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Environmental Torts

Troyen A. Brennan

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*Troyen A. Brennan**

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I. INTRODUCTION

Over the last two decades, a new class of torts has emerged that targets personal injuries caused by toxic substances in the environ-

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ment.[1] These hybrid environmental torts are quite distinct from the trespass-nuisance precedent that is part of traditional tort theory;[2] nor are environmental torts simply a subset of the mass hazardous substance litigation that has remade product liability law.[3] Environmental torts are informed, in a way product law is not, by environmental regulation. These torts are unique because their deterrent signal is transmitted to producers of hazardous environmental pollutants by litigants who have suffered physical injury or disease.

Environmental tort litigation appears to be burgeoning. While comprehensive evidence on the number and average severity of environmental tort claims nationwide is not available, published cases would

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1. These cases include groundwater contamination, see, for example, *Anderson v. Cryovac, Inc.*, 862 F.2d 910 (1st Cir. 1988) (trichloroethylene (TCE) contamination of drinking water wells); *Backes v. The Valspar Corp.*, 783 F.2d 77 (7th Cir. 1986) (phenol contamination of wells); *Renaud v. Martin Marietta Corp.*, 749 F. Supp. 1545 (D. Colo. 1990), aff'd, 972 F.2d 304 (10th Cir. 1992) (hydrazine contamination of groundwater); *Werlein v. United States*, 746 F. Supp. 887 (D. Minn. 1990), vacated, 793 F. Supp. 989 (D. Minn. 1992) (TCE contamination in groundwater); *In re Paoli R.R. Yard PCB Litigation*, 706 F. Supp 358 (E.D. Pa. 1988), rev'd, 916 F.2d 829 (3rd Cir. 1990) (polychlorinated biphenyl (PCB) contamination of groundwater); *Merry v. Westinghouse Elec. Corp.*, 684 F. Supp. 847 (M.D. Pa. 1988) (toxic chemical contamination of wells); airborne contamination, see, for example, *Maddy v. Vulcan Materials Co.*, 737 F. Supp. 1528 (D. Kan. 1990) (airborne contaminants); *Wells v. United States*, 655 F. Supp. 715 (D.D.C. 1987), aff'd, 851 F.2d 1471 (D.C. Cir. 1988) (airborne emissions from lead manufacturing companies); exposure to pesticides, see, for example, *Villari v. Terminix Int'l, Inc.*, 692 F. Supp. 568 (E.D. Pa. 1988) (pesticide contamination of home); *Sterling v. Velsicol Chemical Corp.*, 647 F. Supp. 303 (W.D. Tenn 1986), aff'd in part, rev'd in part on other grounds, 855 F.2d 1188 (6th Cir. 1988) (pesticide manufacturing residues); exposure to radiation; see, for example, *In re Consolidated Atmospheric Testing Litigation*, 616 F. Supp. 759 (N.D. Cal. 1985), aff'd sub nom., *Konizeski v. Livermore Labs*, 820 F.2d 982 (9th Cir. 1987) (nuclear test fallout); *Allen v. United States*, 588 F. Supp. 247 (D. Utah 1984), rev'd, 816 F.2d 1417 (10th Cir. 1987) (nuclear test fallout); *Code v. Rockwell Int'l Corp.*, 778 F. Supp. 512 (D. Colo. 1991) (radioactive releases from a nuclear weapons plant); and exposures combining these and other factors, see, for example, *Elam v. Alcolac, Inc.*, 765 S.W.2d 42 (Mo. Ct. App. 1988) (airborne and waterborne releases by chemical manufacturer); *New Jersey Dep't of Envtl. Protection v. Ventron Corp.*, 468 A.2d 150 (N.J. 1983) (releases from toxic waste dump); *In re "Agent Orange" Prod. Liab. Litig.*, 597 F. Supp 740 (E.D.N.Y. 1984), aff'd, 818 F.2d 145 (2d Cir. 1987) (dioxin spraying in Vietnam); *Vuocolo v. Diamond Shamrock Chem. Co.*, 573 A.2d 196 (N.J. Super. Ct. App. Div. 1990) (dioxin released due to explosion and gradual leakage).

2. Nuisance and trespass law bridge the gap between tort and property law. See generally Thomas W. Merrill, *Trespass, Nuisance, and the Costs of Determining Property Rights*, 14 J. Legal Stud. 13 (1985). The plaintiff-landowner in an action for nuisance or trespass alleges that defendant's pollution invaded the landowner's property rights, not that it caused traumatic personal injury or disease. See, for example, *Boomer v. Atlantic Cement Co.*, 257 N.E.2d 870 (N.Y. 1970); Robert C. Ellickson, *Alternatives to Zoning: Covenants, Nuisance Roles, and Fines as Land Use Controls*, 40 U. Chi. L. Rev. 681 (1973). For a recent discussion of environmental-law theory from a nuisance-trespass perspective, see Carol M. Rose, *Rethinking Environmental Controls: Management Strategies for Common Resources*, 1991 Duke L. J. 1.

3. Hazardous substance litigation is a poorly defined term but often refers to mass product liability cases. For some general discussions of the tremendous number of claims such products can generate, see Marian S. Smith, *Resolving Asbestos Claims: The Manville Personal Injury Settlement Trust*, 53 L. & Contemp. Probs. 27 (Autumn 1990); Kenneth R. Feinberg, *The Dalkon Shield Claimants Trust*, 53 L. & Contemp. Probs. 79 (Autumn 1990).

suggest both are at unprecedented high levels.[4] Yet the topic is only peripherally discussed in law reviews,[5] and has not penetrated most law school courses on tort law.[6] The academic silence is perhaps understandable, since the subject of environmental torts tends to fall between two relatively well-circumscribed disciplines, tort law and environmental law. Moreover, the teachers and theoreticians of both subject areas are somewhat introspective at present. Over the past decade, the debate over reforms that would retard the growth of certain kinds of tort claims has preoccupied many tort law professors and some practition-

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4. See cases cited in note 1. Environmental torts focusing on personal injury are a relatively new legal species. The original and very high-profile environmental torts were based on the spraying of pesticides in Vietnam, which gave rise to the Agent Orange litigation, see *In re "Agent Orange" Prod. Liab. Litig.*, 597 F. Supp. 740 (E.D.N.Y. 1984); Peter H. Schuck, *Agent Orange on Trial* (Harvard, 1986), and the exposure of individuals in rural Utah and Nevada to radioactive fallout from atmospheric testing of nuclear devices by the federal government, see *Allen v. United States*, 588 F. Supp. 247 (D. Utah 1984), rev'd, 816 F.2d 1417 (10th Cir. 1987). A less publicized, but perbaps more instructive situation concerns the DDT litigation in Triana, Alabama. See Francis E. McGovern, *The Alabama DDT Settlement Fund*, 53 L. & Contemp. Probs. 61 (Autumn 1990).

This precedent provides the basis for other environmental tort suits. Unfortunately, no information is available on the number of these cases, although such publications as the Toxics Law Reporter highlight new filings on a weekly basis. See, for example, *Richmond Residents File Class Action in Wake of Chevron Refinery Accident*, 6 Toxics L. Rep. (BNA) 1117 (Feb. 19, 1992); *Los Alamos Lab Admits Waste Disposal, Denies Discharges Caused Residents' Cancer*, 6 Toxics L. Rep. (BNA) 1118 (Feb. 19, 1992). Many of these cases allege very severe money damages. See *Hodges v. Temple Inland, Inc.*, No. B142106 (Tex. Dist. Ct. Feb. 26, 1992) (complaint filed), cited in 6 Toxics L. Rep. (BNA) 1259 (Mar. 18, 1992) (class action alleging $100 billion in damages against 31 paper companies). Large suits have become especially prevalent around nuclear weapons processing sites. See, for example, *Cook v. Rockwell Int'l Corp.*, 778 F. Supp. 512 (D. Col. 1991) (class action involving 60,000 plaintiffs in the area around Rocky Flats Weapon Plant in central Colorado), cited in 6 Toxics L. Rep. (BNA) 835 (Dec. 11, 1991).

The average severity of these claims appears to be much higher than that of conventional or even mass tort litigation. See Deborah R. Hensler, *Trends in Tort Litigation: Findings from the Institute for Civil Justice's Research*, 48 Ohio St. L. J. 479 (1987) (setting forth the average severity for a variety of different classes of tort claims).

5. For example, in a recent article that summarizes a variety of alternatives for a "new agenda" in environmental law, environmental torts are not mentioned. See Richard O. Brooks, *A New Agenda for Modern Environmental Law*, 6 J. Envtl. L. & Litig. 1 (1991).

6. Most torts textbooks contain only limited sections on hazardous or abnormally dangerous activities and nuisance. See, for example, Richard A. Epstein, *Cases and Materials on Torts* Ch. 7 at 548-605 (Little, Brown, 5th ed. 1990); David W. Robertson, et al., *Cases and Materials on Torts* Ch. XIV at 684-703 (West, 1989); Page Keeton, et al., *Cases and Materials on Tort and Accident Law* Ch. 16 at 572-635 (West, 2d ed. 1989).

While environmental textbooks often acknowledge the origins of modern pollution law in trespass and nuisance, they rarely discuss toxic-related injuries that lead to tort litigation. See, for example, John E. Bonine and Thomas O. McGarity, *The Law of Environmental Protection* 237-49 (West, 1984). Some scholars, however, have grudgingly recognized the role of the common law in deterring environmental pollution. See, for example, Roger W. Findley and Daniel A. Farber, *Environmental Law Cases and Materials* 542-67 (West, 2d ed. 1985); Frederick R. Anderson, et al., *Environmental Protection: Law and Policy* 697-777 (Little, Brown, 2d ed. 1990).

ers.[7] Environmental law appears to be experiencing a severe mid-life crisis, as academics struggle to redefine a subject that is increasingly composed of stultifyingly technical statutes.[8] The result of such distractions is that an exciting hybrid of personal injury and environmental law has evolved without much analysis.

This essay develops a theory of environmental torts that has both positive and normative aspects.[9] The positive theory describes why environmental tort litigation occurs. It emphasizes the economic gain, by at least some of the participants, that drives the enterprise. In much of tort law, environmental torts included, the critical economic players are the plaintiffs' attorneys. If the compensation available through contingency fees from personal injury suits is insufficient, attorneys will pursue other kinds of cases. Hence, a positive theory of environmental torts must explain how attorneys are able to gain compensation for their clients, and themselves.

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7. The donnybrook over the recent American Law Institute's Reporter's Study provides an excellent example. See *Enterprise Liability for Personal Injury: Reporter's Study* (ALI, 1991) ("*Reporters' Study*"). The Reporters' Study produced vigorous debate in the American Law Institute's subsequent general meetings. Many academics and practicing lawyers disagreed with its relatively sweeping and, at times, radical recommendations. See, for example, Jerry Phillips, *Comments on the American Law Institute's Study of Enterprise Liability For Personal Injury* (1991) (unpublished manuscript, on file with the author). The American Law Institute now plans to draft a restatement of product liability and the Reporter's Study apparently will serve only as a background document. This debate reflects the ferment in tort doctrine and tbeory. Indeed, one professor bas cbaracterized recent doctrinal changes in tort law as a "fundamental reordering" and a "paradigm shift." See E. Donald Elliott, *Re-Inventing Defenses/Enforcing Standards: The Next Stage of the Tort Revolution?*, 43 Rutgers L. Rev. 1069, 1070 (1991).

8. See the comments by environmental law teachers in Joseph L. Sax, *Environmental Law in Law Schools: What We Teach and How We Feel About It*, 19 Envtl. L. Rep. (Envtl. L. Inst.) 10, 251 (June 1989). In addition, environmental law is beset by the struggle between two rather mutually exclusive paradigms in environmental pollution: environmental ethics and market incentives. Compare Christopher D. Stone, *Earth and Other Ethics: The Case for Moral Pluralism* (Harper & Row, 2d ed. 1990) with Bruce A. Ackerman and Richard B. Stewart, Comment, *Reforming Environmental Law*, 37 Stan. L. Rev. 1333 (1985).

9. See, for example, Richard A. Posner, *Economic Analysis of Law* 20-26 (Little, Brown, 3d ed. 1986). The positive-normative distinction is often opaque, although scholars have strenuously attempted to distinguish the two approaches. See, for example, Gregory Scott Crespi, *The Mid-Life Crisis of Law and Economics Movement: Confronting the Problems of NonFalsifiability and Normative Bias*, 67 Notre Dame L. Rev. 231, 237 (1991); Keith N. Hylton, *Litigation Costs and the Economic Theory of Tort Law*, 46 U. Miami L. Rev. 111, 111 (1991) (noting tbat positive theory justifies tort doctrine, while normative theory criticizes its operational efficiency). *Webster's New Collegiate Dictionary* provides definitions that are reasonable for purposes of tbis Article. "Normative" is the adjective form of "norm," which is defined as "a principle of right action binding upon the members of a group and serving to guide, control, or regulate proper and acceptable behavior." *Webster's Ninth New Collegiate Dictionary* 806 (Merriam-Webster, 1987). "Positive" is defined as "having or expressing actual existence . . . logically affirmative . . . not speculative . . . empirical." Id. at 918. A positive theory, therefore, explains what does happen in the real world, while the normative theory explains the activity in terms of acceptable principles.

A positive theory of environmental tort litigation is presently unavailable. Much of what has been written about toxic torts, and the little that has addressed environmental torts, suggests that environmental tort suits should be rare because the cases are so difficult to win.[10] The variety of scientific, evidentiary, and tort doctrinal issues would appear to frustrate even the most committed plaintiffs' attorneys.[11] Therefore, the challenge for a positive theory of environmental torts is to explain why and how lawyers are able to obtain fees in the face of such obstacles.

The positive and normative theories are not coincident. For a normative theory of environmental torts, the critical concept is deterrence.[12] Just because a fee mechanism drives attorneys to bring tort suits does not mean these suits will deter high-risk activities.[13] Simi-

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10. See especially Neil R. Komesar, *Injuries and Institutions: Tort Reform, Tort Theory, and Beyond,* 65 N.Y.U. L. Rev. 23 (1990); Clayton P. Gillette and James E. Krier, *Risks, Courts, and Agencies,* 138 U. Pa. L. Rev. 1027 (1990).

11. Tort claims for environmental injuries are paradigmatic of what Hensler has called "tier three" torts—that is, mass torts with latent injuries. See Deborah Hensler, 48 Ohio St. L. J. at 483-85 (cited in note 4). Injuries are latent in that the substances involved tend to be solvents or heavy metals that cause subtle neurological or metabolic injuries, or carcinogens that have long incubation periods before the disease manifests itself. Thus, the problems with proving causation in toxic tort litigation, and with the unpredictability of outcome that attends such problems, are exaggerated in environmental injury tort claims. Unlike product-based mass tort litigation, those injured by environmental toxins may be unaware of their exposure. Typically, toxins are dispersed in water or air and do not leave definite footprints to prove their presence. Finally, if injured persons become aware of such exposure and the causal connection between the exposure and their injury years after the latency period has expired, they may find litigation hampered by statute-of-limitations restrictions. See Michael D. Green, *The Paradox of Statutes of Limitations in Toxic Substances Litigation,* 76 Cal. L. Rev. 965 (1988). In combination, issues of exposure, causation, and latency periods make environmental torts extraordinarily burdensome.

12. The focus on the positive side reflects a realistic economic appraisal of tort litigation. On the normative side, rationalizations for tort law centers on deterrence, compensation, and corrective justice. Deterrence is the primary normative reason for the resistance of tort law. See, for example, Guido Calabresi, *The Costs of Accidents: A Legal and Economic Analysis* 68 (Yale, 1970).

Compensation has less merit as a normative rationale for torts. Social insurance can compensate injured individuals much more efficiently. See George L. Priest, *The Current Insurance Crisis and Modern Tort Law,* 96 Yale L. J. 1521, 1550-56 (1987). Moreover, tort suits may provide inaccurate compensation. For example, while many people are negligently injured in hospitals, less than two percent file claims for damages. See A. Russell Localio, et al., *Relation Between Malpractice Claims and Adverse Events Due to Negligence: Results of the Harvard Medical Practice Study III,* 325 New Eng. J. Med. 245, 246-47 (1991). While economic losses are quite high, compensation is generally unavailable through torts. See William G. Johnson, et al., *The Economic Consequences of Medical Injuries,* 267 JAMA 2487, 2488 (1992) (discussing costs of medical injuries).

Corrective justice is discussed in more detail at text accompanying notes 228-29.

13. For instance, in New York in 1984 several hundred million dollars in fees fueled over 3600 claims, but this produced little evidence of deterrence. See Troyen A. Brennan, *An Empirical Analysis of Accidents and Accident Law,* 36 S.L.U. L. J. 823, 864 (forthcoming 1992-93). Although rarely discussed, tort litigation could be a social phenomenon that serves little purpose other than

larly, while there may be many normative reasons that recommend environmental tort litigation as an effective deterrent, doctrinal or evidentiary issues may yet frustrate successful suits. In the latter situation, a normative theory might recommend law reform that increases economic incentives for attorneys to bring environmental tort claims.

Unlike a positive theory, a normative theory is not neutral. Based on an assessment of the incentives that litigation produces, the normative theory should recommend either more or less environmental tort litigation. With regard to environmental torts, that recommendation likely will remain tentative. While scholars have considered the theoretical deterrence effect of torts suits,[14] they have provided startlingly little evidence that common-law litigation actually prevents injuries in an efficacious manner.[15] From a policy perspective, then, one encourages or discourages any type of tort litigation with great caution and little confidence. Environmental torts are no exception.

Empirical evidence suggests that environmental torts suits currently send a weak deterrent signal. Consider the evidence available concerning the optimal level of environmental tort litigation from a deterrence perspective. Scientists estimate that environmental carcinogens cause at least 10,000 deaths annually in the United States.[16] Also,

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haphazardly compensating a few people, whether or not injured, and enriching plaintiffs' attorneys. This possibility renders the segregation of positive and normative theories critical.

14. Some of the hest functional analyses of common-law litigation center on nuisance and trespass. See Frank I. Michelman, *Property, Utility and Fairness: Comments on the Ethical Foundations of "Just Compensation" Law,* 80 Harv. L. Rev. 1165 (1967); Frank I. Michelman, *Pollution as a Tort: A Non-Accidental Perspective on Calabresi's Costs,* 80 Yale L. J. 647 (1971) (book review); Guido Calabresi and A. Douglas Melamed, *Property Rules, Liability Rules, and Inalienability: One View of the Cathedral,* 85 Harv. L. Rev. 1089 (1972). For more recent theoretical analyses of the incentives produced by litigation in the environmental area, see Lewis A. Kornhauser and Richard L. Revesz, *Sharing Damages Among Multiple Tortfeasors,* 98 Yale L. Rev. 831 (1989); Lewis A. Kornhauser and Richard L. Revesz, *Apportioning Damages Among Potentially Insolvent Actors,* 19 J. Legal Stud. 617 (1990).

15. See I *Reporters' Study,* Ch. 14 (cited in note 7).

16. See Richard Doll and Richard Peto, *The Causes of Cancer: Quantitative Estimates of Avoidable Risks of Cancer in the United States Today,* 66 J. Nat'l Cancer Inst. 1191 (1981). Doll and Peto identified 11 known avoidable causes of cancer: tobacco, alcohol, diet, food additives, reproductive and sexual behavior, occupation, pollution, industrial products, medicines and medical procedures, geophysical factors, and infection. Id. at 1220-55. Tobacco, alcohol, diet, food additives, reproductive behavior, and occupation are readily distinguished from environmental factors. Within the category of pollution, Doll and Peto included atmospheric air pollution, drinking water toxins, and the contamination of food by industrial products like heavy metals and pesticide residues. Environmental toxins accounted for two percent of cancer deatbs. In 1988, an estimated 488,000 people died of cancer in the United States, up from 330,000 in 1970. See Bureau of the Census, U.S. Dep't of Comm., *Statistical Abstract of the United States* 79 (1990).

These estimates appear to be conservative for several reasons. First, Doll and Peto's estimates of the particular contributions of certain kinds of toxins are lower than those of other, perhaps as highly regarded, estimates. For instance, Doll and Peto studied the occupational carcinogen asbestos and concluded that in 1975 asbestos led to 500 to 600 deaths from mesothelioma. See Doll and

statistics from 1985-86 indicate that defendants spent a total of $200 million per year on environmental tort litigation, including litigation costs, jury verdicts and settlements.[17] Therefore, each cancer death costs defendants $20,000.[18] In the only other area of tort law where similar figures are readily available, medical malpractice, litigation is estimated to cost defendants $143,000 per death.[19] The environmental litigation deterrence signal is, therefore, relatively weak.

Of course, tort litigation's deterrence effect depends not just on its economic magnitude, but also on the ability of polluters to understand and assess the economic signal. Careful consideration of the circumstances of environmental tort litigants, and of the nature of tort doctrine, might suggest peculiarities that would render the deterrent signal incomprehensible to environmental tort defendants. Nonetheless, the foregoing rudimentary calculations do not provide sufficient basis to conclude that there is too much environmental tort litigation. Therefore, the appropriate normative perspective must be open-minded toward increasing environmental tort litigation, while exploring the nuances of deterrence dynamics.[20]

Peto, 66 J. Nat'l Cancer Inst. at 1308. Selikoff's more careful estimate is that 1100 to 1500 deaths were due to mesothelioma in the mid-1970s. See William J. Nicholson, et al., *Occupational Exposure to Asbestos: Population at Risk and Projected Mortality*, 3 Amer. J. Indus. Med. 259, 301 (1982). Second, Doll and Peto did not anticipate the amount of cancer morbidity and mortality that is now associated with indoor radon air pollution and with the depletion of stratospheric ozone resulting from chlorofluorocarbon pollution. EPA now attributes as many as 30,000 cancer deaths per year to these two factors. Environmental Protection Agency, *Unfinished Business: A Comparative Assessment of Environmental Problems* 28-29 (U.S. Dep't of Comm., 1987) ("*Unfinished Business*").

EPA's 1987 estimate of cancer mortality caused by a restricted list of environmental toxins is also greater than 10,000. In particular, *Unfinished Business* relates that (i) pesticides on food caused more than 6000 deaths; (ii) indoor air pollutants (excluding tobacco smoke and radon) caused more than 1000 deaths; (iii) exposure to chemicals in the environment and toxic air pollution caused 2000 deaths; (iv) inactive waste sites led to 1000 deaths; (v) drinking water contamination caused 400 to 1000 cancer deaths each year; and (vi) a combination of other sources result in another 1000 deaths. Id. at 28-31.

17. Peter Huber estimates settlements and jury verdicts at under $200 million for the years 1985 and 1986. See Peter Huber, *Environmental Hazards and Liability Law*, in Robert E. Litan and Clifford Winston, eds., *Liability: Perspectives and Policy* 136 (Brookings Inst., 1988). If jury verdicts and settlements are worth $100 million per year, and the administrative costs of complex tort litigation are equal to this amount, see Hensler, 48 Ohio St. L. J. at 492 (cited in note 4), the total litigation costs for defendants are at most $200 million per year.

18. Carcinogens are not the only types of environmental health hazards, but in some ways they are the easiest to measure in terms of adverse health effect.

19. See Brennan, 36 S.L.U. L. J. at 832, 856 (cited in note 13) (stating that 7000 negligent deaths in New York hospitals in 1984 produced $1 billion in tort costs). This amount of litigation provides little evidence of deterrence. See Troyen A. Brennan, *Improving the Quality of Medical Care* 10 Yale L. & Policy Rev. 431, 434-38 (forthcoming 1992).

20. The proposition of deterrence through torts can be questioned if one doubts the rationality of human behavior. See Herbert Hovenkamp, *Rationality in Law and Economics*, 60 Geo. Wash. L. Rev. 293-96 (1992). This insight is especially salient when discussing safety signals. See

A critical first step in the development of normative and positive theories of environmental torts is to examine the notion of environmental harm. Torts may target only a subset of the environmental risks that are addressed by environmental law generally. One reason that environmental law seems to be in a state of flux is that the various risks now addressed by environmental law are quite heterogeneous, while the standard assumption in much of the literature is that environmental pollution is homogenous. Accordingly, Part II of this Article deconstructs environmental pollution and identifies the subset of pollution paradigms, centering on illnesses caused by toxic substances, that personal injury litigation can profitably address.

The next step is to consider the alternatives to environmental torts that deter these environmental injuries. Part III suggests that traditional environmental regulation has addressed certain environmental pollution paradigms without much success. Positively, the failure of regulation may explain the persistence of perceived injuries that provide the basis for suits. Normatively, environmental torts may be best characterized as alternative devices for deterrence of environmental injury, again arising because of the failure of conventional regulation. Part IV discusses how other institutional approaches—the market and criminal law—also fail to deter certain types of environmental injury.

Having suggested that tort law can reasonably deter certain paradigms of environmental injury that other institutions fail to address, Part V outlines the distinctive aspects of environmental tort litigation. Part V shows how judges have reduced some of the obdurate barriers in traditional personal injury law to help plaintiffs' attorneys bring successful environmental tort claims, thereby providing a positive theory of environmental torts. Part V also examines the efficiency of the deterrence produced by evolving environmental tort litigation.[21]

II. Paradigms of Environmental Pollution

Before defining the role of environmental torts, a discussion of the concept of environmental injury is necessary. Environmentalism has had a strong attachment to a unitary paradigm of industrial pollution. The chief paradigm for environmental law seems to be one in which sources of industrial pollution foul the local air or river in a manner that is of great nuisance value, but only mildly harmful to human health. This model gave rise to the Clean Air Act in 1970 and Federal

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Richard G. Noll and James E. Krier, *Some Implications of Cognitive Psychology for Risk Regulation,* 19 J. Legal Stud. 747 (1990). Hence, any normative conclusion herein must remain quite tentative.

21. See Elliott, 43 Rutgers L. Rev. at 1077 (cited in note 7).

Water Pollution Control Act in 1972.[22]

Recognition of other paradigms of pollution led to a variety of additions to these venerable statutes, and to the enactment of a bewildering array of others.[23] In addition, another stream of environmentalism focused on protection of the natural environment.[24] Yet, an institutional analysis of environmental law from the viewpoint of the heterogeneity of the problems it targets has not been developed. One sort of environmental injury may be quite different from another and, hence, may call for unique institutional reponses. Formulating a matrix of environmental pollution paradigms is critical to understanding the role of environmental torts.

The taxonomy of environmental paradigms should begin with the division of natural beauty protection from human health protection. This distinction, recently recognized by the Environmental Protection Agency (EPA),[25] separates the ecological impulses of environmentalism from those that sound in public health. For example, the Endangered Species Act in no way intends to enhance human health; rather, it values biological diversity and preventing the degradation of nature. Environmental ethics, and the impressive naturalist-philosophical baggage associated with it, is concerned mainly with this spotted-owl paradigm of environmentalism.[26] Environmental tort law is not targeted at threats to ecological diversity, although certain kinds of public nuisance litigation may be.[27] Personal injury litigation of the sort discussed in this Article alleges harm to human health. Of course, much of environmental law shares the same goals, and specifically aims to deter the same activities, so that targeting human health may have the indirect consequence of preserving purely ecological concerns.

A second major set of bipolar categories involves the geographical relationship between source and environment. Pollution is either dis-

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22. The Clean Air Act was based on setting permissible exposure limits, while the Federal Water Pollution Control Act relied primarily on a permitting system. See Clean Air Act, 42 U.S.C.A. §§ 7401-7671(q) (West 1983 & Supp. 1992); Federal Water Pollution Control Act, 33 U.S.C. §§ 1251-1387 (1988). See also William H. Rodgers, *Environmental Law Treatise* § 3.1 at 182 (West, 1986).

23. See Toxic Substances Control Act, 15 U.S.C.A. §§ 2601-2671 (West 1982 & Supp. 1992) (creating a licensing system for the marketing of toxic substances); Safe Drinking Water Act, 42 U.S.C. §§ 300(f)-300(j)(26) (1988) (setting tolerances for drinking water); Solid Waste Disposal Act, 42 U.S.C.A. §§ 6901-6992(k) (West 1983 & Supp. 1992) (setting guidelines for hazardous waste management).

24. See, for example, Mark Sagoff, *The Economy of the Earth: Philosophy, Law, and the Environment* (Cambridge, 1988).

25. See *Unfinished Business* at 8-20 (cited in note 16) (discussing differences of ecological and public health aspects of environmental law).

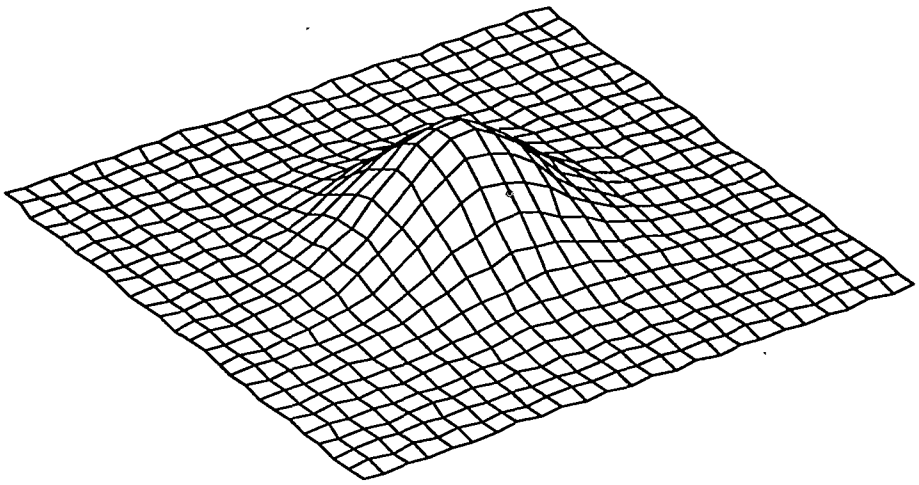
26. See generally Erin Pitts, *The ESA and the Spotted Owl*, 21 Envtl. L. 1175 (1991).

27. See Rose, 1991 Duke L. J. at 11-20 (cited in note 2).

persed from, or concentrated at, a site. Industries build tall stacks, and dump into fast flowing streams in order to disperse pollution over a broad area, and decrease exposure. See Figure 1a.

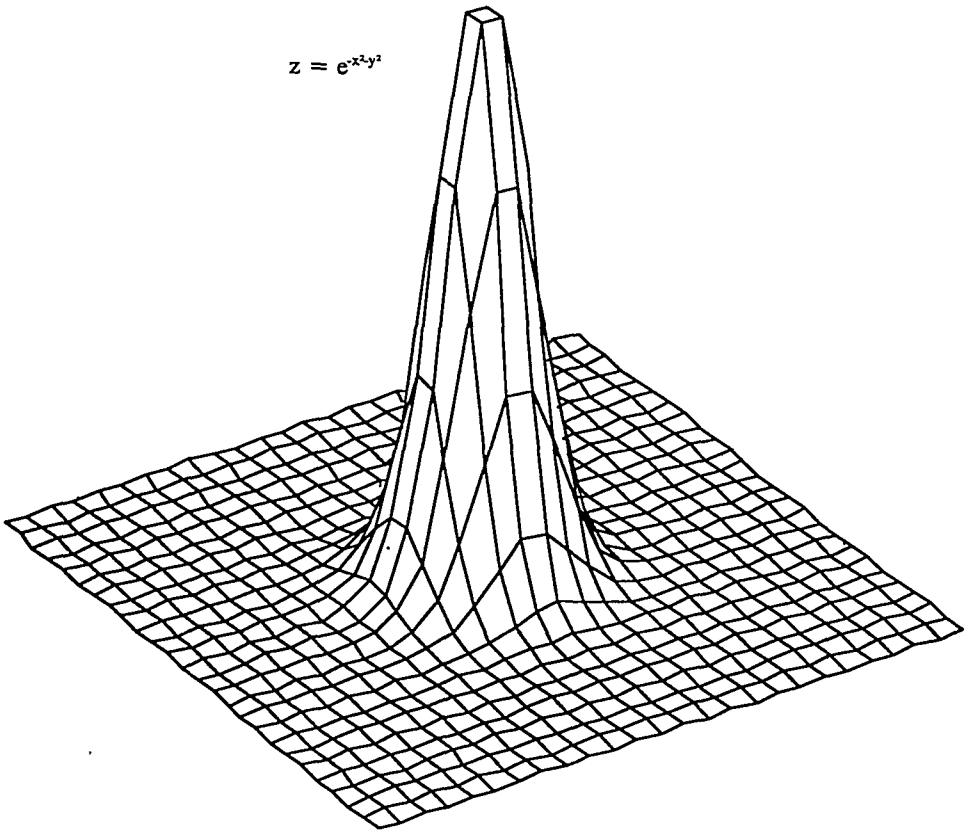
Figure 1a
Dispersed Risk Distribution

$$z = (1.25/2\pi)\, e^{-\frac{1}{2}(x2 + y2)}$$



Other forms of pollution, such as that of ground water or soil at hazardous waste sites, tend to be concentrated, with higher exposures in a limited area. See Figure 1b.

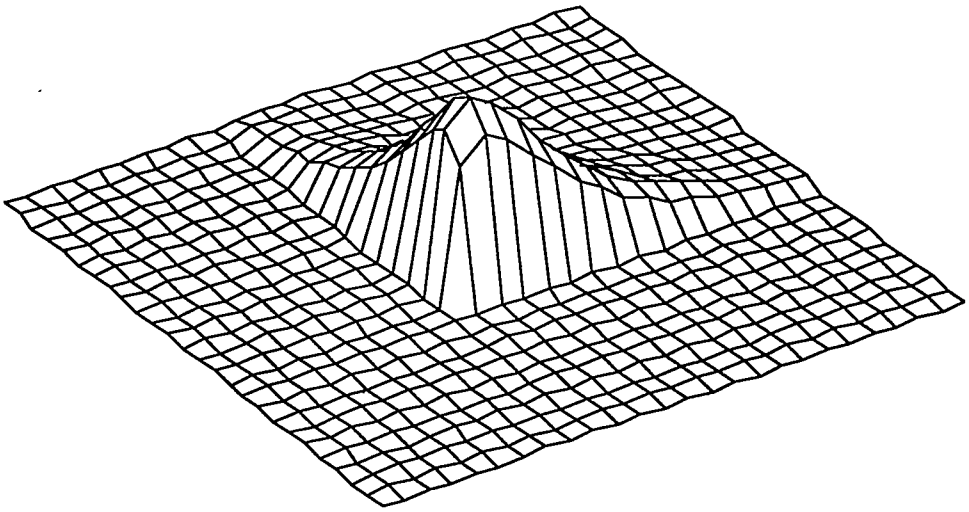
Figure 1b
Concentrated Risk Distribution



Still others may have more complicated risk patterns due to ground water flow mechanics or prevailing winds. See Figure 1c.

Figure 1c
Risk Distribution

$$z = \sqrt{x}\, e^{-x} \sqrt{y}\, e^{-y}$$



These geographic and climatological issues contribute to the configuration of a risk envelope: the spatial distribution of risk from environmental toxins. Environmental regulation has long recognized this distinction: much of the Federal Water Pollution Control Act assumes dispersed pollution, while the Safe Drinking Water Act and Superfund presume concentrated pollution.

The third generic distinction that characterizes environmental paradigms concerns the multiplicity of the sources. The number of sources of pollution sometimes determines environmental regulatory strategies. Some regulations control pollution from a plant that burns solid wastes in an isolated area.[28] Other regulations attempt to minimize pollution from the exhaust of millions of automobiles that crowd cities every morning.[29] While the pollution from each might be controlled through the same generic response—point source controls such as catalytic con-

28. 42 U.S.C. § 7429 (West Supp. 1992) (Clean Air Act).
29. Id. § 7521.

verters for cars and scrubbers for smelters—they are usually considered different environmental paradigms and usually call for different control strategies.

Combining the latter two types of generic distinctions enables us to construct a set of unique environmental paradigms. Four are possible, as shown in Table 1.

Table 1

Geographic Distribution	Multiplicity of Sites: Single	Multiplicity of Sites: Numerous
Concentrated	A	C
Dispersion	B	D

A set of examples restricted to the air medium might be A: an isolated smelter in a valley given to temperature inversion, which creates barometric pressure that keeps the pollution from dispersing, as an example of the concentrated, singular-source paradigm; B: a similar smelter on a plain with strong and constant prevailing winds for the dispersed, singular-source paradigm; C: automobile pollution in a city given to temperature inversions for numerous, concentrated pollution; and D: similar pollution in a city with strong prevailing winds for the numerous, dispersed-source paradigms.[30]

30. This is obviously not the only way to characterize pollution scenarios. It is, rather, a device for illustrating some important points about the kinds of environmental problems for which torts might be a useful source of deterrence.

A final set of distinctions concerns toxicity. The major environmental statutes typically contain particular segments that address toxic substances. For instance the Clean Air Act includes Section 112, which was intended to abate toxic air pollutants, while much of the rest of the Act dealt with "criteria" air pollutants, which, presumably, are not toxic.[31] Unfortunately, the Act has not distinguished toxic and nontoxic pollutants clearly. Most air pollution affects human health. Regulators selected many of the criteria pollutants for special attention because they contributed to "killer smogs" in the 1940s and 1950s. Yet they did not label these pollutants "toxic." Regulators presumed that toxic air pollutants, usually carcinogens, were more deadly or poisonous.[32] But Congress, regulators, and the courts curiously have not developed brightline distinctions between toxic substances and other forms of pollution, and instead typically rely on lists of toxic substances, treating the distinction as if it were self-evident.

Two somewhat legal, somewhat scientific notions seem to be integrated into this toxic-nontoxic dichotomy. The first is potency, or the power to cause disease or death after exposure to small amounts. For instance, regulators long considered dioxin an extraordinarily toxic substance because it killed laboratory animals after exposure to minute doses. On the other hand, they have never characterized carbon monoxide as toxic, even though it too can kill laboratory animals. Part of the reason is that carbon monoxide must be present in rather high concentrations to be lethal. The second factor in determining toxicity is signature status, to use a term popularized by lawyers. Signature diseases are

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31. Clean Air Act § 112, Pub. L. 91-604, 84 Stat. 1690, codified as amended at 42 U.S.C.A. § 7412 (West 1988 & Supp. 1992).

32. The definition of hazardous air pollutant under the old Section 112 of the Clean Air Act was as follows:

> [T]he term "hazardous air pollutant" means an air pollutant to which no ambient air quality standard is applicable and which in the judgment of the Administrator causes, or contributes to, air pollution which may reasonably he anticipated to result in an increase in mortality, or an increase in serious irreversible, or incapacitating reversible, illness.

42 U.S.C. § 7412(a)(1) (1988). Interestingly, the new Section 112 provided by the Clean Air Act Amendments of 1990 eschews the generic definition of hazardous pollutant and instead provides an initial list of over 200 chemicals that Congress considers toxic. 42 U.S.C.A. § 7412(b)(1) (West Supp. 1992). Further additions to this list are planned. See text accompanying notes 89-99.

those that are rare in the absence of certain kinds of exposures.[33] For instance, doctors thought that vaginal adenocarcinoma of the cervix was a rare condition except in women exposed to diethylstilbestrol (DES) in utero. It was, therefore, a signature disease for DES.

A more technical way to characterize signature status is to refer to the epidemiological notion of attributable fraction (or risk) of disease.[34] When a particular disease is highly associated with a certain kind of substance, the attributable fraction of disease is said to be high. For instance, the fraction of mesothelioma attributable to asbestos exposure is well over ninety percent, that is, more than nine out of ten deaths from mesothelioma are the result of asbestos exposure. On the other hand, we know that criteria air pollutants, like sulfur dioxide, are associated with an increased risk of death from pneumonia, but the attributable fraction of such deaths to sulfur dioxide, even in a very polluted area, is less than five percent. Therefore, mesothelioma is a signature disease of asbestos (a toxic substance) whereas pneumonia is not a signature disease of sulfur dioxide (not a toxic substance).

Potency and signature status combine to determine regulatory notions of toxicity; regulators may label a substance toxic even if it does not cause a high attributable fraction of disease, so long as it is very potent, like dioxin. On the other hand, they may consider toxic a substance, like DES, that causes a signature disease, even if people must ingest it in relatively high doses to cause any harm. Figure 2 illustrates this point. I am aware of no toxic substances that are not potent and do not cause a high attributable fraction of disease in an exposed popula-

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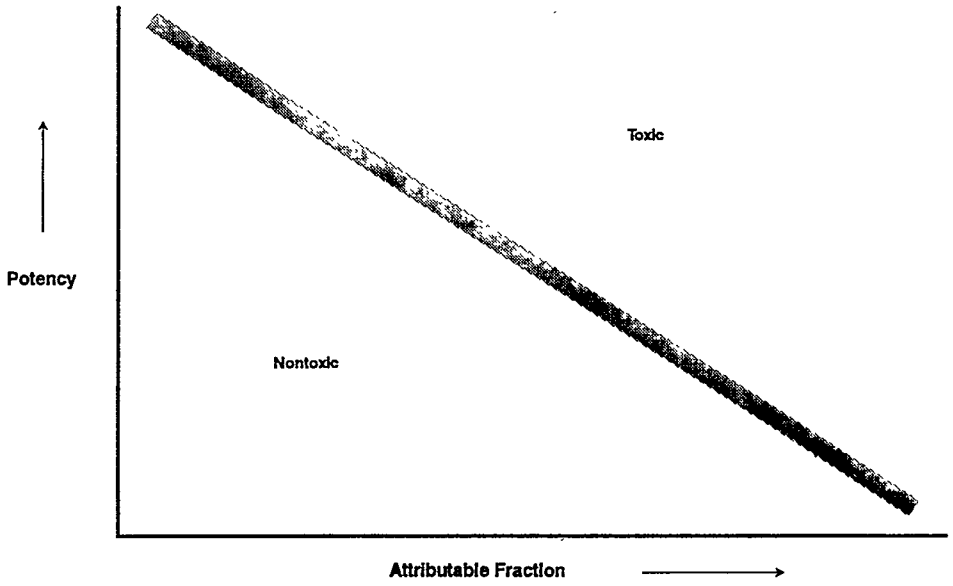
33. See Kenneth S. Abraham, *Individual Action and Collective Responsibility: The Dilemma of Mass Tort Reform*, 73 Va. L. Rev. 845-67 (1987) (discussing the notion of signature diseases).

34. See Troyen A. Brennan and Robert F. Carter, *Legal and Scientific Probability of Causation of Cancer and Other Environmental Diseases in Individuals*, 10 J. Health Pol., Pol'y & L. 33, 50 (1985) (discussing the notion of attributable fraction). Toxicologists rely to a large extent on statistical definitions of morbidity and mortality. Statistics based on epidemiological observations can tell toxicologists that a substance is highly associated with a variety of disease states. See Troyen A. Brennan, *Causal Chains and Statistical Links: The Role of Scientific Uncertainty in Hazardous Substance Litigation*, 73 Cornell L. Rev. 469, 482 (1988) (discussing epidemiology as it applies to hazardous substance litigation). For instance, cadmium is associated with renal impairment and lung cancer. Conversely, the same sort of data reveals that certain diseases are especially prone to environmental influences. For example, exposure to cadmium, a variety of heavy metals, or asbestos can cause lung cancer.

tion. Note that the division between toxic and nontoxic is not sharply defined in Figure 2: a substantial grey zone exists between these categories.

Figure 2
Toxicity as a Function of Potency and Attributable Fraction



Each of the four paradigms based on geographic dispersion and multiplicity of sources fissions when we incorporate the toxic-nontoxic distinction. For instance, a singular coal-fired utility plant may emit primarily criteria (nontoxic) pollutants onto a plain with strong prevailing winds, or a singular smelter may emit toxic, heavy metal pollutants. Each of the resulting eight paradigms suggests a different toxic risk envelope. Applying the ecological-human health distinction to this matrix adds four additional paradigms. For example, sulfur dioxide, which causes acid rain, is primarily an ecological, dispersed, numerous-source-type of pollutant.

This set of paradigms is certainly not the only way to categorize environmental pollution. It is intended for the particular purpose of developing an understanding of the emergence and social utility of environmental torts. Even in the absence of this narrow purpose, one can appreciate that different pollution paradigms could give rise to different control strategies. Each of the twelve environmental pollution paradigms presents it own problems. Concentrated, toxic, single-source pollution such as groundwater contamination calls for different measures

than does dispersed, toxic, single-source pollution, such as emissions from a smelter on a plain with strong prevailing winds. And both differ from numerous-source, dispersed, toxic pollution such as chlorofluorocarbons (CFCs), which may, at present, pose our most serious environmental threat.[35]

The heterogeneity of environmental paradigms has been insufficiently appreciated in environmental law. For purposes of this Article, its absence from discussions of torts caused by hazardous substances is our major concern. For instance, both Professor Neil Komesar's sophisticated analysis of the institutional role of tort law,[36] and the seminal evaluation of legal approaches to abatement of risks by Professors Clayton Gillette and James Krier[37] rely on rather unsophisticated, unitary notions of environmental pollution. Both papers conclude that environmental tort law has little potential as a source for plaintiffs' attorneys fees and little merit as a deterrence-producing institution.[38] A brief overview of their arguments helps illustrate the importance of considering the heterogeneity of environmental paradigms, especially if one is to explain the emergence of environmental torts (positive theory), and assess its deterrence value (normative theory).

Komesar insightfully considers not only the post-injury behavior of injurers and injured, but also their pre-injury actions. He sheds light on the important subject of the ability of institutional actors to develop or react to deterrence signals.[39] He characterizes victims of air and water pollution as having low ex ante expectations of injury, and notes that these injuries have a low per capita impact because of their diffuse nature. On the other hand, the injurer expects ex ante that pollution could have serious repercussions, and after injury has occurred, recognizes the potentially severe losses.

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35. CFC pollution depletes the stratospheric ozone and, as a result, allows more ionizing radiation to strike the surface of the earth. This appears to be causing a huge increase in the incidence of melanoma or skin cancer. The EPA estimates that as many as 15,000 additional deaths of melanoma per year occur as a result of this stratospheric ozone depletion. See *Unfinished Business* at 18 (cited in note 16). CFC pollution is the result of multiple use of spray cans and refrigerators. It is dispersed because there is wide geographic incidence of the use of these products. It is toxic because it causes so much melanoma. Indeed much of the 30% to 40% rise in incidence of melanoma can be attributed to CFCs. Id. at 20.

36. Komesar, 65 N.Y.U. L. Rev. at 23 (cited in note 10).

37. Gillette and Krier, 138 U. Pa. L. Rev. 1027 (cited in note 10).

38. One must conclude, after studying these analyses, that tort law serves little compensation or deterrent purposes in cases of environmental pollution. Indeed, accounting for the phenomenon at all, given these persuasive arguments, is quite difficult. The central propositions of this Article are that these analysts miss some points, particularly that the evolution of environmental torts is rational from the viewpoint of the economic interest of plaintiff attorneys, and is likely from a deterrence perspective.

39. See Komesar, 65 N.Y.U. L. Rev. at 33.

Underlying Komesar's analysis is the paradigm of environmental pollution as nontoxic, dispersed, and originating from a singular source. The singular source would have high stakes in the pollution, both before and after injury; the injured individuals would have low stakes. The pollution is not potent, causes a very low percentage of the diseases with which it is associated, and is dispersed over a wide geographic area. It does not create incentives for action on the part of the injured. As Komesar suggests, this situation rarely would give rise to an environmental tort or to attorneys' fees.[40]

Other paradigms of environmental injury exist, however. If we change the above paradigm to one in which numerous sources, such as automobiles, produce pollution, the institutional distribution shifts in a way that Komesar has not anticipated. To use Komesar's vernacular environmental pollution has an actual and potential low impact for victims and also potential low impact for injurers (the automobile drivers).[41] Since automobiles are numerous and each contributes only small amounts to the total injury burden, automobile drivers are poor recipients of deterrence signals.

Consider now the paradigm of the singular, concentrated, toxic polluter. This seems to resemble Komesar's "Distribution #2,"[42] which involves potential and actual high impact for the polluter (injurer) and actual high impact for the victim. In this situation, a toxic substance that causes a signature-type disease and that is emitted in a concentrated fashion from a singular source, creates the appropriate situation for tort actions by injured individuals. These tort actions inform highly deterrable producers of the situation. Komesar himself would encourage tort litigation in such situations because of its deterrent effect. Plaintiffs' attorneys also find these situations attractive. All of this underlines the fact that some environmental injury paradigms lend themselves to institutional responses such as tort litigation that are inappropriate or inapplicable for other paradigms. Abandoning the unitary concept of pollution makes this fact easily recognizable.

Overcoming the notion that environmental pollution only creates vague, diffuse risk allows one to understand how environmental tort litigation can succeed. Consider Gillette and Krier's argument that common-law litigation cannot produce deterrence for any public risks, including those posed by environmental hazards, largely because of fundamental "access" bias against plaintiffs.[43] Access bias results from liti-

40. Id. at 48-50 (Distribution #3).

41. Id. at 30-33 (I am applying Komesars language here myself; he does not describe this type of distribution).

42. Id. at 38-40.

43. See Gillette and Krier, 138 U. Pa. L. Rev. at 1045 (cited in note 10). Gillette and Krier

gants deciding that these suits are not worthwhile. They base these decisions on an understanding that public risks are "diffuse in their impacts, and of low probability."[44] Obviously, Gillette and Krier have in mind the environmental paradigm of diffuse, nontoxic pollution that carries a low attributable fraction. They fail to consider that public risk, at least the environmental sort, comes in different packages. (Gillette and Krier may respond that they would not call toxic, concentrated pollution a public risk at all, but they seemingly intend to apply their analysis to all forms of hazardous substance litigation, including environmental torts.)

While both Komesar, and Gillette and Krier, may be too simplistic in their discussion of environmental injuries, their analyses demonstrate that courts will not readily apply tort law to nontoxic injury. These authors' concerns about "diffuseness," "low impact" on plaintiffs, and "low probability," are appropriate when substances are not potent, and when they possess a low attributable fraction of disease. It is thus difficult to explain how environmental torts occur, or to advocate the deterrence that they may produce for anything other than toxic injury. Therefore, from here forward, I will restrict the analysis to torts for toxic environmental pollution.[45]

We thus shift our attention primarily to the four paradigms of toxic pollution. The single-source-multiple-source and concentrated-dispersed dichotomies are, of course, simplifications. Each dichotomy really represents a spectrum of sources of pollution. For example, some cases will concern a truly singular pollution source, such as an isolated smelter. Moving along the spectrum toward multiplicity of sources is the case of several paper mills polluting the same river. Next are the numerous oil refineries and steel mills in an industrialized setting that contribute to benzene air pollution. At the far of the spectrum lies the cases involving a near infinite number of pollution sources, for instance the innumerable spray cans and leaking refrigeration units that emit CFCs, which deplete the ozone layer.

While regulations address the spectrum of such pollution, torts cannot. At some point, the number of potential defendants tends to overwhelm the ability of plaintiffs to join them.[46] There is a poorly

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also mention the concept of process bias, an issue I return to in Part V.

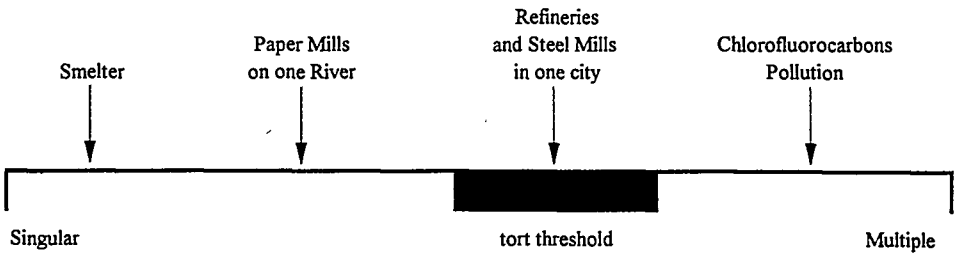
44. Id. at 1046.

45. This is the area where one would expect the lions' share of the action in any case.

46. See text accompanying notes 140-44.

specified threshold beyond which common-law litigation is simply impracticable. See Figure 3.

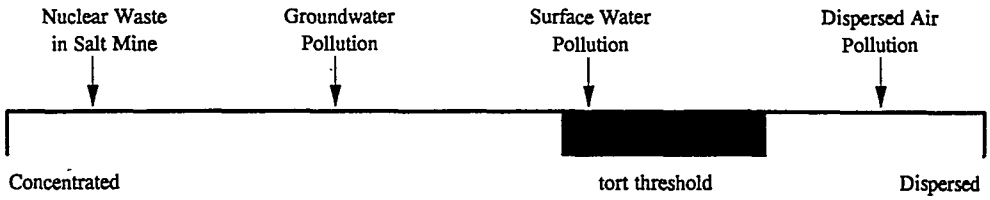
Figure 3



Thus, when there are a near infinite number of pollution sources, regulation is the only answer, and we need not question its efficacy in this Article. For example, I will forego analysis of regulations for CFC control or toxic pollutants from motor vehicles.[47]

The same sort of limits apply to the concentrated-dispersed dichotomy. See Figure 4.

Figure 4



The most concentrated pollution might be exemplified by nuclear wastes encapsulated in geologically stable salt mines. An example of somewhat less concentrated pollution is groundwater contamination in an aquifer with slow subterranean movement. Moving toward more dispersion is the example of surface water pollution in a bay. Air pollution in an area with strong prevailing winds is an example of very dispersed pollution. The latter pollution scenario challenges the limits of mass

47. See 40 C.F.R. § 85 (1974), promulgated in accordance with 42 U.S.C. § 7521(a) (1988) (Clean Air Act § 202(a)).

tort litigation as the plaintiff class grows in size and geographic dispersion. Therefore, successful tort litigation will center on concentrated, singular environmental paradigms. These paradigms also escape many of the normative concerns raised by Komesar, and Gillette and Krier: in such cases, a court can aggregate a defined set of plaintiffs in an action against a single producer. These plaintiffs can focus on the particular features of the pollution.

The other insight gleaned from the Komesar, and Gillette and Krier papers is the importance of an institutional perspective to evaluating the deterrence of injuries. Indeed, if other institutional devices, such as the market, regulation or criminal law, would deter toxic pollution effectively, this would bear importantly on our analysis of environmental tort litigation. If any of these alternatives were capable of dealing with all the various toxic pollution paradigms, discussion of environmental torts would be unnecessary. Therefore, we should digress from tort law to evaluate the other institutional means to deter hazardous pollution-related injuries, while continuing to use the analytical device of environmental paradigms.

III. Regulation and Residual Risk

Over the last twenty-five years, individuals and institutions have devoted massive amounts of political will and intellectual effort to regulating pollution, including toxic pollution. If this effort had been successful in reducing risks of toxic injury to minimal levels, or offered the promise of such reduction in the near future, then a positive theorist would have to ask why environmental torts have emerged. If no or little residual risks remained, then it seems unlikely that plaintiffs would seek attorneys, and less likely that attorneys would take cases. Hence, the existence of tort litigation over environmental toxins suggests the environmental regulation scheme is incomplete.

Of course, litigation may concern pollution that occurred before the regulation regime was in place. The latency period that characterizes many environmental illnesses can be as long as twenty years. Conceivably, today's environmental tort litigation slowly will vanish as those afflicted by diseases caused by toxic pollution of ten to twenty years ago die. Therefore, environmental regulation may work, and yet attorneys are still motivated to bring suit.

While the effectiveness of the regulation may therefore be peripheral to understanding the positive concern of why environmental torts are brought, it remains important on the normative side. If regulation has reduced risk, there is little need for the deterrence function of torts. Tort litigation, especially in the environmental areas, has large administrative costs that can only be justified if it fulfills a deterrent function.

That function is likely to be very thin if regulation of toxins is robust. Therefore, any recommendation for more or less environmental tort litigation will depend on an institutional analysis of the regulation of environmental toxins.

Most environmental regulations do recognize a toxic-nontoxic dichotomy, and so we can concentrate efforts on the former.[48] The major environmental statutes are also media-specific. Toxic control methodologies have varied somewhat between statutes,[49] but most initially reflected the optimism that characterized environmental statutes generally. The Clean Air Act and the Clean Water Act, for example, ambitiously addressed many sources of toxic injury. Congress did not, however, elaborate specific regulatory mechanisms. It left much of the specifics to the agencies, who were to use notice-and-comment rulemaking to develop the concrete rules for citizen and corporate behavior.

The statutes of the early 1970s, and the control strategies to which they gave rise, were perhaps destined to fall short.[50] Acute observers of regulation had long voiced concerns that "comprehensively rational"[51] legislation was beyond the grasp of human, and especially legislative, intellect and that the New Deal independent agencies had failed their mission.[52] An alternative, to "muddle through,"[53] no doubt resonated with the personal experience of many legislators and observers of the

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48. Unfortunately, the toxic provisions of environmental statutes do not recognize the dispersion-concentration, singular-multiple spectra, and so it is impossible to use these to exclude any specific regulatory initiatives from my assessment.

49. See text accompanying notes 67-99.

50. For a historical analysis from a different perspective, see Robert Glicksman and Christopher H. Schroeder, *EPA and the Courts: Twenty Years of Law and Politics*, 54 L. & Contemp. Probs. 249, 252-53 (Autumn 1991).

51. As Colin Diver posits, comprehensive rationality is especially disastrous when a great deal of uncertainty and confiict exists over the problems that give rise to regulation. See Colin S. Diver, *Policymaking Paradigms in Administrative Law*, 95 Harv. L. Rev. 393, 428-29 (1981). Others have sounded similar themes, in particular for environmental and occupational regulation. See generally Richard J. Tobin, *The Social Gamble* (Lexington, 1979); Bruce A. Ackerman and William T. Hassler, *Beyond the New Deal: Coal and the Clean Air Act*, 89 Yale L. J. 1466, (1980); John Mendeloff, *Regulating Safety: An Economic and Political Analysis of Occupational Safety and Health Policy* (MIT, 1979).

52. See, in particular, Theodore J. Lowi, *The End of Liberalism: The Second Republic of the United States* (Norton, 2d ed. 1979); Roger G. Noll, *Reforming Regulation: An Evaluation of the Ash Council Proposals* 110 (Brookings Inst., 1971); Henry J. Friendly, *The Federal Administrative Agencies: The Need for Better Definition of Standards* 160-70 (Harvard, 1962); Kenneth Culp Davis, *Administrative Law Treatise* 1-55 (West, 1958).

53. See David Braybrooke and Charles E. Lindblom, *A Strategy of Decision: Policy Evaluation as a Social Process* 60-100 (Free Press, 1963); Robert A. Dahl and Charles E. Lindblom, *Politics, Economics and Welfare* 80-85 (Harper, 1953). Lindblom himself commented on the problems presented by environmental regulation, finding them a particularly good example of the need to "muddle through." See Charles E. Lindblom, *The Science of "Muddling Through,"* 19 Pub. Admin. Rev. 79 (1959); Charles E. Lindblom, *Still Muddling, Not Yet Through*, 39 Pub. Admin. Rev. 517 (1979).

legislative process. Congress did not heed concerns about comprehensive rationality as it wrote and amended the major environmental statutes in the 1970s, and agencies sought to comply with them.

The toxic substances section of environmental statutes evince the optimism of comprehensive rationality. They were typically segregated from other portions of the statute, and set forth stringent, health-based standards that were to apply to all toxic substances. Yet this required agencies to define the meaning of unacceptable risk.[54] In such determinations uncertainty is the rule.[55] Consider the task created by the hazardous substance provisions of Section 112 of the Clean Air Act. To control pollution for one substance, the statute envisions calculating risk envelopes, similar to those in Figure 1, for every producer across the country (no matter what the degree of dispersion), and then specifying an exposure limit. For a singular site, the simplest case, this means identifying the excess health risk, an extraordinarily difficult task. For numerous sites, agencies must estimate an optimal average reduction of risks. Yet the risk envelopes will vary in size and shape between sites depending on the concentration-dispersion of the pollution, further complicating the task. Any comprehensively rational approach thus faces a nearly intractable set of calculations and estimates. Accordingly, the fact that toxic regulation moved very slowly in the early 1970s is not surprising.

To overcome the difficulties of estimating the multiple risk envelopes for any one substance, the Carter administration adopted a variant of the "comprehensively rational" approach. Representatives of the various health and safety agencies jointly developed generic policies for cancer regulation.[56] In brief, since no safe threshold for exposure to carcinogens was thought to exist, carcinogens were to be regulated to the greatest extent feasible, meaning the lowest exposure that technology

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54. See, in particular, Sanford E. Gaines, *Science, Politics and the Management of Toxic Risks Through Law,* 30 Jurimetrics J. 271, 279-82 (1990); Howard A. Latin, *The "Significance" of Toxic Health Risks: An Essay on Legal Decision Making Under Uncertainty,* 10 Ecology L. Q. 339, 338-42 (1982).

55. Scientific uncertainty abounds in efforts to define the health effects of toxic pollutants. See, for example, Brennan, 73 Cornell L. Rev. at 480 (cited in note 34); Howard Latin, *Ideal Versus Real Regulatory Efficiency: Implementation of Uniform Standards and "Fine-Tuning" Regulatory Reforms,* 37 Stan. L. Rev. 1267, 1272-77 (1985); John D. Graham, *The Failure of Agency Forcing: The Regulation of Airborne Carcinogens Under Section 112 of the Clean Air Act,* 1985 Duke L. J. 100, 104-07 ; John D. Graham, et al., *In Search of Safety: Chemicals and Cancer Risk* 38-79 (Harvard, 1989). For a summary of much of this literature, see Alyson C. Flournoy, *Legislating in Action: Asking the Wrong Questions in Protective Environmental Decision Making,* 15 Harv. Envtl. L. Rev. 327 (1991).

56. See Interagency Regulatory Liaison Group, *Scientific Basis of Identification of Potential Carcinogens and Estimations of Risk,* 44 Fed. Reg. 39858 (1979).

would allow.[57] Both the Occupational Safety and Health Administration (OSHA) and EPA incorporated this tenet into their generic cancer policies.[58] Such policies were facially rational, and conducive to expeditious regulation because they overcame the need to perform exquisitely difficult risk assessments. But, this rational approach irrationally overlooked the issue of costs. While regulators studying their stringent health-based statutory language understandably might exclude costs from their calculations, whether Congress intended this is not clear. More important, generic policies were anathema to regulated industries that had to worry about costs. The generic approach was mortally wounded by *Industrial Union Department, AFL-CIO v. American Petroleum Institute*,[59] the so-called *Benzene* case, still the most important of toxic substance regulation cases.[60] OSHA attempted to rely on its overarching Generic Cancer Policy as a basis for lowering benzene exposure levels. Justice Stevens' plurality opinion, overturning the new standard and the underlying policy, required affirmative proof of "a significant risk of harm and therefore a probability of significant benefits."[61]

In effect, the Court saw OSHA's comprehensive rationality attempt as anything but, in that it constituted regulation with costs, but no proven benefits. After *Benzene*, it was clear that agencies would have to be prepared to calculate the risks posed by hazardous substances and to

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57. See Thomas O. McGarity, *OSHA's Generic Cancer Policy: Rule Making Under Scientific and Legal Uncertainty*, in J.D. Nyhart and Milton M. Carrow, eds. *Law and Science in Collaboration* 55 (Lexington, 1983).

58. See OSHA, *Identification, Classification and Regulation of Potential Occupational Carcinogens*, 45 Fed. Reg. 5002 (1980) (codified at 29 C.F.R. § 1990 (1991)); EPA, *National Emission Standards for Hazardous Air Pollutants; Policy and Procedures for Identifying, Assessing and Regulating Airborne Substances Posing a Risk of Cancer*, 44 Fed. Reg. 58642 (1979).

These cancer policies contained the following principles, among others. First, they assumed that animal bioassays could reveal substances that caused human cancer. Second, they were not to give the same weight to negative epidemiological studies as that given to positive studies or animal bioassays. Third, they assumed that no safe threshold for carcinogens exists. Fourth, they assumed that carcinogens were not site-specific; that is, the EPA thought that a carcinogen in a particular site in an animal was capable of causing cancer in another site in a human being. Finally, the policies emphasized safety in that they assumed worst-case estimates and emphasized prevention of illness in any quantitative assessment.

59. 448 U.S. 607 (1980) (*Benzene*).

60. The case is often used as a paradigm of crisis in administrative law. See Christopher Edley, Jr., *The Governance Crisis, Legal Theory, and Political Ideology*, 1991 Duke L. J. 561, 571 (stating that the *Benzene* case reflects commingling of scientific, political and fairness paradigms).

61. See *Benzene*, 448 U.S. at 644. The Court did not require an explicit cost-benefit analysis, and indeed rejected this interpretation explicitly under another section of OSHA later the same year. See *American Textile Mfrs. Inst., Inc. v. Donovan*, 452 U.S. 490 (1981). Nonetheless, the weighing called for in *Benzene* has much the same effect as would an explicit endorsement of formal cost-benefit analysis.

define the costs of regulation on a case by case basis.[62] The Reagan administration did not attempt to redefine the OSHA Generic Cancer Policy. Perhaps more telling, EPA abandoned generic policies in the mid-1980s and now insists that each substance must be judged independently.[63]

Now regulators face an even more stunning (and perhaps stunting) task. Not only must they calculate and summarize risk envelopes, but they must develop cost estimates for each polluter as well.[64] Since the exposed population around every source varies, costs will also vary. Thus, even if each source had similar risk envelopes, the cost estimates for each site could be quite different. Moreover, singular standards may produce different levels of risk reduction. For example, reducing levels of ambient atmospheric benzene near a steel mill with various toxic plumes may be very expensive. If this mill is situated in a thinly populated area with strong prevailing winds, there might be very little risk reduction for this cost. On the other hand, controls at a smelter in a densely populated area may be very cost-effective from a risk reduction viewpoint. Integrating all of this information from multiple sites to produce a single rational overarching standard seems impossible. While the health-based statutory language must be modified by attention to costs, the cost-benefit goals are not specified in cases like *Benzene*. Hence, the difficulty of getting the cost-benefit analysis right will continue to trouble toxic substance regulation.[65] Neither regulators nor judges have the luxury of concentrating their attention on a single source.

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62. For a recent illuminating discussion of those aspects of the *Benzene* decision, see Frank B. Cross, Daniel M. Byrd, III, and Lester B. Lave, *Discernible Risk—A Proposed Standard for Significant Risk in Carcinogen Regulation*, 43 Admin. L. Rev. 61 (1991).

63. See EPA, *Guidelines for Carcinogen Risk Assessment*, 51 Fed. Reg. 33992 (1986). Some of the assumptions now underlying EPA's approach are at variance with the more conservative points of the Interagency Regulatory Liaison Group's cancer policy. See Howard Latin, *Good Science, Bad Regulation, and Toxic Risk Assessment*, 5 Yale J. Reg. 89, 98-105 (1988).

Industry has become so emboldened by agency hackpedaling on cancer risks that they bave sued to overturn the policies utilized by the National Toxicology Program to identify carcinogens. See *Synthetic Organic Chem. Mfrs. v. Secretary, Dep't of Health and Human Sciences*, 720 F. Supp. 1244 (W.D. La. 1989) (denying motion by chemical manufacturers for preliminary injunction against publication of the Fifth Annual Report on Carcinogens, which focused particularly on chlorinated paraffin, ethyl acrylate, tetrachloroethylene, methylene chloride, and paradichlorobenzene).

64. See Sidney A. Shapiro and Thomas O. McGarity, *Not So Paradoxical: The Rationale for Technology-Based Regulation*, 1991 Duke L. J. 729, 732-33 (discussion of the problems with ex ante risk assessment).

65. A very instructive recent case is *Corrosion Proof Fittings v. EPA*, 22 Envtl. Rep. Cas. (BNA) 1606 (1991) (overturning EPA ban on asbestos products). See also Arthur Fraas, *The Role of Economic Analysis in Shaping Environmental Policy*, 54 L. & Contemp. Probs. 113, 122-24 (Autumn 1991) (discussing the economic benefit of eliminating asbestos). Even an attempt simply to take all potential factors into account, without any attempt at synthesis, may be daunting. See Thomas O. McGarity, *The Internal Structure of EPA Rulemaking*, 54 L. & Contemp. Probs. 57, 80 (Autumn 1991).

Given the uncertainty surrounding risk assessment, regulators have been driven primarily by fear of reversal when courts analyze their risk assessment reasoning.[66] Courts have sympathized with agency hesitance when it is justified by a request to develop better information,[67] or because the agency claims an inability to undertake data collection due to limited resources.[68] Since agency interpretation of statutory language is in some measure unreviewable after the *Chevron* decision,[69] delays in toxic regulation under health-based statutes should be expected.[70]

At least partially in light of the standoff over health-based statutes and cost-benefit analysis, agencies have developed another way to regulate toxic substances, one that emphasizes technological solutions. In cases of nontoxic pollution, agencies have long relied on technology-based standards that specify controls for various processes or industries.[71] On the toxic side, this approach allows the agency to procrastinate about health assessments until the technology is in place. Technology-based regulation thus permits an agency to muddle through in an incremental fashion.[72]

Incrementalism has several theoretical advantages over the herculean task of health-based regulation of toxic substances. It seemingly offers some potential for site specificity. Incrementalism also allows for feedback. An agency can reverse bad, that is, over- or under-risk reduction decisions, quickly with relatively low costs.[73] On the other hand, the incremental process is slow, and incremental changes can be very small. Unlike a singular standard that is intended to reduce risk to a safe level, technological approaches overtly accept ongoing exposure to

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66. See, in particular, John M. Mendeloff, *The Dilemma of Toxic Substance Regulation* 115-22 (MIT, 1988) (detailing how fear of judicial reversal motivates many agency decisions).

67. See, for example, *Sierra Club v. Thomas*, 828 F.2d 783, 798 (D.C. Cir. 1987); *United Steelworkers of America v. Rubber Mfrs. Ass'n*, 783 F.2d 1117 (D.C. Cir. 1986).

68. See, for example, *Cutler v. Hayes*, 818 F.2d 879, 898 (D.C. Cir. 1987); *Public Citizen Health Research Group v. Commissioner, FDA*, 740 F.2d 21, 34 (D.C. Cir. 1984); *Public Citizen Health Research Group v. Auchter*, 702 F.2d 1150, 1158 (D.C. Cir. 1983).

69. See *Chevron U.S.A. v. Natural Resources Def. Council*, 467 U.S. 837 (1984). See also *Heckler v. Chaney*, 470 U.S. 821 (1985); Cass R. Sunstein, *Reviewing Agency Inaction After* Heckler v. Chaney, 52 U. Chi. L. Rev. 653 (1985).

70. Unfortunately, this will lead to some quantifiable increases in mortality as a result of agency delay. See William J. Nicholson and Philip J. Landrigan, *Quantitative Assessment of Lives Lost Due to Delay in the Regulation of Occupational Exposure to Benzene*, 82 Envtl. Health Persp. 185 (1989) (stating that between 1978 and 1987, 30 to 490 excess leukemia deaths resulted from occupational exposures to benzene of greater than one part per million).

71. See John E. Bonine and Thomas L. McGarity, *The Law of Environmental Protection* 256-63 (West, 2d ed. 1991) (discussing the use of technological feasibility in the Clean Water Act).

72. Judge Leventhal recognized this development years before it was clear to other commentators. He noted that tecbnological feasibility had to emerge as the core issue in analysis of health and safety standards. See Harold Leventhal, *Environmental Decisionmaking and the Role of Courts*, 122 U. Pa. L. Rev. 509, 531-35 (1974).

73. Clayton Gillette suggested the reversibility benefit of incremental approaches.

toxic levels of pollutants as the technology improves. Risks still may exist, especially at particular point sources, leaving small areas still exposed to high levels of toxic substances. While health-based regulation appears to have failed, incrementalism is not guaranteed to produce significant risk reduction. However, technological solutions do create a sense that regulation is "working," which must appeal to most regulators and elected representatives. Difficult risk reduction estimates can be postponed.

The rather extensive report card on incrementalism is not encouraging.[74] Consider illustrative examples from the water and air acts. Their toxic substance provisions were intended to curtail exposure to hazardous substances in water and air expeditiously and they presumably encouraged agencies to undertake comprehensively rational approaches. In both instances, those approaches have failed; and in both cases, EPA has decided to pursue an incrementalist approach that puts off the need to assess the burden of toxic substance-induced disease.[75]

In the Clean Water Act,[76] as with the Clean Air Act, Congress segregated the control of toxic pollutants from other aspects of the regulatory structure. In the 1972 legislation, Section 307 defined toxic pollutants broadly[77] and required either an ample margin of safety or a prohibition of discharge.[78] The Act did not provide for consideration of feasibility issues or cost, unlike those sections dealing with conventional discharges.[79] Congress intended this comprehensively rational approach to require that EPA move quickly to regulate water toxins stringently.

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74. Much of this argument is based on a more detailed discussion in a previous work. See Troyen A. Brennan, *Narrowing the Wide Open Spaces: ALI Discussion Paper* (1990) (unpublished manuscript, on file with author). Others have also noted the move towards technology-based standards. See James C. Robinson and William S. Pease, *From Health-Based to Technology-Based Standards for Hazardous Air Pollutants*, 81 Am. J. Pub. Health 1518 (1991).

75. John Dwyer has cited the toxic substance provisions of the original Clean Air Act (Section 112) and the Clean Water Act (Section 307) as examples of "regulatory statutes [that] impose short deadlines and stringent standard setting criteria that are designed to address a single overriding concern, to the exclusion of other factors." John P. Dwyer, *The Pathology of Symbolic Legislation*, 17 Ecol. L. Q. 233 (1990).

76. Federal Water Pollution Control Act Amendments of 1972 ("FWPCA"), Pub. L. No. 92-500, 86 Stat. 816,; Clean Water Act of 1977, Pub. L. No. 95-217, 91 Stat. 1566. These provisions are codified at 33 U.S.C. §§ 1251-1376 (1988).

77. See 33 U.S.C. § 1362(13) (1988) (Clean Water Act § 502(13)), which defines "toxic pollutant" as:

> those pollutants, or combinations of pollutants, including disease-causing agents, which after discharge and upon exposure, ingestion, inhalation or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will, on the basis of information available to the Administrator, cause death, disease, behavior abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction) or physical deformations, in such organisms.

78. See FWPCA § 307(a)(2), (a)(4), codified at 33 U.S.C. § 1317(a)(2), (a)(4) (1988).

79. See 33 U.S.C. § 1316.

As might be expected with such health-based regulation, just the opposite occurred. After passage of the 1972 Amendments, the Administrator slowly developed a toxic pollutant list that contained only eight substances.[80] At the beginning of the Carter administration, the Flannery decree allowed the EPA to retreat from the absolutist health-based standards of the original Section 307 in exchange for action on a variety of pollutants.[81] This negotiation, involving only environmentalists and EPA, created an incrementalist approach to toxic substances in water that Congress had not envisioned in the original legislation.[82]

Under the original decree, at the completion of the engineering approach to water toxics, EPA was obligated to promulgate certain water quality criteria for the sixty-five listed pollutants. By the mid-1980s, many industries had the required "best available technology" (BAT) in place. Unfortunately, the status of toxins in water was still quite uncertain.[83] Thus, the 1987 Amendments to the Clean Water Act turned to the states, requiring them to promulgate strategies for achieving specific standards in those areas where the BAT controls had proven inef-

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80. These included aldrin-dieldrin, benzidine, cadmium, cyanide, DDD-DDE-DDT, endrin, mercury, polychlorinated biphenyls, and toxaphene. See EPA, *Toxic Pollutant Effluent Standards*, 38 Fed. Reg. 24342 (1972). This weak effort itself was prompted by a court order. See *Natural Resources Def. Council v. Fri*, 3 Envtl. L. Rep. (Envtl. L. Inst.) 20,587 (D.D.C. 1973). Further litigation ensued, and eventually both environmentalists and EPA decided that perhaps a negotiated settlement was more appropriate than continued legal fighting over EPA's pace. See William H. Rogers, 2 *Environmental Law* § 4.33 at 480-81 (West, 1986).

81. See *Natural Resources Def. Council v. Train*, 8 Envtl. Rep. Cas. (BNA) 2120 (D.D.C. 1976), modified sub nom. *Natural Resources Def. Council v. Costle*, 12 Envtl. Rep. Cas. (BNA) 1833 (D.D.C. 1979). The agreement committed the Administrator to development of a large number of point source standards (21 major industries that were each discharging a number of toxic pollutants—65 point sources in total). These standards were fundamentally technology-based, featuring engineering controls. The agreement retained only a few of the original health-based standards. For example, under the Flannery decree, cadmium, mercury, and lead, the heavy metals now thought to be among the most toxic of industrial substances, were shifted to engineering control.

The 1977 legislation endorsed the premises of the Flannery decree. See *Environmental Def. Fund v. Costle*, 636 F.2d 1229 (D.C. Cir. 1980), appeal after remand sub nom. *Citizens for a Better Envir. v. Gorsuch*, 718 F.2d 1117 (D.C. Cir. 1983). As the court of appeals noted:

> [B]oth Congress's substitution of an industry-by-industry, technology-based BAT [best available technology] approach for the pollutant-by-pollutant, health-based approach required by Section 307 of the FWPCA, and its decision to specify a list of 65 pollutants—the same pollutants listed in the Agreement—that were to be included in EPA's revised list of toxic pollutants under Section (307)(a), amounted to little more than an 'attempt to conform the statute to the reality of [the] program' EPA had been developing under the terms of the settlement agreement.

636 F.2d at 1241.

82. Litigation under the original health-based standards had resulted in judicial affirmation of the more stringent approach. See, for example, *Hercules Inc. v. EPA*, 598 F.2d 91 (D.C. Cir. 1978) (concerning toxaphene and endrin); *Enviriironmental Def. Fund v. EPA*, 598 F.2d 62 (D.C. Cir. 1978) (concerning polychlorinated biphenyls).

83. See Gaines, 30 Jurimetrics J. at 300 (cited in note 54).

fective.[84] The Amendments also required EPA to promulgate effluent guidelines in a timely manner.[85] EPA's delays eventually led to yet another suit by environmentalists, and a new consent decree.[86] At this point, fifteen years into the regime established by the Flannery decree, great uncertainty remains about how free the surface water is of toxic substances.[87] Moreover, Congress clearly perceives the need to employ health-based media standards to meet the challenge of toxic hot spots that remain after a technology-based program has matured.

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84. See the Water Quality Act of 1987 § 304(*l*)(1)-(*l*)(3), Pub. L. No. 100-4, 101 Stat. 38 (1987), codified at 33 U.S.C. § 1314(*l*)(1)-(*l*)(3) (1988). States were to identify the hot spots and develop plans for new strategies for reducing toxic pollution, using specific numerical criteria. See Lawrence R. Liebesman and Elliott P. Laws, *The Water Quality Act of 1987: A Major Step in Assuring the Quality of the Nation's Waters*, 17 Envtl. L. Rep. (Envtl. L. Inst.) 10311, 10320-21 (1987). Congress was clearly dissatisfied with the gaps left in toxic control by BAT methods. See S 1003-02, 100th Cong., 1st Sess. (Jan. 21, 1987), in 133 Cong. Rec. 1260-61 (1987) (comments of Sen. Burdick). See also Environmental and Nat. Res. Policy Div. of the Congressional Research Service, 100th Cong., 2d Sess., *A Legislative History of the Water Quality Act of 1987* at 125-30 (Comm. Print, 1988).

Following the 1987 Amendments, states have moved quite slowly to develop the new water standards, and EPA has threatened to intervene. The EPA subsequently stated that it would write its own water quality standards, since the states had failed to enact the standards as they were instructed by the Clean Water Act Amendments of 1987. The risk threshold incorporated into these water standards was to be one in one million for exposed individuals. See *States Failure to Set Toxics Criteria Leads EPA to Write Water Quality Standards*, 20 Envtl. L. Rep. (Envtl. L. Inst.) 1985 (1990). The EPA apparently has the authority to object to state standards, or the lack thereof. See *American Paper Inst. v. EPA*, 890 F.2d 869 (7th Cir. 1989) (affirming EPA's authority to review state quality standards).

85. 33 U.S.C. § 1314(m) (1988).

86. *Natural Resources Def. Council v. Reilly*, 22 Envtl. L. Rep. (Envtl. L. Inst.) 20,108 (D.D.C. 1991). On August 25, 1988, six months after the Section 1314(m)(1) deadline had expired, EPA published its first proposed plan, 53 Fed. Reg. 32584 (1988), which identified ten industry categories as "potential candidates" for regulation, and five categories of existing effluent limitation guidelines for review. The final plan, which followed this proposal, was issued on January 2, 1990. 55 Fed. Reg. 803 (1990). It identified only three categories for review and three for revision of existing guidelines, with schedules extending into the mid-1990s for promulgation of guidelines for five new categories. In a memorandum opinion handed down on April 23, 1991, Judge Royce Lamberth found EPA to be in violation of Section 1314(m) and ordered that a status conference be held at which the court would "set a schedule for the establishment of a timetable for the proper implementation of 33 U.S.C. § 1314(m)." 22 Envtl. L. Rep. (Envtl. L. Inst.) at 20,112.

The court issued a consent decree on January 31, 1992, committing EPA to a strict timetable for both the proposal and the final promulgation of effluent guidelines for 18 industry categories. 57 Fed. Reg. 19748, 19750 (1992). In addition, the decree requires EPA to establish a "special task force" composed of representatives from government, citizen groups and scientific organizations. The decision gives this task force wide authority to advise EPA on the entire process of promulgating effluent guidelines, but it is too soon to tell how EPA receives its advice. Finally, the decree requires future rulemaking plans to comply with Section 1314(m), provides for modifications and stays of deadlines in the decree, and provides that the decree is subject to other applicable laws, including appropriations law.

87. EPA does not break out surface water toxins in its analysis of the relative priorities of various health hazards in the environment. See EPA, *Comparing Risks and Setting Environmental Priorities: Overview of Three Regional Projects* 40-41 (EPA, 1989). In some regions, however, industrial point sources remain a source of hazardous pollution. Id.

The toxic air pollution story is remarkably similar, although the decision to move to incrementalism was longer in coming.[88] W. H. Rogers has noted that the hazardous air pollution provisions of Section 112 "stand out as one of the major disappointments of the Clean Air Act,"[89] an opinion that has been shared by many commentators.[90]

The reasons for such disappointment are now familiar. Congress had not ignored the risks posed by hazardous air pollutants.[91] On the contrary, Congress clearly intended that the Clean Air Act of 1970 regulate these risks with much greater rigor than other forms of air pollution.[92] As signed into law by a reluctant President Nixon, Section 112,

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88. The Clean Air Act is one of the most complicated regulatory structures in our government. It takes up 118 pages of the United States Code and as of 1985, regulations created pursuant to the Act required four volumes in the Code of Federal Regulations. See Frederick R. Anderson, et al., *Environmental Protection: Law and Policy* 162-63 (Little, Brown, 2d ed. 1990). The multilevel structure of the Clean Air Act, a product of creative congressional action and ample use of EPA rulemaking authority, has been credited with cleaning the air. Especially with regard to the criteria pollutants, information indicates that air quality has improved in many large American cities. By 1980, sulfur oxides and carbon monoxide levels had dropped significantly. See EPA, Office of Planning and Evaluation, *National Accomplishments in Pollution Control: 1970-1980: Some Case Histories* 82-97 (EPA, 1980). The pollution standard index, the measurement of how frequently air quality is bad enough to create health risks, had improved consistently over the decade from 1975 to 1985. See Conservation Foundation, *State of the Environment: An Assessment at Mid-Decade* 89 (R.R. Donnelley & Sons, 1984). Nonetheless, the most recent EPA data suggests that in several regions, ozone and other criteria air pollutants are amongst the most significant health hazards in the environment. See EPA, *Comparing Risks* at 38-39 (cited in note 87).

89. Rogers, *Environmental Law* § 3.2 at 343 (cited in note 80).

90. See, for example, Gary E. Marchant and Dawn P. Danzeisen, *"Acceptable" Risk for Hazardous Air Pollutants*, 13 Harv. Envtl. L. Rev. 535 (1989); Alan Jay Goldberg, Note, *Toward Sensible Regulation of Hazardous Air Pollutants Under Section 112 of the Clean Air Act*, 63 N.Y.U. L. Rev. 612 (1988); 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 (1986); Graham, 1985 Duke L. J. at 100 (cited in note 55).

Environmentalists and representatives of the state governments and industry have all expressed their views on the drawbacks of Section 112 in the late 1980s. See Clean Air Act (Part 2): Hearings Before the Subcommittee on Health and the Environment of the House Committee on Energy and Commerce, 97th Cong., 1st Sess. 698-708 (1981) (*CAA Hearings*) (testimony of David Doniger, Natural Resources Defense Council senior project attorney); Health Standards for Air Pollutants: Hearings Before the Subcommittee on Health and the Environment of the House Committee on Energy and Commerce, 97th Cong., 1st Sess. 235 (1981) (statement of Robert Abrams, Attorney General of the State of New York); *CAA Hearings* at 722-30 (calling EPA's approacb to control of hazardous air pollutants in courts "simplistic," "counter-productive" and "inappropriate") (statement of Chemical Manufacturers Association representative).

91. The statutory definition of hazardous air pollutants is "an air pollutant to which no ambient air quality standard is applicable and which in the judgment of the Administrator causes, or contributes to, air pollution which may reasonably be anticipated to result in an increase in mortality or an increase in serious, irreversible or incapacitating reversible, illness." 42 U.S.C. § 7412(a)(1) (1988).

92. The mechanism for controlling exposures to hazardous substances was the result of a compromise between the House and the Senate in 1970. The original House bill bad no specific section for hazardous air pollutants. See *A Legislative History of the Clean Air Amendments of 1970*, 93d Cong., 2d Sess. 195-97 (Jan. 1974). The Senate bill, on the other band, set forth methods

dealing with toxic substances, presented a simple but demanding regulatory framework: EPA was to regulate the listed pollutants with an ample margin of safety.[93] But, beneath this relatively straightforward regulatory apparatus lay the same conundrum that visits any effort to regulate hazardous substances like carcinogens. If one accepts a no-threshold level for risks posed by the carcinogen—that is, that any amount of carcinogen can cause cancer—then developing an ample margin of safety without forbidding exposure to such substances is impossible. While parts of the Clean Air Act of 1970 were passed in recognition of the fact that some outdated plants producing large amounts of pollution might have to be closed, Congress apparently did not intend to close entire industries because they present some small, but specifiable risk.[94] Yet the language of Section 112 appeared to require closure for industries that produced air pollution with trace amounts of carcinogens, a step likely associated with unacceptably high economic costs. Hence, EPA was left with a statute that called for what sounded like a comprehensively rational approach to regulation, but was in reality politically and economically infeasible.

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for creating a list of hazardous air pollutants and formulated a nondiscretionary duty to regulate the pollutants within a specific period of time. Id. at 495-98. The Senate Committee Report also defined "hazardous" conservatively, and allowed draconian regulatory responses when necessary to overcome dangers to health: "[A] global prohibition on emissions is a step to be taken only where a danger of health as defined exists." Id. at 420.

In conference, Congress formulated a slightly less conservative definition of "hazardous air pollutant" and required the Administrator to set emission standards "at the level which in his judgment provides an ample margin of safety to protect the public health from such hazardous air pollutant." 42 U.S.C. § 7412(b)(1)(B) (1988). The "may reasonably be anticipated to" portion of the definition of hazardous air pollutant, id. § 7412(a)(1), was added in 1977 to emphasize the precautionary or preventive purpose of the Act, see Clean Air Act Amendments of 1977, H.R. Rep. No. 95294, 95th Cong., 1st Sess., (1977), reprinted in 1977 U.S.C.C.A.N. 1077, 1128-29.

93. The Administrator was to publish a list that "includes each hazardous air pollutant for which he intends to establish an emission standard under this section." 42 U.S.C. § 7412(b)(1)(A) (1988). The Administrator was then to publish proposed regulations within 180 days after the appearance of any pollutant on the list. After a public hearing on the proposed regulations, the Administrator had another 180 days to "prescribe an emission standard for such pollutant, unless he finds, on the basis of information presented at such hearings, that such pollutant clearly is not a hazardous air pollutant." Id. § 7412(b)(1)(B). Congress intended that this emission standard create the ample margin of safety specified above.

94. As Senator Muskie noted in 1977:

> [T]he Clean Air Act [of 1970] is based on the assumption, although we knew at the time it was inaccurate, that there is a threshold. When we set the standards, we understood that below the standard that we set there would still be health effects. The standard we picked was simply the best judgment we had on the basis of the available evidence as to what the unacceptable health effects in terms of the country as a whole would be.

Clean Air Act Amendments of 1977: Hearings Before the Subcommittee on Environmental Pollution of the Senate Committee on the Environment and Public Works, 95th Cong., 1st Sess. at part 3, 8 (1977). While Senator Muskie was referring to automotive emission standards, his remarks are much more acute in consideration of regulation of toxic emissions like carcinogens.

The initial efforts under Section 112 revealed EPA's reluctance to dislocate the economy on behalf of those exposed to airborne carcinogens.[95] But, unlike the accommodation under the Clean Water Act, environmentalists were not willing to accept incrementalism in Section 112, as the decade-long vinyl chloride litigation revealed.[96] In one last

95. See EPA, *National Emission Standards for Hazardous Air Pollutants: Asbestos, Beryllium, Mercury*, 38 Fed. Reg. 8820 (1973) (discussing asbestos exposure during demolition and construction projects). See also *Adamo Wrecking Co. v. United States*, 434 U.S. 275 (1978) (approving a series of work practice standards rather than emission standards).

96. In its first proposed rule, EPA noted that since it was a carcinogen, vinyl chloride may not be safe at any level. See EPA, *National Emission Standards for Hazardous Air Pollutants: Proposed Standard for Vinyl Chloride*, 40 Fed. Reg. 59532, 59533 (1975). As a result, environmentalists argued that EPA should ban vinyl chloride when alternatives were available and eventually phase out the remaining uses of the substance. See EPA, *National Emission Standards for Hazardous Air Pollutants: Standard for Vinyl Chloride*, 41 Fed. Reg. 46560, 46561-62 (1976) (review of comments to proposed regulations). Manufacturers suggested that emission standards should be set on a case-by-case basis using cost-benefit analysis. Id. at 46562. The EPA rejected both options and advocated a BAT approach. Predictably, EPA was sued by public health advocates who noted that Section 112 sanctioned neither cost-benefit analysis nor BAT. See *Hercules, Inc. v. EPA*, 598 F.2d 91, 113 n.42 (1978) (citing *Environmental Def. Fund v. Train*, No. 76-2405 (D.C. Cir. June 24, 1977) (unreported settlement and dismissal of petition for review of vinyl chloride regulations)). The Environmental Defense Fund voluntarily dismissed this case when EPA agreed to produce a more stringent standard and to set, as a goal, zero vinyl chloride emissions. But the failure of OSHA's generic cancer policy in the *Benzene* decision indicated that EPA could not employ "comprehensively rational" policies to regulate carcinogens as was contemplated when the Environmental Defense Fund dismissed its suit.

With the onset of the Reagan administration's regulatory reform policies, little further was done to address the problems of airborne carcinogens. By the mid-1980s, environmentalists had sufficiently focused their interests in air pollution carcinogens to lead to a more conclusive court battle. On January 9, 1985, EPA withdrew the proposals set forth as part of its 1977 settlement with the Environmental Defense Fund and proceeded with a slightly revised version of the original 1976 regulation. See EPA, *National Emission Standards for Hazardous Air Pollutants: Vinyl Chloride*, 50 Fed. Reg. 1182 (1985). This prompted a suit by the Natural Resources Defense Council in the Court of Appeals.

In 1986, Judge Bork, on behalf of the D.C. Circuit Court of Appeals panel, issued an opinion that generally supported EPA's decision to forego health-based regulation of toxics in air. See *Natural Resources Def. Council v. EPA*, 804 F.2d 710 (D.C. Cir. 1986). Relying on statutory language and legislative history, Bork wrote that an emission standard should not necessarily be equivalent to prohibition. Rather, he stated that it was reasonable to assume that the Administrator might appropriately take into account factors other than health. Id. at 718-19. On the other hand, the court rejected EPA's proposition that the 1977 Amendments to the Clean Air Act had essentially ratified the use of cost and technology feasibility considerations under Section 112. Id. at 719. Given this apparent standoff, Bork relied on the Supreme Court's holding in *Chevron U.S.A. v. Natural Resources Def. Council*, 467 U.S. 837 to rule that EPA had made a reasonable interpretation of its statutory requirements. Thus, the court affirmed EPA's decision to withdraw the 1977 proposed regulation.

In a stinging dissent, Judge Skelly Wright pointed out that the Administration's position directly contravened the clear language of Section 112. 804 F.2d at 727 (Wright dissenting). Wright stated that the no-threshold view of carcinogens means that an ample margin of safety for all exposed can occur only by shutting down the industries that emit such substances. Id. at 737-38 (Wright dissenting).

The D.C. Circuit decided to rehear the case *en banc*. The opinion of the *en banc* court, again written by Judge Bork, outlined a compromise solution that removed some of EPA's burden to

effort to develop generic "comprehensively rational" policies, EPA proposed regulations on the meaning of acceptable risk[97] and issued a final rule for the hazardous air pollutant benzene that discussed in great detail the problems with setting health-based standards.[98] The rule hesitatingly endorsed the use of an individual risk level of one death in 10,000 for any one individual.[99] Predictably, environmentalists were displeased with the final rule.[100] The bottom line is that twenty years had elapsed without significant regulation of airborne toxins.

Another round of litigation was avoided though, as attention shifted to the Clean Air Act Amendments of 1990, which created a technology basis for toxic-substance regulation.[101] Strikingly, the amend-

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regulate airborne carcinogens under Section 112. *Natural Resources Def. Council v. EPA*, 824 F.2d 1146, 1155-56 (D.C. Cir. 1987). The opinion clarified that fact that EPA no longer had to consider a zero-risk level as the only safe level. Allowing that the legislative history of Section 112 was ambiguous, the court noted that although EPA primarily must consider health under Section 112, EPA permissibly may consider other factors as well. Id. at 1164. Relying on the *Benzene* decision, the panel noted that "safe" does not necessarily mean "risk-free." Id. at 1165 (citing *Benzene*, 448 U.S. at 642). After estimating the level of safety, the Administrator must determine an ample margin, and may use feasibility considerations in this determination. The Administrator was to employ these economic and technological considerations only for setting a level of safety below that which is considered safe, not in the determination of what is safe.

97. See EPA, *Proposed Rule for National Emission Standards for Hazardous Air Pollutants: Regulation of Radionuclides*, 54 Fed. Reg. 9612 (1989). In the proposed rule, the Agency set forth several methods of risk assessment. Approach A involved determinations of both maximum individual risk and the risk incidence in the population as a whole. EPA would use these factors in case-by-case assessments. This entailed a tradeoff between the maximum individual risks, which would be one additional fatal cancer in 10,000 exposed individuals, and the total expected incidence of disease in the entire United States population. For instance, EPA might allow the individual risks posed to those living near a stationary source to rise if the total expected incidence was lower.

The other approaches centered on either total incidence or level of individual risk. Approach B considered only the total expected incidence, and controlled emissions such that they would not increase the total of fatal cancers by more than one case per year. The regulations based Approaches C and D only on individual risks. Approach C used a threshold of one in 10,000 risk, while Approach D employed a threshold of one in one million risk. Id. at 9622-40.

EPA asserted that Approach C would lead to a closure of 100 facilities and loss of 30,000 jobs, while Approach D would require closing all petroleum refineries and chemical plants in the United States. As might be expected, both environmental activists and industry concerns expressed some dissatisfaction with EPA's theory as well as its risk estimates. See Gary Marchant and Dawn Danzeisen, 13 Harv. Envtl. L. Rev. at 538-40 (cited in note 90).

98. EPA, *Final Rule: National Emission Standards for Hazardous Air Pollutants; Benzene Emissions*, 54 Fed. Reg. 38044 (1989).

99. If the risk exceeded the threshold, the EPA was to integrate other health and risk factors into an overall judgment on acceptability. Thereafter, the agency would set a standard that reflects "an ample margin of safety," to minimize the number of people who were exposed to a greater than one in one million lifetime risk. Id. at 38050-52.

100. Interview with Jacqueline Warren, Staff Attorney, Natural Resources Def. Council (May 14, 1990).

101. The 1990 Amendments to the Clean Air Act include an extensive revision of the section regulating hazardous air pollutants (HAPs). 42 U.S.C.A. § 7412 (West Supp. 1992) (Clean Air Act Amendments of 1990 § 112, Pub. L. No. 101-549, 104 Stat. 2574 (1990)). In the Amendments,

ments contain no risk threshold of the sort that had previously dominated EPA's thinking about hazardous air pollutants.[102] The basis for emission standards in the new Act is "technically possible maximum reductions."[103] While the 1990 Amendments do not specify risk levels, they do provide for further consideration of acceptable risk.[104]

The Clean Air Act Amendments reflect a commitment to make toxic pollution control "workable." Yet residual risk estimation will become critical as time passes. The Senate version of the air toxins provisions of the Clean Air Act Amendments had prescribed specific risk levels that would be tolerated.[105] The eventually adopted House ver-

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Congress listed 189 HAPs for which EPA must establish NESHAPs. EPA must revise this list "periodically," although the Amendments provide no schedule for such revision. Clean Air Act Amendments of 1990 § 303, to be codified at 42 U.S.C.A. § 7412 (West 1992).

The 1990 Amendments direct the EPA to establish standards based on the use of "maximum achievable control technology" (MACT). See Theodore L. Garrett and Sonya D. Winner, *A Clean Air Act Primer: Part I*, 22 Envtl. L. Rep. (Envtl. L. Inst.) 10159, 10163 (Mar. 1992). This implies that an industry may still release a carcinogenic chemical that has no safety threshold but has emissions that current technology cannot completely eliminate. See 42 U.S.C.A. § 7412(d)(2) (West Supp. 1992) (stating that NESHAPs may include "a prohibition on such emissions, where achievable"). The Amendments also allow the EPA to consider "the cost of achieving such emission reduction" in setting emission standards. Id. § 7412(d)(2) (West Supp. 1992).

102. The Senate bill had set two standards for assessing residual risk after applying MACT. The first risk standard was one in one million risk for the most exposed individual. Sources that continued to pose this level of risk could receive case-by-case exceptions if they demonstrated that lower risks were not achievable using nonpollution-control technology. The second risk standard was one in 10,000. When sources exceeded this threshold, EPA could grant them a one-time, five-year extension. Failure to comply at the end of that extension would result in shut-down. See Clean Air Act Amendments of 1989: Report of the Committee on Environment and Public Works of the United States Senate, S. Rep. No. 101-228, 101st Cong., 1st Sess. 148 (1989) (*Committee on Environment Report*).

The Senate version also required the EPA to set risk according to the maximum exposed actual person. It even specified the method for calculating this exposure (involving one standard deviation beyond the mean exposure value). Thus, the Senate version brightlined the level of risk that was tolerable and explicitly required shut-down of a facility that failed to meet the standard.

103. Clean Air Act Amendments of 1990 § 112(d)(2).

104. The new Section 7412(f) requires EPA to study the residual risks remaining after the application of MACT controls. It also requires that the EPA report to Congress by November 15, 1996 with recommendations for further legislation. 42 U.S.C.A. § 7412(f)(2) (West Supp. 1992). If Congress does not act on these recommendations, Section 7412(f) requires EPA to revert to its former health-based standards and promulgate additional regulations for each source category for which EPA finds residual risks. These measures are intended to ensure "an ample margin of safety to protect public health." Id. § 7412(d)(4). EPA must promulgate residual risk regulations for any known human carcinogen for which MACT controls have not reduced the most exposed individual's express cancer risk to less than one in one million. Congress has failed to define "most exposed individual," however, so Section 7412(f) is unclear as to whether this is a theoretical or an actual individual. This issue is likely to cause problems when EPA proposes its residual risk regulations. In addition, Section 7412(f) still allows EPA to take "costs, energy, safety and other relevant factors" into consideration in setting residual risk standards. Id.

105. In essence, the maximally exposed individual may not have a risk of cancer of greater than one in ten thousand after a lifetime exposure. If an individual is so exposed, EPA would shut the plant down. See *Committee on Environment Report* (cited in note 102).

sion, which seemed politically more attractive given the level of concern about the costs of the new Clean Air Act,[106] was mute about what level of risk might be acceptable.

The toxic substance provisions of the Clean Air Act thus look to a future that is now the reality under the Clean Water Act. Once technology standards are in place, one still is faced with toxic hot spots, and then the need to set media standards that focus on health. An incremental, technology-based approach leads to manageable costs, but it does not provide "an ample margin of safety." Some discrete communities will continue to be exposed to hazardous pollutants.[107] This will be especially true with respect to air toxins. At present, Congress assumes that 1,700 to 2,700 excess cancer cases per year nation wide are attributable to hazardous air pollutants.[108] This cancer impact is not spread diffusely over the entire country, as more or less occurs with dispersed criteria pollutants, but is focused on particular facilities.[109] Especially in cases of the concentrated, single-source paradigm of air pollution, identifiable individuals are at risk.

The inability of regulators operating under the Clean Water and Clean Air Acts to guarantee that discrete communities are not exposed

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106. *Cost of Implementing Air Legislation Could Reach Ninety-One Billion, Industry Group Says*, 21 Envtl. Rep. (BNA) 656 (Aug. 3, 1990).

107. Rulemaking under the 1990 Amendments has been slow. See, for example, *EPA Plans to Cut Number of Categories of Industrial Sources Regulated by Air Act*, 22 Envtl. Rep. (BNA) 1558 (Oct. 18, 1991) (discussing EPA's announcement that its rule listing source categories under Section 7412(c)(1), due November 15, 1991, will be two months late). This has prompted the Sierra Club Legal Defense Fund to give notice that it will sue EPA to force the agency to comply with the statutory schedule. *Sierra Club Gives EPA Notice It Will Sue to Shake Loose 50 Overdue Air Act Regulations*, 23 Envtl. Rep. (BNA) 425 (May 29, 1992).

The emphasis on MACT "fixes" has led to some bizarre results. In one case, EPA proposed to allow an Idaho phosphorus plant to more than double its radionuclide emissions (from 2.2 curies/yr. to 4.5 curies/yr.) in return for the owner's installation of a specific scrubbing system. *Proposal Allows More Radionuclide Emissions in Return for Applying New Control Technology*, 22 Envtl. Rep. (BNA) 1301 (Sept. 13, 1991). Also, the General Accounting Office has criticized EPA repeatedly for failing to request enough money to carry out the studies needed to set NESHAPs according to the statutory schedule. *Plan to Cut Toxics Under Air Act Inadequate, Underfunded, GAO Charges*, 22 Envtl. Rep. (BNA) 1027 (Aug. 9, 1991); *House Subcommittee Questions EPA Funding for Clear Air Act Industrial Toxics Provisions*, 22 Envtl. Rep. (BNA) 1767 (Nov. 15, 1991).

108. See *Clean Air Act Amendments of 1990: Report of the Committee on Energy and Commerce of the United States House of Representatives on H.R. 3030*, H.R. No. 490, 101st Cong., 2d Sess. 316 (1990).

109. In January 1990, EPA had found 149 facilities associated with lifetime cancer risks in exposed individuals of greater than one in 10,000. Among these were 52 plants in which cancer risks were greater than one in 1000; seven with cancer risks greater than one in 100; and one with a risk for the surrounding inhabitants of one in 10. Id. at 317, citing EPA, Office of Air Radiation, *Updated Source-Specific Cancer Risk Information*, Air Toxic Exposure and Risk Information System (ATERIS), provided to Rep. Henry A. Waxman, January 10, 1990. EPA based these estimates on emissions caused by a single toxic air pollutant from each plant. In reality, many plants emit several carcinogens, a fact that could multiply isolated risk assessments.

to dangerous risk envelopes of hazardous substances extends beyond these statutory regimes. The enforcement histories of the Safe Drinking Water Act (SDWA)[110], Federal Insecticide, Fungicide and Rodenticide Act (FIFRA),[111] Toxic Substances Control Act (TSCA)[112] and the Resources Conservation and Recovery Act (RCRA) recount similar stories.[113] The risk assessments necessary to undertake health-based rules, which would outlaw unsafe pollution, frustrate administrators. The problem is partially intellectual, since risk assessment involves so much uncertainty about both health and economics, and partially a result of a

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110. Safe Drinking Water Act, 42 U.S.C. §§ 300(f) to 300(j)-26 (1988). See also Goldberg, 63 N.Y.U. L. Rev. at 656 (cited in note 90); Gaines, 30 Jurimetrics J. at 311 (cited in note 54).

111. See Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), 7 U.S.C.A. §§ 136-136(y) (West 1980 & Supp. 1992). Cross has identified a variety of risk assessments completed by EPA under FIFRA and notes that they range from one in a million to up to as high as one in a thousand. See Frank B. Cross, *Beyond* Benzene: *Establishing Principles for a Significance Threshold on Regulatable Risks of Cancer*, 35 Emory L. J. 1, 17-22 (1986).

112. 15 U.S.C.A. §§ 2601-2671 (West 1982 and Supp. 1992). See also Cynthia Ruggerio, *Referral of Toxic Chemical Regulation under the Toxic Substances Control Act: EPA's Administrative Dumping Ground*, 17 B.C. Envtl. Aff. L. Rev. 75 (1989).

113. See Brennan, *Narrowing* at 110-38 (cited in note 74). See also Richard J. Lazarus, *The Tragedy of Distrust in the Implementation of Federal Environmental Law*, 54 L. & Contemp. Probs. 311, 328-31 (1991) (discussing the failure of a variety of environmental statutes to reach statutory goals). In sharp contrast with FIFRA and TSCA, the Resource Conservation Recovery Act, demonstrates a genuine commitment to health-based standards and stringent compliance. See 42 U.S.C. §§ 6901-6992k (1988). Much of this commitment is attributable to the Hazardous and Solid Waste Amendments of 1984 (HSWA), Pub. L. 98-616, 98 Stat. 3221 (1984), which were the product of a remarkable constellation of political events. By 1984, Congress had become a "reluctant regulator," largely because the Reagan Administration was incompetent in the area of hazardous waste storage. Perhaps the most significant provision of HSWA was the threshold for risk assessment, set at a level necessary to protect human health and the environment. See HSWA § 1003(a)(4), codified at 42 U.S.C. § 6902(a)(4) (1988). Observers remain of the consensus that RCRA now demonstrates a dramatic commitment to individual human health and lowest possible risk. See Walter E. Mugdan and Bruce R. Adler, *The 1984 RCRA Amendments: Congress as a Regulatory Agency*, 10 Colum. J. Envtl. L. 215 (1985); William L. Rosbe and Robert L. Gulley, *The Hazardous and Solid Waste Amendments of 1984: A Dramatic Overhaul of the Way America Manages Its Hazardous Wastes*, 14 Envtl. L. Rep. (Envtl. L. Inst.) 10,458 (1984); Janis L. Kirkland and James A. Thornhill, Note, *Federal and State Remedies to Clean Up Hazardous Waste Sites*, 20 U. Richmond L. Rev. 379 (1986). See also Sidney A. Shapiro and Robert L. Glicksman, *Congress, the Supreme Court, and the Quiet Revolution in Administrative Law*, 1988 Duke L. J. 819, 837 (describing HSWA as a dramatic example of prescriptive legislation by Congress).

The judiciary and EPA, however, have undermined the strong language of RCRA in two ways. First, the judicial interpretation of Section 6924(g)(5) is that it allows undetermined amounts of toxics to re-enter the environment. See *Natural Resources Def. Council v. EPA*, 907 F.2d 1146, 1156-58 (D.C. Cir. 1990). Second, EPA has decided to allow a presumption of no pollution migration upon a showing that an industry has met certain technological requirements. 40 C.F.R. § 264.251 (1990).

In addition, EPA's proposed rules for the corrective action program, which requires older hazardous waste treatment, storage, and disposal facilities (TSDs) to clean up older storage sites, make repeated references to the use of best demonstrated available technologies (BDAT), 55 Fed. Reg. 30803 (1990), and to the use of cost considerations in establishing which method of clean-up that the TSD to use, id. at 30824.

lack of resources to address such complex issues. Thus, regulators either move very slowly or opt for incrementalist, technology-based controls that allow postponement of health assessments.

Toxic pollution persists. Another reason suggests that this will remain the case: regulators' political will affects the pace of incrementalism. Agency capture can undermine such will, as Krier and Gillette have discussed in detail.[114] Economic analyses of legislative action and regulation have lent an academic patina to the notion that regulated concerns can come to control agencies.[115] Arguably, incrementalism is more readily captured than is the development of a single, health-based standard. With the latter, environmental advocates can bring high profile suits against EPA.[116] Incrementalism and the decentralization that it brings are less subject to central oversight by environmental advocates.

A corollary to agency capture is executive capture. If the executive branch can fall into the sway of regulated interests, even an agency that wishes to push incrementalism can be captured. The Office of Management and Budget (OMB),[117] and now the Council on Competitiveness[118]

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114. See Gillette and Krier, 138 U. Pa. L. Rev. at 1064-68 (cited in note 10).

115. Public choice analysts developed a theory of a legislative market place in which some accept negative wealth transfers hecause avoiding the loss of that wealth is not cost-effective. Thus, any legislation or regulation defines a supply curve with the brokers heing bureaucrats, politicians, and lobbyists. See Robert D. Tollison, *Public Choice in Legislation,* 74 Va. L. Rev. 379, 342-44 (1988). Given a public choice theory, seeing that effective legislation to control discharge of toxic pollutants into the environment could be bottled up for over 20 years by various interest groups is not difficult. Presumably, industries would much more readily and effectively form interest groups than would the injured public. Of course, public choice theories fail to explain how environmental protection lobhyists can exist, given that their legislative efforts predominantly involve altruistic commitment to a cleaner environment. See Jonathan R. Macey, *Promoting Public-Regarding Legislation Through Statutory Interpretation: An Interest Group Model,* 86 Colum. L. Rev. 223, 228 (1986).

116. For a discussion of how courts may have tried to curb agency capture by requiring the agencies to answer environmental interests, see Glicksman and Schroeder, 54 L. & Contemp. Probs. at 266-68 (cited in note 50).

117. See Robert V. Percival, *Checks Without Balance: Executive Oversight of the Environmental Protection Agency,* 54 L. & Contemp. Probs. 128 (1991). OMB has interfered in toxic regulation. For example, under Section 1313(c) of the CWA, EPA must propose water quality standards for states that have not promulgated standards in compliance with the CWA. 33 U.S.C. § 1313(c) (1988). EPA sent a final rule for imposing such standards on noncomplying states to OMB on April 16, 1992, missing a deadline of February 19, 1992 by two months. See *OMB Reviewing Costs of EPA Final Rule to Set Standards for Toxic Pollutants,* 23 Env't Rep. (BNA) 313 (May 15, 1992). As of May 6, OMB had announced that it was concerned about the cost of the rule, and also indicated that it might recommend that "the criteria for 2,3,7,8-tetrachlorodibenzo-p-dioxin be excluded from the final toxics package," due to EPA's ongoing reassessment of its dioxin criteria. Id.

118. See Keith Schneider, *Bush to Relax Air Pollution Regulation,* N.Y. Times A12 (May 18, 1992) (detailing the victory by the Council on Competitiveness over EPA regarding notification of public ahout toxic air pollution). The Clinton administration seems likely to dismantle the Council on Competitiveness. *Environment May Not Top Clinton's List, But Groups See Opportunities* 23

have hampered regulation that they perceive as cost-ineffective, or simply antibusiness. The conclusion is inescapable: incremental regulatory approaches to toxic pollution will leave some toxic hot spots. Normatively, legislators and agencies should seek other methods of deterring such pollution. One obvious candidate is environmental tort litigation. But before turning there, I examine two other innovative methods for deterring toxic pollution: markets and criminal sanctions.

IV. Other Institutional Approaches: The Market and Criminal Law

A central thesis of this Article is that the failure of one institution, the regulatory apparatus, to control toxic pollution, has created an opportunity for another institution, common-law litigation, to address certain environmental pollution paradigms. It would, however, be premature to turn to torts without first addressing other potential institutional sources of deterrence. The most important of these are market incentives and criminal prosecution of polluters. If, from a normative perspective, we are to recommend torts as a meaningful source of deterrence, the latter institutional responses must be relatively incapable of taking up the slack left by regulation.

First, consider the market-incentive approach to deterring injuries caused by pollution. When Congress began to develop comprehensive environmental statutes in the early 1970s, economists were arguing that market incentives largely should drive environmental policy.[119] In the mid-1970s, Allen Kneese and Charles Schultz advocated a system under which a government agency would charge firms for the pollution they created.[120] The price would equal the amount that people would pay for a particular level of environmental quality.[121] In contrast to the standards of pollution control that would uniformly apply to all sources throughout the country, charges would allow individual firms to weigh the costs imposed by their pollution against the costs of alternatives, such as changes in production or controlled technologies.[122] With the

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Env't Rep. (BNA) 1758-60 (Nov. 13, 1992).

119. See John Harkness Dales, *Pollution, Property and Prices* (Univ. of Toronto, 1968); A. Myrick Freeman, et al., *The Economics of Environmental Policy* (Wiley, 1973).

120. See Allen V. Kneese and Charles L. Schultz, *Pollution, Prices and Public Policy* (Brookings Inst., 1975).

121. Id.

122. Throughout the late 1970s, academics argued forcefully that Congress needed to customize environmental statutes as much as possible, especially by applying incentive structures such as charges and pollution rights that firms could transfer between one another. See generally Bruce A. Ackerman, et al., *The Uncertain Search for Environmental Quality* (Free Press, 1974); James E. Krier, *The Irrational National Air Quality Standards: Macro and Micro Mistakes*, 22 U.C.L.A. L. Rev. 323 (1974); Susan Rose-Ackerman, *Market Models for Water Pollution Control:*

"bubble" initiative in the 1980s, under which regional levels of air pollution were established for different airsheds, EPA effectively created pollution markets by allowing firms to add new sources if a reduction in an existing source offset the pollution created by the new source.[123] Moreover, as Bruce Ackerman and Richard Stewart have suggested, such markets and pollution rights could lead to more effective control by congressional policymakers over environmental initiatives.[124]

In many ways, the turn to overt markets in pollution is unsurprising. Over the last twenty years, Pareto-superiority and cost-benefit analyses have motivated much analysis of both the common-law and administrative-law approaches to pollution.[125] Choices about a particular regulatory initiative, for instance, can be evaluated in light of the potential costs and benefits of the program.[126] The same emphasis on efficiency is dominant in tort law, including environmental torts.[127]

Their Strengths and Weaknesses, 25 Pub. Policy 383 (1977); Thomas H. Tietenberg, *Transferable Discharge Permits and the Control of Stationary Source Air Pollution: A Survey and Synthesis*, 56 Land Econ. 391 (1980); Steven Breyer, *Analyzing Regulatory Failure: Mismatches, Less Restrictive Alternatives, and Reform*, 92 Harv. L. Rev. 547 (1979); Jorge A. del Calvo y Gonzales, *Markets in Air: Problems and Prospects of Controlled Trading*, 5 Harv. Envtl. L. Rev. 377 (1981). By the time Professor Stewart had developed a mature theory of incentive structures within regulation, see Richard B. Stewart, *Regulation, Innovation, and Administrative Law: A Conceptual Framework*, 69 Cal. L. Rev. 1256 (1981), Congress had passed legislation employing these theories.

123. For excellent discussions of the bubble initiative under the Clean Air Act, see Thomas H. Tietenberg, *Emissions Trading: An Exercise in Reform in Pollution Policy* (Johns Hopkins, 1985); Errol Meidinger, *The Development of Emissions Trading in U.S. Air Pollution Regulation*, in Keith Hawkins and John M. Thomas, eds., *Making Regulatory Policy* 153 (U. Pitt., 1989). See also Richard B. Stewart, *Economics, Environment, and the Limits of Legal Control*, 9 Harv. Envtl. L. Rev. 1 (1985). The policy also allows existing sources of pollution in the same state or air pollution control region to reallocate its pollution control under the state implementation plan bubble. Long the subject of litigation, the Supreme Court finally gave its approval of the bubble initiative in 1984. See *Chevron USA v. Natural Resources Def. Council*, 467 U.S. 837 (1984).

124. See Ackerman and Stewart, 37 Stan. L. Rev. at 1355 (cited in note 8). Presumably, Congress could specify certain percentile reductions in pollution over a series of years. These reductions would make pollution rights themselves more valuable and the market would adjust accordingly. The simplicity and efficiency of this notion is attractive, especially since pollution markets presumably lead to "custom" approaches to particular sources of pollution. Individual communities exposed to a much higher level of environmental toxins might expect a better outcome.

125. Pareto-superiority posits that a certain distribution of goods is better than a second distribution of goods if at least one person prefers the first distribution to the second and the remaining individuals are indifferent. While attractive as an ideal, the rule obviously has difficulties in practice. Therefore, Kaldor-Hicks models have tended to prove more influential. A Kaldor-Hicks approach requires that benefits exceed costs, such that those who gain from a project could compensate the losses of others and still retain accumulated profit. See William M. Landes and Richard A. Posner, *The Economic Structure of Tort Law* 16-19 (Harvard, 1987).

126. For instance, economists cast decisions to control air pollution in terms of the number of coal miners' jobs lost, the costs of scrubbers to coal-fired utilities, and the long-term health impacts of various levels of particulate and sulfur-oxide pollution. See generally Bruce A. Ackerman and William T. Hassler, *Clean Coal, Dirty Air* (Yale, 1981).

127. See text accompanying notes 200-10.

Therefore, use of market incentives to control pollution is merely part of the overall ascendance of economic reasoning in the law.

Some advocates of a clean environment have however questioned the virtue of efficiency arguments in environmental law. They argue that pollution is morally offensive, and polluters should not trade it in a market context.[128] Advocates of such "wide-open spaces" environmentalism posit that a clean earth is good in itself. A clean environment is not defined by the political structure of any nation; it represents a more abiding morality.[129] Ecological morality is a theme in environmentalism for those steadfastly opposed to market initiatives.

In a liberal state like our own, market incentives for pollution abatement are probably more acceptable than ecological morality arguments.[130] Yet, even without embracing an environmental ethic, there is reason to believe that market incentives may only be effective with respect to nontoxic pollution. Since hazardous pollution by definition harms human health and even causes death, creating a market in such

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128. Sagoff, for instance, argues that efficiency often creates inequality and that the citizen role should include more than analysis of efficient options in the market. See Mark Sagoff, *The Principles of Federal Pollution Control Law*, 71 Minn. L. Rev. 19, 58-59 (1986). For an earlier discussion of these themes, see Laurence H. Tribe, *Ways Not to Think About Plastic Trees: New Foundations for Environmental Law*, 83 Yale L. J. 1315, 1340-42 (1974).

On another tack, Kelman has opposed market incentives because they fail to carry out the necessary stigmatization of environmental pollution. He believes that "marking," the moral outrage expressed in terms of pollution control, is very important to the society's consideration of environmental quality. See Steven Kelman, *What Price Incentives? Economists and the Environment* 25 (Auburn House, 1981). Kelman also argues that trading some things in the market is inappropriate. Certain commodities simply cannot be traded, largely because individuals tend to "down-value" their effect.

129. As Aldo Leopold wrote, "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong otherwise." See Aldo Leopold, *The Land Ethic*, in *A Sand County Almanac* 240 (Oxford, 1966), quoted in Mark Sagoff, *The Economy of the Earth* 154 (Camhridge, 1988). If a person equates concern for the environment with a philosophy of the moral goodness of nature, then a person must be profoundly opposed to a market approach that allows environmental pollution. Moving from absolutely prohibitory regulation to trading in pollution rights becomes morally incorrect, because it offends the environment to treat pollution as fungible. For a discussion of this theory of morality, see Christopher Stone, *Earth and Other Ethics: The Case for Moral Pluralism* (Harper & Row, 1987). The notion of an environmental ethic is rather closely related to the slightly more legal topic of the public trust doctrine. See *National Audubon Soc. v. Superior Ct. of Alpine Cty*, 658 P.2d 709 (Cal. 1983). See generally Joseph L. Sax, *The Public Trust Doctrine in Natural Resource Law: Effective Judicial Intervention*, 68 Mich. L. Rev. 471 (1970).

130. Brennan, *Narrowing* at 30-38 (cited in note 74). Environmentalists who advocate stigmatization of pollution presume that the use of the market creates property rights, thus a right to pollute. These environmentalists seem too respectful of markets. Treating the market, and notions of property, as forms of regulation in the state, not as absolute rights, is in much more in keeping with the tenets of liberalism. See, for example, James E. Krier, *The (Unlikely) Death of Property*, 13 Harv. J. L. & Pub. Policy 75 (1990). Reminding environmentalists that efficiency itself is an instrumental value, and that markets in pollution are acceptable only insofar as they serve the goal of a cleaner environment, should allay their concerns.

pollution rights also creates a market in human lives. Those firms who face high-cost abatement measures may buy rights to pollute and to expose individuals to pollution that is harmful to health.[131] When the exposed individuals have not been party to the bargain struck by polluters such infringement on the negative freedom of individuals raises serious concerns.[132]

This is not to say that liberalism outlaws commodification of life. Our laws have long reflected both explicit and implicit valuations of human lives. Indeed, regulations evince an incredible variation in the amount we are willing to pay to save human lives.[133] The marketplace also produces such valuations, especially in the form of wage differentials based on the riskiness of an occupation.[134] Yet in the occupational setting there is a critical assumption that the employees knowingly consent to risks when they accept a job. That assumption does not usually exist in the environmental setting. Polluters and polluted typically have nothing approaching the relationship that exists between employer and employee. The latter relationship allows at least the fiction of knowledgeable bargaining. The same fiction cannot realistically be maintained in the context of pollution. Without notions of consent, the exposure to toxic pollution infringes too much upon the population's liberty interest, or negative freedom.

Of course, as discussed above, the difference between toxic and nontoxic pollution is not sharp. It is disingenuous to say that one would prohibit the market from trading rights in pollution that hurts people.[135] For instance, the smog that is part of the Los Angeles basin proposals has significant adverse health effects, yet polluters can trade for the right to contribute to it. The critical issue seems to be the attributable fraction of disease, one of the components of toxicity. Smog may cause respiratory deaths, but it contributes only a small fraction to the

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131. Commodification is a liability of instrumental analyses of law. See Margaret Jane Radin, *Market-Inalienability*, 100 Harv. L. Rev. 1849, 1860-70 (1987).

132. Liberals believe that individuals should be able to make choices and that the state should be impartial regarding these choices. Thus liberalism requires an area of noninterference for the individual, a freedom from interference. See generally Isaiah Berlin, *Four Essays on Liberty* (Oxford, 1969).

133. See Clayton Gillette and Wesley Hopkins, *Federal Valuation of Human Life: Report to the Administrative Conference of the United States* 2 (Admin. Conf., 1988); John Graham and James W. Vaupel, *Value of Life: What Difference Does It Make?*, 6 Risk Analysis 89 (1981); John F. Morrall III, *A Review of the Record*, Regulation 25 (Nov./Dec. 1986).

134. See generally W. Kip Viscusi, *Risk By Choice* (Harvard, 1983); Michael J. Moore and W. Kip Viscusi, *The Quality Adjusted Value of Life*, 26 Econ. Inquiry 369 (1988); Michael J. Moore and W. Kip Viscusi, *Doubling the Estimated Value of Life: Results Using New Occupational and Fatality Data*, 7 J. Pol'y Anal. & Mgmt. 476 (1988).

135. Professor Sunstein relies on this too facile dichotomy. See Cass R. Sunstein, *Administrative Substance*, 1991 Duke L. J. 607, 635.

total mortality attributable to respiratory disease. Regulators view these deaths as "statistical," meaning that specific individual deaths cannot be linked to exposure to a particular substance. On the other hand, a toxic substance like arsenic or lead may account for a substantial fraction of certain diseases in a community surrounding a smelter. The deaths are no longer statistical, but are identifiable.[136] When particular deaths are linked in this manner to pollution, regulators tend to fall away from cost-benefit analysis, just as we as a society, do in other issues in health and safety.[137]

Consider the following environmental pollution paradigms. The first concerns particulate pollution that is concentrated in an urban basin and is emitted from several industrial sources. The particulate pollution contributes to death from pneumonia, but the attributable fraction is less than five percent. We might allow trading of pollution rights without any explicit or implicit consent of the exposed pollution because we do not readily link the deaths to pollution. Now consider two smelters that both produce concentrated lead pollution which falls on surrounding isolated communities. Neurological damage in children can be traced to these smelters, as the attributable fraction of neurological disease caused by lead is high. We are unlikely to allow one smelter to buy further rights to pollute from the other, because the lives affected are no longer statistical.

In light of these considerations, it is hardly surprising that most proposals for market-based abatement have centered on nontoxic, household solid waste,[138] and that integration of market techniques into regulation have centered on criteria (that is, nontoxic) pollutants.[139] While we may allow unconsented exposure to nuisances, we will not do so in the case of hazardous pollution. Thus, market proponents in environmental law have restricted the use of their techniques to certain paradigms of nontoxic pollution.

The other major source of institutional deterrence of environmental pollution is criminal law. Criminal environmental prosecution is per-

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136. Some would say that the smelter "caused" the illness. Everyday discussion of toxicology closely link the notion of cause with the degree of attributable fraction. See Brennan, 73 Cornell L. Rev. at 461 (cited in note 34).

137. This phenomenon is especially prominent in medical care where we are willing to undertake extraordinary expenses to save one life. See Troyen A. Brennan, *Just Doctoring: Medical Ethics in the Liberal State* 175-202 (U. Cal., 1991). Impulses to ration care generally do not apply to an individual patient who could be "rescued." M.E. Levine, *Ration or Reserve: The Elderly Patient in Critical Care*, 12 Critical Care Nursing Quarterly 82, 84 (1989).

138. See generally U.S. Congress, Office of Technology Assessment, OTA-0-424, *Facing America's Trash: What Next for Solid Municipal Waste?* (1959); Richard A. Denison and John Ruston, eds., *Recycling and Incineration: Evaluating the Choices* (Island, 1990).

139. See Joel A. Mintz, *Economic Reform of Environmental Protection: A Brief Comment on a Recent Debate*, 15 Harv. Envtl. L. Rev. 149 (1991).

haps the most exciting area of environmental law today. The federal government has decided that criminal prosecution is a very efficient method of bringing about pollution deterrence.[140] For instance, the Department of Justice alone has increased tremendously the number of criminal environmental cases it has brought in the last five years.[141] Critical to the development of environmental criminal prosecution as a deterrent is the expansion of the scienter and mens rea requirements:[142] courts have proved to be more willing to impute knowledge of violations to corporate officers.[143] Criminal prosecution has gained such momentum that a backlash has begun, with some commentators advocating a threshold of moral culpability before prosecution.[144]

While the ardor of federal and state prosecutors[145] is admirable, there is reason to believe that the deterrent effect they produce will have little impact on the toxic pollution paradigms not affected by regulation or market influences. First, the law may immunize any federal facility from governmental prosesecution.[146] Much more importantly, however, criminal prosecutions can only occur once the courts, legislatures, and agencies have defined particular standards of behavior for those who produce, transport, or store hazardous materials. As noted in Part III, the major problem in regulation of toxic pollution has been the inability of regulators to define impermissible levels of pollution. For instance, in the case of toxic air pollutants, the problem is created by EPA's inability to produce any standards, not industry's disregard of government requirements. The government can use criminal law as a means of deterrence only after the rules are set. For toxic pollution, society has been unable to set the rules.

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140. See F. Henry Habicht II, *The Federal Perspective on Environmental Criminal Enforcement: How to Remain on the Civil Side*, 17 Envtl. L. Rep. (Envtl. L. Inst.) 10478, 10480 (1987).

141. In 1990, the Department of Justice obtained 134 indictments. Courts returned 78% of those indictments against corporations and their top officers. See Roger J. Marzulla and Brett G. Kappel, *Nowhere to Run, Nowhere to Hide: Criminal Liability for Violations of Environmental Statutes in the 1990s*, 16 Colum. J. Envtl. L. 201 (1991).

142. See Keith Welks, *Corporate Criminal Culpability: An Idea Whose Time Keeps Coming*, 16 Colum. J. Envtl. L. 293, 299 (1991); Robert A. Milne, Note, *The Mens Rea Requirements of Federal Environmental Statutes: Strict Criminal Liability in Substance but not Form*, 37 Buff. L. Rev. 307 (1988-89).

143. See, for example, *United States v. Dee*, 912 F.2d 741, 743 (4th Cir. 1990), cert. denied, 111 S. Ct. 1307 (1991). See also Jane F. Barett and Veronica M. Clarke, *Perspectives on the Knowledge Requirements of Section 6928(d) of RCRA after* United States v. Dee, 59 Geo. Wash. L. Rev. 862 (1991).

144. See Benjamin S. Sharp, *Environmental Enforcement Excesses: Over-Criminalization and Too Severe Punishment*, 21 Envtl. L. Rep. (Envtl. L. Inst.) 10,658 (1991); Keith A. Onsdorff and James N. Mesnard, *The Responsible Corporate Officer Doctrine in RCRA Criminal Enforcement: What You Don't Know Can Hurt You*, 22 Envtl. L. Rep. (Envtl. L. Inst.) 10,099 (1992).

145. See Clive I. Morrick, *The Mental Culpability Requirements for Proof of Environmental Crimes in New York*, 16 Colum. J. Envtl. L. 253 (1991).

146. See Stephen Herm, Note, *Criminal Enforcement of Environmental Laws on Federal Facilities*, 59 Geo. Wash. L. Rev. 938, 940-42 (1991).

Abject pessimism about criminal prosecution in toxic pollution is unwarranted, however. The move to technological standards in the Clean Water Act and now in the Clean Air Act may have a synergistic effect with criminal prosecution. If EPA sets tight goals for certain types of industry, and these industries do not meet the goals, criminal prosecution could prove an important means of ensuring compliance.[147] The integration of criminal prosecution with technological standards will be an interesting story in environmental law over the next decade. Nonetheless, the technological standards do not assure the elimination of particular sources of toxic pollution.[148] Therefore, society cannot expect that criminal prosecution will soon eliminate injuries from hazardous substances.

Regulation, market influences and criminal prosecution all produce some toxic pollution deterrence. They do not, however, offer much promise of eliminating the morbidity and mortality associated with this pollution. This means that injuries will still occur, and that attorneys will continue to make colorable claims on behalf of plaintiffs. From a positive viewpoint, environmental tort litigation is likely to continue to feed off of the reservoir of environmental injuries. From a normative viewpoint, there is ample need for any deterrence that tort litigation can muster.

V. The Evolution of Environmental Torts

I have suggested that regulation fails to eliminate environmental injuries, and that tort law may provide an institutional answer that addresses the remaining gaps in public health protection. Normatively, the deterrent effect of litigation would be welcome; positively, we would have a functional explanation for the environmental tort litigation that now exists.

As noted, not all environmental pollution paradigms are viable sources of attorneys fees, hence torts cannot provide rational deterrence in all situations.[149] When multiple sources of toxic pollution contribute to a particular risk envelope, rising administrative costs make common-law litigation unwieldy and inefficient. For instance, lead from automobile emissions may contribute to neurological damage in children. If the attributable fraction of disease were high enough—that is, if lead was

147. Both the Clean Water Act, 33 U.S.C.A. § 1319(c)(1)-(2) (West Supp. 1992), and the Clean Air Act, 42 U.S.C.A. § 7413(c) (West Supp. 1992), provide criminal sanctions for violation of emission standards or discharge of hazardous substances into the environment.

148. See text accompanying notes 70-100.

149. Note, however, that the positive and normative need not align. See notes 10-20 and accompanying text.

the major source of a certain type of neurological diseases—then lawyers might advise plaintiffs to bring environmental tort suits. But a plaintiff could not possibly sue all the drivers of automobiles in a particular region or urban area. Instead of suing drivers, attorneys might try to bring a product liability case against gasoline manufacturers, but the point remains: when there are an extremely high number of defendants, the aggregation costs are too high for tort litigation to be a realistic and efficient source of deterrence.[150]

This is not to say that common-law litigation requires a singular source. The mass product liability cases have shown that while a single manufacturer is in many ways the best target,[151] the courts can, within reasonable limits, tolerate multiple defendants.[152] In many cases the market-share theory of liability has eliminated the previously onerous task of identifying a single defendant.[153] There is, however, a threshold above which multiplicity of defendants overwhelms torts: the answer to CFC pollution is not a suit against all users of spray cans and owners of freon-loaded refrigerators.

The other defining feature of environmental pollution paradigms, concentration versus dispersion, also defines a barrier to efficient use of tort litigation. Broadly dispersed pollution, even if quite toxic, creates

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150. Ardent supporters of mass tort litigation may argue that current procedure law will accommodate even the broadest mass tort claims. See generally David Rosenberg, *The Causal Connection in Mass Exposure Cases: A "Public Law" Vision of the Tort System*, 97 Harv. L. Rev. 851, (1984). For a recent discussion that acknowledges the difficulties of collectivization, see *Reporters' Study* at 383-435 (cited in note 7).

151. To illustrate, courts have been able to consolidate the Dalkon Shield litigation and move it into a hybrid claims facility rather quickly because the A.H. Robbins Company was the only defendant. See generally Kenneth R. Feinberg, *The Dalkon Shield Claimants Trust*, 53 L. & Contemp. Probs. 79, (Autumn 1990).

152. The asbestos suits are a good example of multiple defendants implicated in mass tort. While plaintiffs have brought a large number of suits, the asbestos litigation has moved slowly toward the hybrid procedures that can produce anything approaching expedient resolution of claims. See Marianna S. Smith, *Resolving Asbestos Claims: The Manville Personal Injury Settlement Trust*, 53 L. & Contemp. Probs. 27 (Autumn 1990). See also *Multi-District Panel Transfers 26,639 Cases to Weiner of Eastern District of Pennsylvania*, 6 Toxics L. Rep. (BNA) 257 (1991); *Fireboard Settles Personal Injury Claims Filed by Texas Oil Workers for $185 Million*, 6 Toxics L. Rep. (BNA) 268 (1991); *2,000 New York Plaintiffs Settle Suits for More Than 100 Defendants, Pay $300 Million*, 6 Toxics L. Rep. (BNA) 1268 (1992). In these kinds of mass torts, courts apparently will not allow each plaintiff his or her day in court no matter what the equity considerations. See Jack B. Weinstein and Eileen B. Hershenov, *The Effect of Equity on Mass Torts Law*, 1991 U. Ill. L. Rev. 269, 285. Hence, careful economic analysis of claims facilities should be a priority. See Mark A. Peterson, *Giving Away Money: Comparative Comments on Claims Resolution Facilities*, 53 L. & Contemp. Probs. 113 (Autumn 1990); Ian Ayres, *Optimal Pooling in Claims Resolution Facilities*, 53 L. & Contemp. Probs. 159 (Autumn 1990).

153. See Richard Delgado, *Beyond* Sindell: *Relaxation of Cause-in-Fact Rules for Indeterminate Plaintiffs*, 70 Cal. L. Rev. 881 (1982); Glen O. Robinson, *Multiple Causation in Tort Law: Reflections on the DES Cases*, 68 Va. L. Rev. 713 (1982).

difficulties in aggregating a cast[154] of litigants. A large risk envelope creates problems with identification and boundary. Courts have difficulty identifying epidemiologically the individuals whose disease may be due to an exposure when the at-risk group is geographically diverse.[155] Additionally, as the risk envelope spreads out from the source, the risk decreases as the exposure diminishes. See Figure 1b. The outskirts or boundaries of the risk envelope are very hard to define, making plaintiff identification difficult.[156]

Plaintiffs in the disperson paradigm encounter identification problems that do not arise in other mass tort cases. While mass torts have reached epic proportions,[157] these are typically product cases in which the plaintiffs worked with, or bought, the product. The risk envelope analogy does not apply. Each plaintiff has encountered the product in a manner that can be documented. The same documentation is not possible in environmental torts unless the pollution leaves a residue.[158] Therefore, we would expect environmental torts to provide the most efficient deterrence where the pollution is concentrated and does not originate from a large number of sources—the singular-concentrated paradigm. In these situations, aggregated plaintiffs can wrestle with the specific circumstances of hazardous pollution. These situations are indeed where we tend to find environmental torts.[159]

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154. I avoid use of the term "class" here hecause class actions have heen so rare in mass tort litigation. But see *Cimino v. Raymarck Indus., Inc.* No. B-86-0456 (Dist. Ct. E. Tex. July 9, 1991) (settling a class action brought by 2300 injured asbestos workers).

155. This may not be a problem in the future; epidemiological methods already have been proposed for very large scale studies. See S. Tate, et al., *Feasibility of an Epidemiologic Study of Thyroid Neoplasia in Persons Exposed to Radionuclides from the Hanford Nuclear Facility Between 1944 and 1956*, 59 Health Physics 169 (1990) (proposing a study of thyroid cancer in individuals exposed to plume of radiation from the site up to 200 miles away).

156. The Triana, Alabama DDT litigation is a good example. In 1979, 1200 residents of Triana filed suit against the Olin Corporation, alleging that Olin had exposed tbem to DDT dumped into the Tennessee River. In 1981, these parties settled before trial for about $10,000 per person. However, over the course of the next two years another 10,000 residents in tbe area surrounding Triana filed suit. Francis E. McGovern, *The Alabama DDT Settlement Fund*, 53 L. & Contemp. Probs. 61, 62 (Autumn 1990). These consecutive sets of suits indicate the problem with identifying and aggregating an entire plaintiff class.

157. Jack Weinstein and Eileen Hershenov estimated that there are 175,000 asbestos claimants, 250,000 Agent Orange claimants, and more than 200,000 Dalkon Shield claimants. These cases constitute only a few of the mass torts now in litigation. See Weinstein and Hershenov, 1991 U. Ill. L. Rev. at 269 (cited in note 152).

158. A variety of efforts are underway to demonstrate exposure to bazardous substances through identification of DNA injury. See Troyen A. Brennan, *Helping Courts With Toxic Torts*, 51 U. Pitt. L. Rev. 1, 22 (1989). Another approach is to identify residues of PCB or dioxins in adipose tissue. Id. at 51. The latter is complicated by the fact that most individuals have some background level of hazardous substances like DDT or PCB in their adipose tissue. See McGovern, 53 L. & Contemp. Probs. at 64-65 (cited in note 156).

159. See, for example, *Anderson v. Cryovac, Inc.*, 862 F.2d 910 (1st Cir. 1988) (groundwater pollution from one industrial site alleged to have caused cancer in the surrounding population);

Of course, just because one particular paradigm of environmental paradigm is theoretically most conducive to tort litigation does not mean that torts will provide the kind of signals in that paradigm that regulation, markets and criminal law cannot. As noted, those observers who question the efficacy of environmental tort litigation have failed to consider the heterogeneity of environmental pollution paradigms.[160] Yet even in the singular-concentrated pollution paradigm, there remain impressive difficulties that tort doctrine poses for environmental claims.

The litany of obstacles for toxic tort litigants is long, and all are applicable to environmental tort litigation.[161] First, the common law's definition of cause poorly accommodates the epidemiological notion of risk. Second, long latency periods tend to hamper just resolution of claims. Third, litigants have a difficult time compiling evidence of negligence. The availability of regulatory compliance defenses further exacerabates this problem. Finally, the environmental tort victim has little knowledge about, and evidence of, the kinds of chemicals that plants leak or emit. Even when pollution arises from a singular source, and the pollution is concentrated, the epidemiological evidence demonstrates only increased risk, not legal causation. Moreover, the litigant is unsure of the chemicals to which he or she has been exposed, may discover the injury only after the statute of limitation has run, and may be injured even though the plant complied with the (somewhat lax) federal regulations.

But tort law here, as elsewhere,[162] is changing. Innovative attorneys are finding ways to overcome the doctrinal barriers. In addition,

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Elam v. Alcolac, 765 S.W.2d 42 (Mo. Ct. App. 1988) (pollution from one industrial site alleged to cause ill health in surrounding community); *Maddy v. Vulcan Materials Co.*, 737 F. Supp. 1528 (D. Kan. 1990) (approving settlement between industrial site and neighbors for injuries from alleged emission and migration of airborne gases); *Renaud v. Martin Marietta Corp.*, 749 F. Supp. 1545 (D. Colo. 1990) (suit by community against Martin Marietta Corporation for groundwater pollution emitted from industrial site); *Vuocolo v. Diamond Shamrock Chem. Co.*, 573 A.2d 196 (N.J. Super. Ct. App. Div. 1990) (suit by state and local residents against chemical company for releasing dioxin that allegedly caused decedents' cancer); *Cook v. Rockwell Int'l Corp.*, 778 F. Supp. 512 (D. Colo. 1991), cited in 6 Toxics L. Rep. (BNA) 835 (December 11, 1991) (detailing suits at Rocky Flats Nuclear Plant in which 10,000 plaintiffs are suing for personal injury); *McNeil v. Chevron Corp.*, No. 92-00243, (Cal. App. Dep't Super. Ct. Jan 15, 1992), cited in 6 Toxics L. Rep. (BNA) 1117 (Feb. 19, 1992) (residents of town file class action against Chevron refinery in wake of accident that led to emission of hazardous substances).

160. See also Peter S. Menell, *The Limitations of Legal Institutions for Addressing Environmental Risks*, 5 J. Econ. Perspectives 93, 94-101 (1991).

161. For other reasonable discussions of the problems faced by potential environmental tort litigants, see Howard Latin, *Activity Levels, Due Care, and Selective Realism in Economic Analysis of Tort Law*, 39 Rutgers L. Rev. 487, 491 (1987). Gillette and Krier have categorized problems for litigants in terms of process and access bias. Gillette and Krier, 138 U. Pa. L. Rev. at 1046-60. The identification of paradigms of pollution eliminates some access and some process barriers. Others remain, and are discussed in this Part.

162. See Elliott, 43 Rutgers L. Rev. at 1070 (cited in note 7).

changes in statutory law complement the developments in the common law. As environmental tort litigation evolves, understanding and describing the changes that enable more successful claims is central to a positive theory of environmental torts. These changes can be classified as: decreasing entry barriers (overcoming statute of limitations and lowering information costs); addressing causation problems (probabilistic causation and medical monitoring reforms); and easing liability standards (prohibiting regulatory compliance defense and endorsing strict liability as opposed to negligence).

Innovations in environmental torts also have normative implications, as increased litigation presumably affects deterrence. But more litigation does not necessarily contribute efficient and rational deterrence. Indeed, as discussed in the introduction, litigation may not produce deterrence at all. It may only overdeter, leading to inefficient enterprise activity.[163] Therefore, while describing the evolution of environmental torts, we should conjecture how the changes might modify deterrence, realizing that we have little empirical evidence with which to assess any hypotheses.

A. Reducing Entry Barriers

1. Decreasing Information Costs

The ignorance of plaintiffs and their attorneys about the nature of pollution produced by industry is a major impediment to litigation. However, a number of statutory enactments are now providing information on toxic exposures for residents surrounding particular sources.

Among these innovative statutory measures are the Comprehensive Environmental Response Compensation and Liability Act[164] (CERCLA), and various right-to-know provisions associated with a number of federal and state laws. CERCLA, also known as Superfund, has become perhaps the most prominent federal environmental statute. Its primary function is to ameliorate hazardous waste sites. It differs from other vast congressional environmental initiatives in that it utilizes a number of common-law doctrines, including strict, joint and several, and retroactive liability, to shift burdens to individuals who have contributed to a hazardous waste site.[165]

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163. Overdeterrence seems doubtful given the relative lack of deterrence provided by other institutions.

164. Pub. L. No. 96-510, 94 Stat. 2767 (1980), codified at 42 U.S.C. §§ 9601-9675 (1988).

165. The literature on CERCLA is nearly as vast as the litigation that it has prompted. For a good discussion of the litigation under CERCLA, see Jones and McSlarrow, . . . *But Were Afraid to Ask: Superfund Case Law 1981-1989,* 19 Envtl. L. Rep. (Envtl. L. Inst.) 10,430 (1989). See also John C. Buckley, *Reducing the Environmental Impact of CERCLA,* 41 S.C. L. Rev. 765 (1990); Jeff Civins, *Environmental Law Concerns in Real Estate Transactions,* 43 Sw. L. J. 819 (1990).

For purposes of this Article, Superfund's synergistic effect on individual citizens' litigation is critical.[166] In the Superfund Amendment and Re-Authorization Act of 1986 (SARA),[167] Congress mandated that EPA develop lists of hazardous substances that pose the greatest threats at hazardous waste sites and compile profiles of each of these substances regarding their toxicological principles.[168] SARA also required the Agency for Toxic Substances and Disease Registry (ATSDR) to produce new health assessments at particular Superfund National Priority List (NPL) sites.[169] These studies were to entail an analysis of the risk that the hazardous substances at the site posed to humans as well as specific information on exposure and contamination.[170] Citizens can obtain the health assessments at specific sites.[171] Moreover, new Section 117 of SARA made funds available that exposed individuals may use to obtain technical assistance regarding hazardous substance

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Several excellent discussions of the mechanics of CERCLA are available. See generally Jan Paul Acton, *Understanding Superfund: Progress Report* (Rand 1989); Office of Technology Assessment, *Coming Clean: Superfund Problems Can Be Solved* (OTA, 1989) [hereinafter *"Coming Clean"*]. The clean-up task is proceeding slowly. At this time, of 1175 national priority list sites, only 34 have had site work completed. Moreover, only 177 are in the critical remedial action stage. See Acton, *Understanding Superfund* at 27. Many believe that rather than 1200 or 1300 NPL sites, over 10,000 such sites will eventually be listed on the NPL. See *Coming Clean* at 7.

166. Courts have recognized that under Section 107 of CERCLA individual private parties, in addition to the United States, can sue for clean-up costs. See *Ascon Properties Inc. v. Mobil Oil Corp.*, 866 F.2d 1149, 1152 (9th Cir. 1989); *Kalick v. Allis-Chalmers Corp.*, 658 F. Supp. 631, 637 (W.D. Pa. 1987). See generally James L. Rogers and Eugene C. McCall, *The Private Plaintiff's Prima Facie Case Under CERCLA Section 107*, 41 S.C. L. Rev. 833 (1990).

Private citizens, however, made little use of this provision from 1980 through 1986. Perhaps in recognition of this, Congress added an explicit citizen suit provision to CERCLA in the Superfund Amendments and Reauthorization Act of 1986 (SARA). SARA § 1-9, Pub. L. No. 99-499, 100 Stat. 1612, codified at 42 U.S.C. § 9659 (1988). The new provision allowed suits by private citizens against those who violate CERCLA requirements as well as against the federal government for failing to undertake nondiscretionary duties. Id. Some, however, feel that the citizen suit provisions will do little to change the course or scope of CERCLA. See Jeffrey M. Gaha and Mary E. Kelly, *The Citizen Suit Provision of CERCLA: A Sheep in Wolf's Clothing?*, 43 Sw. L. J. 929 (1990). Moreover, SARA's restrictions on the timing of suits will no doubt crimp citizen litigation.

In general, SARA was another example of a mid-1980s effort by Congress to increase the speed and viability of EPA's enforcement by creating specific deadlines and mandating initiatives. See generally Timothy B. Atkeson, et al., *An Annotated Legislative History of the Superfund Amendments and Reauthorization Act of 1986 (SARA)*, 16 Envtl. L. Rep. (Envtl. L. Inst.) 10,360 (1987).

167. The original CERCLA legislation created the Agency for Toxic Substances and Disease Registry (ATSDR) within the Department of Health and Human Services. CERCLA required ATSDR to act as a central repository for investigations of health effects of hazardous substances, to conduct studies at hazardous waste sites, and to develop a registry of individuals who were exposed to hazardous substances. This work proceeded very slowly. As a result Congress, acting through SARA, created specific duties and time tables for the ATSDR. Id. at 10375.

168. 42 U.S.C. §§ 9604(i)(2), (i)(3).

169. Id. § 9604(i)(6)(A) (1988).

170. Id. § 9604(i)(6).

171. Id. § 9604(i)(6)(B).

assessment.[172] Finally, SARA created a new federal standard that would toll state statute-of-limitation periods at "the date the plaintiff knew or reasonably should have known that the personal injury . . . [was] caused or contributed to by the hazardous substance or pollutant or contaminant concerned."[173]

The information available from the ATSDR considerably lightens the burden on common-law litigants injured by hazardous wastes. In effect, the ATSDR develops the data on causation that formerly would have been compiled by the plaintiffs, a very onerous task. Moreover, the ATSDR will provide specific information on exposure and contamination that was previously unavailable. ATSDR grants constitute the financial basis for a common-law case. Perhaps most importantly, the ATSDR information is presumably objective and nonpartisan.[174] Such compilation of causation and exposure information by an impartial body should enable plaintiffs and their attorneys to make more rational decisions about the merit of potential claims.[175]

The burgeoning of right-to-know statutes under both federal and state law is another development that increases the availability of infor-

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172. Id. § 9617(e)(1), (e)(2). The amount available under this program may exceed $50,000. Id.

173. Id. § 9658(a)(1). In order to fill the gaps in existing knowledge, CERCLA also empowers ATSDR to provide grants for research on specific substances. See id. § 9604(i)(5). Primary responsible parties and registrants under TSCA and FIFRA are to bear the costs of these assessments. Id. § 9604(i)(5)(D).

174. See Brennan, 51 U. Pitt. L. Rev. at 44 (cited in note 158).

175. It is too early to tell whether or not this sunny prospect will bear out. At least one very prominent environmental tort case, *In re Paoli R.R. Yard PCB Litigation*, 706 F. Supp. 358 (E.D. Pa. 1988) (granting defendant's motion for summary judgment), rev'd, 916 F.2d 829 (3d Cir. 1990), focused in part on an ATSDR study at the site, as well as ATSDR documents concerning the toxicity of PCBs. Defendant's summary judgment motion, which had been granted by the District Court, was overturned on Circuit Court review. At both the trial and appellate level, the ATSDR information played a prominent role. See 706 F. Supp. at 370-78; 916 F.2d at 847.

Unsurprisingly, courts increasingly intermingle Superfund litigation with environmental tort claims. Such cases have forced federal courts to consider the comparative roles of statutory (that is, CERCLA) and common law in the design of remedies for those exposed to hazardous wastes. For instance, plaintiffs have sought medical monitoring remedies as response costs under CERCLA. See 42 U.S.C. § 9607(a)(4)(B). Some courts have allowed medical monitoring costs under Section 107(a)(4)(B). See, for example, *Brewer v. Ravan*, 680 F. Supp. 1176 (M.D. Tenn. 1988); *Williams v. Allied Automotive, Autolite Div.*, 704 F. Supp. 782 (N.D. Ohio 1988); *Lykins v. Westinghouse Elec. Corp.*, 27 Envtl. Rep. Cas. (BNA) 1590, 18 Envtl. L. Rep. (Envtl. L. Inst.) 21,498 (E.D. Ky. 1988). Others have refused, noting that the state's common law allows such claims. They reason that in these states tort law is the proper vehicle for medical monitoring. The most thorough discussion of this issue is in *Ambrogi v. Gould, Inc.*, 750 F. Supp. 1233, 1246-50 (M.D. Pa. 1990). For further discussion, see *In re Hanford Nuclear Reservation Litigation*, 780 F. Supp. 1551 (E.D. Wash. 1991); *Woodman v. United States*, 764 F. Supp. 1467 (M.D. Fla. 1991); *Keister v. Vertac Chem. Corp.*, 21 Envtl. L. Rep. (Envtl. L. Inst.) 20,677 (E.D. Ark. 1990); *Werlein v. United States*, 746 F. Supp. 887 (D. Minn. 1990). While these innovations apply only to Superfund sites, they nonetheless exhibit a judicial willingness to consider carefully the appropriate roles of torts and statutory provisions.

mation on hazardous substances in the environment and, presumably lowers the barrier to tort litigation.[176] While the most prominent right-to-know law primarily affects occupational safety and health issues,[177] the passage of Title III of SARA,[178] known as the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA), created hazard-warning duties for companies that release environmental toxins.[179] While acknowledging that problems in enforcement of EPCRA exist, most commentators nonetheless agree that the reporting requirements

176. Kip Viscusi has argued for the efficiency advantages of greater information regarding hazards in the work place, and presumably elsewhere, when linked to individual choice about risks. See W. Kip Viscusi, *Risks By Choice: Regulating Health and Safety in the Work Place*, Chs. 7-9 (Harvard, 1983). Moreover, hazard communication clearly fits the liberal state's insistence on personal choice and individual liberties. Therefore, hazard communication would seem to he an integral part of any liberal approach to toxic substances in the environment. Not all would agree. Producers would prefer to avoid imposition of liability and loss of trade secrets. See Paulette L. Stenzel, *The Need for A National Risk Assessment Communication Policy*, 11 Harv. Envtl. L. Rev. 381 (1987); Nicholas Ashford and Charles Caldart, *The Right-to-Know: Toxics Information Transfer in the Work Place*, 6 Ann. Rev. Pub. Health 383 (1985) (dismissing the privacy concerns that producers may have).

177. The first of the federal right-to-know regulations was OSHA's Hazard Communication Standard (HCS). The HCS requires that manufacturers decide whether or not a workplace chemical is a health hazard. If it is, then the manufacturer must comply with extensive labeling and reporting rules. See 29 C.F.R. § 1910.1200 (1987). The manufacturer must append a warning label to any hazardous ingredient unless it is a trade secret. Id. § 1910.1200(h)(1)(i)(1). The manufacturer must then incorporate these warnings into a material safety data sheet that details the nature of the hazards presented by the chemicals as well as the steps to take should any exposure occur. Id. § 1910.1200(g). Some have criticized the amount of discretion granted to manufacturers under the OSHA rule. See Susan D. Carle, Note, *A Hazardous Mix: Discretion to Disclose and Incentives to Suppress Under OSHA's Hazard Communication Standard*, 97 Yale L. J. 581 (1988).

Courts have interpreted the OSHA standard to preempt more stringent state right-to-know statutes. See, for example, *Ohio Mfrs. Ass'n v. City of Akron*, 801 F.2d 824 (6th Cir. 1986); *New Jersey State Chamber of Comm. v. Hughey*, 774 F.2d 587 (3d Cir. 1985). See also James T. O'Reilly, *Driving a Soft Bargain: Unions, Toxic Materials and Right To Know Legislation*, 9 Harv. Envtl. L. Rev. 307, 309 n.13 (1985) (listing state right-to-know statutes). Some have argued that from an economic point of view, such preemption is ill-advised. See, for example, Elinor P. Scbroeder and Sidney A. Shapiro, *Responses to Occupational Disease: The Role of Markets, Regulation and Information*, 72 Georgetown L. J. 1231 (1984).

A good deal of on-going litigation regarding the scope of the HCS still exists. See *Dole v. United Steel Workers of Am.*, 494 U.S. 26 (1990); Mark L. Goldstein, *Hazard Communication in the Work Place*, 7 Hofstra Labor L. J. 303 (1990).

178. Pub. L. No. 99-499, 100 Stat. 1729 (1986), codified at 42 U.S.C. §§ 11001-11050 (1988).

179. EPCRA has three parts. Subtitle A details a structure of state and local emergency response planning communities and requires the promulgation of emergency response plans, 42 U.S.C. §§ 11001-11005 (1988). Subtitle B spells out the requirements for reporting by facilities where hazardous substances are manufactured or stored. Id. §§ 11021-11023. Subtitle C sets forth enforcement, citizens suit, and trade secret provisions. Id. §§ 11041-11050. Congress did not intend for EPCRA to preempt more stringent state requirements, and some avenues of state and federal cooperation seem available. See Robert Abrams and Douglas H. Ward, *Prospects for Safer Communities: Emergency Response, Community Right To Know and Prevention of Chemical Accidents*, 14 Harv. Envtl. L. Rev. 135, 152 (1990) (noting the states that have recently adopted laws improving EPCRA's existing provisions and establishing prevention planning).

will make more information available for tort litigants.[180] Producers now recognize that local citizens will be increasingly aware of the hazards produced and used at industrial sites. This knowledge may deter cavalier use and disposal of hazardous substances, since information on exposure to hazardous chemicals could galvanize the community of people living around a particular facility. For potential environmental tort claims, the plaintiff's knowledge about exposure and the potential injuries associated with that exposure creates the possibility that plaintiffs may negotiate a reasonably efficient settlement with a producer. This could also serve as a rational deterrence signal.[181]

In addition to the federal right-to-know laws, several state initiatives are notable.[182] Foremost among these is Proposition 65, California's Safe Drinking Water and Toxic Enforcement Act.[183] Approved by sixty-two percent of California voters in 1986, Proposition 65 requires the state government to publish a list of chemicals known to be carcinogenic or teratogenic, forces businesses to warn those who may be exposed to a listed chemical, and prohibits discharge of such chemicals into drinking water.[184] The state already has listed certain chemicals as carcinogens[185] and has brought a good deal of enforcement litigation for failure to warn.[186] Interestingly, Proposition 65 puts the burden on the

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180. See Michael Baram, et al., *Managing Chemical Risks: Corporate Response to SARA Title III* 10-12 (Tufts, 1990); Michael D. Green, *When Toxic Worlds Collide: Regulatory and Common Law Prescriptions for Risk Communication*, 13 Harv. Envtl. L. Rev. 209, 224-231 (1989). Indeed, Green discusses the interrelationships of EPCRA and tort suits in some detail and notes the impact that EPCRA warnings may have on statutes of limitations definitions under SARA. Id. at 225-226.

181. See Steven Shavell, *Liability for Harm Versus Regulation of Safety*, 13 J. Legal Stud. 357, 360 (1984) (noting that for a tort to play an important deterrent role, equality of information must exist between plaintiff and defendant). Along these lines, Congress seemingly could design the right-to-know laws with particular incentives for producers to provide useful information. See Mary L. Lyndon, *Information Economics and Chemical Toxicity: Designing Laws to Produce and Use Data*, 87 Mich. L. Rev. 1795 (1989). Congress has incorporated right-to-know provisions incorporated into numerous federal statutes. See, for example, 15 U.S.C. §§ 2607, 2613 (1988) (TSCA); 7 U.S.C. §§ 136h(d), 136s (1988) (FIFRA).

182. See, for example, Sharon A. Treat, *The New Jersey Right To Know Act*, 38 Rutgers L. Rev. 755 (1986) (reviewing the New Jersey Worker and Community Right To Know Act, N.J. Stat. Ann. §§ 34:5A-1-31 (West Supp. 1986)).

183. See Cal. Health and Safety Code §§ 25180.7, 25189.5, 25192, 25249.5-.13 (West Supp. 1988).

184. See generally Judith A. DeFranco, *California's Toxics Initiative: Making It Work*, 39 Hastings L. J. 1195 (1988); Melinda Haag, *Proposition 65's Right To Know Provision: Can It Keep Its Promise to California Voters?*, 14 Ecol. L. Q. 685 (1987).

185. See William S. Pease, et al., *Risk Assessment for Carcinogens Under California's Proposition 65*, 10 Risk Analysis 255, 255 (1990) (noting that 333 chemicals or chemical mixtures are included on the governor's list as carcinogens).

186. See, for example, *State Files Proposition 65 Law Suits Against Firms for Ethylene Oxide Emissions*, Envtl. L. Rep. (Envtl. L. Inst.) 545 (July 27, 1990).

discharger of chemicals to show that the chemical itself poses no significant risk of human disease.[187]

The information-creating aspects of SARA, and the state and federal right-to-know statutes bespeak a much different approach to environmental problems than would have been contemplated fifteen years ago.[188] Before the *Benzene* decision and the failure of the generic cancer policies of OSHA and EPA, there was a certain optimism about comprehensive regulation of hazardous substances. In the post-*Benzene* period, Congress and the states appeared to be more interested in reiterating individual's rights, especially by giving them more information on chemical exposure. These innovative regulations should increase litigation, which at least promises rational deterrence.[189] SARA and right-to-know statutes encourage environmental tort litigants by providing them with low cost information.[190] Citizens living near a concen-

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187. See Cal. Health and Safety Code § 25249.10(c) (West Supp. 1988).

188. The Clean Water Act also contains right-to-know provisions. See 33 U.S.C. § 1318(v) (1988). This section of the CWA authorizes the EPA to require permit-holders to keep records and report of hazardous wastes going into surface water, and to afford the public access to this information.

189. Of course, the failure of Big Green—the California initiative that would have phased out the use of carcinogenic or teratogenic pesticides, prohibited the sale of food containing pesticides, mandated establishment of purely health-based tolerance for food and set stringent health-based standards for discharge of toxic pollutants into state waters—indicates that citizens may not be ready to give up on cost-benefit analysis. See generally Gregory J. Mertz, *Dead But Not Forgotten: California's Big Green Initiative*, 60 Geo. Wash. L. Rev. 506 (1992). Costly regulations, or at least those to which society can affix a clear price tag and that go beyond mere empowering of individuals regarding the level of their exposure, may not be part of the future in state environmental initiatives. See also S.H. Verhovek, *Albany Looks Longingly at Land It Can't Buy*, N.Y. Times E6 (Nov. 25, 1990) (detailing demise of New York's expensive Environmental Quality Bond Act).

190. Right-to-know statutes and environmental tort litigation can be seen as part of a "greening" of environmental law, a movement to citizen-based litigation from reliance on comprehensive rational regulation. Another aspect of greening is the recent increase in citizen suits under various environmental statutes. Most of the major environmental statutes long have allowed individuals to act as private attorneys general. See generally Robert F. Blomquist, *Rethinking the Citizen as Prosecutor: Model of Environmental Enforcement Under the Clean Water Act*, 22 Ga. L. Rev. 337 (1988); Barry Boyer and Errol Meidinger, Note, *Privatizing Regulatory Enforcement: A Preliminary Assessment of Citizen Suits Under Federal Environmental Laws*, 34 Buff. L. Rev. 833 (1985). Since the mid-1980s, the numher of citizen suits filed under either the Clean Water Act or the Clean Air Act have increased significantly. See Jeannette L. Austin, Comment, *The Rise of Citizen-Suit Enforcement in Environmental Law: Reconciling Private and Public Attorneys General*, 81 Nw. U. L. Rev. 220, 221-22 (1987).

Notwithstanding the Supreme Court's introduction of a number of obstacles to citizen suits under the Clean Water Act in *Gwaltney v. Chesapeake Bay Found.*, 484 U.S. 49 (1987), and academic concerns about tbe interference of private rights with public programs, see Richard B. Stewart and Cass R. Sunstein, *Public Programs and Private Rights*, 95 Harv. L. Rev. 1193 (1982), citizen suits activity continues unabated, see, for example, *Carr v. Alta-Verde Indus., Inc.*, 931 F.2d 1055 (5th Cir. 1991); *Atlantic States Legal Found. v. Tyson Foods, Inc.*, 897 F.2d 1128 (11th Cir. 1990).

Increasing citizen awareness and citizen participation in regulation-enforcement, however, will probably not lead to a radical restructuring of environmental law. Some scholars believe otherwise. See, for example, James Paul Kimmel, Comment, *Disclosing the Environmental Impact of Human*

trated, singular site increasingly have tools available to learn about their exposure to hazardous chemicals.

2. Changing Statutes of Limitation

Statutes of limitation establish a limit of two to four years, depending on applicable state law, from the time that the cause of action "accrued" for a plaintiff to file a claim. Courts conventionally find that an action has accrued once the defendant has acted wrongfully and thereby caused injury to the victim. That interpretation occasions no particular difficulties when the harm done is immediately visible, such as a motor vehicle accident or a plane crash. However, the diseases that follow toxic exposures—most notably, though by no means solely, cancers—typically have latency periods between the original exposure and the ultimate manifestation of the disease, the latter being the time when the victim realizes the need to seek redress for the harm done. Without some qualifications to the conventional understanding of "accrual," the vast majority of environmental injury claims could never even be filed.

Fortunately, the courts have responded to this problem. Their response was heavily influenced by a Supreme Court ruling in 1949 that under the Federal Employer's Liability Act (FELA), the limitation period did not begin to run until the individual employee had discovered the silicosis inflicted by long-term exposure to silica dust on the job.[191] By now, approximately forty states have explicitly adopted some form of this "discovery rule."[192]

Courts need to interpret the discovery principle carefully and generously in order to ameliorate the effect of standard limitation periods on environmental exposure cases. A person who lives near a hazardous waste site may learn that she has developed leukemia, for example, but may not connect her disease with exposure to the waste site for some time thereafter. The victim may be unaware of the presence of the waste site in the area, or the scientific community may be unaware of the connection between this type of exposure and disease. The courts have developed a variety of doctrinal formulae that give plaintiffs some latitude in discerning the causal connection between their current ill-

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Activities: How A Federal Pollution Control Program Based on Individual Decision-Making and Consumer Demand Might Accomplish the Environmental Goals of the 1970s in the 1990s, 138 U. Pa. L. Rev. 505 (1989) (sketching the outlines of a consumer, market-based approach to environmental regulation. Kimmel's notion of an environmental impact index, while useful in many ways, cannot be taken as a serious alternative to command-and-control regulation. This Article offers the tort system as a complement to environmental regulation, not in any way as an alternative.

191. See *Urie v. Thompson*, 337 U.S. 163 (1949).

192. See *Developments—Toxic Waste Litigation*, 99 Harv. L. Rev. 1458, 1605-06 (1986).

ness and the defendant's prior activity.[193] However, even forty years after the emergence of the "discovery" principle, the statute of limitation has been one of the most successful defenses regularly asserted in asbestos litigation.[194]

Scholars have conducted vigorous debate over the last several years about the pros and cons of statutory limitation periods, particularly in the toxic tort area. Some scholars advocate the enactment of ten- or twenty-year statutes of repose. These statutes would remove from enterprises any specter of liability for a multiplicity of later-discovered tort suits, including suits that may turn on lost or stale evidence of the initial exposures.[195] Others have argued, persuasively, that avoiding such rigid statutes of repose and adopting a relaxed interpretation of when "discovery" occurs better serves the substantive goals of tort law in the environmental area.[196]

The Superfund Section 301(e) Study Group proposed, and the Congress enacted in SARA, a mandatory federal standard governing when state limitation periods may begin for purposes of any personal injury actions "caused or contributed to by exposure to any hazardous substance, or pollutant or contaminant, released into the environment from a facility."[197] The federal trigger is the "date the plaintiff knew (or reasonably should have known) that the personal injury . . . [was] caused or contributed to by the hazardous substance or pollutant or contaminant concerned."[198] This new federal standard provided a reasonable balance between the interests of enterprises and victims. This balance will permit the vast bulk of legitimate environmental tort claims to proceed, while still providing some legal spur to victims to file their claims as soon as they could reasonably know about them.[199] From

193. Compare *Larsen v. Johns-Manville Sales Corp.*, 399 N.W.2d 1 (Mich. 1986) (holding that time starts running from manifestation of disease itself) with *Zeleznik v. United States*, 770 F.2d 20 (3d Cir. 1985) (holding that time starts from discovery of the immediate cause of injury) and *Rose v. A.C.& S., Inc.*, 796 F.2d 294 (9th Cir. 1986) (holding that time starts when the defendant's own involvement becomes known).

194. See Michael D. Green, *The Paradox of Statutes of Limitations in Toxic Substance Litigation*, 76 Cal. L. Rev. 1965, 1969-70 (1988).

195. See Richard A. Epstein, *The Temporal Dimension in Tort Law*, 53 U. Chi. L. Rev. 1175 (1986). On statutes of repose generally, see Francis E. McGovern, *The Variety, Policy and Constitutionality of Product Liability Statutes of Repose*, 30 Am. U. L. Rev. 579 (1981).

196. See Green, 76 Cal. L. Rev. at 1970 (cited in note 194) (arguing that Congress should abolish statutes of limitation in toxic tort litigation).

197. 42 U.S.C. § 9658(a)(1)(1988).

198. Id. § 9658(b)(4)(A) (1992) (referring to provisions outlined in 42 U.S.C. §§ 9658(a)(1)), 9658(b)(4)(B)).

199. In those legal settings where the federal statute does not apply of its own accord, the common-law discovery principle should be developed along these same lines. See, for example, *Covalt v. Carey Canada, Inc.*, 860 F.2d 1434 (7th Cir. 1988) (holding that CERCLA does not apply to an occupational disease claim against the manufacturer of asbestos because courts cannot con-

a normative viewpoint, it seems commendable. On the positive side, tort law clearly has evolved to ensure that friction between latency periods and statutes of limitation does not obstruct reasonable claims.

B. Changing Liability Standards

1. Regulatory Compliance

Much of this Article is devoted to an examination of environmental torts, and the deterrence they may produce, as a complement to regulatory policy. If, however, defendants can use compliance with lax regulations as a defense, environmental tort litigation will flounder. Moreover, if regulation efficiently prevents environmental injuries through ex ante rules, a proposition that seems doubtful in the area of environmental toxic injury, tort litigation becomes an unwelcome producer of overdeterrence. Thus, the use of a regulatory compliance defense is central to both positive and normative descriptions of environmental torts: the former because a regulatory compliance defense will inhibit litigation, the latter because of the centrality of complementary deterrence to the usefulness of common-law litigation of environmental injuries.

Scholars have discussed rather widely the relative theoretical benefits of the common-law for accident prevention vis-à-vis regulation.[200] Steven Shavell likely has done the best conceptual analysis.[201] He concludes that when an injurer's knowledge about risk is greater than that of regulators or other authorities, when information is needed from the injured about the nature of their harm, and when the injured's assets are not too small, liability seems superior to state initiatives.[202] In light of the poor performance of regulations in developing information, the multiplicity and heterogeneity of sites of toxic pollution, the knowledge inequity between regulators and injurers (Shavell's first condition) arguably persists even given the growing influence of right-to-know stat-

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sider the interior of a place of employment the "environment" for purposes of CERCLA).

200. Some have advocated much greater use of regulatory initiatives. See generally E. Donald Elliott, *Goal Analysis versus Institutional Analysis of Toxic Compensation Systems*, 73 Georgetown L. J. 1357 (1985); W. Kip Viscusi, *Toward a Diminished Role for Tort Liability: Social Insurance, Government Regulation, and the Contemporary Risks to Health and Safety*, 6 Yale J. Reg. 65 (1989). Others are committed to common-law litigation and to court assessment of risks. See generally Clayton P. Gillette and James E. Krier, *Risk, Courts, and Agencies*, 138 U. Pa. L. Rev. 1027 (1990); Guido Calabresi, *Torts—The Law of the Mixed Society*, 56 Tex. L. Rev. 519 (1978). Scholars are unlikely to resolve this debate without significant empirical research. See text accompanying notes 14-18. See generally Donald Dewees, *Tort Law and the Deterrence of Environmental Pollution*, in T.H. Tietenberg, ed. *Innovation in Environmental Policy* 139 (Elgar, 1992); Lewis A. Kornhauser and Richard L. Revesz, *Apportioning Damages Among Potentially Insolvent Actors*, 19 J. Legal Stud. 617, 651 (1990) (planning new analyses of regulation versus tort litigation).

201. See Steven Shavell, *Economic Analysis of Accident Law* 277-86 (Harvard, 1987).

202. Id. at 286.

utes. Information about injuries is definitely needed from injured parties (Shavell's second condition).

The third condition is really a matter of payment of the costs of litigation. If plaintiffs' attorneys are willing to take cases either because of the aggregative value of claims, or because of some sense of altruistic commitment to compensation for injury, then the individual plaintiff's assets are not so important. Therefore, with regard to Shavell's conditions, liability is theoretically attractive and a regulatory compliance defense should not displace it.[203] This has certainly been the posture of common-law courts, which have traditionally resisted finding a defendant's adherence to regulations to exculpate them from liability.[204] Tort litigation has proceeded independently of regulation and with the implicit assumption that any deterrence it produces is complementary.

Advocates of tort reform, especially in the area of product liability, have begun to reassess the assumption of complementary deterrence.[205] Overdeterrence is a theoretical probability, although, as elsewhere, no empirical evidence is available.[206] Nonetheless, fears of tort crisis have led to state laws that preclude punitive damages in drug product liability cases,[207] to the SARA provisions that shield cleanup activities,[208] and to a few federal court decisions that overtly accept a compliance defense.[209]

The merits of a regulatory compliance defense must depend somewhat on the role played by torts and regulation in a given area of accident law. For instance, ex ante regulation through a culling statute,[210] which requires proof of safety before marketing can begin, might be so potent that allowing ex post tort litigation would decrease enterprise levels without accomplishing more safety. Thus in drug product liability, the FDA's oversight of the introduction of new products generates real deterrence, and suggests that further tort litigation might amount to overdeterrence (especially in the case of punitive damages). On the other hand, culling statutes that are weakly enforced do not provide the

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203. As Shavell notes, a mixture of safety regulation and liability, specifically minimal safety standards and a threat of liability, is perhaps the optimal situation from a deterrence viewpoint. Id. at 288.

204. See Restatement (Second) of Torts § 288C (1965).

205. See generally Paul Dueffert, Note, *The Role of Regulatory Compliance in Tort Actions*, 26 Harv. J. Leg. 175 (1989).

206. See, for example, Viscusi, 6 Yale J. Reg. at 68 (cited in note 200). The ALI Report report on enterprise liability also cites administrative costs. See *Reporters' Study* at 88-91 (cited in note 7). Both authorities note that little empirical work on the subject exists.

207. *Reporter's Study* at 77-83 (Chapter 16, *Regulatory Compliance*).

208. 42 U.S.C. § 9619 (1988) (CERCLA § 119).

209. See, for example, *Jefferson County School Dist. R-1 v. Gilbert*, 725 F.2d 774 (Colo. 1987) (finding city not liable for intersection design if it complied with federal regulations).

210. See Brennan, *Narrowing* at 68 (cited in note 74).

same foundation for a compliance defense. Or if a regulatory scheme is poorly devised and leaves specific holes in the safety net it is designed to create, then regulatory standards should not exculpate defendants. The perception that regulatory control of toxic pollution has been incomplete, and the possibility of efficient deterrence from tort litigation at some sites suggests that the availability of a regulatory compliance defense should be limited, at least for now.

Regarding the positive description of environmental torts, it seems the judicial animosity must be limiting its utility of the regulatory compliance defense.[211] Nonetheless, the defense will continue to arise, especially as environmental torts intermingle with litigation under statutory provisions such as Superfund. The weight of regulatory compliance is likely to become a salient issue as judges become cognizant of the parallel intentions of environmental statutory law and torts.

2. Strict Liability

The other critical liability issue in environmental torts is the choice of a negligence or strict liability standard in environmental litigation. Environmental litigants could face a negligence standard, courts being unwilling to accept that environmental pollution is an unduly dangerous and inappropriate undertaking.[212] The plaintiff must then prove substandard care by the polluter. Given a certain latency period between exposure and discovery of injury, much of the necessary evidence of negligence might be cold or unavailable to a plaintiff by the time of the lawsuit. This is a tremendous burden for potential litigants.

Of course, courts can opt for strict liability. Strict liability enables a court to identify the best preventor of injury and to affix liability.[213]

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211. I have been unable to find an environmental tort case where a regulatory compliance defense was successful.

212. See W. Page Keeton, et al., *Prosser and Keeton on the Law of Torts* § 78 at 547-48 (West, 5th ed. 1984) (commenting on *Rylands v. Fletcher*, L.R. 3 H.L. 330 (1868)).

213. See Guido Calabresi and Jon T. Hirschoff, *Toward a Test for Strict Liability in Torts*, 81 Yale L. J. 1055, 1060 (1972). As Komesar points out, Calabresi's analysis is most justified when accidents are highly preventable, such that the avoided costs outweigh the problems with over-insurance created by the strict liability standard. See Komesar, 65 N.Y.U. L. Rev. at 73 (cited in note 10).

Shavell's more technical consideration of the issue buttresses Calabresi's functional analysis. See generally Shavell, *Economic Analysis of Accident Law* at 5-83 (cited in note 201). Shavell factors in the interaction of the plaintiff's and defendant's knowledge as well as each player's relative carefulness, and concludes that courts should prefer strict liability in situations analogous to environmental torts. Shavell's paradigm is the health risks posed by microwave ovens. He notes that strict liability is preferable when (i) an individual has imperfect knowledge of the substantial health risks associated with such products, (ii) courts have difficulty ascertaining the possibilities of designing safe microwave ovens and (iii) there is very little contributory negligence by users. Id. at 57-58. Kornhauser and Revesz draw similar conclusions regarding the use of strict liability in CERCLA. See Lewis A. Kornhauser and Richard Revesz, *Sequential Decisions by a Single*

This analysis depends heavily on the assumption that the parties, especially the defendant, have greater information than do courts.[214] While this may not be true in other areas of tort litigation, it seems a reasonable assumption in environmental torts. Courts, and presumably regulators, may be uncertain as to how to balance costs and benefits; strict liability forces the party best suited to undertake such calculus—the defendant—to do so.[215]

But utility analyses should not be the only consideration. Litigation itself presents information costs and claim costs. While information costs decrease by moving to a strict liability standard, claims costs increase, as strict liability leads to more suits.[216] Fears about increased claims may inhibit use of strict liability.[217]

In a related vein, strict liability may cause overdeterrence. Regarding product liability, many have argued persuasively that a strict liability standard can be unfair, especially given an ex post analysis. They reason that strict liability can eliminate any foreseeability defenses, and so holds individuals liable for injuries created by products that, at the time of exposure, defendants had no idea were dangerous.[218] While others point out that eliminating a foreseeability defense encourages research on the part of defendants into the effects of their products, rigid strict liability still seems unfair and inefficient.[219] Therefore, fears persist that generalized use of strict liability would lead to much greater costs through overdeterrence,[220] even though a modified foreseeability

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Tortfeasor, 20 J. Legal Stud. 363, 370-72 (1991).

Since environmental tort litigants presumably have very little control over exposure, have little information on health risks, and cannot significantly increase these risks by their own activities, little reason exists to force them to prove that a polluter was negligent. The fact that an analyst with a completely different viewpoint from law and economics can arrive at the same conclusion is interesting and, in some ways, reassuring. See Richard L. Abel, *A Critique of Torts*, 37 UCLA L. Rev. 785, 826 (1990) (urging use of a strict liability standard).

214. See Howard Latin, *Activity Levels, Due Care, and Selective Realism in Economic Analysis of Tort Law*, 39 Rutgers L. Rev. 487, 501 (1987).

215. See Guido Calabresi and Alvin K. Klevorick, *Four Tests for Liability in Torts*, 14 J. Legal Stud. 585, 614 (1985).

216. See William M. Landes and Richard A. Posner, *The Economic Structure of Tort Law* 65 (Harvard, 1987).

217. Landes and Posner agree with Shavell that important factors in selecting a liability standard are the injurer's activity level and the injured's potential for contributory negligence. Id. at 69. Indeed, Landes and Posner note that "[i]f a change in the defendant's but not in the plaintiff's activity level is an efficient method of accident avoidance, strict liability is attractive and will be the rule chosen." Id. at 70. Since exposure to environmental pollution is usually passive, contributory negligence is rare.

218. See *Beshada v. Johns-Manville Prods. Corp.*, 447 A.2d 539, 540 (N.J. 1982).

219. See Robert L. Rabin, *Indeterminate Risk and Tort Reform: Comment on Calabresi and Klevorick*, 14 J. Legal Stud. 633, 638 (1985).

220. See Alan Schwartz, *Products Liability, Corporate Structure, and Bankruptcy: Toxic Substances and the Remote Risk Relationship*, 14 J. Legal Stud. 689, 703-05 (1985). Schwartz

defense theoretically could answer some of these concerns.[221]

Nonetheless, in most environmental tort cases, courts have adhered to a strict liability standard.[222] This may result less from a theoretical consideration of strict liability's benefits than from an assumption that environmental toxins should be considered abnormally dangerous and

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cites the analysis by John E. Calfee and Richard Craswell, *Some Effects of Uncertainty on Compliance with Legal Standards*, 70 Va. L. Rev. 965 (1984). Calabresi and Klevorick respond that decisions to undertake research would likely be fairly stochastic. Overdeterrence situations would cancel out those in which the investigation of hazards associated with a product is minimal (underdeterrence). Perhaps more to the point, answering any of these questions without decent empirical information is difficult, as Calabresi and Klevorick allow. See Calabresi and Klevorick, 14 J. Legal Stud. at 626-27 (cited in note 215).

221. With the growing awareness that environmental pollutants may be hazardous to one's health, defendants' claims that they could not foresee health injuries should fade. Both producers and plaintiffs are now instructed by the many examples of seemingly innocuous materials that led to multiple, significant injuries. See generally Brennan, *Toxic Torts* at 41-43 (discussing a variety of mass torts). Moreover, if one dates this awareness from the 1970s, we are now approaching a time when the latency period for any disease reaches back only to a point when we were aware of the potential threats represented by chemicals and other products. Therefore, the foreseeability defense in the strict liability actions should fade over the next decade.

Also, as litigants become aware of exposure, they may begin to sue for medical monitoring, rather than waiting for a latency period to elapse. See text accompanying notes 225-44. Remedies fashioned concurrently with exposure raise less concern about the unfairness of ex post strict liability standards. In these cases, defendants are unable to argue that courts are unfairly holding them liable for damages that were not foreseeable. Therefore, in cases that impose strict liability on an ex post basis, it may be wise to adopt a knowledge defense for now, while realizing that the defense has limited value in environmental tort litigation and that over the course of the next decade, the case for it will become much weaker.

One other important issue is the role of insurance in a strict liability, as opposed to negligence, regime. Schwartz has suggested that the move to strict liability has evaporated the availability of insurance, forcing many to self-insure. See Gary Schwartz, *The Ethics and the Economics of Tort Liability Insurance*, 75 Cornell L. Rev. 313, 316 (1990). Schwartz cites Priest's estimate that self-insurance financed 60% of all product liability payoffs. See George L. Priest, *The Anti Trust Suits and the Public Understanding of Insurance*, 63 Tulane L. Rev. 999, 1009 (1989).

Schwartz proceeds to argue that self-insurance should induce producers to undertake more aggressive risk management. Since environmental liability insurance is unavailable, see Kenneth S. Abraham, *Environmental Liability and the Limits of Insurance*, 88 Colum. L. Rev. 942, 952-54 (1988), this may indicate that insurers have decided that gradual releases of pollution are so within defendant's control as "to render inadvisable a regime of insurance." See Schwartz, 75 Cornell L. Rev. at 344. In this regard, the theory that strict liability forces producers who are best able to respond to deterrence signals to do so, integrates neatly with the unavailability of insurance. See Komesar, 65 N.Y.U. L. Rev. at 40 (cited in note 10).

222. See, for example, *Sterling v. Velsicol Chem. Corp.*, 647 F. Supp. 303 (W.D. Tenn. 1986) (holding chemical corporation strictly liable to neighbors for personal injuries and property damage caused by corporation's inherently and abnormally dangerous activities in operating a hazardous waste dump), aff'd in part, rev'd in part on other grounds, 855 F.2d 1188 (6th Cir. 1988); *State Dep't of Envtl. Protection v. Ventron Corp.*, 468 A.2d 150 (N.J. 1983) (holding landowner strictly liable for harm caused by toxic wastes stored on his property that flow onto the property of others). But see *Sprankle v. Bower Ammonia & Chem. Co.*, 824 F.2d 409 (5th Cir. 1987) (finding no strict liability in a case involving exposure of a factory worker to anhydrous ammonia stored in defendant's factory and used as part of its regular manufacturing activities).

thus "worthy" of strict liability.[223]

The use of strict liability does encourage claims and helps to explain the emergence of environmental torts. Strict liability is thus central to the positive theory. As with regulatory compliance, it is difficult theoretically to anticipate the effect on the underdeterrence-overdeterrence calculus induced by strict liability.

C. *Accommodating Causal Evidence*

1. Probabilistic Causation

Liability standards must be integrated with causation rules to develop a rational approach to tort litigation.[224] Specification of causal standards is as, if not more, important than identification of an appropriate liability standard. As many have discussed, proving causation with epidemiological and other toxicological evidence can be quite troublesome.[225] A general discussion of this subject is beyond the scope of this Article.[226] Herein, the focus can be on the primary problem with causation in hazardous substance litigation: the threshold set by the more-probable-than-not standard.[227] Most environmental carcinogens

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223. The Restatement (Second) of Torts sets forth six factors to be considered in determining whether an activity is abnormally dangerous: 1) the existence of a high degree of risk of some harm to the person, land, or chattels of others; 2) the likelihood that the harm that results from the activity will be great; 3) the inability to eliminate the risk by the exercise of reasonable care; 4) the extent to which the activity is not a matter of common usage; 5) the inappropriateness of the activity to the place where it is carried on; and 6) the extent to which the activity's value to the community is outweigbed by its dangerous attributes. *Restatement (Second) of Torts* § 520 (1977). Courts can readily find these factors applicable to the environmental torts discussed in this Article. But see *Indiana Harbor Belt Railroad Co. v. American Cyanamid Co.*, 916 F.2d 1174 (7th Cir. 1992) (acrylonitrile transport by railroad does not constitute abnormally dangerous activity).

224. Steven Shavell has shown that causation policies will vary depending on the liability standard employed. See Steven Shavell, *Uncertainty Over Causation and the Determination of Civil Liability*, 28 J. L. & Econ. 587, 596 (1985).

225. The list of articles dealing with causation in tort law and particularly in hazardous substance litigation is quite long. Among the most important are John Borgo, *Causal Paradigms in Tort Law*, 8 J. Legal Stud. 419 (1979); Steven Shavell, *An Analysis of Causation and the Scope of Liability in the Law of Torts*, 9 J. Legal Stud. 463 (1980); Daniel A. Farber, *Toxic Causation*, 71 Minn. L. Rev. 1219 (1987); Mark Kelman, *The Necessary Myth of Objective Causation Judgments in Liberal Political Theory*, 63 Chi.-Kent L. Rev. 579 (1987); David Rosenberg, *The Causal Connection in Mass Exposure Cases: A "Public Law" Vision of the Tort System*, 97 Harv. L. Rev. 849 (1984); Shavell, 28 J. L. & Econ. 587 (cited in note 224); and John Makdisi, *Proportional Liability: A Comprehensive Rule to Apportion Tort Damages Based on Probability*, 67 N.C. L. Rev. 1063 (1989). See also Brennan, 73 Cornell L. Rev. at 480 (cited in note 34).

226. For enlightening discussions about general issues of causal concepts in the law, see Wrigbt, 73 Cal. L. Rev. at 1742-50 (cited in note 225) (citing Wex S. Malone, *Ruminations on Cause-In-Fact*, 9 Stan. L. Rev. 60 (1956)); H.L.A. Hart and A.M. Honore, *Causation in the Law* (Oxford, 1959); Richard A. Epstein, *A Theory of Strict Liability*, 2 J. Legal Stud. 151 (1973). For discussion of recent controversies concerning scientific evidence of causation, see Peter Bell, *Strict Scrutiny of Scientific Evidence*, Toxics L. Rep. (BNA) 1014 (Jan. 10, 1992).

227. To illustrate this threshold, consider the *Allen* case, in which mature epidemiological

and toxins do not have high attributable fractions. Thus, most fail to meet the more-probable-than-not standard,[228] and cannot lead to successful tort litigation, and hence deterrence.

The threshold 50-50 probability significantly reduces some administrative costs and may minimize some error costs.[229] However, such a threshold weakens the deterrence signal, especially in the area of environmental tort litigation, and thus the threshold should be abandoned. To correct the flaw in deterrence induced by a more-probable-than-not standard, economists and others have advocated imposing liability in proportion to the probability of causation.[230] In an environmental case for instance, the polluter could compensate each person according to the probability of causation, or the attributable fraction of disease. This represents a move away from traditional theories of causation that emphasize a single injured individual and a single causally-linked responsible party; its use has prompted a spirited debate about justice in tort law.[231] Some critics fear that the statistics upon which probability of

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evidence indicated that exposure to radiation caused a certain percentage or proportion of all of particular kinds of cancers. *Allen v. United States*, 588 F. Supp. 247 (D. Utah 1984), rev'd, 816 F.2d 1417 (10th Cir. 1987). An example using a simplified form of that data would proceed as follows: Suppose that in the southern half of the state of Utah, one would expect to see 100 cases of leukemia over a five-year period. Now, since the residents have been exposed to radiation, they experience a 50% increase in their risk of developing leukemia. Therefore, instead of 100 cases of leukemia, one would find 150 cases. This means that 50 out of the 150 cases of leukemia are attributable to radiation exposure. The fraction of leukemia mortality attributable to the radiation exposure is 33% (50/150). But since only one-third of individuals have leukemia as a result of exposure, no one can meet the more-probable-than-not standard of causation. See generally Troyen A. Brennan and Robert F. Carter, *Legal and Scientific Probability of Causation of Cancer and Other Environmental Disease in Individuals,* 10 J. Health Politics, Pol. & L. 33 (1985).

Now if the exposure to radiation had caused a tripling of leukemia risk, the exposed group would develop 300 cases of cancer. This means that 200 out of 300, or 66%, of the cases of cancer would be attributable to exposure. For any one individual in this situation, it is more probable than not that leukemia resulted from the exposure (66% being greater than 51%).

228. For another discussion of this problem, see Makdisi, 67 N.C. L. Rev. at 1070-71 (cited in note 225).

229. Steven Shavell suggests that administrative costs will increase if one moves away from the threshold standard, largely because of an increase in number of suits filed. See Shavell, 28 J. L. & Econ. at 604 (cited in note 224). The deterrent effect hopefully would offset these administrative costs.

230. See, for example, Steven Shavell, *Economic Analysis of Accident Law* 116-17 (Harvard, 1987).

231. See Richard A. Epstein, *Causation—In Context: An Afterword,* 63 Chi. Kent L. Rev. 653 (1987). Epstein's discussion of Coase provides an excellent reflection on Epstein's view of causation and tort law. Id. at 665-66. Therein, Epstein must posit that the troubling nature of the Coase theorem is that it treats high-handedly tbe "traditional law/property rights" that are central to Epstein's world view. As Richard Wright notes perspicaciously, Epstein confuses the notions of cause with those of individual responsibility and legal right. See Richard W. Wright, *Causation, Responsibility, Risk, Probability, Naked Statistics, and Proof: Pruning the Bramble Bush by Clarifying the Concepts,* 73 Iowa L. Rev. 1001, 1004-05 (1988). See also Makdisi, 67 N.C. L. Rev. at 1073 (cited in note 225). Probability of causation is said to link injury more tightly to payment

causation is based entail error that somehow diminishes justice.[232] To a large extent, however, these concerns center on what Richard Wright has helpfully termed "naked statistics" and not on the evidence underlying probabilistic causation.[233]

Nonetheless, if carried to an extreme, use of probability of causation would challenge our fundamental assumptions about evidence and tort causation. For example, courts could consider every individual with lung cancer a member of a potential group of plaintiffs who could sue all the producers of particulate-matter air pollution. A small attributable fraction of all lung cancers could be attributable to this type of air pollution, perhaps less than one percent. If consolidation of such a large class were possible, the case would be viable for plaintiffs and their attorneys. Indeed, courts potentially could conceptualize many sorts of injuries as such mass torts, undermining common-law doctrine in a worrisome manner.[234] Perhaps in light of this, some keen observers of tort litigation have recommended limiting proportionate probabilistic causation.[235] A threshold eliminates a good deal of the concern about the administrative costs associated with full use of probability of causation,

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in that it leads to compensation based directly on the harm caused by a defendant. Perhaps more importantly in the area of environmental tort litigation, probability of causation brings about the corrective justice that otherwise would not occur given the more-probable-than-not threshold. Probability of causation firmly ties the defendant to a penalty that is equivalent to his tortious conduct. See also Christopher H. Schroeder, *Corrective Justice and Liability for Increasing Risks*, 37 U.C.L.A. L. Rev. 439 (1990) (advocating corrective justice as a rationale for risk-hased liability).

232. See, for example, Daniel Shaviro, *Statistical-Probability Evidence and the Appearance of Justice*, 103 Harv. L. Rev. 530 (1989).

233. Thus, many of the debates ahout the evidentiary value of statistics entail paradigms regarding hlue buses and drivers of convertibles. See, for example, D.H. Kaye, *Apples and Oranges: Confidence Coefficients and the Burden of Persuasion*, 73 Cornell L. Rev. 54, (1987); Neil B. Cohen, *Conceptualizing Proof and Calculating Probabilities: A Response to Professor Kaye*, 73 Cornell L. Rev. 78 (1987). I have argued that these issues tend not to bear on probability of causation in epidemiology in that the latter contains no possibility of a gold-standard (eye-witness) evaluation of what actually occurred: probabilistic evidence is all that is or could be availahle. See Brennan, 73 Cornell L. Rev. at 482 (cited in note 34).

234. See generally Laurence H. Tribe, *Trial by Mathematics: Precision and Ritual in the Legal Process*, 84 Harv. L. Rev. 1329 (1971); Charles Nesson, *The Evidence or the Event? On Judicial Proof and the Acceptability of Verdicts*, 98 Harv. L. Rev. 1357 (1985).

235. For instance, Daniel Farber would limit probability of causation to those situations in which the court could point to a most likely victim. See Farber, 71 Minn. L. Rev. at 1221 (cited in note 225). The ALI's Reporters' Study advocates use of full compensation when the attrihutable fraction is greater than 80%. See II *Reporters' Study* at 344-47 (cited in note 7). This sort of symmetry provides a greater sense of justice.

The Presidential Commission on Catastrophic Nuclear Accidents takes a somewhat similar approach. See Presidential Commission on Catastrophic Nuclear Accidents, Report to the Congress, Vol. 1, 107-08 (1990). The Commission recommended paying full compensation for any cancer where the probability of causation exceeds 50% and a declining proportion to a probability of causation equal to 20%. This generous, if asymmetric, approach conforms to the common-law standard on one end, but gives plaintiffs who fail to meet the threshold a break down to the 20% threshold. Id. at 108.

yet allows suit by many who are exposed to environmental hazards, but who would today fail to reach the more-probable-than-not threshold.

When modified by use of a threshold, probabilistic causation seems especially helpful in the paradigm of a singular, concentrated risk envelope. The exposed population will be subject to a single epidemiological study, which will produce the sort of data needed to calculate attributable fractions. The product will be rational compensation, and perhaps more importantly, equitable and efficient deterrence. Probabilistic causation therefore has a great deal of normative appeal. It integrates statistical evidence, does away with the more-probable-than-not barrier, and prompts more litigation that can produce potentially rational deterrence.

While widely advocated, courts have only slowly adopted probabilistic causation.[236] Several major settlements were based on probabilistic notions of causation,[237] however, and insurance companies have begun to consider it as a remedy in environmental suits.[238] The prospect of probabilistic causation must, therefore, be inducing litigation. As such, it is likely to become a major part of the positive theory of litigation.

2. Use of Medical Monitoring

The foregoing discussion of probability of causation normatively proposed compensation based on attributable fractions in hazardous substances cases in which there is mature epidemiological evidence. While controversial, it is much less so than other proposals for using probability of causation in tort law. Many have advocated compensa-

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236. Both Judge Jenkins in the *Allen* case and Judge Weinstein in the *Agent Orange* litigation endorsed probabilistic causation. *Allen*, 588 F. Supp. at 358-70; *Agent Orange*, 597 F. Supp. at 787-90. But few courts have ordered it as the basis for a remedy. Arizona courts have accepted epidemiological evidence in cases involving the deaths of uranium miners from lung cancer. See, for example, *State Compensation Fund v. Joe*, 543 P.2d 790 (Ariz. Ct. App. 1975). Probabilistic evidence of causation appears to provide enough basis to force a trial on the merits, even if the court does not ultimately grant a remedy. In *Werlein v. United States*, 746 F. Supp. 887 (D. Minn. 1990), the court ruled that expert testimony that TCE is a human carcinogen and is harmful to humans at the dosage levels ingested by the plaintiffs created a disputed factual issue sufficient to withstand a motion for summary judgment. In accord, see *Backes v. Valspar Corp.*, 783 F.2d 77, 80 (7th Cir. 1986) (holding that evidence that children experienced an unusual concentration of ailments while drinking water from wells that might have been contaminated with phenols was sufficient to withstand a motion for summary judgment because there was "some grounding for a belief that the children's symptoms . . . were due at least in part to wastes dumped by [defendant]"). The *Backes* court stated that a plaintiff in a toxic tort suit cannot prevail without showing a reasonable certainty that the defendant was the cause of his ailments, but noted that "a *reasonable* certainty is not a certainty; it is a probability." Id. at 80. See generally Brennan, 73 Cornell L. Rev. at 471-78 (cited in note 34).

237. See note 254.

238. Personal communication with Dennis Connolly, Johnson and Higgins (July 31, 1992).

tion for damages as a result of exposure to risk.[239] Emphasizing the ex ante perspective, the liability-for-risk thesis is that the defendant should compensate an exposed population based on the probability that some members will develop disease or injury. This approach places greater confidence in our ability to predict risks than current scientific information would suggest is reasonable.[240] In many hazardous substance cases, we cannot predict outcomes well. Only after society incurs mass injuries and scientists study exposed populations for a long period of time does it become clear that a certain fraction of diseases was caused by the exposure.[241]

The alternative to such monitoring, as described in the previous section, is ex post compensation of a population after injuries have occurred.[242] In most cases, this will require study of exposed people for a

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239. See, for example, Landes and Posner, *Economic Structure of Tort Law* at 257-69 (cited in note 216); R. Cooter and T. Ulen, *Law and Economics* at 418-21 (1988); Glen O. Robinson, *Multiple Causation in Tort Law: Reflections on the DES Cases*, 68 Va. L. Rev. 713 (1982); Rosenberg, 97 Harv. L. Rev. 849 (cited in note 225).

240. See sources cited in note 55.

241. See id. at 48. Consider for example, asbestos exposure. We can now predict with some accuracy the attributable fractions associated with exposure to high levels of asbestos. However, we can only mathematically model risks of those exposed to lower exposures, such as those that occur in schools, and controversy surrounds these risk calculations. See Dean H. Hasbimoto, et al., *Should Asbestos in Buildings Be Regulated on an Environmental or Occupational Basis?* in Phillip J. Landrigan, Homayun Kazemi, eds., *The Third Wave of Asbestos Disease* 609, 610-11 (N.Y. Acad. of Sciences, 1991). On the tort side, treating risk calculations as having great merit would be peculiar when we know, on the regulatory side, that the lack of confidence in risk assessments drives so much regulatory failure in the environmental area.

242. The selection of an ex ante risk compensation as opposed to an ex post probabilistic causation standard depends on its corrective justice and efficiency benefits. Regarding corrective justice, Glen Robinson, for example, argues, with reference to Kant, that "the morality character of a particular action is fixed by the circumstances at the time the action is taken and not by subsequent events." Robinson, 68 Va. L. Rev. at 789 (cited in note 239). Thus, from a common-sense, moral point of view, the creation of risk, not some ex post calculations, should be paramount. For a longer discussion of these issues, see Schroeder, 37 U.C.L.A. L. Rev. 439 (cited in note 231). Compare Kenneth W. Simons, *Corrective Justice and Liability for Risk-Creation: A Comment*, 38 UCLA L. Rev. 113 (1990). Even a property-rights-based analysis of corrective justice can find justice in ex ante compensation so long as courts consider the generation of risk as constituting a wrongful invasion of a person's rights. See Alan Schwartz, *Causation in Private Tort Law: A Comment on Kelman*, 63 Chi.-Kent L. Rev. 639, 646 (1987).

On the other hand, an ex post probabilistic causation standard that uses strict liability with a limited defense based on state of knowledge captures much the same sense of morality. Again the court holds the defendant liable for damages occurring as a result of risk creating behavior. Moreover, if we limit the knowledge defense in environmental tort cases, this standards retains the justice of judging a person's action based on their knowledge of the time of action.

Regarding efficiency, both approaches deal with the significant problem of underdeterrence. However, compensation based on risk can subsequently provoke both under- and overdeterrence in that risk calculations can be quite inaccurate, sometimes overestimating, sometimes underestimating risks. While these differences may be stochastic and eventually wash out, it nonetheless creates a good deal of unpredictability and frustrates efforts to develop reasonable insurance mechanisms. In addition, the ex ante approach appears to provoke significant moral hazard. See

period of time slightly longer than the expected latency period, so that scientists can calculate true attributable fractions. For instance, defendants would not compensate a group exposed to benzene and other solvents in drinking water as a result of leakage from a hazardous waste site at the time of exposure. Instead, the court, perhaps by enlisting private contractors, would evaluate the group on an ongoing basis. As diseases associated with the exposure began to occur in a statistically excess fashion, attributable fraction concepts could provide the basis for compensation and liability.[243]

Some would argue that this kind of ex post compensation is "a not-very-satisfactory alternative."[244] They reason that there may be too little incentive to induce plaintiffs to bring suits, leading to underdeterrence, and that this kind of ex post compensation is so contrary to traditional tort law principles "that it could not be adopted without a profound revolution" in tort law.[245] With regard to the latter point, the questions of what constitutes a greater revolution in tort law is debatable. Those who would compensate ex ante find that liability compensation based on risk is not extraordinary. One can only conclude, however, that their thinking on this manner likely is based on the mistaken assumption that for most sorts of environmental exposure, ex ante risk calculations are possible.[246] In any situation involving a major environmental exposure, even at a singular, concentrated site, it will be difficult to predict the exact burden of disease caused by the exposure, in part because the exposures themselves are difficult to quantify. Nevertheless, a possibility remains that diseases which do not manifest themselves immediately will eventually occur. A suit that is initiated just after the exposure will lead to appropriate disposition for those injured acutely. However, a larger number of individuals may be at risk for developing disease over the next five to twenty years. Immediate tort liti-

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Schwartz, 14 J. Legal Stud. at 696 n.19 (cited in note 220).

243. Richard Wright, criticizing this approach, cites Papineau's observation that "partitioning into reference classes with associated probabilities merely identifies possibly applicable reference classes—causal generalizations." Wright, 73 Iowa L. Rev. at 1047 (cited in note 231) (citing D. Papineau, *For Science and the Social Sciences* 64-65 (1978)). Wright's contention can be taken in two ways. First, he might be saying that overspecification of logistic regression analysis can lead to false results. Most epidemiologists would accept this charge, but would also conduct specification tests on any epidemiological model and identify particular pertinent causes. The other charge that Wright might be making is that one needs some causal, necessary-sufficient condition reasoning before doing ex post causal analyses based on statistics. Indeed, if one integrates these features, Wright is quite happy with ex post probabilistic causation. Id. at 1053. Of course, all Wrigbt is saying is that any factors put into a regression model must be the result of some particularistic causal reasoning. Epidemiologists would also applaud this requirement.

244. Landes and Posner, *Economic Structure of Tort Law* at 265 (cited in note 216).

245. Id.

246. See note 240 and accompanying text.

gation relying on ex ante risk calculation cannot address these latent, unpredictable injuries.[247]

Ex post probabilistic causation is thus normatively attractive. Moreover, far from being revolutionary, it can be accomplished through existing tort law remedies entailing use of medical monitoring.[248] Compensation for monitoring through a system of periodic examinations for plaintiffs, recognizes that increased risk is a form of injury. However, it confines the award to costs that flow from the specific harm that has occurred, not from the harm that may occur in the future. Screening and close follow-up of the exposed population can lead to early diagnosis and treatment of potentially fatal diseases. Thus, both public health and fairness rationales support awarding such damages.

Some courts have balked at awarding medical monitoring damages. In *Jackson v. Johns-Manville Sales Corp.*,[249] the court ruled that evidence concerning increased risk of cancer was overly prejudicial. In an earlier case, *Rheingold v. E.R. Squibb and Sons*,[250] a New York court held that increased risk was not equivalent to physical injury and thus did not constitute compensable disease. Indeed, the latter ruling highlights a major problem courts have with surveillance as a form of damages. Generally, the plaintiff has no cause of action in tort unless he or she suffers an identifiable, compensable injury.[251] As William L. Prosser and W. Page Keeton have written, "Actual loss or damage resulting to the interests of another [is a necessary element of a negligence cause of action]. . . . The threat of future harm, not yet realized is not enough."[252] As a result, judges have hesitated to provide monitoring costs when plaintiffs have not yet suffered physical damage.

The reasonableness of surveillance damages has, however, slowly induced courts to skirt the physical injury requirement. For instance, in *Villari v. Terminix Int'l, Inc.*,[253] the court ruled that while physical damage in the form of disease was a necessary threshold for awarding medical surveillance damages, the plaintiffs need not demonstrate symptoms of the disease before surveillance could begin. Other courts

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247. Of course, we should not underestimate the amount of time necessary to reach final disposition of toxic tort cases. For instance, some cases arising out of the Love Canal incident, first investigated in 1978, are only now coming to trial. See *In re Love Canal Actions*, 547 N.Y.S.2d 174 (N.Y. Sup. Ct. 1989).

248. See Leslie S. Gara, *Medical Surveillance Damages: Using Common Sense and the Common Law to Mitigate the Dangers Posed by Environmental Hazards*, 12 Harv. Envtl. L. Rev. 265, 270-71 (1988).

249. 727 F.2d 506 (5th Cir. 1984).

250. No. 74 Civ. 3420, slip. op. at 10 (S.D.N.Y. Oct. 8, 1975).

251. See *Schweitzer v. Consolidated Rail Corp.*, 758 F.2d 936, 942 (3d Cir. 1985).

252. Keeton, et al., *Prosser and Keeton on the Law of Torts* at 165 (cited in note 212).

253. 663 F. Supp. 727 (E.D. Pa. 1987).

have been more straightforward, requiring only the potential for physical injury, not physical injury itself.[254] These courts recognize that some medical monitoring actually constitutes an epidemiological study designed to provide evidence of increased risk for disease.[255]

Given the normative basis of medical monitoring, several restraints on its use seem appropriate. First, courts should not use a medical monitoring fund to pay plaintiffs directly, so that they can, if they like, seek additional medical attention.[256] Direct payments to plaintiffs do not necessarily serve the overall purpose of medical monitoring: to diagnose and identify early illnesses for which an exposed population is at risk. For this reason, several courts have hesitated to award medical monitoring damages as a form of injunctive relief without assurance that such costs would not be more than the total payments to individual plaintiffs.[257]

Second, treating medical monitoring costs as compensable damages is *not* the equivalent of reimbursing individuals for fear of cancer, nor

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254. See *Habitants Against Landfill Toxicants v. City of New York*, 15 Envtl. L. Rep. (Envtl. L. Inst.) 20937 (N.Y. Sup. Ct. May 20, 1985); *Merry v. Westinghouse Elec. Corp.*, 684 F. Supp. 847 (M.D. Pa. 1988). Perhaps the leading case on this issue is *Ayers v. Township of Jackson*, 525 A.2d 287 (N.J. 1987). The New Jersey Supreme Court ruled that "the cost of medical surveillance is a compensable item of damages where the proofs demonstrate, through reliable expert testimony . . . the relative increase in the chance of onset of disease in those exposed, and the value of early diagnosis." Id. at 606. Medical monitoring thus provides some assurance to the exposed population that any latent diseases will be diagnosed promptly. For a review of recent cases, see Amy B. Blumenberg, Note, *Medical Monitoring Funds: The Periodic Payment of the Future Medical Surveillance Expenses in Toxic Exposure Litigation*, 43 Hastings L. J. 661 (1992).

255. For instance, in a Hawaii heptachlor mass exposure case, the court set up a medical monitoring fund to study the health impacts of exposure to heptachlor in cow's milk on the island of Oahu. See *In re Heptachlor Litig.*, Civ. Nos. 76335, 76338, Memorandum in Support of Motion for Approval of Disbursements (Mar. 31, 1988). The foundation created to administer the monitoring fund now contemplates several discrete studies. The most important of these will be a series of case control studies in which the researchers will compare blood levels of heptachlor in lactating mothers on Oahu with those of mothers from other states. The epidemiological studies will provide the basis for discerning whether the exposed population has increased levels of certain diseases. They also satisfy the early detection aspects of medical surveillance in that the researchers will publicize any risks uncovered.

Another theme for medical monitoring might be a modification of the settlement of the DDT exposure at Triana, Alabama. See McGovern, 53 L. & Contemp. Probs. at 65-70 (cited in note 156). At Triana, anyone with an elevated level of DDT could receive some compensation. Additionally, anyone with a high level of DDT and one of several listed ailments, including cancer, reproductive problems, high blood pressure, and increased cholesterol, could receive additional compensation. Presumably, part of the fund could have been set aside to pay for a case-control study of those individuals with higher levels of DDT, allowing monitors to identify excess disease in the exposed population.

256. This relief was offered in *Ayers*. See 525 A.2d at 607-10.

257. See, for example, *Werlein v. United States*, 746 F. Supp. 887, 895 (D. Minn. 1990). This case, like several others, centers on Superfund-based medical monitoring claims. See note 175. Courts have denied these remedies under Superfund largely because they assume the remedies are available under state common law.

for the pain and suffering associated with increased risk—so-called "cancerphobia."[258] While some courts have appeared willing to reimburse individuals for the pain, discomfort, fear, anxiety, annoyance, and emotional distress suffered as a result of exposure to potentially hazardous vapors,[259] this type of reimbursement is highly variable and introduces a great deal of uncertainty into hazardous substance litigation. It contrasts sharply with medical monitoring damages: the court must base such damages on expert testimony, including perhaps input from court-appointed experts or science panels regarding the presence of a substantially increased risk of disease.[260]

Third, there must be some scintilla of evidence of toxic injury, or a significant potential for such injury, before medical monitoring remedies can be granted. Many scholars are concerned that widespread use of medical monitoring could lead to a tidal wave of new cases because any group of individuals exposed to any chemical could request specific, periodic tests.[261] Perhaps monitoring should be limited to situations in which a large number of people have been exposed to significant concentrations of one of the fifty most toxic chemicals as designated by the ATSDR, or to situations in which some symptoms of injury already can be demonstrated in the exposed population. Setting a threshold seems to be a tractable issue, and will be necessary to prevent the overdeterrence that would come with excessively broad use of medical monitoring damage awards.

Medical monitoring, then, provides a vehicle for ex post probabilistic causation and obviates the need for making the sort of uneducated guesses that must be a part of any ex ante compensation based on risk.[262] It checks compensation until, from an epidemiological point of

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258. See Paul A. Kidwell, Comment, *"Cancerphobia" and Increased Risk of Developing Cancer Due to Toxic Exposure: Will it Spread to Missouri?*, 53 Mo. L. Rev. 325, 346 (1988).

259. See *French v. Moore*, 661 P.2d 844 (Mont. 1983) (awarding $190,000 to couple for anxiety and emotional distress resulting from exposure to hydrocarbons). Whether the court's intention was to compensate for a present but subclinical injury, or was simply to use a pragmatic method for dealing with the latency period, is not clear in this kind of case.

260. A critical issue is the threshold risk necessary to bring about medical monitoring. Risks of greater than one in 1000 might be one option. Only at this level will a reasonably restricted exposed group evince excess disease.

261. Medical monitoring was this Article's most controversial recommendation when I presented a draft to ALI's General Meeting in May, 1991.

262. See Robinson, 68 Va. L. Rev. at 793 (cited in note 239). There are other alternatives for overcoming a latency period and yet avoiding ex ante compensation of risk. For instance, Frank Cross has recommended use of defendant-bought insurance policies for exposed individuals. Those people who eventually develop toxic-related disease can use these policies for health expenses and income replacement. See generally Frank B. Cross, *Environmentally Induced Cancer and the Law: Risks, Regulation and Victim Compensation* (Quorum, 1989). Whether actuaries would be able to write policies for such restricted populations with such uncertain risks is questionable. See Troyen A. Brennan, *Book Review*, 30 Jurimetrics J. 511, 515 (1990).

view, certain individuals have been injured demonstrably. Thus, those who have been exposed to risks but were not injured receive no compensation other than the on-going medical monitoring.[263]

Medical monitoring has other benefits as well. It keeps the defendants involved and forces them to seek ways to mitigate risk during the latency period, thus decreasing moral hazard. Medical monitoring also creates costs, hence deterrence signals, for producers who could otherwise, quite rationally in a market sense, discount to present values the cost of injuries that will occur after a latency period has run.[264] In summary, attributable fraction concepts of disease compensation on an ex post basis with medical monitoring from the time of exposure until the end of the latency period can ameliorate problems with causation in hazardous substance litigation.[265] This combination of doctrines, more than any other development, makes environmental tort litigation a real possibility.

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263. The defendant would likely have to set aside some set of resources in an escrow account as compensation for diseases should they occur. This begins to raise concerns about bankruptcy and efficiency. See Schwartz, 14 J. Legal Stud. at 705-06 (cited in note 220).

264. See Donald N. DeWees, *Economic Incentives for Controlling Industrial Disease: The Asbestos Case*, 15 J. Legal Stud. 289 (1986).

265. Any use of medical monitoring and ex post probabilistic causation for bazardous substance and injuries is dependent on mass litigation tecbniques in wbich the court consolidates the class of individuals. While most courts have viewed mass tort class actions with a jaundiced eye, see, for example, *In re Temple*, 851 F.2d 1269 (11th Cir. 1988); *Raye v. Medtronic Corp.*, 696 F. Supp. 1273 (D. Minn. 1988), a number of prominent environmental torts have proceeded as class actions, see, for example, *Allen v. United States*, 588 F. Supp. 247 (D. Utah 1984); *Sterling v. Velsicol Chem. Corp.*, 855 F. 2d 1188 (6th Cir. 1988); *In re Paoli*, 706 F. Supp. 358 (E.D. Pa. 1988); *Jenkins v. Raymark Indust., Inc.*, 109 F.R.D. 269 (E.D. Tex. 1985). See also Tomas D. Rowe and Kenneth D. Sibley, *Beyond Diversity: Federal Multiparty, Multiforum Jurisdiction*, 135 U. Pa. L. Rev. 7 (1986); David Rosenberg, *Class Actions for Mass Torts: Doing Individuals Justice by Collective Means*, 62 Ind. L. J. 561 (1987). Moreover, bankruptcy court provides a mandatory class action witb strong management by court-appointed trustees. See, for example, *In re A.H. Robins Co., Inc.*, 88 Bankr. 742 (E.D. Va. 1988).

On balance, there is reason to believe that current federal procedure will allow the kinds of class actions necessary to bring successful environmental tort litigation, especially around sites of concentrated singular toxic pollution. See Francis E. McGovern, *Resolving Mature Mass Tort Litigation*, 69 B.U. L. Rev. 659, 670 (1989). Moreover, both the ALI, see ALI, *Complex Litigation Project: Tentative Draft No. 2* (April 6, 1990), and the American Bar Association (ABA), see ABA Commission on Mass Torts, *Revised Final Report and Recommendations* at i-iii (1989), have recommended expanding the use of class certification in collective litigation of mass torts. The details of these proposals go beyond the scope of this Article. It suffices to say that in various parts, the ALI and tbe ABA are in favor of mandatory class actions with some removal to federal courts, and with strong sanctions and penalties, including compelled joinder to discourage class memhers from opting out.

These innovations likely would make environmental torts more attractive to entrepreneurial lawyers, although one would not expect for them alone to create a new flood of unnecessary litigation. See, for example, Gillette and Krier, 138 U. Pa. L. Rev. at 1051 (cited in note 10). Gillette and Krier are also suspicious of risk assessment and ex ante risk in tort litigation. Id. at 1081.

VI. Conclusion

The purpose of this Article has been to explain environmental tort litigation and to ask whether it has social utility. The first task, the positive theory, was compelled by the observation that environmental tort litigation does occur, a phenomenon that was difficult to explain in light of existing theoretical literature that suggested it would be nearly impossible for plaintiffs to bring successful claims. If this were the case, then attorneys could not expect reasonable economic compensation from their efforts and we would expect to see little or no environmental tort litigation. Thus, the phenomenon of environmental tort litigation over exposure to toxic chemicals prompts the question: Why is it occurring?

The answer lies in a more sophisticated understanding of environmental injury and in a recognition of the evolution of certain tort doctrines. Most of the observers of environmental pollution tend to adhere to a singular notion of broadly dispersed pollution to which any one individual has a very low level exposure. Moreover, the pollution is seen as a melange of toxins from a variety of different point sources. While this is perhaps the most prevalent environmental pollution paradigm, it is not the only one. As I have suggested, especially in pollution paradigms that tend toward rather concentrated pollution from a singular source, potential litigants may be able to identify the pollution source as a cause of certain injuries. In these situations, attorneys may be able to aggregate claims sufficiently that they have a reasonable expectation of compensation for their clients and fees for themselves. This insight helps explain why we see environmental tort litigation, and why previous assessments of plaintiffs' probabilities of success have been too pessimistic.

Equally important, other analyses of environmental tort litigation have not recognized the changes now occurring in tort doctrine. Modifications of statutes of limitations have removed some access barriers to courts. Far more importantly, right-to-know statutes and regulatory initiatives like SARA have made information on specific sites accessible to potential litigants. As a result, the knowledge gap between litigants and producers of pollution has narrowed considerably. This greatly encourages litigation.

Liability standards also have accommodated environmental tort litigation. Broad use of strict liability does away with the need to prove negligence. Courts have not used regulatory compliance defenses in environmental cases to any extent. This means that liability standards are generally friendly to potential plaintiffs.

Finally, and most important, the combination of probabilistic causation with medical monitoring helps overcome the otherwise extraordi-

narily daunting problems associated with causation in hazardous substance litigation. Courts may order medical monitoring remedies, which, in combination with probabilistic causation, render settlements in these cases a real possibility. Therefore, the process and access barriers to environmental tort litigation do not look as sturdy as some have suggested. The positive theory of environmental tort litigation therefore appears rather complete.

The normative theory is anything but complete. As noted, we have extraordinarily little evidence upon which to base recommendations for or against tort litigation in general. This is especially true in the environmental area. While "back of the envelope" calculations about the economic signal faced by producers of toxic pollution compared to the amount of mortality produced by such pollutions suggests that comparatively little environmental tort litigation exists, this does not seem a satisfactory basis upon which to make major policy recommendations. On the other hand, from a public health perspective, we rarely have the luxury of complete evidence.

There are some reasons to encourage environmental tort litigation from a normative vantage point. Perhaps most important, an analysis of regulatory approaches to environmental toxins suggests that the administrative state has developed inadequate deterrence mechanisms. Incremental policies now in place appear to allow the persistence of exposure to toxic substances for discrete communities. This assessment may change, especially if Congress or the executive agencies prove less prone to capture. The evolution of regulation does, however, leave little room for optimism in this regard.

As such, environmental torts that are brought in particular environmental pollution paradigms, especially those where a singular source concentrates pollution over a discrete community, offer the prospect of rational deterrence. Changes in common-law doctrines that allow suits also appear to create the basis for more rational deterrence. Probabilistic causation and medical monitoring will permit the development of remedies that fit the injuries caused by pollution, creating rational deterrence. While the possibility remains that litigation may have no deterrent impact whatsoever, or may even have a negative impact by producing overdeterrence, an evenhanded evaluation of environmental tort doctrine suggests otherwise.

It is possible to imagine social experiments that would estimate and characterize the deterrence produced by environmental torts. For instance, certain states could adopt strict liability, outlaw regulatory compliance defenses, and insist on use of medical monitoring and probabilistic causation in environmental tort cases. Over time, one could assess enterprise levels, morbidity and mortality from toxic pollution, and

compensation for attributable injuries. These states could then compare their results to statistics from states without such reforms. Social experimentation on this grand scale seems, however, unlikely.[266]

For now, the incidence of environmental tort litigation is simply too low to support any empirical analysis. Instead we must rely on the kind of conjecture that has characterized the normative theory of environmental torts discussed here. This Article's tentative conclusion is that more litigation, incorporating some of the caveats noted above, is advisable from a deterrence point of view. Given the failure of regulation and the theoretical benefits of common-law litigation, any other course seems to sanction the status quo of morbidity and mortality from environmental pollution.

266. On the other hand, courts could apply this sort of research design to natural variations between states that courts have previously applied elsewhere. See Brennan, 36 S.L.U. L. J. at 827-33 (cited in note 13) (discussing difficulties of obtaining useful empirical evidence in tort law).