental risk.[266] The transfer of pesticides to a landfill in Tennessee polluted groundwater with carcinogenic organic solvents, implicated as a source of various health problems.[267] Incineration is generally a safe procedure for hazardous waste disposal, but certain standards for sewage sludge disposal were estimated to save 0.2 cases of cancer by prohibiting land disposal while creating 2 additional cancers by shifting to incineration.[268] Such action requires the expenditure of money in order to increase public health risk — the worst of all possible worlds. Further trade-offs may occur in a conflict between protection of human health and the natural ecology.[269]

Id. at 34.

262. Applegate, *supra* note 38, at 1653-54.

263. *Id.*

264. Thomas C. Marshall et al., *A Risk Assessment of a Former Pesticide Production Facility*, *in* THE RISK ASSESSMENT OF ENVIRONMENTAL AND HUMAN HEALTH HAZARDS, *supra* note 75, at 461, 502.

265. Brett et al., *supra* note 259, at 427.

266. United States v. Princeton Gamma-Tech, Inc., 31 F.3d 138, 141 (3d Cir. 1994).

267. THE CONSERVATION FOUND., STATE OF THE ENVIRONMENT: AN ASSESSMENT AT MID-DECADE 329 (1984).

268. U.S. OFFICE OF MANAGEMENT AND BUDGET, REGULATORY PROGRAM OF THE UNITED STATES GOVERNMENT 25 (1991).

269. *See* Glenn W. Suter, II et al., *An Approach for Balancing Health and Ecological*

Additional risks of remediation may arise in air pollution control. When a proposed regulation required expensive and energy-intensive equipment to control emissions from coal-fired power plants, researchers discovered that "the equipment would have reduced power plant efficiency by about one percent, so an additional four large power plants nationally would have been needed."[270] From this, a "simple analysis indicated that more workers would die in such a large-scale construction program and many more public fatalities would be associated with operating the four added power plants" than the one life projected to be saved by the rule.[271] Some environmentalists proclaim the economic benefits of public health regulation because of new markets for pollution-control products, but the downside of this is the added manufacturing risk: "To the extent that government regulations mandate other economic efforts, such as the installation of pollution-control equipment, there will be some injuries and deaths associated with manufacturing of this equipment."[272] This health cost does not dejustify all efforts to control pollution (except perhaps under the precautionary principle itself), but the potential mortality risks demonstrate that blind precaution can be counterproductive.

The shifting of risk media characterized by hazardous substance cleanup is pervasive in environmental regulation.[273] In many cases, measures to preclude air pollution only shifted the problem to the water, and vice versa. The Clean Air Act "requirement that all coal-burning power plants install scrubbers to remove sulfur dioxide from their smokestacks has generated tons of sulfur sludge that must be disposed of elsewhere."[274]

Risks at Hazardous Waste Sites, 15 RISK ANALYSIS 221, 222 (1995) (observing that remediation to protect ecological values may cause "accidental injuries and deaths among workers" and "increased exposure on and off the site to contaminants in dust, vapors, emissions from treatment facilities, etc."). Conversely, cleanups to protect human health can cause habitat destruction and additional contaminant exposure. *Id.* Efforts to reduce one ecological risk to animals may likewise require harms to plants and other animal species. *Id.*

270. Keeney, *supra* note 56, at 629.

271. *Id.*

272. W. Kip Viscusi, *Risk-Risk Analysis*, 17 J. RISK UNCERTAINTY 5, 6 (1994).

273. *See* Lakshman Guruswamy, *The Case of Integrated Pollution Control*, 54 LAW & CONTEMP. PROBS. 41, 42 (Autumn 1991) ("Limitations on discharges in one medium, such as air, while correcting the immediate pollution problem within that medium, often do little more than shift the pollution to another medium. Such transfers can create even greater problems in the medium to which they are moved."); Richard J. Lazarus, *The Meaning and Promotion of Environmental Justice*, 5 MD. J. CONTEMP. LEGAL ISSUES 1, 3 (1995) (declaring that "the laws generally convert environmental risks of one kind or at one location to residual risks of another kind or at another location").

274. GRAHAM & WIENER, *supra* note 49, at 13. The authors further observe that the

Resultant water quality regulations "have for years removed toxic pollutants from water and disposed of them in landfills, some of which promptly leached into groundwater."[275] The EPA conceded that its water quality effluent guidelines for the chemical industry "fail to treat substantial portions of volatile and semi-volatile pollutants but rather transfer them to the air."[276] One commentator suggests that the "present regime concentrates on moving pollution from one place to another . . . [so] pollutants ultimately re-enter the flow of material in the environment."[277] The common answer to this problem is pollution prevention, but even these programs aimed at reducing the use of toxic chemicals may produce "production processes that reduce one kind of pollution by increasing another."[278] The commonality of such intermedia shifts does not condemn all pollution-control programs. Some media present less risk of human exposure than do others. Exposure may be relatively more safe from some media — a substance that causes lung cancer from inhalation in the air may not be so hazardous when ingested in water. The critical point is that a media shift may increase or decrease risk, so that this consequence must be considered lest blind application of the precautionary principle produce greater risk.

Another instance of counterproductive control measures can be found in regulation of nuclear power. The most serious nuclear accident that has occurred, at Chernobyl, resulted from "an effort to increase reactor safety by providing yet another source of emergency power."[279] After the far less serious accident at Three Mile Island in Pennsylvania, "nuclear plants worldwide were shut down and restarted more frequently for safety checks, although these phases of operations (as with aircraft takeoffs and landings) are by far the riskiest operational stages."[280] Certain screening

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scrubber requirement has "ironically also increased emissions of other pollutants such as the greenhouse gas carbon dioxide." *Id.*

275. CROSS, *supra* note 47, at 149.

276. *Id.* (quoting EPA water quality effluent guidelines for chemicals industry).

277. Guruswamy, *supra* note 273, at 41.

278. Richard J. Lazarus, *Pursuing "Environmental Justice": The Distributional Effects of Environmental Protection*, 87 NW. U. L. REV. 787, 794 (1993); *see also* HARVARD CTR. FOR RISK ANALYSIS, *supra* note 257, at 4 (summarizing presentation of Dr. Lester Lave of Carnegie Mellon who explained how efforts to reduce small amount of toxic emissions attributable to automobile manufacturers could perversely increase emissions from suppliers of automotive inputs).

279. WILDAVSKY, *supra* note 122, at 130.

280. Roger Kasperson et al., *The Social Amplification of Risk: A Conceptual Framework*, 8 RISK ANALYSIS 177, 184 (1988).

requirements for nuclear power plant personnel "can pose a threat to reactor safety when [they] delay the entry of needed expert personnel during an accident such as the one at Three Mile Island."[281] Some requirements aimed at reducing the risk of radiation release to the outside population cause workers to be needlessly exposed to radiation in retrofitting operations.[282] Nuclear safety regulation is obviously necessary, but blind application of the precautionary principle across the board will increase the overall risk level by creating new sources of hazard.

The adverse effects of remediation can also be seen in areas other than public health regulation. The unfortunate oil spill in Prince William Sound, Alaska provoked extensive efforts to clean up the oil from the beaches and water. This straightforward effort at environmental protection may well have damaged the overall ecosystem. Efforts to clean oil from the beaches as rapidly as possible caused the use of high-pressure hot water jets that may have "cooked" more organisms to death than were harmed by the oil itself.[283] Other measures may also have been counterproductive; the mere human presence at the cleanup site caused harm from simple "trampling."[284] The cleanup efforts did not merely cause harm, they apparently caused more harm than benefit and more harm than the oil spill caused in the first place.[285] The counterproductive cleanup was not

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281. WILDAVSKY, *supra* note 122, at 127.

282. *Id.* at 124.

283. *See Washing Alaska's Oiled Beaches Backfired, Caused More Damage than Good, Scientists Say*, 21 Env't Rep. (BNA) 2228 (Apr. 12, 1991) [hereinafter *Washing Alaska's Oiled Beaches Backfired*].

284. *See* Frank B. Cross, *Restoring Restoration for Natural Resource Damages*, 24 U. TOL. L. REV. 319, 336 (1993); *see also* EASTERBROOK, *supra* note 4, at 56 (reporting concerns of researcher Dennis Lees). Easterbrook notes that:

> Lees's concern was that the cleanup did more damage than the spill. Under pressure from public opinion, Exxon and the Coast Guard committed themselves to a grand-scale cleanup operation that at its peak placed in the sound the greatest concentration of vessels engaged in a single operation since the Normandy landing. Hundreds of ships of all sizes anchored in the fjord, motors spewing exhaust and lubricants. Heavy helicopters thundered overhead; floatplanes and seaplanes darted everywhere. Navy landing craft were run ashore on beaches to act as dormitories for cleanup crews, crushing intertidal ecosystems beneath their bulks. In many ways, these mechanized intrusions were of greater magnitude to the sound than one spill from a single vessel, even a spill of great proportions.

Id.

285. The chief scientist of the National Oceanic and Atmospheric Administration declared that the "abundance and diversity of life is significantly lower" at cleaned up sites "than on places left alone with oil." *Washing Alaska's Oiled Beaches Backfired, supra* note 283, at 2228. Others reported that the "[t]reated beaches are clearly in the worse shape."

unique to the Exxon Valdez spill. Similar problems occurred with the Torrey Canyon oil spill and efforts to restore Mount St. Helens after its eruption.[286] The Court of Appeals for the First Circuit rejected a restoration program following a Caribbean oil spill, reporting that the restoration itself could be "unjustifiably dangerous to the healthy mangroves and marine animals still present in the area."[287]

In another type of paradoxical peril, safety measures may not increase the particular risk being addressed, but can create different, collateral risks that may exceed the intended benefit of the rule. The best known case of this risk involves automobile fuel efficiency regulations. In response to the OPEC threat, Congress created Corporate Average Fuel Economy (CAFE) standards in order to save fuel and reduce pollution. To meet the CAFE standards, automobile manufacturers had to produce smaller, lighter cars that get better gas mileage. Tragically, these smaller cars are less safe when involved in highway accidents. Robert Crandall and John Graham found that each five hundred pound reduction in the weight of cars was associated with at least a fourteen percent increase in the risk of serious injury and death.[288] The National Highway Traffic Safety Admin-

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Richard A. Kerr, *A Lesson Learned, Again, at Valdez*, 252 SCIENCE 371, 371 (Apr. 19, 1991). A study by the Moss Landing Institute found that the shoreline cleanup would "increase immediate ecological damage and delay recovery" of the ecosystem. JOHN KEEBLE, OUT OF THE CHANNEL: THE EXXON VALDEZ OIL SPILL IN PRINCE WILLIAM SOUND 266 (1991). The cleanup process in the sound itself may have left the area "with its ecological balance so traumatized, so it may never recover." *Hearings on Oil Spill Response Technology Before the Subcomm. on Oceanography, Great Lakes and the Outer Continental Shelf of the House Comm. on Merchant Marine and Fisheries*, 102d Cong. 118 (1991) (statement of Rep. Hertel).

286. With respect to the harm of cleanup at Torrey Canyon, see Kerr, *supra* note 285, at 371. With respect to Mount St. Helens, see Jerry F. Franklin et al., *Re-Creation of Ecosystems at Mount St. Helens: Contrasts in Artificial and Natural Approaches*, *in* 2 REHABILITATING DAMAGED ECOSYSTEMS 17 (John Cairns ed., 1988).

287. Puerto Rico v. S.S. Zoe Colocotroni, 628 F.2d 652, 676 (1st Cir. 1980), *cert. denied*, 450 U.S. 912 (1981).

288. Robert C. Crandall & John D. Graham, *Automobile Safety Regulation and Offsetting Driver Behavior: Some New Empirical Estimates*, 74 AM. ECON. REV. 328, 328-30 (1984). Crandall and Graham estimated that CAFE could cost thousands of lives and tens of thousands of serious injuries. *Id.; see also* Leonard Evans & Michael C. Frick, *Car Size or Car Mass: Which Has Greater Influence on Fatality Risk?*, 82 AM. J. PUB. HEALTH 1105, 1105 (1992) (concluding that reduced car mass is associated with increased safety risk to occupants); John D. Graham, *The Safety Risks of Proposed Fuel Economy Legislation*, 3 RISK 95, 126 (1992). Upon judicial review, the Court of Appeals for the D.C. Circuit stressed that the likely consequence of the CAFE standard appeared to be an increase in traffic fatalities. *See* Competitive Enter. Inst. v. NHTSA, 956 F.2d 321, 326-27 (D.C. Cir. 1992) (reviewing evidence and finding that nothing in record "appears to undermine the

istration (NHTSA) has wavered in its policy on CAFE standards under political pressure, but did take a stand against increasing the fuel efficiency standards further.[289] The "U.S. Department of Transportation estimates that 1,300 lives are lost per year because of the switch from larger cars to the smaller, more fuel-efficient vehicles."[290] Ironically, while the CAFE standards made cars more fuel efficient, they may not have decreased total automobile fuel consumption, meaning that the standards traded safety for nothing.[291] Other studies suggest that some automobile recalls may also cause greater risk than they prevent.[292]

The debate over mandating child safety seats on airlines reflects another aspect of this risk. While child safety seats themselves increase safety, requiring the use of such seats would require the parents of young children to purchase a second ticket to travel by air, which in turn would make air travel unaffordable for many and induce them to drive to their destinations. This effect would mean more infant deaths because driving risks are much higher than those from air travel, even without the safety seats.[293]

Somewhat more indirect risks from regulation arise from the offsetting behavior of consumers affected by the rule. Imposing safety precautions can have a lulling effect on consumers, causing them to take more voluntary risks and counteract the benefit of the safety measures. The Consumer Product Safety Commission (CPSC) rule requiring safety caps on some drug bottles apparently had just this effect. One study found that parents took fewer precautions in reliance on the reputedly childproof caps, so that poisonings actually increased. The regulatory action may have produced 3500 additional analgesic poisonings per year.[294] Other

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inference that the 27.5 mpg standard kills people").

289. *See* Kazman, *Death by Regulation, supra* note 30, at 21 (observing that NHTSA analyses suggest that hazardous effects of automobile downsizing have more than counteracted beneficial consequences of mandated airbags).

290. VISCUSI, *supra* note 30, at 3.

291. *See* Peter Passell, *Were the Government's Mileage Standards for Cars a Mistake?*, N.Y. TIMES, Apr. 6, 1995, at D2 (noting that "growth in the number of vehicle-miles traveled has more than offset the improved efficiency of the auto fleet"). More efficient cars are cheaper to drive, thus encouraging more driving. This may not entirely offset the energy savings from efficiency, but it probably creates an even greater safety risk — more driving presumably means more accidents.

292. *See* Keeney, *supra* note 56, at 629 (citing study by Lester Lave which found that recall of cars for inspection and replacement of potentially defective axle part would cause more risk from extra driving than risk associated with recall).

293. *See* Kazman, *Death by Regulation, supra* note 30, at 19.

294. VISCUSI, *supra* note 30, at 240.

research demonstrated similar increases in risk in response to CPSC standards on bicycles, cribs, carpets, and matches.[295] The lulling effect is not reason in itself to eschew regulation, but the effect illustrates the potential counterproductivity of government action. This risk is especially pronounced when government overclaims the benefits from a regulation, thereby producing a false sense of security in the affected public.

II. Additional Indirect Risks of the Precautionary Principle

The direct physical risks of safety described in Section I above present the most compelling cause against the precautionary principle because the risk transfer is so blatant and direct. With a few exceptions (e.g., international use of DDT, coal-fired power generation), the magnitude of perverse risk creation from this physical transfer is fortunately rather small.[296] Cass Sunstein has noted that the existence of counterproductive control measures may not be "so troubling," because "most of the time the risks we face are, or seem, blessedly low."[297] Many of the examples described in Section I involved the government regulating a miniscule risk and creating a greater, but still exceedingly small, new risk. These judgments are not wise but neither are they typically catastrophic.

Greater health risks are caused indirectly by the deployment of the precautionary principle. This section discusses two important indirect mechanisms of counterproductivity in public health regulation. First, there are substantial health risks from the misallocation of government resources to attack the wrong problems. Precautionary pursuit of tiny risk is harmful to the extent that greater risks are overlooked. Second, there are health risks from the societal economic costs of regulation. These consequences are now examined.

A. Health Risks of Political Resource Misallocation

In practice, the precautionary principle suffers from tunnel vision. Advocates focus on an apparent public health problem, demand that it be

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295. *Id.* at 243.

296. This issue is addressed in a recent NAS Report. The report found that natural chemicals presented a greater dietary risk than synthetic chemicals, but all were present at such low levels that they were "unlikely to pose an appreciable cancer risk." Jane E. Brody, *Food Chemical-Cancer Link? Expert Panel Is Not Worried*, N.Y. TIMES, Feb. 16, 1996, at A1. A significant risk might be created, however, if fears caused less consumption of anticarcinogenic produce. *Id.* at A10.

297. Cass R. Sunstein, *Foreword* to JOHN D. GRAHAM & JONATHAN B. WIENER, RISK VERSUS RISK: TRADE-OFFS IN PROTECTING HEALTH AND THE ENVIRONMENT at vii (1995).

addressed out of precaution, and further demand that regulation be particularly strict to avoid any risk of adverse effects. The debate unfortunately dwells on the merits of the particular problem under consideration, without any attention to opportunity costs. In reality, there are a myriad of potential public health and environmental issues to address and a limit to the time, effort, and money available. Consequently, the precautionary principle is not precautionary in overall effect. Focusing great precaution upon the instant problem must reduce precaution upon other problems, which may prove greater and more serious.[298] In this sense, the precautionary principle gives fealty not to precaution, but to whatever issue happens to alight atop the agenda for attention.[299]

A current movement both within and without the government is known as comparative risk.[300] This approach contends that the government should compare the magnitude of various environmental risks to public health and should focus its regulatory attention upon the greatest of these risks. The agencies have a limited budget and number of employees, although drafting a regulation may take considerable time and investigation.[301] Moreover, society has limited financial resources and limited

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298. *See* Applegate, *supra* note 38, at 1657 (suggesting that "agency that lacks a deliberate planning and priority-setting process will simply respond to the crisis du jour and will drift, squander its resources, and ultimately accomplish little").

299. *See, e.g.*, John Graham, Making Sense of Risk: An Agenda for Congress 2 (unpublished paper, presented at American Enterprise Institute Conference on Risk Assessment and Public Policy (Oct. 27, 1994)) (observing that "[l]arge amounts of resources are devoted to slight or speculative dangers while substantial and well-documented dangers remain unaddressed").

300. *See, e.g.*, U.S. ENVIRONMENTAL PROTECTION AGENCY, UNFINISHED BUSINESS: A COMPARATIVE ASSESSMENT OF ENVIRONMENTAL PROBLEMS (1987) (attempting to develop EPA comparative risk assessment program). The debate over comparative risk is thoroughly addressed in WORST THINGS FIRST?, *supra* note 123. The current use of comparative risk in government agencies is presented most directly in F. Henry Habicht, II, *EPA's Vision for Setting National Environmental Priorities*, *in* WORST THINGS FIRST?, *supra* note 123, at 33, 33-46, and Charles W. Kent & Frederick W. Allen, *An Overview of Risk-Based-Priority Setting at EPA*, *in* WORST THINGS FIRST?, *supra* note 123, at 47, 47-68. *See generally* John S. Applegate, *Worst Things First: Risk, Information and Regulatory Structure in Toxic Substances Control*, 9 YALE J. REG. 277 (1992); Frank B. Cross, *Why Shouldn't We Regulate the Worst Things First?*, 4 N.Y.U. ENVTL. L.J. 312 (1995).

301. *See, e.g.*, Richard Andrews, *Long-Range Planning in Environmental Health and Regulatory Agencies*, 20 ECOLOGY L.Q. 515, 516 (1993) (remarking that "agency regulatory processes have become labyrinthine and cumbersome" due to "inadequate resources, increasingly heavy burdens of proof to justify agency proposals, constant and detailed oversight," and other factors); Applegate, *supra* note 300, at 286 (observing that "information and analysis costs associated with developing a major regulation are high in any event, but extensive industry involvement requires extensive analysis during the rulemaking process

"worry beads" with which it may concentrate its concern. Historically, even with precautionary concern, a federal agency has been unable to issue more than two or three major public health regulations of chemicals in a year. [302] Given such limits, precautionary attention to one problem inevitably draws responsive efforts from other problems.[303]

Insofar as the precautionary principle diverts action from problem *A* to problem *B*, the principle is counterproductive whenever the risk from *A* is greater in magnitude than that from *B*. Yet, by its very terms, the precautionary principle ignores this loss in its single-minded focus on eliminating any risk of a risk from the problem under attention.[304] Even the Supreme Court noted that if government agencies must respond to public fears of risk, the "available resources may be spread so thin that agencies are unable adequately to pursue protection of the physical environment and natural resources."[305] Stephen Breyer was not on the Court at the time of that decision, but he has written that dollars spent unnecessarily on precaution mean that the "money is not, or will not be, there to spend, at least if we want to address more serious environmental or social problems — the need for better prenatal care, vaccinations, and cancer diagnosis, not to mention daycare, housing and education."[306]

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to respond to arguments and prepare for the inevitable court challenge").

302. Applegate, *supra* note 300, at 287. The Occupational Safety and Health Administration has a budget that will permit no more than two major rules per year. CROSS, *supra* note 47, at 140.

303. *See* Milton Russell, *The Making of Cruel Choices*, *in* VALUING HEALTH RISKS, COSTS, AND BENEFITS FOR ENVIRONMENTAL DECISION MAKING, *supra* note 30, at 15, 18 (stressing that "the selection of any action simultaneously rejects others").

304. *See* Dennis J. Paustenbach, *A Survey of Health Risk Assessment*, *in* THE RISK ASSESSMENT OF ENVIRONMENTAL AND HUMAN HEALTH HAZARDS, *supra* note 75, at 27, 101 ("Money or regulatory attention spent on one risk is not available for another, so it is important not to waste resources on trivial risks. Here, conservatism is counterproductive, and risks are increased if resources are shifted from significant risks to small, exaggerated risks.").

305. Metropolitan Edison Co. v. People Against Nuclear Energy, 460 U.S. 766, 776 (1983).

306. BREYER, *supra* note 30, at 19. For a real world example of this effect, see Graham, *supra* note 299, at 8 (observing that in Columbus, Ohio, "environmental mandates from U.S. EPA are forcing cuts in basic public health services typically provided by the state's health department"). While perfect fungibility is illusory, the author stresses that "resources for protection against dangers are being rationed" today. *Id.* There is a trade-off between resources for regulation of a given pollutant and other public health protection resources. One case study found that environmental activists siphoned off government resources intended for low-income assistance in order to fuel environmental litigation that was contrary to the interests of the poor. *See* H. Peter Metzger & Richard A. Westfall, *The*

The trade-off between these objectives is concededly imperfect. Government resources are not perfectly fungible nor are they always efficiently allocated.[307] Less money for toxic chemical regulation does not necessarily translate into more money for childhood vaccinations.[308] Yet, the imperfection of the trade-off does not deny its existence, and the trade-offs are most likely to occur within agencies, which have some flexibility in whether to allocate their attention to, say, the ambient ozone standard or the ambient standard for airborne particulates.[309] When the federal courts required the EPA to expedite its regulation of radionuclides in the air, "the agency had to take personnel from development of new source performance standards, which probably would have provided more overall health protection."[310] Likewise, the FDA's felt need to focus on minimal risks from pesticides in foods has diverted its attention from the much greater hazards of microbial contamination.[311] The health risks from misprioritization caused by the precautionary principle may be substantial. Research at the Harvard Center for Risk Analysis finds that improved

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Great Ecology Swindle, POL'Y REV., Winter 1981, at 71.

307. *See* David A. Wirth & Ellen K. Silbergeld, *Risky Reform*, 95 COLUM. L. REV. 1857, 1884 (1995) (criticizing Breyer because "he assumes without proof that those resources could be more effectively allocated elsewhere").

308. *See* E. Donald Elliot, Jr., *A Cabin on the Mountain: Reflections on the Distributional Consequences of Environmental Protection Programs*, 1 KAN. J. L. & PUB. POL'Y 5, 8 (1991) (declaring that he had to "be a little skeptical about whether the money we spend on cleaning up toxic waste sites really would go to dealing with infant mortality instead").

309. *See* Warren & Marchant, *supra* note 59, at 388 n.42 (declaring that "enormous resources are being committed to reduce air pollutants such as ozone and sulfur dioxide, which affect health and the environment but have not been shown to cause death, while relatively little has been spent to reduce small soot particles, which EPA estimates may be causing as many as 60,000 premature deaths in the United States per year").

310. CROSS, *supra* note 47, at 153.

311. *See* Roger Middlekauff, *Issues of Food Safety and Quality Relating to Food Ingredients*, *in* CONSUMER DEMANDS IN THE MARKETPLACE 45, 48 (Katherine L. Clancy ed., 1988) (observing that preoccupation with cancer risks from food additives "has distracted the public from other food and food-ingredient concerns that may have an even greater impact on their health"); Passell, *supra* note 63, at D12 (suggesting that focus on pesticides has diverted FDA attention from contaminated meat, eggs, and other foods); *see also* Perry J. Gehring, *Risk Management in the Absence of Credible Risk Assessment*, *in* PESTICIDE RESIDUES AND FOOD SAFETY, *supra* note 102, at 267, 274 ("Because of the anxieties generated in those areas where we cannot provide exact quantification, we find ourselves diverting resources away from more significant risks. For example, while the risk estimated from exposure to pesticide residues in food averages on the order of one cancer in a million, the risk of illness from microbial contamination is one in a hundred, with the risk of death estimated at about one in a thousand.").

prioritization could save an additional 60,000 lives each year.[312] This figure assumes a redistributive efficiency beyond realistic achievement. Yet, the study demonstrates that even a marginal ten percent redirection of resources could save thousands of lives. Unfortunately, the precautionary principle takes no account of these indirect effects of regulation and thereby ignores the readily available benefit from a prioritization based upon the best scientific evidence.

The precautionary principle creates a second form of political research misallocation because its quixotic quest for the best defeats our ability to achieve the good. By its nature, the precautionary principle aims for virtually absolutist goals, eliminating any hint of risk from a substance subject to government regulation. This approach fails to account for the inevitable trade-off between the "depth" and the "breadth" of government action. Regulating any one substance more strictly or deeply requires additional resources that will unintentionally preclude more widespread regulation of a greater number of risks.

John Mendeloff's study of the Occupational Safety and Health Administration (OSHA) demonstrated the dichotomy between the depth and breadth of regulatory action.[313] He referred to the trade-off as one of overregulation and underregulation. The overregulation of any one substance as compelled by the precautionary principle would lead to the underregulation of other substances never attended by the agency. Mendeloff noted that OSHA began by adopting the four hundred occupational health standards already set by a private group, the American Conference of Government Industrial Hygienists (ACGIH). OSHA thereby was able to hit the ground running with standards in place, and the agency was to revisit and modify the ACGIH standards as appropriate and set additional standards for theretofore unregulated substances. From its 1970 inception until 1986, OSHA reconsidered and lowered the ACGIH standards for only ten chemicals; during the same time period, ACGIH had lowered its standards for nearly one hundred chemicals and adopted recommended exposure limits for an additional two hundred chemicals.[314] Mendeloff found that ACGIH could regulate many more chemicals because its response to any given chemical was less strict — the ACGIH exposure reductions were about fifty percent, while OSHA's typical reduction was

312. *See generally* Tammy O. Tengs et al., *Five Hundred Life-Saving Interventions and Their Cost-Effectiveness*, 15 RISK ANALYSIS 369 (1994).

313. JOHN MENDELOFF, THE DILEMMA OF TOXIC SUBSTANCE REGULATION: HOW OVERREGULATION CAUSES UNDERREGULATION AT OSHA (1988).

314. *Id.* at 82.

around ninety percent.[315] While the ACGIH reductions for any one chemical under consideration were less, ACGIH addressed so many more substances that its reductions promised to save several hundred more lives than did the OSHA actions.[316]

Mendeloff's dilemma is further demonstrated by the historic pattern of EPA regulation of hazardous air pollutants. The language of the Clean Air Act suggested that hazardous air pollutants had to be regulated so stringently as to eliminate any risk of health harm, however remote — a virtual physical impossibility.[317] As a consequence, the EPA regulated very few substances as hazardous air pollutants (less than one each year), acknowledging that the Act's strict decision rule had "deterred the listing and promulgation of many regulations."[318] Congress finally confronted this reality in the 1990 amendments to the Act, which "clearly recognized the value of trading stringency for speed and scope."[319] Comparable examples can be found in other areas of government public health regulation.[320] Thus, "the price of excessively stringent statutory criteria is a sluggish or paralyzed standard-setting process."[321]

Stephen Breyer has characterized this problem as the counterproductive effort to eliminate the "last ten percent" of risk from a substance or activity. He declares that strategy unwise because it involves "high cost, devotion of considerable agency resources, large legal fees, and endless

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315. *See* John Mendeloff, *Regulatory Reform and OSHA Policy*, 5 J. POL'Y ANALYSIS & MGMT. 440, 442 (1986).

316. *Id.*

317. *See* Frank B. Cross, *Section 111(d) of the Clean Air Act: A New Approach to the Control of Airborne Carcinogens*, 13 B.C. ENVTL. AFF. L. REV. 215, 226-27 (1986).

318. *Id.* at 227. This story is also told in John P. Dwyer, *The Pathology of Symbolic Legislation*, 17 ECOLOGY L.Q. 233 (1990). Dwyer observes that the stringent precautionary margin of safety standard in the law made it difficult for standards to survive judicial review and served to polarize the interested parties, thereby preventing an effective compromise solution. *Id.* at 279-81.

319. Applegate, *supra* note 300, at 327.

320. Mendeloff cites § 4 of the Toxic Substances Control Act as a provision that contains such stringent requirements as to limit the EPA to two to three promulgated rules each year. John Mendeloff, *Does Overregulation Cause Underregulation? The Case of Toxic Substances*, REGULATION, Sept./Oct. 1981, at 50. The stringency of the Delaney Clause has meant that it is seldom effectively used for cancer prevention. *See* CROSS, *supra* note 47, at 144 (suggesting that clause "had made no meaningful contribution to cancer protection"). As the NHTSA promulgated stricter auto safety standards, its pace slowed, and NHTSA virtually abandoned its standard-setting efforts. JERRY L. MASHAW & DAVID L. HARFST, THE STRUGGLE FOR AUTO SAFETY 10-11 (1990).

321. John P. Dwyer, *Overregulation*, 15 ECOLOGY L.Q. 719, 737 (1988).

argument" with only limited payoff.[322] Such stringent rules are also more likely to be challenged in court and overturned on judicial review.[323] Even when such rules are adopted successfully, the effort to eliminate the last ten percent wastes considerable resources. Breyer quotes an EPA administrator as observing that "about 95 percent of the toxic material could be removed from [Superfund] waste sites in a few months, but years are spent trying to remove the last little bit."[324] Draconian standards under Superfund have undermined effective cleanup and health protection measures.[325] The precautionary principle's insistent demand for ever higher safety margins in each regulation perversely serves to reduce the overall amount of effective public health regulation.[326]

A regulatory program that focused upon the greatest risks to public health and the environment would produce greater benefit, yet the precautionary principle eschews such risk comparisons. In addition to addressing the greatest risks, the government should also consider the remediability of environmental problems.[327] It makes little sense to dwell extensively upon even a great problem that cannot feasibly be solved. The precautionary principle does not take remediability into account, however. The principle presses for zero risk, regardless of formal realizability. Thus, the precautionary principle obstructs consideration of two key factors — priorities and capabilities — in maximizing the protection of public health and the environment.

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322. BREYER, *supra* note 30, at 11; *see also* Warren & Marchant, *supra* note 59, at 388 (reporting that attempt to "defend overly stringent regulations that provide limited extra benefits at high marginal costs" requires agencies to "expend both resources and precious political capital" that could be better devoted to other problems).

323. BREYER, *supra* note 30, at 10; *see also* FREDERICK ANDERSON ET AL., ENVIRONMENTAL IMPROVEMENT THROUGH ECONOMIC INCENTIVES 15 (1977) (observing that when government requirements are extremely costly or unproved, "a firm can reasonably expect to make a convincing case in court about the infeasibility or unreasonableness of the emission requirements").

324. BREYER, *supra* note 30, at 11 (quoting Superfund project manager Leo Levenson).

325. *See generally* Frank B. Cross & Scott Segal, *And the Meek Shall Inherit a Cleaner Earth*, 9 J. NAT. RESOURCES & ENVTL. LAW 269 (1993-94) (demonstrating how strict liability standards and insistence upon "utter purity" cleanup standards have frustrated implementation of law).

326. *See, e.g.*, Douglas N. Jones & Richard A. Tybout, *Environmental Regulation and Electric Utility Regulation: Compatibility and Conflict*, B.C. ENVTL. AFF. L. REV. 31, 35 (1986) (declaring that as "a result of our collective unwillingness to address explicitly the economics of saving lives, we are saving far fewer lives than we could with the resources devoted to that purpose").

327. *See* Applegate, *supra* note 38, at 1663-64 (stressing that "tractability of a problem and the administrability of the remedy also ought to be considered").

B. Health Risks of Economic Costs

The true health costs of unnecessary and expensive regulation are largely overlooked in the debate over environmental and public health protection. As previously noted, the debate tends to be drawn between health protection for average Americans and financial costs to large corporations. The real effects of regulation, however, are somewhat more complex. Regulatory costs will be borne not by the corporation itself, but by its customers (higher prices) or workers (fewer jobs or reduced wages).[328]

Many environmental and public health regulations are extraordinarily costly. EPA regulations impose economic costs of tens of billions of dollars annually, according to the agency itself.[329] Overall social costs will generally exceed the direct compliance costs.[330] Much of the cost of regulation will be passed on to consumers in the form of higher prices.[331] Moreover, these regulatory costs are felt most severely by the most disadvantaged groups — those least able to afford them. Robert Bullard has

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328. *See* Cross, *supra* note 52, at 762-64 (demonstrating both theoretically and empirically that regulatory costs are primarily borne by consumers and workers); *see also* Alfred F. Conard, *Who Pays in the End for Injury Compensation? Reflections on Wealth Transfers from the Innocent*, 30 SAN DIEGO L. REV. 283, 288 (1993) (reporting that costs generally will be borne by consumers but could be passed back to workers); International Union, United Auto., Aerospace & Agric. Implement Workers v. OSHA, 938 F.2d 1310, 1319 (D.C. Cir. 1991) (contending that costs may be passed on to consumers or passed back to labor in form of reduced wages).

329. *See* Michael Hazilla & Raymond J. Kopp, *Social Cost of Environmental Quality Regulations: A General Equilibrium Analysis*, 98 J. POL. ECON. 853, 857 (1990) (summarizing EPA estimates of regulatory costs).

330. *See id.* at 865 (displaying table reporting that social costs generally exceed direct compliance costs); *see also* Ann P. Bartel & Lacy G. Thomas, *Predation Through Regulation: The Wage and Profit Effects of the Occupational Safety and Health Administration and the Environmental Protection Agency*, 30 J.L. & ECON. 239, 239-40 (1987) (noting that indirect costs of regulation can exceed direct compliance costs); Maureen L. Cropper & Wallace E. Oates, *Environmental Economics: A Survey*, 30 J. ECON. LIT. 675, 722 (1992) (declaring that in long-run "social costs of the Clean Air and Clean Water Acts exceed simple expenditure estimates because of the effects of decreases in income on saving and investment").

331. *See* Sue Lieu, *Regional Impacts of Air Quality Regulation: Applying an Economic Model*, 9 CONTEMP. POL'Y ISSUES 24, 29 (1991) (finding that southern California air quality control plan would increase prices); Paul R. Portney, *The Macroeconomic Impacts of Federal Environmental Regulation*, 21 NAT. RES. J. 459, 486 (1981) (concluding that environmental regulation increased average inflation rate by 0.4% to 0.6%); Adam Rose, *Modeling the Macroeconomic Impact of Air Pollution Abatement*, 23 J. REGIONAL SCI. 441, 456-57 (1983) (suggesting that much, but not all cost, will be passed on to consumers); *see also supra* note 330 (citing sources discussing social costs of environmental regulations).

observed that most of this nation's environmental policies "distribute the costs in a regressive pattern while providing disproportionate benefits for the educated and wealthy."[332]

While industry typically complains of the costs of compliance with regulation, experience has shown such complaints to be occasionally overstated. Nevertheless, the true costs of environmental and public health regulations are significant, and some experience reveals that the estimated costs of regulation have been underestimated.[333] Unobserved, indirect costs may well dwarf the obvious direct compliance costs of environmental and other public health regulation. Several large studies have examined the consequences of health and safety regulation on business productivity and concluded that over thirty percent of the decline in the rate of productivity growth in this country could be attributed to such rules.[334] Enhanced productivity is the key to higher wages and economic growth;[335] reductions in productivity correspondingly undermine national economic welfare.[336] The total financial costs of environmental regulation may be enormous.

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332. Bullard, *supra* note 135, at 239.

333. *See generally* Miriam Heller et al., *Environmental Accounting Case Study: Amoco Yorktown Refinery, in* GREEN LEDGERS: CASE STUDIES IN CORPORATE ENVIRONMENTAL ACCOUNTING 47 (Daryl Ditz et al. eds., 1995). Compliance costs were initially estimated to be around 3% of non-crude operating costs. The authors' closer investigation of indirect effects revealed that "environmental costs were found to be approximately 22% of non-crude operating costs," and "even this understates the total costs, in that it does not include estimates of unknown future environmental liabilities — for example, from waste disposal." *Id.* at 79.

334. *See generally* EDWARD F. DENISON, ACCOUNTING FOR SLOWER ECONOMIC GROWTH 124 (1979) (concluding that 40% of decline in productivity growth in 1970s was due to environmental and occupational safety and health regulation); Frank M. Gollop & Mark J. Roberts, *Environmental Regulations and Productivity Growth: The Case of Fossil-Fueled Electric Power Generation*, 91 J. POL. ECON. 654 (1983) (concluding that environmental regulation of such utilities caused 44% reduction in utilities' productivity); Wayne B. Gray, *The Cost of Regulation: OSHA, EPA and the Productivity Slowdown*, 77 AM. ECON. REV. 998 (1987) (finding 30% of decline attributable to EPA and OSHA rules); James C. Robinson, *The Impact of Environmental and Occupational Health Regulation on Productivity Growth in U.S. Manufacturing*, 12 YALE J. REG. 387 (1995) (finding that overall productivity was 11% less due to environmental and occupational health rules).

335. *See* SAR A. LEVITAN & DIANE WERNEKE, PRODUCTIVITY: PROBLEMS, PROSPECTS AND POLICIES 3 (1984) (reporting that "declining rate of productivity growth in recent years has been identified as a key factor behind the difficulties besetting the American economy").

336. *See* WILLIAM J. BAUMOL ET AL., PRODUCTIVITY AND AMERICAN LEADERSHIP 2 (1989) (reporting that "less than a 1 percentage point lag in productivity growth for one century was sufficient to transform the United Kingdom from the world's undisputed industrial leader into the third-rate economy that it is today").

When framed in comparison with a risk to human health, even large financial costs may seem morally insignificant. The protection of human life is beyond material valuation. Most Americans do not behave as if human life has infinite financial value (many accept paying jobs that produce a health risk and demand more pay for riskier jobs). Nevertheless, when it comes to government policy, there may be reluctance to sacrifice health for money. Yet this perspective makes an obvious mistake of reducing money to the paper on which it is printed, treating currency as if it were an end in and of itself.

Money has value only because of the things that it can buy. Some of the things that money can buy advance public health. Correspondingly, having less money may mean poorer health. It has become commonly known that "richer is safer." Ample empirical evidence confirms that greater wealth generally means better health.[337] Greater wealth may promote health by enabling individuals to make protective expenditures, such as the purchase of a child safety seat, a bicycle helmet, a smoke detector, or a fire extinguisher for the home.[338] Others believe that lower income is a great source of psychological stress that undermines health.[339] Alternatively, there is evidence that richer societies tend to demonstrate more concern for health protection,[340] and economic growth may encourage the development of newer and safer products.[341] As recently elaborated:

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337. *See generally* Cross, *supra* note 52 (summarizing evidence that greater wealth means better health).

338. *See* W. Kip Viscusi, *Mortality Effects of Regulatory Costs and Policy Evaluation Criteria*, 25 RAND J. ECON. 94, 94-109 (1994). The poor have a higher rate of deaths from fire that may be attributed to their lack of protective expenditures such as smoke detectors or inferior home wiring. *See* Melvin D. Nelson, Jr., *Socioeconomic Status and Childhood Mortality in North Carolina*, 82 AM. J. PUB. HEALTH 1131, 1132 (1992).

339. *See* Ralph Catalano, *The Health Effects of Economic Insecurity*, 81 AM. J. PUB. HEALTH 1148, 1148 (1991) (finding association of economic insecurity and psychological distress); Ralph L. Keeney & Detlof von Winterfeldt, *Why Indirect Health Risks of Regulations Should Be Examined*, 16 INTERFACES 13, 20 (1986) (noting that stress is associated with heart attacks); Ronald Kessler, *Stress, Social Status, and Psychological Distress*, 20 J. HEALTH & SOC. BEHAV. 259, 259 (1979) (reporting association between poverty and stress); James S. House et al., *Age, Socioeconomic Status, and Health*, 68 MILBANK Q. 383, 403-05 (1990) (summarizing studies on association of income with sociological difficulties).

340. *See* Cross, *supra* note 52, at 734-35 (setting forth theory that greater wealth tends to lead to concern for health protection).

341. *See* PETER W. HUBER, LIABILITY: THE LEGAL REVOLUTION AND ITS CONSEQUENCES 160-61 (1988) (noting that new products are safer than their predecessors); *see also supra* notes 124-54 and accompanying text (discussing relative safety of new products and facilities in comparison to older products and facilities).

> A general increase in the standard of living influences societal structure. A wealthier society leads to the development of a better and more diverse medical research establishment, to larger markets to stimulate creation of safer products, to an infrastructure of health clubs and many opportunities for exercise, and to the societal resilience to rapidly and efficiently attack new unforeseen problems threatening our collective health and safety.[342]

Some combination of these dynamics yield better health as overall national income rises. On average, higher GNP means a reduction in morbidity and mortality.[343]

The evidence for the association of wealth and health is substantial. International comparisons reveal that wealthier nations have longer life expectancies.[344] Studies within the United States likewise demonstrate that those with higher incomes have less morbidity and mortality.[345] Still other

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342. Ralph L. Keeney, *Mortality Risks Induced by Economic Expenditures*, 10 RISK ANALYSIS 147, 148 (1990).

343. The association of greater income and better health is strong at lower income levels and declines markedly at high income levels. Thus, greater wealth will not enhance the health of Bill Gates, for example. *See* Cross, *supra* note 52, at 762-63 (summarizing curvilinear association of wealth and health). As it happens, most of the costs of environmental regulations burden those at lower income levels. The consequences of regulation typically appear in price increases or cutbacks in employment among blue-collar workers. Economists have shown that regulatory costs tend to be passed on in a regressive fashion. *See* Hamid Beladi & John Rapp, *Urban Unemployment and the Backward Incidence of Pollution Control*, 27 ANNALS REGIONAL SCI. 163, 163-72 (1993) (reporting that job losses from environmental regulation are concentrated in blue-collar urban areas); Greg B. Christiansen & Thomas H. Tietenberg, *Distributional and Macroeconomic Aspects of Environmental Policy*, *in* 1 HANDBOOK OF NATURAL RESOURCE AND ENERGY ECONOMICS 345, 389 (Allen V. Kneese & James L. Sweeney eds., 1985) (summarizing evidence on regressive distribution of costs of regulation and job losses); Leonard P. Gianessi et al., *The Distributional Impacts of Uniform Air Pollution Policy in the United States*, 93 Q. J. ECON. 281, 297 (1979) (reporting that poor spend eight times higher portion of income on environmental regulations). Thus, the association of compliance costs and reduced health is applicable to environmental and public health regulations.

344. *See* J.R. Goldsmith, *Young Adult Mortality As an Index: Associations with Income and Social Indicators*, 2 EUR. J. EPIDEM. 282, 292 (1986); Richard G. Wilkinson, *National Mortality Rates: The Impact of Inequality?*, 82 AM. J. PUB. HEALTH 1082, 1082 (1992); Randall Lutter & John F. Morrall, III, *Health-Health Analysis: A New Way To Evaluate Health and Safety Regulation*, 8 J. RISK UNCERTAINTY 43, 53-56 (1994).

345. *See generally* Kenneth S. Chapman & Govind Hariharan, *Controlling for Causality in the Link from Income to Mortality*, 8 J. RISK UNCERTAINTY 85 (1994); Harriet O. Duleep, *Measuring the Effect of Income on Adult Mortality Using Longitudinal Administrative Record Data*, 20 J. HUM. RESOURCES 238 (1986); Mary Haan et al., *Poverty and Health: Prospective Evidence from the Alameda County Study*, 125 AM. J. EPIDEM. 989 (1987); Jack Hadley & Anthony Osei, *Does Income Affect Mortality? An Analysis of the Effects of Different Types*

research shows that death rates vary over time for a specific group of individuals, depending on their income levels.[346] Thus, an increase in wealth of, say, $1000 would perhaps reduce one's risk of injury or disease or premature death by one in one thousand. Scholars have used this data to show that a societal loss in the range of $5 million to $10 million engenders sufficient additional risk to create a statistical probability of an additional death.[347]

Suppose we adopt or strengthen a regulation in reliance upon the precautionary principle, without clear evidence of any benefit. If that regulation imposes deadweight social costs of $5 million or more, we have good reason to believe that an additional premature death will result from the costs of the rule. Given the reliance on the precautionary principle, we have little or no comparable evidence of realizable health benefits from the rule. Hence, this application of the principle could cause more health harm than it prevents.

The above risk is not entirely abstract; past regulations have produced counterproductive health effects from excessive costs. For example, the EPA's attempts to regulate airborne emissions from benzene transfer operations produced an estimated benefit of less than one cancer case each year, even using conservative risk assessment methods.[348] This regulation cost nearly $200 million, and similar extrapolation methods would suggest that the rule therefore cost dozens of lives, many more than it saved.[349]

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of Income on Age/Sex/Race-Specific Mortality Rates in the United States, 20 MED. CARE 901 (1982).

346. *See* John D. Graham et al., *Poorer Is Riskier*, 12 RISK ANALYSIS 333, 333-36 (1992).

347. *See* Cross, *supra* note 52, at 742 (reviewing studies that project one additional death from income loss of $1.9 million on low end to $12.4 million on high end). The results tend to cluster around $5 million to $6 million per life. *Id.* at 773.

348. EPA National Emission Standards for Hazardous Air Pollutants; Benzene Emissions from Chemical Manufacturing Process Vents, Industrial Solvent Use, Benzene Waste Operations, Benzene Transfer Operations, and Gasoline Marketing System, 55 Fed. Reg. 8292, 8294 (1990). This estimate was based upon an "upper bound" risk estimate that included an assumption that some individuals spent their entire 70-year lifetime outdoors at the site of the highest benzene exposure from the transfer operation. *Id.* at 8305.

349. *See* Kenneth S. Chapman & Govind Hariharan, *Controlling for Causality in the Link from Income to Mortality*, 8 J. RISK UNCERTAINTY, 85, 86 (1994) (reporting that "OSHA's proposed air quality standards would lead to about 13 new deaths through the indirect effect of reduced income on mortality — a number dangerously close to the 8 to 14 lives they were expected to save annually"); Cross, *supra* note 52, at 777-78; *see also* Viscusi & Zeckhauser, *supra* note 253, at 39 (observing that "some government regulations save fewer lives and injuries per $1 million than what is created by $1 million in expenditures").

The financial cost of regulation — thoroughly disdained by those pursuing the precautionary principle — thus translates into lives lost.

Financial costs of regulation may also have a longer-term adverse effect on environmental protection. An increasing amount of research demonstrates that economic growth correlates with more environmental protection.[350] When the economy is growing, people demand greater environmental protection, while times of recession cause pressure to weaken environmental regulation.[351] While no single environmental regulation is likely to produce severe adverse economic consequences, each rule contributes to a cumulative economic burden. To the extent that the precautionary principle counsels promulgation of costly rules with little health benefit, the long-term consequences of the principle are environmentally perverse.

III. An Alternative to the Precautionary Principle

Because they are sound, the principles underlying the precautionary principle should not be wholly abandoned. Scientific knowledge of public health risks will always be tainted by some measure of uncertainty. The existence of such uncertainty should not serve as a barrier to government regulation — the demand for certainty is a case for imprudent paralysis of environmental protection. But neither can the uncertainty itself be a justification for government regulation. A new methodology of administrative analysis is required to prevent environmental and public health rules from doing more harm than good.

Because structural incentives in the status quo unfortunately encourage counterproductive regulatory action, some corrective methodology is required. Precautionary conservatism is built into the regulatory mindset because failure to act can result in embarrassment before Congress and the

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350. John M. Antle & Gregg Heidebrink, *Environment and Development: Theory and International Evidence*, ECON. DEV. & CULTURAL CHANGE 603 (1995) (reporting study that higher-income nations increased undeveloped parkland and afforestation); Frank B. Cross, *A Syncretic Perspective on Environmental Protection and Economic Growth*, 2 KAN. J.L. & PUB. POL'Y 53 (1992) (demonstrating that environment has improved with economic growth and reporting statistical correlation between income and reduced air pollution); Gene M. Grossman & Alan B. Krueger, *Economic Growth and the Environment*, Q. J. ECON. 353 (1995) (finding positive relationship between national income and measures of environmental quality in developed nations); Douglas Holtz-Eakin & Thomas M. Selden, *Stoking the Fires: CO_2 Emissions and Economic Growth*, 57 J. PUB. ECON. 85 (1995) (finding that higher-income countries emit less carbon dioxide as per capita gross domestic product increases).

351. *See* Cross, *supra* note 350, at 54-59 (reviewing historical evidence for correlation between economic growth and regulatory demand, and between economic recession and anti-regulatory demand).

public,[352] while the adverse health consequences of regulation remain largely invisible (the fact that some food additives are linked with reduced rates of cancer, for example, is not generally known).[353] Just as private enterprise may ignore the externalities of pollution associated with production, government may ignore the externalities of risk created by the regulations they produce. Furthermore, the compartmentalized, media-based structure of environmental statutes and authority creates tunnel vision among regulators who focus upon their territory without regard for adverse external consequences.[354] The precautionary principle gives administrators ample excuse to exercise their inherent inclinations to ignore the adverse consequences of their regulations.

The precautionary principle is all but designed to create risk as a by-product of regulation. Of course, abandoning the precautionary principle will not conveniently eliminate the presence of uncertainty about the magnitude of environmental and public health risks. This uncertainty about risk can be considered seriously, however, without being so heavily weighted as the precautionary principle commands. Regulators should acknowledge uncertainty and its magnitude, which will bound any risk estimate within a zone, rather than a precise point estimate. This will provide a moderately accurate assessment of target risk. Even absent reliance on precaution, regulators also must at least consider the possibility that adverse health consequences may result from government action.

John Graham and Jonathan Wiener argue for a procedure called Risk Trade-Off Analysis (RTA).[355] RTA is to be a "more systematic, rigorous method for recognizing and resolving risk trade-offs," but not a purely mathematical calculation.[356] While RTA is aimed at identifying and assessing the coincidental adverse side effects of regulatory action, the parameters

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352. *See supra* note 30 and accompanying text (discussing evidence that precaution is inherent in structure of regulatory system).

353. *See* GRAHAM & WIENER, *supra* note 49, at 230 (observing that decisionmaker acting against target risk may gain "support or mollification of key constituencies," while "the decisionmaker is unlikely to take account of countervailing losses imposed on constituencies who are not participating in the dialogue"). The authors refer to this as the problem of the "omitted voice," a problem that the authors find prevalent in regulation. *Id.* at 231-33.

354. *See* BREYER, *supra* note 30, at 11-19. Graham and Wiener elaborate on this point by referencing the bounded nature of the oversight structure in government and conclude that "mission-oriented agencies tend to overpromote their target goals and neglect side effects." GRAHAM & WIENER, *supra* note 49, at 237; *see also* Warren & Marchant, *supra* note 59, at 391.

355. GRAHAM & WIENER, *supra* note 49, at 19-41.

356. *Id.* at 19. The authors observe that the analysis "will often require both objective information and personal judgment, both expert analysis and ethical values." *Id.*

of the proposed analysis are left somewhat vague. RTA, like cost-benefit analysis, could take many forms, ranging from a simple off-the-cuff estimate to a carefully detailed analysis of each and every possible implication of regulatory action.

Although innately appealing, RTA may create unwise decisionmaking. Whenever a new analysis is required before regulating, the administrative system clogs and action becomes much more difficult. Donald Hornstein warns of "super-synopticism," which requires exhaustively full information on all aspects of any problem before taking action.[357] Such full information ultimately is never available, and regulated industries can be counted upon continually to raise additional questions that demand answers.[358] The quest for synoptic comprehension produces "paralysis by analysis." William Rodgers warned that the "insatiable pursuit of data also facilitates delay and the avoidance of controversy; any decision dependent upon extensive data-gathering promises to be long in incubation and short on results and controversy."[359] Graham and Wiener acknowledge this risk of RTA, noting that one must decide upon "the value of more information (to better decisions) and the cost (including delay of decisions)."[360]

Public health decisionmaking cannot become unduly preoccupied with the risks of regulation. Doing so would replace the risks of action with those of inaction. The precautionary principle has been misapplied to environmental risks but should not be conversely misapplied to risks of government action. The goal should be better regulation, not zero regulation.[361] Consequently, any rigid, new, comprehensive analytical require-

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357. Donald T. Hornstein, *Lessons from Federal Pesticide Regulation on the Paradigms and Politics of Environmental Law Reform*, 10 YALE J. ON REG. 369, 386 (1993). Elsewhere Hornstein argues that "synoptic ideals impose informational and analytical burdens that make effective government intervention impossible." Donald T. Hornstein, *Paradigms, Process, and Politics: Risk and Regulatory Design*, *in* WORST THINGS FIRST?, *supra* note 123, at 158.

358. *See* CROSS, *supra* note 47, at 89 (1989) (observing that cost-benefit analysis requirements permitted "a delaying strategy by industry or other opponents of carcinogen regulation"); David C. Vladeck & Thomas O. McGarity, *Paralysis by Analysis: How Conservatives Plan To Kill Popular Regulation*, AM. PROSPECT, Summer 1995, at 78 (arguing that seemingly neutral procedural requirements for regulation are nothing more than beard for bias against any regulation).

359. William Rodgers, *Benefits, Costs, and Risks: Oversight of Health and Environmental Decisionmaking*, 4 HARV. ENVTL. L. REV. 191, 200 (1980); *see also* Thomas O. McGarity, *Regulatory Analysis and Regulatory Reform*, 65 TEX. L. REV. 1243, 1302-03 (1987) (pointing out inherent "tension between timeliness and analysis").

360. GRAHAM & WIENER, *supra* note 49, at 21.

361. If risk trade-off analysis is captured by antiregulatory interests, it will lose credibil-

ments are to be avoided. Yet some additional analysis is obviously required if regulations are not to do more harm than good.

One promising approach to avoid counterproductive risks of regulation is to focus regulation on truly significant risks. This aligns the avoidance of regulatory risks with the comparative risk movement, which has already made headway in government agencies.[362] When the government regulates significant risks, the regulation may well create its own risks, but the government-created risks are less likely to exceed the regulated risk. However, when "the expected returns from the safety features demanded are so tiny," people will "end up much less safe."[363]

While comparative risk analysis and elimination of reliance on the precautionary principle reduces the probability of counterproductive regulatory action, there remains a prospect of perverse consequences. Indeed, it is possible that a focus on the greatest risks might also cause the greatest adverse consequences. Analysis of risk trade-offs is currently quite rare.[364] Hence, there is a need for some measure of RTA, as advocated by Graham and Wiener, even after prioritizing attention toward the greatest risks.

The requirements of RTA should not become too rigid. Regulating agencies should consider the most obvious risks of action, such as probable substitutes, known foregone benefits, and direct risks from remediation. A closely detailed analysis is probably unnecessary, insofar as the by-product risks are inevitably somewhat speculative. The agencies should be given authority to consider these offsetting risks and a directive to at least

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ity, much as health/health analysis has suffered. *See* Cross, *supra* note 52, at 744-45 (reporting how consideration of health effects of economic costs of regulations has been demeaned in Congress as merely excuse for agenda of interests desirous of preventing any regulation). RTA must be structured and presented as regulatory improvement, not regulatory relief.

362. *See supra* note 300 and accompanying text (discussing comparative risk movement, particularly within EPA).

363. Nathwani & Narveson, *supra* note 130, at 616.

364. The EPA's analysis of chlorine regulation is remarkable because it has at least considered the relative safety of chlorine substitutes. *See* Graham, *supra* note 299, at 22. Such consideration is the exception. Graham observes that:

> Congress needs to mandate consideration of risk trade-offs because agencies sometimes have incentives to downplay risks that are being induced by their policies. For example, in the 1980s the National High Traffic Safety Administration refused to acknowledge that automobile fuel economy rules were decreasing occupant safety by encouraging vehicle manufacturers to build smaller and lighter cars. NHTSA is beginning to acknowledge this competing risk but only reluctantly following a court order.

Id.

consider the magnitude of the risks before regulating. Had government institutions acted deliberately in response to the indoor asbestos scare, rather than responding in a panic, the risk created by removal might well have been avoided.[365]

A simple form of RTA should be employed by agencies, whenever authorized. In the course of this RTA, agencies should consider the existence of countervailing risks from the most obvious sources, as described above. No precise algorithm should be compelled; agencies should consider the risks on a case by case basis. Judicial review of agency decisions should be correspondingly limited to egregious failure to consider risky consequences of action.[366] Excessive analytic requirements or judicial second-guessing will only muck up the system. One must rely to some measure upon the good faith of agencies (constrained by public comments and attendant risks of publicity) in order to act beneficially. Clearly, however, the unexamined precautionary principle is an insufficient basis for regulatory action.

IV. Conclusion

The precautionary principle rests upon an illusion that actions have no consequences beyond their intended ends. In fact, there is no such thing as a risk-free lunch. Efforts to eliminate any given risk will create some new risks, while possibly reducing other ancillary risks.[367] If one's intent

365. *See* Cross, *supra* note 245, at 88-94 (observing that risks of removal were known, but were temporarily ignored in response to public demands for precautionary action).

366. *See* GRAHAM & WIENER, *supra* note 49, at 263 (suggesting that some court review is essential to prevent agencies from neglecting countervailing risks and to "help instill in agencies diligent attention to risk trade-offs"). Yet Graham and Wiener concede that the "courts have not . . . been a reliable source of leadership for more intelligent management of society's risk portfolio." *Id.* at 260. One may hope for some self-restraint from courts themselves. *Cf.* Corrosion Proof Fittings v. EPA, 947 F.2d 1201, 1222 (5th Cir. 1991) (declaring that EPA must show "reasonable relationship" between costs and benefits of regulation but need not prepare "an exhaustive, full-scale, cost-benefit analysis").

367. Policymakers must appreciate that action may have unforeseen benefits as well as risks. Graham and Wiener suggest that these coincidental risk reductions are likely to be far less common than countervailing risk increases, due to the characteristics of agencies. GRAHAM & WIENER, *supra* note 49, at 232-33. While this is probably true, there are some obvious instances where coincidental ancillary risk reductions may be substantial and should be considered. For example, actions taken to reduce coal-fired generation in the interest of combatting global warming could produce a substantial ancillary health benefit from reduction in airborne particulates and occupational fatalities. As discussed above, a shift from coal to nuclear power would produce substantial health benefit. *See supra* notes 62-77 and accompanying text (discussing serious environmental and health problems posed by coal and calculating benefits of switching to nuclear power).

is truly to protect public health and the environment, all of these incidental risks must be considered, contrary to prevailing applications of the precautionary principle.

The objective of this Article is to demonstrate how frequently countervailing risks can arise from well-intended programs aimed at risk reduction. The reader may object that my examples are selectively chosen. In fact, I have not sought to demonstrate that every environmental program is counterproductive, because many are not. For example, I believe that the prevailing ambient air quality standards have been net beneficial. The body of this Article does present a large number of cases of counterproductive action, including some of the government's most prominent environmental policies. The number and significance of these examples should be sufficient to command attention and response.

Other readers may dispute the claims of my specific cases and contend, for example, that nuclear power is more hazardous than fossil fuel-fired generation of electricity or energy conservation. No intellectually honest person could profess to have the dispositive truth about such a question. My thesis is not dependent upon the facts of any particular example, however. Indeed, one who opposes my nuclear power example on the facts implicitly concedes the existence of trade-offs and a measure of uncertainty about their magnitude. This is all I need to establish in order to delegitimate the precautionary principle.

Rhetorically, the precautionary principle may prove quite useful to advocates of one particular policy or another. Pragmatically, the principle is destructive, even self-destructive. Protecting public health requires recognition of the consequentialist complexity of regulatory action. Simplistic rhetorical devices cannot account for this complexity. Environmental protection requires a more thoughtful response.

LECTURE