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Keum J. Park*

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JUDICIAL UTILIZATION OF SCIENTIFIC EVIDENCE IN COMPLEX ENVIRONMENTAL TORTS: REDEFINING LITIGATION DRIVEN RESEARCH

*Keum J. Park**

INTRODUCTION

Success in environmental tort cases frequently hinges upon highly sophisticated scientific and other technical evidence. With constant scientific innovation[1] in areas as diverse as bioremediation,[2] sediment chemistry,[3] thermography,[4] and gas chromatography,[5]

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* J.D. Candidate, 1996, Fordham University School of Law; B.S., 1993, Massachusetts Institute of Technology.

1. "Science advances so quickly nowadays. We can't just count scientific noses." Katherine Bishop, *Leaps of Science Create Quandaries on Evidence*, N.Y. TIMES, Apr. 6, 1990, at B6 (quoting Federal District Judge John McNaught of Boston).

2. Bioremediation is a technology of enhancing the biodegradation processes for the cleanup of oil spills. *See* H. P. Pritchard, Abstract, *EPA's Alaska Oil Spill Bioremediation Project*, 25 *Envtl. Sci. & Tech.* No. 3, at 372 (1991), *available in* WESTLAW, WR-ABS Database; R.Z. Hoff, Abstract, *Bioremediation: An Overview of Its Development and Use for Oil Spill Cleanup*, 26 MARINE POLLUTION BULL. No. 9, at 476 (1993), *available in* WESTLAW, WR-ABS Database.

3. "Sediment chemistry" was utilized to track the movement and biodegradation process of oil spilled into Prince William Sound by the Exxon Valdez. *See* D.K. Button, Abstract, *Interactions between Marine Bacteria and Dissolved-Phase and Beached Hydrocarbons after the Exxon Valdez Oil Spill*, 58 APPLIED AND ENVTL. MICROBIOLOGY No. 1, at 243 (1992), *available in* WESTLAW, WR-ABS Database.

4. Thermography is a new diagnostic technique which purports to objectively quantify pain and injury by measuring differentials in local skin temperature. *See* Andrew B. Lustigman, *A New Look at Thermography's Place in the Courtroom: A Reconciliation of the Conflicting Evidentiary Rules*, 40 AM. U. L. REV. 419 (1990).

5. Gas chromatography, a technique that separates compounds according to molecular weight, has been used to measure the exposure of marine organisms to petroleum. *See* M.M. Krahn et al., Abstract, *Comparison of High Performance

new techniques of diagnosing injury as well as natural resource damage have resulted in a myriad of scientific specialties.[6] For many years, courts have grappled with the problems surrounding the admissibility of expert testimony derived from newly ascertained or applied scientific theories.[7] When judges are presented with dense, technology-rich language of scientific evidence, they often require the help of scientists to cull the legal issues that the scientific evidence bears to light.[8] Since the technology is so far-removed from the generalist judge's own repertoire of knowledge, he may be more reluctant to issue speedy, pre-trial judicial action that may significantly curtail further environmental damage.[9] Further-

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Liquid Chromatography/Fluorescence Screening and Gas Chromatography/Mass Spectrometry Analysis for Aromatic Compounds in Sediments Sampled After the Exxon Valdez Oil Spill (1993), 26 ENVTL. SCI. & TECH. No. 4, at 699 (1993), *available in* WESTLAW, WR-ABS Database.

6. Steven P. McDonald & Jon K. Wactor, *Practicing in the Brave New World of Scientific Litigation Post Daubert v. Merrell Dow*, RECORDER, Oct. 5, 1994, at 10.

7. One example of novel scientific evidence used to prove general causation in *In re Exxon Valdez Litigation*, 767 F. Supp. 1509 (D. Alaska, 1991) involved chemical fingerprinting. Exxon utilized scientific evidence gathered in a 1990 study by the U.S. Geological Survey ("USGS") that the oil residues in sediments and beaches at Prince William Sound in Alaska did not have the chemical characteristics of the North Slope oil that Exxon's tanker had been carrying. Keith A. Kvenholden, the lead scientist of the study, stated that "residues from the Exxon Valdez and asphalt spills are readily distinguishable, because the asphalt originated from California oil, which has very different characteristics." Andrew Blum, *It Touts "Fingerprints": Exxon Tries New Tack on Spill*, NAT'L L.J., May 31, 1993, at 3; *see also* K.A. Kvenvolden, Abstract, *Hydrocarbons in Oil Residues on Beaches of Islands of Prince William Sound, Alaska*, 26 MARINE POLLUTION BULL. No. 1, at 24 (1993), *available in* WESTLAW, WR-ABS Database.

8. *See* Constance Holden, *Science in Court: Expert Testimony in Damage Suits Involving Toxic Substances*, 243 SCIENCE 1658, 1659 (1989); Bishop, *supra* note 1, at B6.

9. One commentator has observed that our nine hundred year old judicial system probably never anticipated lay jurors and a single generalist judge to be subject to scores of expert witnesses armed with new-fangled information far ouside the scope of day-to-day experiences. Clifton T. Hutchinson & Danny S. Ashby, Daubert v. Merrell Dow Pharmaceuticals, Inc.: *Redefining the Bases for Admissibility of Expert Scientific Testimony*, 15 CARDOZO L. REV. 1875, 1879 (1994). During the first-phase of the *Exxon* trial, which only considered the issue of liability, jurors listened to "18 witnesses from the defendant, Exxon, and 42

more, the particular subject matter may cause both judges and juries to "decide an issue by something other than the scientific force of the testimony."[10] In many of these types of cases, only the use of expert testimony enables a trier of fact begin to determine whether there is an injury, much less who is liable.[11] The cases are document intensive, involve a great deal of discovery, expert witnesses, and often a huge amount of technological data with their own concepts and language.[12]

For example, in the civil litigation over the Exxon Valdez oil spill of 1989, lawyers on either side amassed millions of pages of documents, interviewed hundreds of witnesses and spent months in technical libraries to master details about the life cycles of the damaged animal and plant species.[13] Rooms of scientific data and a cadre of scientists were used to prove that the oil spill caused a cascade of toxic effects to the natural environment of Prince William Sound, and resulted in direct losses to a vast array of inhabitants.[14] The plaintiffs were a diverse group of Alaska natives, commercial fishermen, fish processors and distributors, area businesses, state and local municipalities, and environmental groups.[15]

The extensive use of experts and cutting-edge scientific evidence in cases like the *Exxon Valdez* litigation has led tort reform advocates such as Peter Huber[16] of the Manhattan Institute to criticize

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from the plaintiffs side." Emily Barker, *The Exxon Trial: A Do-it-yourself Jury*, AM. LAWYER, Nov. 1994, at 68.

10. McDonald & Wactor, *supra* note 6, at 10. One study has even suggested that highly technical expert testimony is processed differently by the human brain than other types of information. *See* Nancy J. Brekke et al., *Of Juries and Court-Appointed Experts*, 15 LAW & HUM. BEHAV. 451, 455 n.1 (1991).

11. *Id.*

12. Keith Schneider, *An Exxon Verdict of $286.8 Million*, N.Y. TIMES, Aug. 12, 1994, at A1.

13. *Id.*

14. Barker, *supra* note 9, at 68.

15. Thomas R. Kline et al., *Energy Resources Law: Environmental Constraints on Energy Development*, 25 TORT & INS. L.J. 270, 277 (1990); *see* Stewart Yerton, *A Look Back at Big Suits*, AMER. LAWYER, Mar. 1994, at 112.

16. *See* PETER W. HUBER, GALILEO'S REVENGE: JUNK SCIENCE IN THE COURTROOM (1991). This book has sparked a debate among legal scholars about the nature and extent of the abuse of science in litigation. *See, e.g.*, Paul C. Giannelli, *Junk Science: The Criminal Cases*, 84 J. CRIM. L. 105, 107 (1993);

the structure of the modern tort system.[17] Huber attacks the laxity of evidentiary rules which encourages a supposedly staggering volume of quack scientific testimony not much better than that used in the Salem witch trials.[18] The reason why almost every environmental tort case involves the use of a large amount of scientific evidence is that proving causal relationships is extremely difficult.[19] The difficulty is aggravated when the forces causing harm "do not produce a signature disease," and there exists "no generally accepted biological theory about how these substances produce their alleged effect," and there is only a "weak correlation between the substance or force and the injury."[20] Further, many claimants do not prevail in litigation because they fail to meet the stiff "preponderance" standard that our tort system requires.[21] Also, in environ-

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Jeff L. Lewin, Book Review, *Calabresi's Revenge? Junk Science in the Work of Peter Huber*, 21 HOFSTRA L. REV. 183 (1992); Virginia E. Nolan & Edmund Ursin, *Galileo's Revenge: Junk Science in the Courtroom*, 254 SCIENCE 1663, 1664 (1991)(book review).

17. The issue of junk science entered into the political arena as well. Under the direction of former Vice President Dan Quayle, the President's Council on Competitiveness formed a Civil Justice Reform Task Force to investigate and root out junk science excesses in the courtroom. Giannelli, *supra* note 16, at 109.

18. HUBER, *supra* note 16, at 3.

19. Valerie Mike, *Understanding Uncertainties in Medical Evidence: Professional and Public Responsibilities, in* ACCEPTABLE EVIDENCE: SCIENCE AND VALUES IN RISK MANAGEMENT 115, 118 (Deborah G. Mayo & Rachelle D. Hollander eds., 1991) [hereinafter ACCEPTABLE EVIDENCE]. Proof of causation consists of two parts: general causation and specific harm. General causation analyzes whether exposure to a substance causes harm to anyone. Specific causation asks whether exposure to a substance caused a particular plaintiff's injury. Both general and specific causation must be shown in order to successfully pass the preponderance of the evidence test. Merely demonstrating that something resulted in the plaintiff's injuries is insufficient, and the plaintiff must be able to show a direct causal link between the defendant's act and the plaintiff's injuries. Joseph Sanders, *From Science to Evidence: The Testimony on Causation in the Bendectin Cases*, 46 STAN. L. REV. 1, 14 (1993).

20. Sanders, *supra* note 19, at 14.

21. Lewin, *supra* note 16, at 201 n.75. The burden of proof required to demonstrate causation is one of preponderance of the evidence, and courts have generally attached the requirement that the causal link have a "degree of certainty exceeding fifty percent." The law does not accept a causal link that has a less than fifty percent certitude. The standard, however, is considered by most to impose an "all or nothing burden upon the plaintiff." Joseph P. Salvo, *Emerging*

mental litigation, novel and quickly developing scientific techniques or theories oftentimes are the only evidence available.[22]

One of the problems that complex environmental torts poses to generalist courts is that the judges are reluctant to impose court orders or injunctions that may impede the scientific investigation process.[23] It is crucial for judges to understand the science methodology that is the crux of the case before a proper legal judgment can be made.[24] However, there is no one to guide the trial judge at the interface between science and the law.[25] Apart from hindering the trial judge's ability to take proactive measure in equity, the esoteric nature of expert testimony may prevent judges from effectively reviewing the material during pretrial hearings, and performing a screening function.[26]

Views of Probablistic Evidence and Causation in Toxic Tort Actions, 8 N.Y. ST. B.A. ENVTL. L.J. No. 4, Dec. 1985, at 15, 18. While a determination that "thirty percent of a given incidence of a disease can be ascribed to a particular causal agent is no less valid than a determination that fifty-one percent of the given incidence of the disease was caused by the same agent," the law rejects the causal link in the former scenario. *Id.*; *see* Lewin, *supra* note 16, at 201 n.75 (citing E. Donald Elliott, *The Future of Toxic Torts: Of Chemophobia, Risk as a Compensable Injury and Hybrid Compensation Systems*, 25 HOUS. L. REV. 781, 786 (1988)("[T]he unreasonably demanding standard of traditional tort law virtually compels plaintiffs' lawyers to use experts who will distort the available scientific evidence.").

22. Much of the science relevant to environmental law are innovative and ground-breaking and by virtue of their newness, lack a wide-based acceptance in the scientific community at large. Its newness renders it unsuitable for validation by judicial notice. Novel evidence embodies three components: (1) a source, meaning the mechanism, instrument, device, or theory; (2) a conduit such as an expert who interprets the source; and (3) the data or results made accessible through or evaluated by the source. Steven M. Egesdal, Note, *The Frye Doctrine and Relevancy Approach Controversy: An Empirical Evaluation*, 74 GEO. L.J. 1769, 1769 (1986).

23. *See* Richard L. Marcus, *Discovery Along the Litigation/Science Interface*, 57 BROOK. L. REV. 381, 394 (1991)(stating that judges deciding toxic tort cases often "worry that the limitations protective orders place on dissemination of information scientists receive through discovery may conflict with the ordinary presumption of openness in scientific research").

24. *See* Bishop, *supra* note 1, at B6.

25. *Id.*

26. Hutchinson & Ashby, *supra* note 9, at 1889 n.81.

To guide them in deciding whether expert testimony should be admitted, federal courts have looked to the "general acceptability" of an opinion in the scientific field of inquiry as the key basis for admissibility of such evidence at trial.[27] This standard presented a difficult hurdle for plaintiffs in environmental litigation, where novel and quickly developing scientific techniques or theories are frequently the only available evidence.[28] The common-law rule, first articulated in *Frye v. United States*[29] was followed by a majority of federal courts, but was noticeably absent from the Federal Rules of Evidence when the Rules were codified in 1975.[30]

Three years ago, in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*,[31] the United States Supreme Court explicitly displaced the *Frye* standard, declaring that "general acceptability" is no longer a precondition to placing scientific evidence before a jury.[32] Rather,

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27. *See* Frye v. United States, 293 F. 1013, 1014 (D.C. Cir. 1923).

28. Egesdal, *supra* note 22, at 1769.

29. *Frye*, 293 F. at 1014.

> Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs.

Id.; McDonald & Wactor, *supra* note 6, at 10.

30. Lewin, *supra* note 16, at 186 n.18; *see* FED. R. EVID. 702, 703.

31. 113 S. Ct. 2786 (1993).

32. Id. at 2793-2794, 2799. One commentator has written that many of the ills of "modern liability science" in the courtroom was readily remedied by ensuring that scientific evidence was "'generally accepted' by other scientists." HUBER, *supra* note 16, at 202.

> A sophisticated, modern application of *Frye* looks to the methods behind a scientific report, not to its finely detailed conclusions. An epidemiological study will easily survive *Frye* even if it is the very first to report, for example, a link between Bendectin and birth defects, so long as standard protocols for conducting such studies have been observed and the data are reported with error bands, significance tests, and similar statements of caution suitable for a refereed professional journal. What should not survive, however, is a crude imitation of science, the unpublished hunch, the letter to the editor, the impres-

the court stated that a "flexible" test, consistent with the "liberal thrust" of the Federal Rules of Evidence was the more proper approach to use in assessing expert scientific testimony.[33] The Court stressed the importance of trial judges in continuing their roles as "gate-keep[ers]" to limit jury confusion and speculation,[34] yet also recognized that its new approach, though flexible, could have the unwanted effect of preventing the jury from "learning of authentic insights and innovations."[35] More importantly, the Court conceded that its decision was a compromise and that it could not reconcile the problems that arise at the interface between legal and scientific inquiry.[36]

Nowhere is the interdependent, yet fractious relationship between science and the law more evident than in the environmental tort litigation arena.[37] There is a growing concern in the scientific community that environmental toxic tort cases present special problems and challenges to traditional modes of scientific inquiry.[38] Large environmental disasters such as the Exxon Valdez spill provide a fertile ground of data and financial resources for innovative research at an accelerated and intensified rate.[39] Novel science en-

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> sionistic "mosaic theory," in which the lawyer's science of harmonious coupling substitutes for systematic observation and analysis.

Id. at 200.

33. *Daubert*, 113 S. Ct. at 2794. *Daubert* provided the following general description of the trial court judge's role:

> Faced with a proffer of expert scientific testimony, then, the trial judge must determine at the outset, pursuant to Rule 104(a), whether the expert is proposing to testify to (1) scientific knowledge that (2) will assist the trier of fact to understand or determine a fact in issue. This entails a preliminary assessment of whether the reasoning or methodology underlying the testimony is scientifically valid and of whether that reasoning or methodology properly can be applied to the facts in issue.

Id. at 2796.

34. *Id.* at 2797-99.

35. *Id. See also* Hutchinson & Ashby, *supra* note 9, at 1883.

36. *Daubert*, 113 S. Ct. at 2799.

37. Hutchinson & Ashby, *supra* note 9, at 1877 n.20 (1994).

38. *Id.* at 1877-78.

39. *See* Timothy Egan, *Lawsuits Snarl Study of Imperiled Alaskan Eagles*, N.Y. TIMES, Sept. 19, 1989, at C1 ("[a]s much as they lament the spill, biologists say the chance to study the effects of oil's toxic chemicals on the food chain

ables more plaintiffs to litigate, which in return provides incentive for further scientific discovery.[40] At the same time, however, successful litigation by both parties requires strict controls over the disclosure of all evidence gathered by researchers, and an adherence to discovery protocols.[41] The result is that crucial scientific research which provides valuable information about environmental damage becomes unavailable for immediate application to short-term and pre-litigation cleanup efforts.[42]

This paper analyzes the role of litigation-driven science in environmental tort litigation. Part I introduces the modes of scientific inquiry and discusses evidence at the interface between science and legal practice, such as environmental litigation. Part II examines the standards articulated in *Daubert* and analyzes the Supreme Court's

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represents a potential scientific bonanza."); Alane Fitzgerald, *Valdez Litigation Will Shape Future Environmental Law*, OFFSHORE, May 1991, at 81.

40. *Id.*

41. *See* Michael Parrish, *Secret Studies Put Spill Damage at $15 Billion*, L.A. TIMES, Oct. 8, 1991, at A1; Lisa Busch, *Science under Wraps in Prince William Sound*, SCIENCE, May 10, 1991, at 772.

42. Lisa Busch, *Science under Wraps in Prince William Sound*, 252 SCIENCE 772, 772 (1991). Delays in receiving information needed for immediate cleanup in the Exxon Valdez spill forced one governmental agency to proceed without it. *Id.* ("While waiting for results from field tests conducted in Alaska and at other spills, the National Oceanic and Atmospheric Administration took a cautious approach that supported the use of bioremediation, and monitored its effectiveness to rule out potential detrimental impacts to the marine environment.").

In many instances, research is a long-term endeavor, and litigation, though it may be long-term demands short-term analysis, and early judgment and valuation of scientific factual matter. John Cushman, *Legal Ripples of Spill are Said to Distort Big Picture of Damage*, N.Y. TIMES, May 1, 1990, at C4 ("Because the litigants need data on damages quickly as the cases move to trial, short-term research is being emphasized over more complex long-term studies. Most studies emphasize looking at a single species rather than the entire biological system, and the work is concentrating on relatively few species, mostly those with direct commercial value. This undermines attempts to reach broad conclusions about the environmental consequences of the spill."). Policymakers and courts, in their need for quick answers, may treat "tentative scientific judgments . . . as definitive conclusions and the qualifications intended by scientists may be lost." Sheila Jasanoff & Dorothy Nelkin, *Science, Technology, and the Limits of Judicial Competence*, *in*, SCIENCE AND LAW: AN ESSENTIAL ALLIANCE 15, 31 (William A. Thomas, ed., 1983).

recognition of the conflict that exists in the legal adjudication based on scientific proof. Part III discusses the methodology currently used by the legal system in handling scientific evidence in environmental toxic tort litigation, and critically evaluates assumptions that it has made about the utility of scientific evidence in the courtroom. This paper concludes by recommending a fundamental rethinking of the role of science in the adjudication of complex environmental cases.

I. THE USE OF SCIENCE IN ENVIRONMENTAL LAW

The role of scientific studies and analysis in federal agencies has steadily increased over the last decade. The United States Environmental Protection Agency, for instance, routinely utilizes animal data and extrapolates them to human beings for purposes of risk assessment.[43] Many federal statutes mandate federal agencies to study the risks before initiating regulatory programs designed to achieve a prescribed margin of safety.[44] While risk assessment information is usually gathered for regulatory purposes, private civil litigants will often attempt to offer quantitative risk assessment as evidence during trial.[45] The use of scientific evidence is crucial for a party to successfully litigate an environmental tort.[46] For exam-

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43. *See Guidelines for Carcinogen Risk Assessment*, 51 Fed. Reg. 33,992, 33,994, 33,999-34,401 (1986).

44. Anthony J. Thompson & Donald C. Baur, *Improved Scientific Capabilities and the Management of Environmental Risk*, Toxics L. Rep. (BNA) 1532, 1532 (May 3, 1989) (citing NATIONAL RESEARCH COUNCIL, RISK ASSESSMENT IN THE FEDERAL GOVERNMENT: MANAGING THE PROCESS, 18-19 (1983)). Risk assessment provisions are a part of several federal environmental statutes, including: (1) Toxic Substances Control Act, 15 U.S.C. § 2601(b)(2) (1994); (2) Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. § 9604 (1994). *See* 40 C.F.R. pt. 300 (1995); (3) Resource Conservation and Recovery Act, 42 U.S.C. § 6939a(b)(2) (1994); (4) Clean Water Act, 33 U.S.C. § 1314(a)(7) (1994); (5) Federal Insecticide, Fungicide, and Rodenticide Act, 7 U.S.C. § 136a(c)(5)(c) (1994).

45. *See* Vern R. Walker, *Keeping a Risk Assessment Out of Evidence*, Toxics L. Rep. (BNA) 1501 (Apr. 26, 1989); W. John Moore, *Judge Defends Courtroom as Tort Forum*, LEGAL TIMES, Mar. 25, 1985, at 2 (reporting that "information generated by the government . . . either in litigation or as part of its record-keeping activities . . . is the key component in determining whether a plaintiff has a case").

46. The *Daubert* decision, while it will affect the admissibility of scientific

ple, proving causation of incurrence of response costs under the Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA"),[47] is frequently determinable only by reference to scientific opinion.[48] In hazardous waste cleanups under the CERCLA, the "[e]xpert's opinion as to fate and transport of chemicals in the soil and groundwater may be the sole means of interpreting evidence at trial, and the use of medical and toxicological experts the principle means of attempting to bring rationality to the issue of 'how clean is clean.'"[49] The Superfund cleanups usually take place years after dumping activites have occurred, and scientific tests and analysis play an integral role in the evaluation of site conditions.[50]

Another significant use of scientific evidence is for natural resource damage assessment under section 1006(e) of the Oil Pollution Liability and Compensation Act of 1990 ("OPA").[51] Under federal law, state and federal governments have statutory power to recover for injury to natural resources and require the defendant to restore all damaged natural resources to their condition before the spill, or to acquire comparable resources as a replacement for what was ruined.[52] As a result of the Exxon Valdez oil spill, Congress

evidence under RCRA and CERCLA, may not apply to other kinds of environmental cases. For instance, in Sierra Club v. Marita, 46 F.3d 606 (1995), the Seventh Circuit declared that *Daubert*'s test for admissibility of scientific expert testimony does not apply to an agency's scientific decisions. *Id.* at 622. In *Marita*, the Sierra Club sued the United States government, asserting that the U.S. Forest Service failed in its responsibility under the National Environmental Policy Act, 42 U.S.C. § 4321 (1994), to utilize "high quality" science in preparing environmental impact statements. *Id.* at 621. The issue in the case was whether government decision-makers received the benefit of a complete range of scientific information so that they adequately understand the consequences of uncertainty. *Id. See Supreme Court Decision Could Affect Evidence Allowed into Environmental Cases*, 17 Chem. Reg. Rep. (BNA) No. 4 101 (Apr. 23, 1993) (reporting that *Daubert* "may impinge on government standards when agencies shift from rule-making to enforcement. . . . In rule-making, courts generally defer to Environmental Protection Agency expertise when dealing with scientific ambiguities").

47. 42 U.S.C. §§ 9601-9675 (1994).

48. McDonald & Wactor, *supra* note 6, at 10.

49. *Id.*

50. *Id.*

51. 33 U.S.C. § 2701-2761 (1994).

52. *See* Oil Pollution Act of 1990, 33 U.S.C. § 2706(c); CERCLA, 42 U.S.C.

passed the OPA establishing procedures for natural resource trustees to determine resource injuries, assess natural resource damages, including the reasonable costs of assessing damages, present a claim, recover damages and develop and implement a plan for the restoration, rehabilitation and replacement of the natural resources under their trusteeship.[53]

A. *The Scientific Method*

Before a proper critique of the current judicial assessment of scientific evidence can be made, it is first necessary to articulate the views on the character of scientific truths, and the relation of these truths to the discipline of adjudicating legal disputes. It has been said that the pursuit of science "stands in sharp contrast to the windy agnosticism of the modern philosopher, litigator, or social engineer."[54] Scientists, according to one science Nobel laureate,

> believe that the world is knowable, that there are simple rules governing the behavior of matter and the evolution of the universe. [They] affirm that there are eternal, objective, extrahistorial, socially neutral, external and universal truths and that the assemblage of these truths is . . . physical science. Natural laws can be discovered that are universal, invariable, inviolate, genderless and verifiable.[55]

Like Glasgow, the Supreme Court also deemed it appropriate to distinguish the mode of scientific inquiry from that of legal knowledge.[56] While the *Daubert* decision serves as a guide to

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§ 9607(f) (1994); Federal Water Pollution Control Act, 33 U.S.C. §§ 1251-1376 (1994). *See also* Carol E. Kinkins & Kevin A. Gaynor, *Issues Attendant Upon Natural Resource Damage Claims*, C921 ALI-ABA 699 (Jun. 20, 1994); Thomas C. Milch & Michael D. Daneker, *Key Issues in Natural Resource Damages*, C948 ALI-ABA 715 (Oct. 27, 1994).

53. The Department of Interior has successfully used a computer model, known as the Natural Resource Damage Assessment Model for Coastal and Marine Environments, 43 C.F.R. § 11.41(a)(1) (1995), to monetarily assess natural resource damages during litigation. Frank L. Amoroso & Linda R. Keenan, *Liability for Restoration is Looming*, NAT'L L.J. 19 (Feb. 4, 1991) (citing Colorado v. United States Dept. of Interior, 880 F.2d 481 (D.C. Cir. 1989)).

54. HUBER, *supra* note 16, at 221 (quoting Nobelist Sheldon Glasgow, whom Huber calls a "student of real science").

55. *Id.*

56. *Id.* at 221-28. *See Daubert*, 113 S. Ct. at 2798-99; *see supra* note 88 and

trial judges in determining the usefulness of questionable scientific evidence, it fails to clarify the confusion that arises when the legal system intermingles with ephemeral scientific evidence that is constantly evolving.[57] This distinction assumes an inherent difference between the discovery for truth in the courtroom, and the search for scientific truth.[58] In one simplified sense, legal inquiry is often discussed in relative terms,[59] while science is often discussed in absolutes.[60] The role of the judge as adjudicator perhaps is viewed as being limited to weighing the interests of discrete parties,[61] while the roles of cohorts in the scientific field may move beyond value comparisons in search of universal truths.[62]

As one scientist has observed, scientific truths, once uncovered by man, prove themselves "universal," and "inviolate," but the nature of scientific inquiry itself, is never so definite.[63] The sci-

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accompanying text.

57. The Court, however, did draw attention, in dicta, to the larger and more profound dilemma of the challenges in keeping the shifting spheres of scientific and legal inquiry intact. *Daubert* 113 S. Ct. at 2798-99.

58. *See* John I. Thornton, *Uses and Abuses of Forensic Science*, *in* SCIENCE AND LAW: AN ESSENTIAL ALLIANCE 79, 86 (William A. Thomas, ed., 1983) (stating that "[l]aw and science on occasion have conflicting goals, each having developed in response to different social and intellectual needs. The goal of law is the just resolution of human conflict, while the goal of science traditionally has been cast, although perhaps too smugly, as the search for 'truth.'").

59. *See id.* at 86-87. The court must weigh societal values, as "[t]he principles of [the legal system] are not the product of scientific observation, but embody a system of values." *Id.* at 87 (quoting Glanville Williams, PROOF OF GUILT (1958).

60. Until the birth of quantum mechanics in the earlier part of the century, when many so-called scientific truths were called into question and uncertainty itself became a principle of science, the prevalent mode of scientific inquiry was to use a discrete set of scientific principles to explain with precision the cause of a phenomenon. Salvo, *supra* note 21, at 16; DAVID Z. ALBERT, QUANTUM MECHANICS AND EXPERIENCE 61 (1992) (stating that the "quantum-mechanical description of the world is necessarily incomplete").

61. *See* Jasanoff & Nelkin, *supra* note 42, at 31.

62. Marcus, *supra* note 23, at 385.

63. Huber argues that scientists are not "dogmatic" about their beliefs, as a "generous measure of doubt and self-criticism is an integral part of modern science." HUBER, *supra* note 16, at 221-22.

entific methodology of hypothesis testing, which is widely used in research, is "based on a frequentist approach to statistical inference."[64] Probability has been defined as "long-run frequency, obtained conceptually from a long series of identical experiments . . . ."[65] By its very nature, a process dependent on probabilities cannot provide absolute, invariable answers. One difficulty in using probabilistic evidence to prove causation arises in tests for chemical toxicity.[66] For instance, "guarding against false positives increases the likelihood of false negatives."[67] When a chemical is thought to cause "relatively rare diseases, sample populations are small, using a statistical rule that guards against false positives increases the likelihood of false negatives [and] decreases confidence in the reliability of results."[68]

Science's quest for absolute truths does not make scientific findings immutable.[69] To the contrary, instead of being insistent about their beliefs, scientists must "acknowledge significant objections to [their] findings, and suggest ways in which they might be contradicted or confirmed."[70] The legal system thus cannot

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64. Mike, *supra* note 19, at 126-27.

65. *Id.* at 126.

66. Rachelle D. Hollander, *Expert Claims and Social Decisions: Science, Politics and Responsibility*, *in* ACCEPTABLE EVIDENCE: SCIENCE AND VALUES IN RISK MANAGEMENT 160, 167 (1991).

67. *Id.*

68. *Id.*

> [G]ood science, in the sense of science that does not predict a toxic effect when there is none, is purchased at the cost of overlooking some toxicity. This kind of good science is also more likely to predict no toxic effect when there is one. . . . [I]t also may conflict with good regulation, which may purchase the security of preventing a greater incidence of disease at the cost of banning or slowing the development of harmless chemicals . . . .

Id.

69. HUBER, *supra* note 16, at 221.

70. *Id.* at 221-222. Huber observes that "[t]he modern scientist is a credulous skeptic—skeptic in that he demands serious evidence and proof; credulous in that he concedes . . . that every measurement, correlation, analysis, or theory may contain some margin of error, which may in turn conceal important but unrecognized new truth. There is thus, today, a science even to uncertainty . . . . Good science systematically allows for its own error, and remains expressly open to the plausibly unorthodox." *Id.* at 222.

expect orthodoxy in a scientific study when none exists. Indefiniteness is inherent in science. Scientific uncertainty is unavoidable in the methods used to establish scientific facts and in the facts themselves. Much of the scientific evidence gathered is "probablistic rather than absolute and provisional rather than final, and it can never be devoid of uncertainty or the possibility of inaccuracy or incompleteness."[71] In some instances, questions about the "quality and interpretation of data . . . cannot be resolved definitively on the basis of current scientific knowledge," and are based on incomplete evidence.[72]

Scholars have observed that a vast political change has occurred in the industrial or post-industrial world, transforming it from "an administrative state to a scientific state."[73] They note

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71. Ellen K. Silbergeld, *Risk Assessment and Risk Management: An Uneasy Divorce*, *in* ACCEPTABLE EVIDENCE, *supra* note 19, 99, at 101. Silbergeld describes two types of uncertainty that are inherent in scientific knowledge:

> Systematic uncertainties are those limits on knowledge that are derived from the types of knowledge being sought: in [one] case, information about likely human health risks based on data from nonhuman species. Specific uncertainties are those arising from limitations of specific datasets, for instance, problems in experimental protocols, limits of statistical power, and the failure to control important covariates . . . placing a high value on prevention implies a willingness to tolerate considerable uncertainty. In contrast, placing higher value on repairing damage than on preventing it—as in traditional tort law that works after the fact of injury,—the amount of allowable uncertainty (in causation) is usually quite small. As stated by Judge Jack Weinstein in the Agent Orange case regarding the health effects associated with the exposure of soldiers in Vietnam to dioxin:
>
>> The difference between avoidance of risk through regulation and compensation for injuries after the fact is a fundamental one. In the former, risk assessments may lead to control of a toxic substance even though the probability of harm to any individual is small and the studies necessary to assume the risk are incomplete; society as a whole is willing to pay the price as a matter of policy. In the latter, a far higher probability (greater than 50%) is required since the law believes it unfair to require an individual to pay for another's tragedy unless it is shown that it is more likely than not that he caused it.

Id.; *see also* Jasanoff & Nelkin, *supra* note 42, at 24.

72. Jasanoff & Nelkin, *supra* note 42, at 24.

73. Rachelle D. Hollander, *Expert Claims and Social Decisions: Science,*

three roles that science plays in this new political world: first, science serves as a "product," and is promoted and controlled in the service of innovation; second, science is used as "evidence" where "information and the interpretation of the results of scientific research [is used] in policymaking;" finally, science provides the "scientific method," serving as the protocols and techniques involved in "analytical, experimental, and empirical" research.[74] This multi-faceted utility of scientific knowledge complicates the task of examining the relationship between scientific knowledge and legal adjudication.

Science that "exists at the confluence of law and science" is generally called "forensic science."[75] This area of scientific specialization studies and practices the application of natural and physical sciences for the just resolution of social and legal issues.[76] Thus, any scientific inquiry conducted in relation to a legal proceeding falls under the rubric of "forensic science."[77] It is questionable whether a distinction should be made between scientific evidence gathered independently of litigation, and that gathered necessarily as a result of ensuing litigation. For example, much of the research conducted in the wake of the Exxon Valdez litigation was initiated and paid for by litigating parties,[78] and is, therefore, forensic. This has raised the argument that the quality and reliability of scientific research is negatively impacted by research "driven largely by legal considerations rather than scientific ones."[79] Thus far, the Supreme Court has not articulated a

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Politics, and Responsibility, in ACCEPTABLE EVIDENCE, *supra* note 19, 160, at 163 (citing Juren Schmandt & James E. Katz, *The Scientific State: A Theory with Hypotheses*, 11 SCI. TECH. & HUM. VALUES 40-52 (1986)).

74. *Id.*

75. *See* John I. Thornton, *supra* note 58, at 79-81. While forensic science has traditionaly been closely associated with the criminal justice system, the use of forensic science, usually adaptations of existing disciplines, is increasing in the civil litigation and regulatory context. *Id.* Thorton states that a distinguishing factor between a forensic scientist and other scientists is the "expectation of routine appearances in a court of law." *Id.*

76. *Id.* at 79-80.

77. *Id.* at 79.

78. *See* Cushman, *supra* note 42, at C4.

79. *Id.* . There is, however, support for the opinion that forensic scientists play a valuable role in "introduc[ing] . . . science into the legal process in an

separate standard for evaluating litigation-drive science and has uniformly applied standards for the admissibility and reliability of scientific evidence, regardless of the impetus or reasons for the research itself.

B. Daubert's *Framework*

In its effort to provide a general framework for trial judges, the Supreme Court refrained from "set[ting] out a definitive checklist or test"[80] for assessing the reliability and relevance of expert scientific testimony. The *Daubert* court stated that "under the Rules the trial judge must ensure that any and all scientific testimony or evidence admitted is not only relevant, but reliable."[81] Then, to help the trial judge in performing the role of "gatekeep[er],"[82] the Court essentially set forth two guidelines for the lower courts. First, it emphasized the multiplicity of factors that the trial court should take into account in making its "preliminary assessment of whether the reasoning or methodology underlying the testimony is scientifically valid and of whether that reasoning or methodology properly can be applied to the facts in issue."[83] Second, it explicitly reminded the trial judges of the other applicable Federal Rules of Evidence that the trial judge can refer to for guidance.[84]

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objective and impartial manner," and "strive to be advocates of nothing other than their own opinions." Thornton, *supra* note 58, at 84.

80. *Daubert*, 113 S. Ct. at 2786, 2796.

81. *Id.* at 2795.

82. *Id.* at 2798.

83. *Id.* at 2796. The four "general observations" that the court made are:

> (1) Whether a "theory or technique" can be "tested";
>
> (2) Whether the theory or technique has been "subjected to peer review and publication";
>
> (3) In the case of a scientific technique, the "known or potential rate of error . . . and the existence and maintenance of standards controlling the technique's operation;" and
>
> (4) The degree of acceptance within the "relevant scientific community and an express determination of a particular degree of acceptance within that community."

Id. at 2796-97.

84. *Daubert* states that Rule 703 provides that expert opinions based on otherwise inadmissible hearsay are to be admitted only if the facts or data are "of a type reasonably relied upon by experts in the particular field in forming opinions

The Court then remanded the case without application of its newly announced principles.[85]

The *Daubert* court purposely left its "scientific validity" test vague, consistent with the views of leading legal and scientific scholarship, that "scientists, do not assert that they know what is immutably true," but are "committed to searching for new, temporary theories to explain, as best they can, phenomena."[86] It recognized a distinction between scientific and legal certainty,[87] and the conflict that arises when our judicial system's requirement of legal sufficiency, the preponderance of the evidence standard, incorrectly forces courts to measure the true value of a scientific process.[88] The *Daubert* decision, as does the *Frye* decision, continue to encourage the use of peer-review as at least one

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or inferences upon the subject." *Id.* at 2797-98 (citing FED. R. EVID. 703). Rule 706 allows the court at its discretion to procure the assistance of an expert of its own choosing. *Id.* (citing FED. R. EVID. 706). Finally, Rule 403 permits the exclusion of relevant evidence "if its probative value is substantially outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the jury." *Id.*

85. *Id.* at 2799; *see* Donald R. Frederico, *Admissibility of Scientific Evidence Stirs Debate:* Daubert *Decision Fails to Provide Clear Guidelines*, MASS. LAWYERS WEEKLY, Aug. 16, 1993, at S2.

86. *Daubert*, 113 S. Ct. at 2795. The Court also quotes similar views of the American Association for the Advancement of Science, the National Academy of Sciences, and seminal legal works on scientific evidence. *Id.*

87. *Id.* at 2798.

88. *Id.* The Supreme Court explicitly pointed out a distinction between the two disciplines:

> [T]here are importance differences between the quest for truth in the courtroom and the quest for truth in the laboratory. Scientific conclusions are subject to perpetual revison. Law, on the other hand, must resolve disputes finally and quickly. The scientific project is advanced by broad and wide-ranging consideration of a multitude of hypotheses, for those that are incorrect will eventually be shown to be so, and that in itself is an advance. Conjectures . . . are of little use, however, in the project of reaching a quick, final, and binding legal judgment . . . about a particular set of events in the past.

Id. at 2798.

For a discussion of the tension between scientific and legal causation, and the nature of scientific proof and the doctrine of legal causation, see Salvo, *supra* note 21, at 18-20.

basis to ensure the quality of scientific evidence.[89] The Court's decision, however, still keeps ambiguous *when* evidence must be peer-reviewed.

The Court seems to be focusing on pre-litigation peer-review as a basis for analyzing scientific sufficiency. However, the overall scheme of the litigation process inhibits sharing of information and scientific coordination among researchers of different litigating parties, until the discovery requirements take effect.[90] The irony of the situation becomes clear when one considers that most of the scientific evidence used during the Exxon litigation was conducted and gathered after the lawsuit had already been filed.[91] The *Daubert* court's mode of analysis does not seem to squarely apply to scientific research conducted during the course of litigation. Thus, in order for the trial courts to be able to apply the *Daubert* factors, the litigants will want to gather evidence that they want to introduce in court *before* the court has to determine its admissibility during in limine proceedings.

II. PROPOSED RECOMMENDATIONS FOR CHANGE

Suggestions for tort reform and resolution of adjudicatory problems related to scientific evidence abound.[92] Many of these suggestions focus on improving the level of scientific understanding by lawyers and simplifying and elucidating the technical information used to make legal decisions.[93] Such proposals may be pro-

89. *Daubert*, 113 S. Ct. at 2797. The de-emphasis of "general acceptability," in theory, however, should allow for the introduction of more cutting-edge science and technology that is not generally known by the scientific community. McDonald & Wactor, *supra* note 6, at 10.

90. Confusion and non-cooperation regarding environmental evidence occurs not only between opposing parties, but between governmental offices, as well. Cushman, *supra* note 42, at C4 ("For instance, efforts to coordinate scientific research between the state and the Federal Government lapsed . . . amid bitter negotiations between the two over a proposed criminal plea bargain by Exxon. Under it the company would have contributed hundreds of millions of dollars for further research and for restoration projects. The state objected to the terms of the Federal plea bargain, which fell apart, straining relations between Alaska and the Justice Department.").

91. *See* Fitzgerald, *supra* note 39, at 81; Bryan Hodgson, *Exxon Spill Ends Up Tarnishing Image of Science*, L.A. TIMES, Oct. 16, 1994, at B3, col. 1.

92. Jasanoff & Nelkin, *supra* note 42, at 17.

93. *Id.* at 27-28 (suggesting that although a combination of technical uncer-

cedurally, structurally, or educationally-based.[94] One proposal, in the area of product liability, suggests a "seriated trial format" in which questions of causation are discussed and resolved before any claims for damages are reviewed.[95] Another suggestion has been made to organize discovery in phases: a preliminary phase to define issues, followed by discovery on the merits of the case.[96] There has also been a proposal that calls for the use of a "cadre of scientific experts who would act as aides to appellate judges, helping them to understand problems of scientific methodology and to assess substantive data."[97] Yet another reform measure suggests that a system of specialty courts run by expert judges be established to resolve technically-laden litigation.[98]

A. *Public Repository of Raw Data*

It has been suggested that a public repository for raw data and subpoenaed documents gathered by adversarial and nonadversarial researchers, and non-party governmental agencies such as the National Oceanic and Atmospheric Administration ("NOAA"), would provide multiple benefits.[99] It would coordinate the work

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tainty, a diversity of regulatory policies, and complex array of social, moral, and religious questions are involved in the judicial resolution of problems related to scientific and technological advances, most proposals for judicial reform focus narrowly on increasing judges' and lawyers' technical competence).

94. *Id.* at 27.

95. *Id.*

96. *See* Larry Lempert, *Seeds of Technology Sprout into Complex Litigation*, LEGAL TIMES, June 13, 1983, at 16. One court forced all asbestos litigation to undergo a bench trial before it was deemed entitled to a jury trial. *Id.* In another court, a simultaneous trial of liability issues in five asbestos cases was tried before different juries and presided over by the same judge. *Id.* Judge Thomas D. Lambros of the Northern District of Ohio, who presided over 90 of the Cleveland consolidated asbestos cases, "instituted several innovative and controversial procedures to speed the settlement including computer analysis of the cases, the use of summary jury trials and limits on the time available for the taking of depositions." W. John Moore, *Judge Defends Courtroom as Tort Forum*, LEGAL TIMES, Mar. 25, 1985, at 2.

97. *See* Jasanoff & Nelkin, *supra* note 42, at 27.

98. *Id.* at 27-28. Other reform recommendations include the appointment of scientific advisers, special masters, or technological magistrates. *Id.*

99. *See* Hodgson, *supra* note 66, at B3.

of the researchers, enable scientists to review one anothers research plans in advance, and duplicate tests that produce particularly interesting results.[100]

B. *Advisory Jury*

A court may also utilize its powers under Rule 706 of the Federal Rules of Evidence to create a non-adversarial technical advisory panel.[101] The litigants may participate in the selection of the panel members[102] and divide the advisor costs evenly among themselves.[103] In order to protect the confidentiality of scientific research that has been subpoenaed, only technical advisors or other scientists would be allowed to read the subpoenaed raw data.[104] In non-jury trials the court can appoint an "advisory jury" that would consist entirely of experts. In the alternative, the court can appoint "special masters" to hear motions or evidence before the trial.[105] Based on the special master's findings, the judge can make more informed decisions whether or not to grant

100. *See* Cushman, *supra* note 42, at C4. (Noting that "[l]awyers for Exxon, the state and the Federal Government have required nearly total secrecy about the results of the research, at least until it is shared among the litigants in the pretrial 'discovery' process. There is no public repository for raw data, and no research results or analysis are being published in scientific journals").

101. FED. R. EVID. 706.

102. A large database of technical experts are commercially available. One such service is the Technical Advisor Service for Attorneys ("TASA"), a 35 year old organization that provides attorneys with the names of experts in a variety of fields. As of March 1995, TASA had a directory of 22,000 experts in fields ranging from pure scientists and manufacturers to shoemakers. So far, very few judges have utilized this service to locate court-appointed experts. Telephone interview with Carol Stein, Director of Corporate Communications, TASA (Mar. 15, 1995).

103. Much of the cost of the environmental research stemming from the spill was paid for by litigants, and not by the court. *Cushman, supra* note 42, at C4.

104. *See* Eliot Marshall, *Court Orders Sharing of Data*, SCIENCE, July 16, 1993, at 284.

105. Michael J. Saks, *Accuracy v. Advocacy: Expert Testimony Before the Bench*, TECH. REV., Aug. 1987, at 42; *see generally* Michael D. Green, *Legal Theory: Expert Witnesses and Sufficiency of Evidence in Toxic Substances Litigation: the Legacy of Agent Orange and Bendectin*, 86 NW. U. L. REV. 643 (1992).

pre-trial remedies.[106] These techniques may also reduce the number of scientific issues left for the judge or jury to cope with at the trial.[107] A variation of the non-jury trial idea proposes the use of technical advisors.[108] The limited role as a technical advisor to the court would avoid subjecting the court's expert to discovery. The court could also limit the use of the adviser to consulting on factors related to validity and relevance.[109] Proposals such those outlined above may receive support from the judicial community. A national survey of trial judges showed that about half of the judges advocated the increased utilization of technical advisors.[110]

However, the proposals described above fail to alleviate problems that cannot be remedied by simply educating the lawyers and judges involved in litigation about the technical jargon. Suggestions for increasing judicial competence in technical areas may fall short in the long run, for "the problems faced by the courts in dealing with controversies in these areas cannot be attributed simply to lack of judicial expertise."[111] It is crucial for the judiciary to recognize that complex environmental evidence, just by virtue of its scientific nature, should not be viewed as the bane of efficient courtroom litigation. In fact, complex, technical evidence is quite common in many other areas of the law such as "large antitrust cases or other litigation involving major corporate entites and multiple parties."[112]

Indeed, one commentator has stated that the most troubling aspects of complex environmental cases may have "little to do

106. Green, *supra* note 105, at 643.

107. *See* Saks, *supra* note 105, at 42.

108. McDonald & Wactor, *supra* note 6, at 10.

109. *Id.*

110. In the survey of state and federal trial judges, 44% of federal judges favored the greater use of scientific panels to advise the judiciary on the qualifications of expert witnesses on the validity of their evidence. Louis Harris & Associates, Inc., *Judge's Opinions on Procedural Issues: A Survey of State and Federal Trial Judges Who Spent at Least Half Their Time on General Civil Cases*, 69 B.U. L. REV. 731, 741 (1989).

111. Jasanoff & Nelkin, *supra* note 42, at 31.

112. *Id.* at 22.

with their scientific or technical dimensions."[113] Rather, "[c]ourts are confronted with voluminous records and lengthy procedural wranglings."[114] An examination of the law's treatment of the scientific field may elucidate what, if any, changes must be made in the way environmental torts should be adjudicated.

III. RETHINKING THE JUDICIAL ASSESSMENT OF SCIENTIFIC PROOF

One legal scholar has characterized the tension between scientific and legal thought as a difference in classical ethos. Scientists possess an "ethic of disinterestedness" which "serves to suppress conflicts of personal or material interest in furtherance of a common stake in the scientific enterprise."[115] Parties of a lawsuit, however, are engaged in an ethic of "maximum self-interest" where a "particular solution will maximize the outcome of one of the parties only at the expense of the other."[116] Hence the objective of achieving "justice" is not the same as finding the truth or the "scientifically valid result."[117]

Since the scientific community checks the utility and quality of scientific research, "subjecting new theories and findings to peer review and independent verification, it is often assumed the same standards prevail when science is applied to the fact-finding process in a judicial trial."[118] In practice, however, the self-monitoring processes of the scientific community become disrupted.[119]

Our current litigation system impedes the scientific research process which often provides critical data necessary to stop ongoing harms in the aftermath of an environmental accident.[120] The hindrance of useful research does not necessarily arise

113. *Id.*

114. *Id.*

115. Marcus, *supra* note 23, at 384.

116. *Id.* at 384.

117. *Id.* at 385.

118. Peter J. Neufeld & Neville Colman, *When Science Takes the Witness Stand*, SCI. AMER., May 1990, at 46.

119. *Id.*

120. Cushman, *supra* note 42, at C4.

through the fault of lawyers or judges assigned to a particular case, but through the court's imposition of traditional legal procedures that conflict with the modes of scientific inquiry.[121]

Currently, adjudicative fact-finding operates in a manner that conflicts with proper scientific fact-finding. First, our legal system requires all confrontations to conclude, and the litigation to result in a fixed set of legal resolutions.[122] While "theories that are so firmly established as to have attained the status of scientific law, such as the laws of thermodynamics,"[123] attain a sense of permanence, most scientific evidence gathered in the aftermath of the Exxon Valdez are inchoate forms of science, requiring the input of other researchers to challenge its hypotheses and the underlying data that support them.[124] The scientific findings thus transcend the boundaries of the individual research project, and are part of a continual process of refining and purifying scientific learning.[125] Second, the evidentiary process requires parties to dissect and encapsulate these emerging scientific notions into piecemeal testaments of scientific truths, which may be used to

121. In Allen v. United States, 588 F. Supp. 247 (D. Utah 1984), *rev'd on other grounds*, 816 F.2d 1417 (10th Cir. 1987), a case involving injuries suffered as a result of radioactive fallout from U.S. atomic testing facilities in Nevada, the trial judge acknowledged the causation problems inherent in the current system. He decided to "abandon traditional principles of tort causation." Salvo, *supra* note 21, at 21.

122. Marcus, *supra* note 23, at 388 & n.24 (quoting James A. Martin, *The Proposed "Science Court,"*, 75 MICH. L. REV. 1058 (1977): "Nothing in the scientific method guarantees that hypotheses will be tested or when they will be tested, while the adversary process usually guarantees that all points of an opposing position will be raised and decided within the time limits of the litigation.").

123. *Daubert*, 113 S. Ct. at 2796 n.11.

124. *See supra* note 22 and accompanying text.

125. For instance, many scientific questions that arise in making risk-benefit assessments for setting environmental standards "cannot be answered by science . . . they transcend science." Poali F. Ricci & Lawrence S. Molton, *Risk and Benefit in Environmental Law*, *in* SCIENCE AND LAW: AN ESSENTIAL ALLIANCE 57 (William A. Thomas ed. 1983). In the regulatory context, such as the risk assessment of environmental impacts, "U.S. regulators place a higher value on formal analytical methods, whose validity can be publicly tested and verified than do regulators in most European countries." Sheila Jasanoff, *Acceptable Evidence in a Pluralistic Society*, *in* ACCEPTABLE EVIDENCE, *supra* note 19, 29.

bolster or defeat discrete points of law or fact.[126] The following is a critique identifying the potential failure in the present judicial system's handling of complex scientific evidence.

A. *Post-crisis Judicial Management*

The current tort system employs what the author calls a "morning after" or post-crisis litigation model.[127] This system assumes that the judge's main judicial function occurs at the trial stage of litigation, and not before. Evidence is gathered in anticipation of presenting it at a future trial date. For example, to build evidence in their separate lawsuits against the defendant, both federal and state researchers in the Exxon Valdez lawsuit killed over 500 ducks, deer, seals and other animals.[128] In addition, government officials stored more than 36,000 frozen bird carcasses to exhibit during the trial.[129] While the plaintiffs amassed a wealth of evidence to present at the trial stage, relatively few studies provide information needed to obtain prospective relief.[130] The trial process implicitly assumes that the actual crisis phase is complete,

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126. *See* Holden, *supra* note 8, at 1658. In *Daubert*, the Supreme Court identified what appears to be the closest similarity between scientific endeavors and legal inquiry: "The work of a judge is in one sense enduring and in another ephemeral . . . In the endless process of testing and retesting, there is a constant rejection of the dross and a constant retention of whatever is pure and sound and fine." *Daubert*, 113 S. Ct. at 2799 n.13 (quoting BENJAMIN CARDOZO, THE NATURE OF THE JUDICIAL PROCESS, 178, 179 (1921)).

127. Post-crisis management is common in the business arena. One business article detailing what business organizations should disclose to the public in the wake of a financial or public-image crisis recommended different modes of action based on whether the "actual crisis phase [was] complete, and . . . no further risk to the health and safety of others or to the environment," continued to exist. Jeffrey Kaufman, et al., *The Myth of Full Disclosure: A Look at Organizational Communications during Crises*, BUS. HORIZONS, July 1994, at 29.

128. David Postman, *More Losses in Prince William Sound: Government Kills Wildlife for Evidence*, OIL DAILY, Oct. 30, 1990, at 4.

129. *Id.*

130. The federal Fish & Wildlife Service announced a five-year study to determine how oil affected the eagle population. However, the study failed to determine how to rescue injured birds or do immediate tests to save the winter population. Timothy Egan, *Lawsuits Snarl Study of Imperiled Alaskan Eagles*, N.Y. TIMES, Sept. 19, 1989, at C1.

with no further risk to the health and safety of others or to the environment. Such is not the case with many environmental disasters. A litigation system which provides legal resolutions mostly for events that have already occurred is an inadequate forum for environmental torts.[131] Court procedures for post-crisis judicial intervention are well-developed: after determining liability, the court thoroughly analyzes evidence for the calculation of damages. Judicial intervention, earlier in the litigation process, could prevent further environmental damage; however, courts are reluctant to grant these even in environmental cases.

Judicial discretion at the pre-trial preparation level is underutilized.[132] As the complexity and variety of scientific evidence and expert testimony continue to grow in environmental law, the judges must become much more involved with a case long before the trial begins.[133] Other than presiding over discovery motions

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131. The current judicial approach to scientific evidence, where the courtroom is a "neutral observer," is closely tied to the classical, and somewhat outdated conception of the universe advocated by Niels Bohr, termed, "metaphysical realism." Bohr presumed the universe was real "independently of human observers or any acts of observation." MENAS KAFATOS & ROBERT NADEAU, THE CONSCIOUS UNIVERSE: PART AND WHOLE IN MODERN PHYSICAL THEORY 3-4 (1990).

This view has been largely dispelled since the dawn of modern physical theory in the 1940s. Modern schools of scientific thinking believe that "neutral observation" is impossible, and that the validity of any physical theory is dependent on the observer. *Id.* Thus, the only way that a phenomenon can be presumed "real" is if it is subject to proof in repeatable and rigorous controlled conditions. This modernized view is called "epistemological realism." *Id.*

In *Daubert*, the Supreme Court's encouragement of an active judicial role in assessing the validity of the scientific proof through the four-prong test is akin to the principle of epistemological realism. *See supra* note 83 and accompanying text. Judges still need, however, to change fundamentally their perception of themselves as neutral observers as well as neutral arbiters of the law. The judges' duty to adjudicate the trial neutrally and fairly does not encompass a duty to remain a neutral observer, who, waits until the scientific inquiry has been entirely completed before assessing it. Their participation in the early stages of litigation can have a profound impact on the quality and efficacy of the scientific evidence gathering process.

132. *See supra* note 23 and accompanying text.

133. The active judicial involvement that is being encouraged, however, should not necessiate the judges' interjection of personal biases or the premature reaching of conclusions prior to satisfactory evaluation of facts. These two problems

and pre-trial hearings, the court usually does not take an active part in the preparation for litigation. The courtroom itself will not undertake to understand the scientific contours of a case, or arm itself with technical advice until the need arises within an individual case.[134] The problem presented by a post-crisis adjudicative focus is compounded in that, in many instances, evidence is not static. While tangible evidence such as the murder weapon, or the carcass of an otter drowned by an oil slick, may be preserved,[135] and catalogued for trial use, much of the on-going evidence gathered by the numerous researchers after the Exxon Valdez oil spill, is evolving and not constant.[136] Scientific evidence is intellectual evidence, and should be treated differently.

B. *Disclosure Limitations*

The discovery rules under the Federal Rules of Civil Procedure allow parties of litigation to request relevent information from each other.[137] Once a party receives a request for information, that party is legally obligated to answer truthfully and completely.[138] Yet there is no requirement that information not requested

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are commonly associated with the alternative to our own adversarial system, the "Napoleonic" or "Continental" system, used by much of the world. Saks, *supra* note 105, at 42 (the Napoleonic system "mandates that judges play a much more active role in investigating the facts and developing a case. The judges have a staff of their own investigators and call on their own expert witnesses.").

134. In a 1989 survey of trial judges, 76% of federal judges surveyed favored the greater use of independent court-appointed witnesses. Symposium, *Issues in Civil Procedure: Advancing the Dialogue*, 69 B.U. L. REV. 731, 740 (1989). In practice, however, judges generally have been reluctant to exercise their authority under Rule 706 to appoint technical experts to assist the court in making scientific determinations, either at the pre-trial or at the trial level. Judges have cited a variety of reasons for their reluctance to use the tools they have, including unfamiliarity with the subject matter, and the fear of intruding in the adversary process. Holden, *supra* note 8, at 1658 (reporting on a workshop held by scientists and lawyers on improving procedures for the use of scientific evidence in toxic torts).

135. Postman, *supra* note 128, at 4.

136. Cushman, *supra* note 42, at C4.

137. FED. R. CIV. P. 26(B)(1). *See* Marcus, *supra* note 23, at 400-05.

138. *Id.* at 400 (citing FED. R. CIV. P. 26(b)(1) and stating that "discovery is allowed as to any relevant matter that is not privileged").

be provided.[139] This "loop-hole" in the disclosure requirements has resulted in overly cautious and zealous withholding of scientific research, even between parties on the same side of the litigation,[140] for unclear litigation advantage purposes,[141]. For instance, state scientists who worked on the Exxon Valdez damage assessment findings withheld information from the NOAA oil spill response unit, and required time-consuming duplication of the state's damage assessment findings.[142]

This mode of discovery especially affects the resolution of environmental tort cases. Prevention of disclosure of scientific findings by parties preparing for litigation can severely curtail the growth and ultimately, the utility of the research.[143] The civil litigation over the Exxon Valdez oil spill demonstrates that, at least in the area of environmental torts, the current judicial system stymies efficient scientific research by preventing the open-exchange of valuable scientific information between plaintiffs and

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139. *Id.*

140. *See* Marshall, *supra* note 104, at 284.

141. Busch, *supra* note 42, at 772. Shortly after the Exxon spill, the Attorney General of Alaska issued a series of memos to state scientists ordering them to keep their data on the spill, especially those pertaining to the contentious issue of environmental damage, secret. *Id.*

142. *Id.* The NOAA is a federal agency charged with providing unbiased scientific information to assist spill-response organizations in handling emergencies. *Id.* The state damage assessment data was not made available to NOAA response teams until two years after the spill. After sharing the data, the state team was forbidden by Alaska's attorney general to discuss the results at a technical advisory group meeting composed of state, federal, and Exxon scientists. *Id.*

143. *See* Cushman, *supra* note 42, at C4. Exxon Corporation, as well as governmental bodies such as Alaska, published very little of the data stemming from the spill. *Id.* The data that was released was done in "a piecemeal [fashion] and not in the detail needed for other scientists to review them. The only rigorous scientific reviews [were] held behind closed doors by the agencies financing the research." *Id.*; Alane Fitzgerald, *Valdez Litigation Will Shape Future Environmental Law*, OFFSHORE, May 1991, at 81 ("the Exxon litigation and settlements has . . . caused a deep furor among the scientific community [with] the emergence of litigation-driven science, coupled with the legal sealing of scientific evidence related to the spill.").

defendants.[144] Thus, because of their adversarial ties, scientists were hampered from truly engaging in open discussion.[145]

This stifling of scientific data goes against the "hallmark of scientific inquiry," in which "findings are shared and discussed by the whole scientific community."[146] Much of the information gathered by government and defense-hired researchers in the Exxon litigation could have been used in the immediate and mid-term clean-up efforts.[147] Instead, our traditional adversarial system compels the parties to store evidence under "lock-and-key."[148]

Usually, in scientific research, findings are shared and discussed by the whole scientific community.[149] But all researchers of the Valdez oil spill were forbidden not only to share their results, but even to say what type of research they were undertaking.[150] It has been suggested that if scientists served in a limited

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144. *See* Frank L. Amoroso & Linda R. Keenan, *Liability for Restoration is Looming*, NAT'L L.J., Feb. 4, 1991, at 19.

145. *Id.*

146. Fitzgerald, *supra* note 143, at 81.

147. *See supra* notes 42, 138 and accompanying text.

148. Egan, *supra* note 130, at C1.

> Data gathered by Exxon, including information that could save birds and animals now . . . is being withheld as the company prepared to defend itself against a host of lawsuits arising from the spill. Biologists fear that legal considerations are compromising scientific inquiry as the focus of one of the world's largest environmental restoration projects moves from cleanup to courtroom . . . . As much as they lament the spill, biologists say the chance to study the effects of oil's toxic chemicals on the food chain represents a potential scientific bonanza that could be lost in legal maneuvering. The legal implications will tie up all that valuable information for a long time. The information won't be lost, but it won't be coming out in time for us to do anything to help the eagles. Now is the time we need it.

Id.

149. *Id.*

150. Almost all information about the economics studies related to the spill were kept secret by requiring all researchers involved to sign contracts containing non-disclosure clauses in contracts. *See* Michael Parrish, *Secret Studies Put Spill Damage at $15 Billion*, L.A. TIMES, Oct. 8, 1991, at A1. Furthermore, a technical advisory committee composed of scientists hired by Exxon, the state of Alaska, and federal agencies were forbidden by their respective litigation parties from

role as technical advisers to the court, they would avoid being subjected to discovery.[151] The court could also tailor the use of the adviser to help clarify questions related to validity and relevance.[152]

The premature emphasis on litigation may also harm the ability of a potentially responsible party ("PRP") to ensure the efficiency and accuracy of damage assessments and then to use the findings to initiate full remedial measures.[153] In connection with the assessment of natural resource damages caused by the Exxon Valdez, the company complained about the lack of cooperation among the various investigating agencies and the general failure to share empirical data and expertise which would have aided in immediate clean-up efforts.[154]

C. *Scientific Testimony*

Compelled testimony may further disrupt the fragile relationship that scientists have with the legal system. The Federal Rules of Civil Procedure liberally allow discovery of all information relevant to the proceeding, from any person, party or non-party.[155] There is no recognized exception for non-retained experts.[156] While courts in the past have been reluctant to interfere with the lives of non-party experts by allowing compelled, but compensated testimony, case law long before the *Daubert* decision established the power of the court to compel testimony from involuntary experts.[157]

Such use of novel science in courts may result in a great intrusion of the judicial system into the scientific world.[158] One soci-

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disclosing the results of scientific studies. *See* Busch, *supra* note 42, at 772.

151. McDonald & Wactor, *supra* note 6, at 10.

152. *Id.*

153. *See* Amoroso & Keenan, *supra* note 144, at 19; Busch, *supra* note 42, at 772.

154. *Id.*

155. McDonald & Wactor, *supra* note 6, at 10.

156. *Id.* See generally Richard L. Marcus, *Evidence: Discovery Along the Litigation/Science Interface*, 57 BROOK. L. REV. 381 (1991), for a thorough discussion of the problems of accommodating the concerns of both science and litigation in the discovery context.

157. McDonald & Wactor, *supra* note 6, at 10; FED. R. EVID. 706.

158. *See id.* (questioning whether judges and juries will be evaluating the valid-

ologist who had been studying the Alaskan coastal villages to measure the levels of community stress from the Exxon spill was ordered by a federal district court to surrender his raw data.[159] While this particular researcher's experience may lead one to conclude that not recognizing a "scholar's privilege"[160] will chill scientific inquiry into important environmental disasters, a recent amendment to Rule 45 provides a limited exception for scholars.[161] Federal Rule of Civil Procedure 45(c)(3)(B)(ii) provides that a subpoena may be quashed if it "requires disclosure of an unretained expert's opinion or information not describing specific events or occcurrences in dispute and resulting from the expert's study made not at the request of any party . . . ."[162]

Finally, cross-examination of an expert witness typically focuses on undermining the credibility or impeaching witnesses rather than on clarifying for the jury basic discrepancies and weaknesses in the witness' direct testimony.[163] For example, in the Bendectin cases, cross examination typically involved queries regarding the expert's fees in order to suggest that the expert is a hired gun, rather than to critically evaluate the scientific underpinnings of his research.[164]

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ity of "developing scientific inquiry" or "junk science").

159. *See* Marshall, *supra* note 104, at 284. The judge required the sociologist to surrender raw data from a published work but allowed him to withhold information he had collected on a confidential basis and had not cited in a published report. *Id.*

160. *See* Marcus, *supra* note 23, at 381 (discussing the common law history behind the "scholar's privilege").

161. *See* FED. R. CIV. PROC. 54(c)(3)(B).

162. The need requirement that the amended Rule 45 imposes is the same as that necessary to secure work product under Rule 26(b)(3). Marcus, *supra* note 23, at 421 n.171.

163. *See generally* Clifton T. Hutchinson & Danny S. Ashby, Daubert v. Merrell Dow Pharmaceuticals, Inc.: *Redefining the Bases for Admissibility of Expert Scientific Testimony*, 15 CARDOZO L. REV. 1875 (1994).

164. *See* Sanders, *supra* note 19, at 48; *see also* John S. Applegate, *Witness Preparation*, 68 TEX. L. REV. 277, 311 (1989) ("While the adversarial system touts the effectiveness of cross-examination for revealing the truth, there is little empirical support for this conclusion.").

CONCLUSION

The environmental tort arena is a forecast of the growing body of legal problems that will arise as our long-standing traditions of adjudication are continually challenged by quickly emerging technological advances. Those of us with a penchance for a precise, technical basis for legal decisions will likely be disappointed with the litigation process. Currently, our system heavily favors the presentation and resolution of post-crisis evidence, rather than immediate, and preventive measures that may benefit the public in the long run. Some state that the traditional processes of adjudication are no longer capable of handling many of these disputes. However, the problem may lie in the legal system's insistance upon a narrow, mechanistic standard of proof that stems from a myopic view of the modes of scientific inquiry. This problem may be remedied by modifying the many adjudicative restraints which rely heavily on limiting the flow of information and time in order to preserve courtroom order.