

Empirical Environmental Scholarship

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The most important development in legal scholarship over the past quarter century has been the rise of empirical research. Drawing upon the traditions of legal realism and the law and economics movement, a variety of social science techniques have delivered fresh perspectives and punctured false claims. But environmental law has been slow to adopt empirical tools, and our findings indicate that it lags behind other fields. There are several clear benefits from an empirical agenda to explore how to make environmental law more effective. But no previous article has applied the lessons from empirical scholarship in other fields to environmental law. This Article fills that gap by assessing the state of environmental empirical scholarship, evaluating the strengths and weaknesses of published approaches to answering empirical questions, and recommending methods to advance the empirical research agenda.

Where environmental law scholarship has employed empiricism, it has done so mostly in the pollution control area. More empirical environmental law research relies on analysis of existing data than on the generation of new data, and experimental treatments are completely absent from our review of the literature. One strength of the empirical work in environmental law is analyzing existing data to determine correlations using regression analysis and statistics. But empirical environmental law scholarship underperforms in offering policy prescriptions. This assessment of the field identifies several methods and sources of data that may prove useful in advancing and sharpening empiricism's contribution to law reform and implementation.

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INTRODUCTION

The most important development in legal scholarship over the past quarter century has been the rise of empirical research. Drawing upon the traditions of legal realism and the law and economics movement, a variety of social science techniques have delivered fresh perspectives and punctured false claims.¹ Environmental law, while not immune from the trend of increasing contributions from empirical research, nonetheless seldom incorporates insights from empirical investigations.² An empirical agenda could facilitate reforms to improve environmental law's effectiveness. However, no previous article has applied the lessons from empirical scholarship in other fields to environmental

1. Tracey E. George, *An Empirical Study of Empirical Legal Scholarship: The Top Law Schools*, 81 IND. L.J. 141, 144–46 (2006) (describing the roots of empirical legal scholarship in legal realism and law and economics). For an example of an empirical study puncturing false claims, see Victor D. Quintanilla & Cheryl R. Kaiser, *The Same-Actor Inference of Nondiscrimination: Moral Credentialing and the Psychological and Legal Licensing of Bias*, 104 CAL. L. REV. 1, 68–70 (2016) (questioning the rationale of the “same-actor” doctrine using psychological science and empirical data on implicit bias).

2. See *infra* Part III, accompanying notes 120–122.

law.³ This Article fills that gap by assessing the state of empirical environmental scholarship, evaluating the strengths and weaknesses of published approaches to answering empirical questions, and recommending methods to advance the empirical environmental law research agenda.

Some commentators estimate that empirical methods now appear in about half of all articles published in legal journals.⁴ But environmental law has been slow to adopt empirical tools, and our findings indicate that it lags behind other fields.⁵ Where environmental law scholarship has employed empiricism, it has done so mostly in the pollution control area.⁶ More empirical environmental law research relies on analysis of existing data than on the generation of new data, and experimental treatments are completely absent from our review of the literature.⁷ One strength of the empirical work in environmental law is mining existing data to determine correlations using regression analysis and statistics. However, empirical environmental law scholarship underperforms in offering concrete policy prescriptions. This assessment identifies several methods and data sources that may prove useful in advancing and sharpening empiricism's contribution to environmental law reform and implementation.

Part I of this Article reviews the rise of empirical research in legal scholarship and circumscribes the domains of both empirical research and environmental law that we explore in this study. Part II discusses our method of review of environmental law scholarship, explains how we coded articles, and summarizes our results. We illustrate some of the difficult coding judgments we made in probing the empirical dimensions of the literature. Part III explains the significance of our findings with special attention to how environmental law might make better use of empirical methods. It describes empirical research's contributions to positive law and how the articles we reviewed interrogated existing data. Part III also discusses the challenge and promise of generating new datasets and policy recommendations. We conclude that the relative paucity of empirical research in environmental law, while not an inherent shortcoming in the field, nonetheless points to some promising areas of new research. A greater emphasis on quantified, systematic observations in environmental law research can better direct scarce resources toward more effective human health protection and ecological sustainability.

3. Other authors have highlighted the need to expand environmental legal scholarship beyond "a reliance on jurisprudential theories of 'legal principles'" in order to promote maturation of the field. Elizabeth Fisher et al., *Maturity and Methodology: Starting a Debate about Environmental Law Scholarship*, 21 J. ENVTL. L. 213, 245 (2009).

4. Shari Seidman Diamond & Pam Mueller, *Empirical Legal Scholarship in Law Reviews*, 6 ANN. REV. L. & SOC. SCI. 581, 586, 591 (2010).

5. See Michael P. Vandenbergh, *Beyond Elegance: A Testable Typology of Social Norms in Corporate Environmental Compliance*, 22 STAN. ENVTL. L.J. 55, 83–85 (2003) (lamenting the lack of empirical research examining the role of norms in compliance with environmental laws despite bodies of research on compliance in other areas, such as tax law).

6. See *infra* Table 2.

7. See *infra* Table 5.

I. EMPIRICAL RESEARCH AND ENVIRONMENTAL LAW SCHOLARSHIP

Scholars have not settled on a single definition of empirical legal scholarship. Most researchers introduce their discussion of empiricism with their own definitions, which generally share a commitment to some form of the Greek root of the word, *empeirikos*, meaning experience.⁸ American legal empiricism can be traced through the towering influence of Oliver Wendell Holmes' critique of formalism: "The life of the law has not been logic: it has been experience."⁹ Some modern scholars emphasize the role of empirical research in testing a falsifiable hypothesis through the use of statistical techniques.¹⁰ This narrow definition of empirical research is modeled on the natural science paradigm of hypothesis testing through controlled experiments. However, most definitions encompass a broader scope by emphasizing the core idea of observation at the heart of empiricism. For instance, in their influential article, Professors Lee Epstein and Gary King argue that "[w]hat makes research empirical is that it is based on observations of the world—in other words, data, which is just a term for facts about the world."¹¹ Under this definition, most legal scholarship other than theory would be empirical.

For the purposes of this Article, we focus on the *systematic* and *quantitative* dimensions of empirical legal studies. Positive observations about judicial opinions and statutes have been a staple of environmental law since its very beginnings, and do not serve to distinguish newer empirical techniques in the law journals.¹² The rise of online databases in the 1980s, especially Westlaw and Lexis, ushered in an era of comprehensive computer searching that yielded many articles examining a wide range of attributes of judicial decisions and statutes.¹³ This work continues today, but it does not reflect the

8. *Empiric*, SHORTER OXFORD ENGLISH DICTIONARY (5th ed. 2002).

9. OLIVER WENDELL HOLMES, JR., *THE COMMON LAW* 1 (1881). John Dewey's influential work in the social sciences also promoted the notion that effective research could view policies as hypotheses in application of the scientific method. See generally JOHN DEWEY, *LOGIC: THE THEORY OF INQUIRY* (1938).

10. See, e.g., George, *supra* note 1, at 146 ("[Empirical legal] scholars, unlike doctrinalists, take a primarily positive approach and utilize the scientific method to evaluate the relevant evidence."); Michael Heise, *The Past, Present, and Future of Empirical Legal Scholarship: Judicial Decision Making and the New Empiricism*, 2002 U. ILL. L. REV. 819, 821 (2002) ("[W]hen I speak of empirical legal scholarship I refer only to the subset of empirical legal scholarship that uses statistical techniques and analyses.").

11. Lee Epstein & Gary King, *The Rules of Inference*, 69 U. CHI. L. REV. 1, 2–3 (2002).

12. This need to distinguish empirical techniques is central to the definitions excluding doctrinal analysis from most reviews of empirical law scholarship. E.g., Russell Korobkin, *Empirical Scholarship in Contract Law: Possibilities and Pitfalls*, 2002 U. ILL. L. REV. 1033, 1035 (2002) (arguing that despite an expansive conception of empiricism in theory, distinguishing empirical techniques from traditional, doctrinal scholarship requires a narrower definition that excludes articles studying a small number of judicial opinions anecdotally).

13. See, e.g., Richard L. Revesz, *Environmental Regulation, Ideology, and the D.C. Circuit*, 83 VA. L. REV. 1717, 1721 (1997) (compiling 250 challenges to EPA decisions decided by the D.C. Circuit through Lexis and Westlaw); see also Daniel A. Farber & John E. Nowak, *The Misleading Nature of Public Forum Analysis: Content and Context in First Amendment Adjudication*, 70 VA. L. REV. 1219,

more recent developments in legal scholarship that employ different databases, experimental approaches, and statistical and regression analysis. A useful review of the recent wave of empirical research in environmental law should recognize the longer tradition of doctrinal scholarship, but focus on how the newer applications of the empirical method contribute to understanding environmental law.

While we seek to distinguish empirical analysis from traditional doctrinal research, circumscribing our study domain to explicit hypothesis testing would exclude many important new lines of research that point the way toward more effective use of empiricism. We adopt a middle ground also to limit our analysis to a manageable number of articles. Professor Shari Diamond's 2002 definition of empirical research yields an optimal scope for our purposes: "[T]he systematic organization of a series of observations with the method of data collection and analysis made available to the audience."¹⁴ The focus on systematic organization embraces a variety of coding exercises that can yield insights into the elements of legal actions and environmental outcomes, a common variety of contemporary approaches to environmental law scholarship.¹⁵ Yet, it excludes the vast majority of doctrinal articles that make anecdotal observations about the legal world without systematic collection or quantitative analysis. Doctrinal research remains the lifeblood of legal scholarship and serves as the baseline against which we measure the rise of empiricism.

Identifying a useful definition of empirical scholarship only gets us halfway to our aim. We also need to delimit the scope of environmental law, a field with a notoriously fuzzy boundary.¹⁶ We aimed to capture a broad array of empirical research about the relationship between legal tools, such as liability and regulation, and actual environmental quality. Therefore, we did not restrict our study to articles about environmental law statutes or judicial decisions. Instead, we employed a relatively expansive definition:

1221 & n.15 (1984) (evaluating the Court's use of the term "public forum" through cases turned up in a Westlaw search); Christopher D. Stone, *From a Language Perspective*, 90 *YALE L.J.* 1149, 1152 (1981) (attributing the decline in the importance of treatise-writing in legal scholarship to, in part, the rise of Lexis and Westlaw).

14. Shari Seidman Diamond, *Empirical Marine Life in Legal Waters: Clams, Dolphins, and Plankton*, 2002 *U. ILL. L. REV.* 803, 805 (2002).

15. See, e.g., Eric Biber & Berry Brosi, *Officious Intermeddlers or Citizen Experts? Petitions and Public Production of Information in Environmental Law*, 58 *UCLA L. REV.* 321, 354–64 (2010) (comparing the Fish and Wildlife Service (FWS) recovery priority rankings between animals listed by FWS's own initiative and animals listed only after a petition).

16. See, e.g., Robert L. Fischman, *What is Natural Resources Law?*, 78 *U. COLO. L. REV.* 717, 719 (2007) (arguing that natural resources law is more than merely an advanced topic in property or environmental law); A. Dan Tarlock, *Is There a There There in Environmental Law?*, 19 *J. LAND USE & ENVTL. L.* 213, 217–18 (2004) ("[W]hen one sums up . . . [what] make[s] up the core of what most people consider environmental law, one is hard pressed to reduce them to a set of distinctive, fundamental principles, let alone rules that can be applied to a wide range of current and future issues . . .").

environmental law research analyzes any legal issue focused on pollution, species or habitat conservation, land use, natural resource management, or climate change. Therefore, our definition includes less traditional environmental law topics, such as an examination of the effects of performance-based renewable energy policies under the 2007 Energy Independence and Security Act on biofuel production, food prices, and greenhouse gas emissions.¹⁷ Our scope excludes articles using decision-making tools applied in environmental law, such as cost-benefit analysis, when the articles address environmental consequences only tangentially.¹⁸ As with other efforts to define whether articles qualify as environmental law scholarship, our method is “more of an art than a science.”¹⁹

Our study excludes the vast domains of public health, epidemiology, conservation biology, and other related fields where empirical studies are often relevant to a legal question. Including literature that is relevant but that is not law scholarship itself would swamp the relatively small numbers of law articles.²⁰ Even law professors contribute to nonlegal journals that address the effectiveness of law.²¹ However, those articles tend to have little legal analysis. To avoid wading into the debate about what constitutes an ever-expanding universe of legal scholarship itself, we narrowed this study’s domain by searching only journals closely affiliated with law schools and legal organizations.²² The proxy of law-related publishers of journals to indicate legal scholarship is weak. Some articles meeting our criteria for environmental law have minimal connection to legal analysis.²³ However, law journals are more attentive to the importance of legal analysis and linking empirical results to existing legal scholarship. Law journals remain a fair representation of the expansion of the scope of scholarship published by law professors, which has

17. See, e.g., Madhu Khanna et al., *Land Use and Greenhouse Gas Mitigation Effects of Biofuel Policies*, 2011 U. ILL. L. REV. 549, 549–50 (2011).

18. See, e.g., John Bronsteen et al., *Well-Being Analysis vs. Cost-Benefit Analysis*, 62 DUKE L.J. 1603, 1633 (2013) (comparing well-being analysis to cost-benefit analysis as applied to EPA’s regulation of pulp and paper production).

19. Linda K. Breggin et al., *Trends in Environmental Law Scholarship 2008–2015*, 46 ENVTL. L. REP. (Envtl. Law Inst.) 10,647, 10,647 (2016); see also Fisher et al., *supra* note 3, at 219–20 (describing the “intellectual incoherence” of environmental law scholarship).

20. See generally Kenneth Chay et al., *The Clean Air Act of 1970 and Adult Mortality*, 27 J. RISK & UNCERTAINTY 279 (2003) (an example of an empirical study of an environmental issue that is non-law scholarship).

21. See Robert L. Fischman & J.B. Ruhl, *Judging Adaptive Management Practices of U.S. Agencies*, 30 CONSERVATION BIOLOGY 268, 268 (2016); Martin F.J. Taylor, Kieran F. Suckling & Jeffrey J. Rachlinski, *The Effectiveness of the Endangered Species Act: A Quantitative Analysis*, 55 BIOSCIENCE 360, 360 (2005).

22. Some non-law-school legal organizations publish influential journals, such as Environmental Law Reporter News & Analysis, published by the Environmental Law Institute.

23. See, e.g., Cary Coglianese & Jennifer Nash, *Performance Track’s Postmortem: Lessons from the Rise and Fall of EPA’s “Flagship” Voluntary Program*, 38 HARV. ENVTL. L. REV. 1, 81–86 (2014) (engaging in quantitative analysis of Performance Track, one of EPA’s main voluntary programs, but not engaging in legal analysis).

broadened in the past two decades with the rise of faculty who have earned research degrees in the social sciences. Though changing, academia still regards law journal publication as the premier showcase for recognizing contributions to legal scholarship.

II. METHOD, CODING, AND RESULTS

We reviewed empirical environmental law studies published in U.S. law journals as of January 1, 2017. Seventy-three of the 2400 articles we reviewed fell within the scope of our definitions of both empirical and environmental law research. We searched in the Westlaw database “JLR” of law reviews and journals using two primary search strings with limiting criteria: [adv: TE(environment! & data! & method! & analys!)], search within results for [“Table 1*” OR “Table I*” AND ATLEAST2(empiric!); and (TE(environment!) & TI(empirical))]. This method produced sixty-six of the articles we ultimately included. We also searched the archives of the *Journal of Empirical Legal Studies* (not available on Westlaw) for all articles containing the terms “environment” and “environmental,” which produced three relevant articles. Finally, to estimate the range of articles a researcher conducting an exploratory investigation into empirical environmental law studies might encounter, we searched Westlaw for: [adv: empirical & “environmental law”] and reviewed the first 100 articles. This resulted in four additional relevant articles that did not appear using the other search terms. Therefore, our search for empirical environmental law articles yielded seventy-three pieces reported in this study.

The search method errs on the side of undercounting empirical environmental law articles in order to review scholarship both self-identifying as empirical and representing more quantitatively sophisticated research methods. For instance, adaptive management has emerged over the past decade as an important legal issue. In particular, courts grapple with the discontinuities between legislative requirements and best management practices.²⁴ More broadly, adjustment to climate change across legal silos has led to a growing body of literature on resilience and adaptive governance.²⁵ Nonetheless, our search failed to unveil some relevant case study research because it did not employ the terms or methods commonly associated with systematic organization of observations.²⁶ Finally, and most importantly, our method

24. See J.B. Ruhl & Robert L. Fischman, *Adaptive Management in the Courts*, 95 MINN. L. REV. 424, 444–48 (2010).

25. See Tracy-Lynn Humby, *Law and Resilience: Mapping the Literature*, 4 SEATTLE J. ENVTL. L. 85, 99–104 (2014) (surveying the literature on law and resilience).

26. For instance, our search failed to find any of the adaptive management articles Humby categorized as “strongly empirical,” meaning they employed “a case study methodology, i.e. an in-depth, multi-dimensional exploration of a particular case or cases.” *Id.* at 101. Two examples of this category of scholarship not included in our research are Barbara Cosens, *Resilience and Law as a Theoretical Backdrop for Natural Resource Management: Flood Management in the Columbia River*

employed a coarse filter that relied on authors to self-identify their research as empirical. Therefore, some articles that employed empirical techniques but did not identify them as such fell outside our scope.²⁷ This is a particular problem for a field with weak empirical conventions, as scholars pursuing systematic, quantitative research may fail to self-label their work as empirical. Nonetheless, our parsimonious method has the advantage of allowing us to compare our results with other studies of empirical legal scholarship, which generally formulate search algorithms employing the same terms we do.²⁸

For the seventy-three articles that met our criteria both for empirical and environmental law scholarship, we coded several attributes. Table 1 shows the publication dates for all articles employing empirical methods in environmental law scholarship. Because environmental law accounts for relatively few empirical articles, there is substantial annual variation in publishing. However, it is clear that the most recent decade we canvassed, 2007 to 2016 (forty-five articles),²⁹ authors published twice as many empirical articles as in the decade before, 1997 to 2006 (twenty-one articles). We collected other basic attributes of those publications: specific law or doctrine at issue, data source, whether the article engaged in hypothesis testing of a specific theory or solely in exploratory analysis, and whether the article made a specific policy recommendation. Subpart A covers most of the attributes we coded. Though some, such as date, are self-explanatory, others require more description in order to understand our coding. Subpart B addresses the framework we developed to categorize different types of empirical research reported in the legal literature.

Basin, 42 ENVTL. L. 241 (2012), and Sandra Zellmer & Lance Gunderson, *Why Resilience May Not Always be a Good Thing: Lessons in Ecosystem Restoration from Glen Canyon and the Everglades*, 87 NEB. L. REV. 893 (2009).

27. See generally Oliver A. Houck, *The Endangered Species Act and Its Implementation by the U.S. Departments of Interior and Commerce*, 64 U. COLO. L. REV. 277 (1993); Albert C. Lin, *Participants' Experiences with Habitat Conservation Plans and Suggestions for Streamlining the Process*, 23 ECOLOGY L.Q. 369 (1996); Joel A. Mintz, "Neither the Best of Times Nor the Worst of Times": *EPA Enforcement During the Clinton Administration*, 35 ENVTL. L. REP. (Envtl. Law Inst.) 10,390 (2005) (evaluating enforcement performance through analysis of responses to a standard set of interview questions). In at least one case, a relevant article that did self-identify as empirical nonetheless failed our search criteria. See Jeffrey J. Rachlinski, *Noah by the Numbers: An Empirical Evaluation of the Endangered Species Act*, 82 CORNELL L. REV. 356 (1997) (reviewing CHARLES C. MANN & MARK L. PLUMMER, *NOAH'S CHOICE: THE FUTURE OF ENDANGERED SPECIES* (1995)).

28. See, e.g., Diamond & Mueller, *supra* note 4, at 585–88 (comparing the search algorithms employed by their study and previous studies).

29. Many law journals did not complete publication of their 2016 volumes by the end of the calendar year, so the number of empirical environmental law articles we counted in the second decade is a minimum estimate.

Table 1: Trend in Publication Dates of Empirical Environmental Law Articles.
This table shows the number of empirical environmental law articles published by year, as of January 1, 2017.

Year	Number of Articles
Before 1997	6
1997	5
1998	4
1999	1
2000	1
2001	2
2002	0
2003	2
2004	2
2005	3
2006	1
2007	3
2008	8
2009	2
2010	5
2011	5
2012	6
2013	3
2014	8
2015	2
2016	3
Total	73

A. Coding Basic Attributes

1. Specific Law or Doctrine Studied

Reflecting the prominence of the Environmental Protection Agency (EPA) statutes in environmental law scholarship, empirical environmental articles examined pollution control legislation far more frequently than other laws. Within the pollution control legislative category, the Clean Air Act, Clean Water Act, and hazardous waste statutes each appeared in fifteen to twenty empirical studies. The next most frequently cited law, the Endangered Species Act (ESA), appeared in only five articles. Table 2 summarizes the laws studied in the empirical environmental law scholarship we identified. Several articles did not address specific laws and instead focused on institutional behaviors, including the behavior of the judiciary, agencies, and private institutions.

Table 2: Laws Studied. *This table shows the numbers of articles, out of seventy-three, that addressed different laws. Articles may address more than one law. Some articles addressed issues, such as the judicial behavior, that do not address any particular environmental law.*

Law	Number of Articles
Federal pollution control statutes	33
Endangered Species Act	5
National Environmental Policy Act	4
Federal public land statutes	4
Other federal statutes (e.g., tax, energy)	4
Property and takings law	3
State environmental statutes	3
State water law	2

2. Data Source

Conventional legal scholarship interprets governmental decisions as data that reveal insights about the law. Court decisions traditionally dominated legal scholarship, but environmental law matured in an era when scholars increasingly turned to legislation and regulation to provide content for legal analysis. We include as legal documents any record carrying some force of law or embodying the decision of a government actor, such as an agency rule, program, permit, analysis, or enforcement record. In coding the empirical environmental law literature, we distinguished between legal documents and other sources of information. Nonlegal sources of information often drive environmental regulation initiatives. Table 3 shows that most nonlegal sources of data describe demographic facts (e.g., community racial composition, per capita income), economic information (e.g., prices), facility characteristics (e.g., pollution emissions), and land and resource use (e.g., siting information). Demographic information was the most common nonlegal data type employed in the empirical research. For instance, environmental justice empirical studies often employ census data to determine socioeconomic profiles of communities affected by hazardous waste facilities.³⁰ The empirical documentation showing racial disparities in impact helped prompt the EPA to establish its office of environmental justice in 1992.³¹ This line of environmental law research represents perhaps the high point of empirical environmental law research effectiveness in influencing administrative reform.

30. See, e.g., Robert D. Bullard, Paul Mohai, Robin Saha & Beverly Wright, *Toxic Wastes and Race at Twenty: Why Race Still Matters After All of These Years*, 38 ENVTL. L. 371, 372 (2008).

31. *Id.* at 380–81 (arguing that the empirical documentation alone would not have succeeded without advocacy).

Table 3: Nonlegal Data Sources Employed in Empirical Environmental Law Scholarship. *This table shows the numbers of articles (out of thirty-two coded for Category B2) that employed each type of nonlegal data. Articles may employ more than one type, so the numbers add up to more than thirty-two. Other types of data employed in fewer than five articles, not counted in the table, include ambient environmental conditions.*

Type of Nonlegal Data	Number of Articles
Demographic information (e.g., racial composition, per capita income)	18
Economic information (e.g., profit, prices)	6
Facility characteristics (e.g., facility type, pollution emissions)	5
Land and resource use (e.g., zoning, siting)	5

The data sources for some articles did not fit cleanly into either category. For example, Professors Eric Biber and Berry Brosi used data from the Fish and Wildlife Service's (FWS) ESA recovery priority ranking system to challenge the assumption that public participation via listing petitions and citizen suits misdirects agency resources.³² While the recovery priority rankings are a type of government decision, the rankings are based on real-world data reported by the FWS that the authors also used in their analysis.³³ We resolved this close call by coding the article in both the category for content analysis of government documents and quantitative analysis of nonlegal data.

3. Distinguishing Hypothesis Testing from Exploratory Analysis

We sought to distinguish between hypothesis testing, on the one hand, and descriptive or exploratory data analysis, on the other. Though there is no bright line between the two, hypothesis testing is associated with widely accepted, standard definitions and rules of analysis, such as "yes/no" triggers strictly defined by crossing a particular threshold of significance. Hypothesis testing requires all factors that impact the relevant outcome to be constant, so that the treatment (e.g., application of a regulation) can be verified as an isolated effect.³⁴ Therefore, it is most closely associated with experimental design

32. Biber & Brosi, *supra* note 15, at 324–25.

33. *Id.* at 335 ("FWS's recovery priority system ranks species according to (1) the degree to which the species is threatened with extinction; (2) the ease with which the species could be recovered; (3) the level of taxonomic uniqueness of a species; and (4) whether protection of the species would result in conflict with economic development, in that order of priority.")

34. Michael Greenstone & Ted Gayer, *Quasi-Experimental and Experimental Approaches to Environmental Economics*, 54 J. ENVTL. ECON. & MGMT. 21, 22 (2009).

(Category A3) and quasi-experimental comparisons (Category B3).³⁵ Exploratory analysis can be less formal—allowing for researchers to devise their own statistical tests—and more descriptive. It is more about measuring and less about testing. It is also nearly ubiquitous in empirical environmental law. Unlike our methodological categories, our study did not allow multiple coding for articles with exploratory analysis. If an article engaged in both exploratory data analysis and hypothesis testing, we coded it for hypothesis testing. We made this judgment even if the article’s primary thrust was descriptive and only tangentially tested a hypothesis.³⁶ Table 4 shows that 56 percent of the empirical environmental law articles employed hypothesis testing. If the article engaged in hypothesis testing, we also coded whether the authors use sophisticated statistical analysis such as multivariate regression or other testing algorithms, or only drew conclusions from empirical evidence to support or disprove a hypothesis. Where the articles did test hypotheses, most of the articles simply relied on counts of data rather than statistical analysis.

Table 4: Hypothesis Testing and Policy Recommendations. *This table shows the number of articles that engaged in narrow hypothesis testing and that offered specific policy recommendations, out of the seventy-three identified.*

Attribute	Number of Articles
Hypothesis testing	41
Policy recommendation	35
Hypothesis testing article that also offered policy recommendation	12

We counted articles as hypothesis testing only if the authors assessed the validity of a theory by attempting to identify observable implications that the researcher “would expect to detect in the real world if [their] theory is right.”³⁷ Well-designed hypothesis testing also identifies evidence against the theory being tested.³⁸ We did not categorize as hypothesis testing those articles engaging only in null hypothesis testing as part of a statistical test. Hypothesis testing for the purposes of this research must be attached to a theory. The authors must assess the validity of a theory by attempting to identify observable implications that the researcher “would expect to detect in the real world if [their] theory is right” and, ideally, by identifying evidence against the theory being tested.³⁹ Professor Kristen Engel’s *State Environmental Standard-*

35. See *infra* Part II.B for a detailed explanation of the categories.

36. See, e.g., James E. Krier & Stewart E. Sterk, *An Empirical Study of Implicit Takings*, 58 WM. & MARY L. REV. 35, 64 (2016) (conducting a descriptive, positive analysis of takings cases that incidentally highlighted an inconsistency between the results and the Priest-Klein hypothesis that lawyers settle cases in which outcomes appear certain).

37. Epstein & King, *supra* note 11, at 62.

38. *Id.* at 76.

39. *Id.* at 62.

Setting: Is There a “Race” and is it “To the Bottom”? is a prime example of research employing statistical techniques (though not ones that control for confounding variables) to test an established hypothesis.⁴⁰ Engel gathered information from the existing literature, her own surveys of environmental regulators, real-world economic indicators, and polluter location data to test the classic “race-to-the-bottom” theory.⁴¹ The theory posits that federal environmental standards need to establish a “floor” for regulation to prevent states from competing to retain and attract industry through ever more lax regulation. Engel combined multiple sources of data to produce an unusually convincing argument supporting the theory, though the debate about how generally the “race to the bottom” characterizes state behavior rages on twenty years later.

We categorized articles that do not seek to determine the validity of a narrowly drawn hypothesis as constituting exploratory data analysis. Exploratory analysis is particularly important in many areas of environmental law where broadly applicable theories have yet to be advanced. These articles may embrace statistical techniques, but they did not attempt to test any particular theory. Instead, they offer positive accounts of environmental law that are often not apparent without systematic study. For example, Professor Michael Vandenberg studied agreements that private firms and other actors entered into in response to public environmental law to analyze the influence of these “second-order” agreements on the regulatory administrative state.⁴² Our study applies an exploratory analysis to a coded dataset of articles to describe the contours of empirical environmental law.

A 2007 update of a landmark 1987 report commissioned by the United Church of Christ’s (UCC) Commission for Racial Justice illustrates the difficulty we sometimes encountered in differentiating between hypothesis testing and exploratory analysis.⁴³ The authors essentially retested the UCC’s 1987 hypothesis on the relationship between siting environmental “bads” and demographics, finding again that “[r]ace continues to be the predominant explanatory factor in [hazardous waste] facility locations and clearly still matters.”⁴⁴ However, the stated purpose of the new research is to update the UCC’s study using new census data, assess the progress of environmental justice over the past twenty years, and make policy recommendations accordingly. We categorized this research as an exploratory article because the

40. Kirsten H. Engel, *State Environmental Standard-Setting: Is There a “Race” and is it “To the Bottom”?*, 48 HASTINGS L.J. 271, 279–80 (1997).

41. *Id.* at 316.

42. Michael P. Vandenberg, *The Private Life of Public Law*, 105 COLUM. L. REV. 2029, 2034 (2005); cf. Amy L. Stein, *Climate Change Under NEPA: Avoiding Cursory Consideration of Greenhouse Gases*, 81 U. COLO. L. REV. 473, 485–86 (2010) (analyzing the impacts of litigation by environmental groups on “pressuring agencies to incorporate consideration of climate change into NEPA documents”).

43. Bullard, Mohai, Saha & Wright, *supra* note 30.

44. *Id.* at 372.

authors did not primarily aim to prove or disprove the UCC's 1987 findings. Our judgment on placing articles in different categories limits the replicability of our study.

4. Policy Recommendations

We also tracked whether the articles included a recommendation for law or policy changes based on empirical findings. We categorized articles as offering policy recommendations only if they included suggestions for concrete steps that lawmakers or administrators could take to advance a course of action that the author's research determined would be beneficial. Essentially, the study had to include "some framework for connecting 'is' and 'ought'" to link the quantitative results with normative goals.⁴⁵ For example, Engel engaged in a detailed discussion of specific policy recommendations to overcome the regulatory problem that she empirically verified.⁴⁶ A 2013 study of invasive plant regulation offered three specific actions that state legislatures should consider: establish a formal role for science advisory councils, define the term "invasive species" more precisely, and shift to a civil liability penalty regime to punish the introduction of invasive species.⁴⁷ Compared to other academic fields, legal scholarship is distinctive in its demand for a "punch line," the key policy-relevant recommendation that emerges from the insights discovered in the research. Therefore, it surprised us that 52 percent of the articles failed to offer specific recommendations.⁴⁸

Many empirical studies, even those testing hypotheses, stop short of recommendations. For instance, Professors Michael Toffel and Jodi Short tested "whether voluntary disclosure of self-detected compliance violations can reliably indicate to regulators the presence of effective self-policing efforts that might warrant a reduction in regulatory scrutiny of the disclosers."⁴⁹ Their research employed rigorous statistical methods, such as multivariate regression, and a combination of real-world environmental and government intervention data to advance a literature that had been "criticized for being 'noncommittal on the question of whether voluntary disclosure policies are worthwhile complements to conventional enforcement strategies,'" as well as to evaluate predictions of previous articles about self-policing's deterrent effects.⁵⁰ The

45. Joshua B. Fischman, *Reuniting 'Is' and 'Ought' in Empirical Legal Scholarship*, 162 U. PA. L. REV. 117, 120 (2013).

46. Engel, *supra* note 40, at 369–74.

47. James S. Neal McCubbins, A. Bryan Endres, Lauren Quinn & Jacob N. Barney, *Frayed Seams in the "Patchwork Quilt" of American Federalism: An Empirical Analysis of Invasive Plant Species Regulation*, 43 ENVTL. L. 35, 74–76 (2013).

48. See *infra* Part III.D for our speculations on the cause of this result.

49. Michael W. Toffel & Jodi L. Short, *Coming Clean and Cleaning Up: Does Voluntary Self-Reporting Indicate Effective Self-Policing?*, 54 J.L. & ECON. 609, 611 (2011).

50. *Id.* at 638. Toffel and Short's article is also an example of an article that tests an established theory using rigorous statistics.

authors suggest that self-policing could be a viable regulatory alternative, but recommend further research instead of suggesting any specific regulatory changes.⁵¹ Therefore, our narrow standard precluded counting the article as having a policy recommendation.

B. Coding Categories of Empirical Environmental Research

We modified Professors Michelle Mello and Kathryn Zeiler's 2008 framework for distinguishing among six different categories of empirical research.⁵² Our typology focuses on both the kind of data analyzed and the empirical method employed in the research.⁵³ Our categories are not exclusive, and many articles displayed more than one category of empirical environmental law. There is a clear dichotomy between articles that generate new data (Category A) and those that analyze existing data (Category B). Within the two categories of data, however, the boundaries between methods are often fuzzy. Among the articles generating new data, we distinguish among case studies (Category A1), surveys or interviews (Category A2), and experimental designs (Category A3). Where case studies supplement public information with data from interviews, we coded them as both A1 and A2.⁵⁴

Empirical environmental law scholarship uses methods of generating new data less often than methods analyzing existing data. Among the articles analyzing existing data, we distinguish among coding content of governmental documents (Category B1), quantitative analysis of existing data, generally from outside legal documents (Category B2), and controlled observational or quasi-experimental comparisons (Category B3). While the sources of data vary considerably in the existing data category, we found that coding content of documents (Category B1) in law journals always involved some kind of governmental decisions. Conversely, quantitative analysis (Category B2) of existing data generally involved sources from outside of legal documents,

51. *Id.* at 640.

52. Michelle M. Mello & Kathryn Zeiler, *Empirical Health Law Scholarship: The State of the Field*, 96 GEO. L.J. 649, 651–52 (2008) (describing two components of empirical scholarship: 1) utilization of data, and 2) employment of the scientific method). We also considered using Diamond and Mueller's one-through-four scale of empirical content (which incorporates Diamond's 2002 definition) and Humby's strong empirical/weak empirical dichotomy, but found that these approaches did not adequately capture the diversity of empirical environmental law studies. Diamond & Mueller, *supra* note 4, at 586 (categorizing articles along a single continuum by extent of original empirical work); Humby, *supra* note 25, at 101 (simply distinguishing between "weak empirical" and "strong empirical" research).

53. *Cf.* Korobkin, *supra* note 12, at 1038 (discussing two dimensions: source of data and main purpose of investigation). Though the type of analysis will generally emerge from the purpose of investigation, we believe coding for the analysis type is a more replicable approach, with fewer inferences, than identifying the purpose of investigation.

54. See David S. Caudill & Donald E. Curley, *Strategic Idealizations of Science to Oppose Environmental Regulation: A Case Study of Five TMDL Controversies*, 57 U. KAN. L. REV. 251, 254 (2009) (supplementing their documentation related to five Total Maximum Daily Loads (TMDLs) with interviews with EPA and Pennsylvania Department of Environmental Protection officials).

though they were often generated through governmental requirements, such as effluent monitoring under Clean Water Act permits.⁵⁵

Table 5: The Six Categories of Empirical Environmental Law Scholarship. This table shows the number of articles in each category of empirical legal scholarship out of the seventy-three identified.

Method	Category A Generate New Data	Category B Use Existing Data
1	Case study 11	Government document coding 34
2	Survey or interview 19	Nonlegal data 32
3	Experimental design 0	Quasi-experimental techniques 38

Table 5 summarizes our six categories. Many studies included more than one methodological approach. We adopted an inclusive approach to coding articles for the categories of empirical research—when in doubt about whether an article fit in a category, we coded affirmatively. Therefore, our findings err on the side of over-counting the variety of empirical work performed in each of the articles. Category B3 articles were the most common (thirty-eight of seventy-three), closely followed by Category B1 (thirty-four out of seventy-three) and Category B2 (thirty-two out of seventy-three). The following sections describe each empirical category and highlight articles that exemplify the category or illustrate its outer boundaries.

As a preliminary note, our categories do not differ in their rigor, which is related to trustworthiness of an empirical method in a variety of applications. One empirical method may have great rigor for a particular purpose but not another. For example, quantitative methods are often associated with rigor because they lend themselves to statistically robust tests. However, though quantitative methods may reduce complex case studies to statistically amenable coding, they may overlook the messier dynamics that tell a richer story about how the law operates.⁵⁶ Above all, it is important to recognize empirical research as instrumental. It is an approach to better understand some question about the law. Different questions demand different empirical methods of investigation. For instance, content analysis coding may better suit hypothesis

55. See Robert L. Glicksman & Dietrich H. Earnhart, *The Comparative Effectiveness of Government Interventions on Environmental Performance in the Chemical Industry*, 26 STAN. ENVTL. L.J. 317, 323–26 (2007).

56. Sergio Puig, *Does Bureaucratic Inertia Matter in Treaty Bargaining? Or, Toward a Greater Use of Qualitative Data in Empirical Legal Inquiries*, 12 SANTA CLARA J. INT'L L. 317, 320 (2013). Some scholars employed the analytical narrative approach drawing on game theory to help generate the richer narrative. See ROBERT H. BATES ET AL., ANALYTIC NARRATIVES 3 (1998).

testing than exploratory analysis.⁵⁷ We do not intend our categorical divisions to imply a judgment on the relative quality or usefulness of the research.

1. Category A1: Case Studies

Case studies examine a particular facet of environmental law through the intensive analysis of one or several illustrative situations. Qualitative case studies are the paradigm of doctrinal research. To qualify as empirical research for our purposes, these articles must attempt to measure the impacts of environmental law and policy in quantifiable ways, even if the sample size is small. Most of the articles in this category mix the quantitative accounts with deeper qualitative descriptions. Several studies, including the earliest empirical environmental law article by fourteen years,⁵⁸ conducted site-specific case studies of environmental decision making about pollution control and resource use.⁵⁹ Case studies may be mere positive descriptions of environmental law in action. Nevertheless, they often deploy empirical methods to critical effect. For instance, the earliest article carefully documented the cost-benefit analysis used by the Delaware Estuary Comprehensive Study to propose pollution control measures to the Delaware River Basin Commission.⁶⁰ The authors were able to dig behind the information released by public agencies to link compliance costs with waste-load data. They also learned about the pollution control standard-setting process through interviews with people representing the commission, polluters, and cities.⁶¹ Combining Categories A1, A2, and B2, they concluded that the pollution standard-setting exercise revealed the limits of cost-benefit analysis in honestly grappling with fundamental questions about environmental quality.⁶²

Four out of seven of the empirical articles on environmental justice included or focused entirely on case studies. The environmental racism theory posits that people bear unequal environmental risks based on race. Both proponents and critics of the theory found support in case studies. For example, Thomas Lambert and Christopher Boerner investigated the siting of hazardous waste sites in St. Louis and disputed the environmental racism hypotheses.⁶³

57. John B. Gates, *Content Analysis: Possibilities and Limits for Qualitative Data*, 73 JUDICATURE 202, 203 (1990).

58. Bruce A. Ackerman et al., *The Uncertain Search for Environmental Policy: The Costs and Benefits of Controlling Pollution Along the Delaware River*, 121 U. PA. L. REV. 1225, 1227 (1973).

59. See, e.g., Fred O. Boadu et al., *An Empirical Investigation of Institutional Change in Groundwater Management in Texas: The Edwards Aquifer Case*, 47 NAT. RESOURCES J. 117, 119 (2007) (analyzing a case study of the change in water appropriation rules in the Edwards Aquifer from a rule of capture to a permit system); Caudill & Curley, *supra* note 54, at 253–54 (analyzing a case study of disputes surrounding five TMDLs issued to pollutant dischargers in Philadelphia).

60. Ackerman et al., *supra* note 58.

61. *Id.* at 1247.

62. *Id.* at 1290.

63. Thomas Lambert & Christopher Boerner, *Environmental Inequity: Economic Causes, Economic Solutions*, 14 YALE J. ON REG. 195, 203–04 (1997).

They found “no significant difference in poverty rates and percentages of minority residents between census tracts with active [waste] facilities” and those without, and weak evidence of a difference when inactive hazardous waste facilities were included in the study.⁶⁴ Racial disparities across census tracts only became noticeable when significant disparities in housing values were already present. The authors concluded that low housing values caused by existing environmental problems attracted minority and poor residents to move in and white residents to leave, “as opposed to the contrary causation assumptions made by environmental discrimination theorists.”⁶⁵ That same year, Marie Kirk and Christine Wade analyzed the flow of tax revenue from hazardous waste facilities in three California communities and found that the low-income communities of color harmed by hazardous waste saw little benefit from the revenues.⁶⁶ The environmental justice articles also illustrate how development of case studies often employs some existing data. As Table 6 illustrates, more than half of Category A1 publications also employ research methods from Category B2.⁶⁷

Table 6: Co-occurrence of Categories of Empirical Environmental Law Articles. *This table shows the number of articles in each category of empirical legal scholarship that also meet the criteria for another category, out of the seventy-three identified.*

	A1	A2	A3	B1	B2	B3
A2	4					
A3	0	0				
B1	1	5	0			
B2	6	7	0	7		
B3	3	9	0	14	21	

64. *Id.* at 203.

65. *Id.* at 204.

66. Marie A. Kirk & Christine L. Wade, *A Taxing Problem for Environmental Justice: The Tax Money from Hazardous Waste Facilities, Where It Goes, and What It Means*, 16 STAN. ENVTL. L.J. 201, 203–04 (1997).

67. *See supra* Part II.B.1.

2. Category A2: Survey and Interview Data

These articles included data from surveys or interviews conducted by the authors, and were the only examples of authors conducting field research of their own instead of relying on data collected by others. Though such surveys may be considered a kind of experiment,⁶⁸ we separated them from more conventional experimental designs that randomize treatments. Professor Sally Simpson et al.'s study of corporate environmental crime control strategies exemplifies the core of Category A2: a study based entirely on an author-designed and administered survey.⁶⁹ Recognizing that official data sources cannot possibly include undiscovered crimes or managers' thought processes, the authors constructed a factorial survey⁷⁰ to compare the effects of command-and-control versus self-regulation crime control strategies on managerial decision making.⁷¹ The authors found that, for this group of respondents, the threat of both types of strategies were nearly as effective, but did not "substantially lessen the powerful influence of career benefits on offending intentions."⁷²

Table 6 shows that several articles coded in Category A2 employ surveys to supplement systematic content analysis of government documents or some other research approach.⁷³ For example, Professor Dave Owen reported on semi-structured interviews to gather qualitative data from federal agency employees⁷⁴ on their impression of the effects of critical habitat designation on the outcome of ESA biological opinions.⁷⁵ The interview data served to round out the conclusions Owen drew from his analysis of over four thousand biological opinions (a Category B1 method—Coding Government Decisions). However, they did not constitute the core dataset on which the article is based, unlike other Category A2 articles.

68. Adam Chilton & Dustin Tingley, *Why the Study of International Law Needs Experiments*, 52 COLUM. J. TRANSNAT'L L. 173, 226–31 (2013).

69. Sally S. Simpson et al., *An Empirical Assessment of Corporate Environmental Crime-Control Strategies*, 103 J. CRIM. L. & CRIMINOLOGY 231, 242–44 (2013).

70. *Id.* The authors explain that:

Factorial surveys combine experimentally manipulated hypothetical scenarios (vignettes) with survey questions to measure respondents' intentions, decisions, attitudes, or judgments. These designs, unlike more traditional survey techniques, allow researchers to manipulate a full range of circumstances that may affect a decision—essentially taking into account the complexity and richness in the way people approach decisions and evaluations.

Id. at 242 (internal quotations and citations removed).

71. *Id.* at 234.

72. *Id.* at 263 ("[F]or every unit increase in sanction risk, the odds of being willing to offend decrease by 43% for formal sanctions and 51% for informal sanctions.").

73. See *supra* Part II.B.1.

74. Dave Owen, *Critical Habitat and the Challenge of Regulating Small Harms*, 64 FLA. L. REV. 141, 163, 173 (2012).

75. See generally 16 U.S.C. § 1533 (2012) (designation of critical habitat); *id.* § 1536(b) (biological opinions).

3. Category A3: Experimental Design

Experimental designs use randomized treatments on study participants to assess policy interventions while minimizing the impact of confounding variables more than can be achieved with multivariate regression analysis alone.⁷⁶ The random treatment element seeks to reduce selection bias. The best experiments involve people, places, or situations where the treatment and the control groups are as identical as possible except for the treatment itself. Thus, any differences in outcomes can be credited to the treatment.⁷⁷

Experimental designs are the paradigm of the scientific method for testing hypotheses about causation. Mello and Zeiler call this form of empirical research the “gold standard.”⁷⁸ Other scholars note that deductive argumentation in law makes field observation more useful, which may explain why we encountered no articles in this category. In fact, as with all methods, experiments bring both advantages and disadvantages to the problem of testing theories.⁷⁹ The chief advantage is the control of extraneous factors to selectively separate different possible explanations for results. Experiments are also more likely to be replicable. On the other hand, laboratory conditions never completely mirror the real world. A theory confirmed in a laboratory may not explain reality.⁸⁰

Some legal fields embracing empirical methods have tested many theories about how the law works.⁸¹ However, these methods are a poor fit for most research in environmental law, which defies laboratory study. Studying environmental law is more like studying ecology: researchers have to observe effects *in situ*, embedded in the messy realities of the world where interventions are seldom random. Still, some of the experimental research published in law journals, while not expressly connected to an environmental law problem (and thus outside of the scope of our study), does offer useful lessons for environmental law. For instance, Professor Jeremy Blumenthal’s experiments on group deliberation and the endowment effect could be adapted to environmental law issues.⁸² Such experiments would contribute to our

76. See Mello & Zeiler, *supra* note 52, at 660; see also Donald P. Green & Dane R. Thorley, *Field Experimentation and the Study of Law and Policy*, 10 ANN. REV. L. & SOC. SCI. 53, 54 (2014) (examining the growth of experimental field studies in a variety of legal domains).

77. Greenstone & Gayer, *supra* note 34, at 27.

78. Mello & Zeiler, *supra* note 52, at 660. Other researchers point to the artifacts of experimental approaches, such as the use of homogeneous subjects of college students, as a basis to prefer non-experimental empirical approaches.

79. See Rachel Croson, *Why and How to Experiment: Methodologies from Experimental Economics*, 2002 U. ILL. L. REV. 921, 922 (2002).

80. *Id.* at 922–23.

81. See, e.g., Jean Braucher et al., *Race, Attorney Influence, and Bankruptcy Chapter Choice*, 9 J. EMPIRICAL L. STUD. 393, 393–97 (2012) (discussing studies finding that attorneys play a key role in chapter choice and that they tend to guide African Americans disproportionately toward one particular choice).

82. Jeremy A. Blumenthal, *Group Deliberation and the Endowment Effect: An Experimental Study*, 50 HOUSTON L. REV. 41 (2012).

understanding of the limits of contingent valuation in environmental impact analysis and cost-benefit balancing. Therefore, we included experimental design as a plausible category for empirical environmental law methods that generate new data. If we had not carved out a special category for interviews and surveys, many articles currently coded Category A2 would have qualified as employing experimental designs.

While no articles included in our study met the randomization requirement, Vandenberg's "conceptual framework that accounts for the influence of norms on environmental decision-making" could be adapted by future researchers into a replicable experimental framework.⁸³ For instance, Vandenberg discusses how testable hypotheses about the deterrence effects of various internal norms could be verified or disproved through behavior psychology experiments.⁸⁴ In general, the intersection of law and psychology lends itself to exploration through experimental design,⁸⁵ though the literature underrepresents environmental law. Cognitive and social psychology have already offered important frameworks for discovering how people perceive and decide environmental conflicts.⁸⁶ Experimental, behavioral economics also offers many model studies that can be adapted for environmental law reform.⁸⁷ Finally, though less common to legal scholarship than economics, methods from other social sciences have productively unmasked the assumptions of economic approaches to data methods.⁸⁸ Legal scholars have a wealth of options in designing new experimental approaches to better understand how people project meaning onto the environment.

4. Category B1: Coding Government Decisions

Category B1 studies share two characteristics: 1) the authors analyze and code the content of all or a large random sample of cases or other government decisions on a particular subject matter, and 2) the authors draw "inferences based on both [this] thematic analysis and frequency counts of various [decision] characteristics."⁸⁹ Characteristic of studies that generate data through

83. Vandenberg, *supra* note 5, at 57.

84. *Id.* at 141, 143. Vandenberg subsequently coauthored a study that undertook a test of his norms hypothesis through surveys. Simpson et al., *supra* note 69.

85. See, e.g., Quintanilla & Kaiser, *supra* note 1 (discussing how psychological experiments have disproved the basis for the "same-actor" inference in federal common law).

86. See, e.g., PAUL SLOVIC, THE PERCEPTION OF RISK 1–6 (2000) (comparing utility theory to bounded rationality and how they affect individuals' perceptions of the risk of extreme natural events).

87. E.g., Fredrik Carlsson & Olof Johansson-Stenman, *Behavioral Economics and Environmental Policy*, 4 ANN. REV. RESOURCE ECON. 75, 93 (2012) (discussing how behavior economics can advance environmental resource economics); cf. Elizabeth Hoffman & Matthew L. Spitzer, *Experimental Law and Economics: An Introduction*, 85 COLUM. L. REV. 991, 1002–03 (1985) (introducing laboratory experiments to research in law and economics).

88. William Boyd et al., *Law, Environment, and the "Nondismal" Social Sciences*, 8 ANN. REV. L. & SOC. SCI. 183, 184 (2016).

89. Mello & Zeiler, *supra* note 52, at 658.

coding are the qualitative judgments supporting the coding choices. Authors conducting Category B1 studies of environmental law most frequently use data from judicial decisions. These studies also analyze regulations and state and federal statutes, but they rarely use other agency decision documents.

Professor Jason Czarnecki's 2008 study of the *Chevron* Doctrine as applied in environmental law cases is a clear example of a typical coding analysis of government decisions.⁹⁰ He examined three years of U.S. Court of Appeals environmental law cases and coded them for several criteria, including *Chevron* deference and outcome for the EPA, to address questions about judicial review of agency interpretation of environmental law.⁹¹ Stein's 2010 study of environmental impact statements issued for energy exploration activities is an example of a rare qualitative analysis of these types of agency documents⁹²—a somewhat surprising result, given the wealth of data available in these environmental analyses. Though other articles dealt with the National Environmental Policy Act (NEPA) as a subject of litigation,⁹³ only one other article grappled with the content of environmental impact statements.⁹⁴

Another example of coding agency documents in order to engage in quantitative analysis examined biological opinions required by the ESA.⁹⁵ Owen assessed how the documents implemented a statutory duty to protect critical habitat from adverse modification. While Owen's study reported the service biologists' jeopardy, adverse modification, and take findings in biological opinions, his article did not include after-the-fact data measurements from the real world as a Category B2 article would. He did, however, fine tune his conclusions based on Category A2 interviews.

To count as an analysis of government decisions, Category B1 articles must analyze the content of the government decision, not merely whether a decision was made. As with all of our categories, there are difficult judgment calls in placing an article that seems to straddle boundaries. For instance, Professor Lesley McAllister's *Enforcing Cap-and-Trade: A Tale of Two Programs* comfortably fits in Category A1 as a case study.⁹⁶ However, it fails to qualify in Category B1 because, even though she counted notices of

90. Jason J. Czarnecki, *An Empirical Investigation of Judicial Decisionmaking, Statutory Interpretation, and the Chevron Doctrine in Environmental Law*, 79 U. COLO. L. REV. 767 (2008).

91. *Id.* at 786–87.

92. Stein, *supra* note 42, at 500–17.

93. See, e.g., David Markell & J.B. Ruhl, *An Empirical Assessment of Climate Change in the Courts: A New Jurisprudence or Business as Usual?*, 64 FLA. L. REV. 15, 57–65 (2012) (examining all climate change litigation matters filed in 2010 and 2011).

94. See John Ruple & Mark Capone, *NEPA, FLPMA, and Impact Reduction: An Empirical Assessment of BLM Resource Management Planning and NEPA in the Mountain West*, 46 ENVTL. L. 953 (2016) (reviewing sixteen environmental impact statements that underwent revisions by the Bureau of Land Management).

95. Owen, *supra* note 74, at 165.

96. Lesley K. McAllister, *Enforcing Cap-and-Trade: A Tale of Two Programs*, 2 SAN DIEGO J. CLIMATE & ENERGY L. 1 (2010) (comparing the Acid Rain and Regional Clean Air Incentives Market programs).

violation and tracked the reason for their being issued, she did not categorize content through coding. Similarly, we excluded Professors Victor Flatt and Paul Collins's environmental enforcement research from Category B1 because the authors only tallied government-issued penalties.⁹⁷ They did not analyze government decision-making documents and make categorization decisions based on the contents. The article is, nonetheless, an excellent example of empirical environmental law research employing quasi-experimental tools (Category B3). In contrast, Professors David Caudill and Donald Curley's case study *codes* rather than *counts* the arguments in the public record in order to examine how stakeholders criticize water-quality decisions relating to impaired waters surrounding Philadelphia.⁹⁸ It therefore qualifies as Categories A1 and B1. Category B1 articles may include some simple descriptive statistics, such as mean, standard deviation, frequency, or proportion. Any statistical analysis that attempts to control for confounding variables would also be classified as a controlled observational or quasi-experimental study (Category B3).

5. *Category B2: Quantitative Analysis of Data Other than Government Decisions*

These studies undertake quantitative analysis of environmental or socioeconomic data to test the effects of a policy or other legal decision making on the "real" world. Category B2 studies ranged from assessments of whether hazardous waste facility siting was racially based⁹⁹ (a particularly hot topic in the 1990s) to western water market structure.¹⁰⁰ We classified articles as Category B2 if they used any statistical technique, from simple descriptive statistics to univariate or bivariate analysis, as long as the analysis examined actual environmental or social data—not simply information contained in a legal document. We consider data from permit reporting requirements (as opposed to the permits themselves, which are government decisions) as B2-eligible data, which we coded as facility characteristics in Table 3. For example, Professors Robert Glicksman and Dietrich Earnhart's study of environmental performance falls in Category B2 because it employed discharge levels reported as part of permit compliance to address the effectiveness of enforcement interventions.¹⁰¹ Table 3 tallies the numbers of articles using

97. Victor B. Flatt & Paul M. Collins, Jr., *Environmental Enforcement in Dire Straits: There Is No Protection for Nothing and No Data for Free*, 85 NOTRE DAME L. REV. 55, 73 (2009).

98. Caudill & Curley, *supra* note 54, at 264–65. In supplementing the public record by interviewing stakeholders, the study also falls into Category A2. *Id.* at 262–63.

99. See, e.g., Lambert & Boerner, *supra* note 63, at 204 (analyzing the demographic characteristics of the population surrounding hazardous waste facilities).

100. Kristiana Hansen et al., *An Econometric Test of Water Market Structure in the Western United States*, 55 NAT. RESOURCES J. 127 (2014).

101. Robert L. Glicksman & Dietrich H. Earnhart, *Effectiveness of Government Interventions at Inducing Better Environmental Performance: Does Effectiveness Depend on Facility or Firm Features?*, 35 B.C. ENVTL. AFF. L. REV. 479, 495–96 (2008).

different types of nonlegal data, which included census reports, hazardous waste facility information, industrial effluent data, and land-use records.

6. *Category B3: Controlled Observational or Quasi-Experimental Studies*

Category B3 articles are “[m]ore sophisticated designs—controlled observational or quasi-experimental studies using multivariate regression techniques” to “control for confounding variables.”¹⁰² Because much environmental law research investigates the effect of a new rule, quasi-experimental studies can illuminate why something measurable (e.g., asthma-related hospital admissions) changed after the new rule took effect. Quasi-experimental methods must be applied opportunistically whenever nature, politics, or an accident creates some difference where there formerly was none.¹⁰³ The “pre/post analysis” version of Category B3 simply compares outcomes before a new rule with those after.¹⁰⁴ Though exogenous environmental changes may also occur in the time frame, multivariate regression analyses may be employed to identify and separate out some effects that are not due to the rule change.¹⁰⁵ A famous example of this kind of opportunistic quasi-experiment debunked a long-assumed association of reduced energy consumption and daylight saving time (DST). When Indiana moved from using DST for some of its counties to imposing DST for most of its counties in 2006, Professors Matthew Kotchen and Laura Grant compared the electricity consumption of different counties over the transition period.¹⁰⁶ For legal regimes that vary by state, comparing relevant data across jurisdictions can also yield quasi-experimental evidence about effects much as comparing counties new to DST with those that had long used DST helped show the energy consumption effects. This is a commonly employed tool in other areas of law,¹⁰⁷ such as torts, where federal uniformity is weak.

We limited coding for this category to studies that employed analyses to enhance the accuracy of their study by controlling for confounding variables. For example, though a close call, we did not include Professor David Uhlmann’s *Prosecutorial Discretion and Environmental Crime* in Category B3 because he did not report results of regression and correlation models.¹⁰⁸ He indicated that he performed the analyses but rejected them as inadequate to

102. Mello & Zeiler, *supra* note 52, at 659.

103. Greenstone & Gayer, *supra* note 34, at 31.

104. Mello & Zeiler, *supra* note 52, at 652, 659.

105. *Id.* at 660.

106. Matthew J. Kotchen & Laura E. Grant, *Does Daylight Saving Time Save Energy? Evidence from a Natural Experiment in Indiana*, 93 REV. ECON. & STATISTICS 1172, 1173 (2011) (finding that though saving time saves on electricity used for lighting, it prompts increases for heating and cooling).

107. E.g., Thomas E. Willging, *Past and Potential Uses of Empirical Research in Civil Rulemaking*, 77 NOTRE DAME L. REV. 1121, 1132 (2002) (describing the prevalence of controlled observational and quasi-experimental methods in law and economics).

108. David M. Uhlmann, *Prosecutorial Discretion and Environmental Crime*, 38 HARV. ENVTL. L. REV. 159 (2014).

explain the relationship among aggravating factors in environmental prosecutions.¹⁰⁹ Despite our stringent coding practice, more articles employed this method than any other one. One reason may be the influence that economics has had on empirical legal scholarship—quasi-experimental techniques are common in economics literature.¹¹⁰

The Category B3 articles may include data from any of the other categories, and also fit the “uses statistics” requirement of the more restrictive definitions of an empirical study.¹¹¹ Researchers frequently used real-world, B2 data as the basis for testing the effects of environmental laws and policies, so many articles (44 percent) fell into both Category B2 and Category B3 (Table 6). For instance, Professor Vicki Been et al. drew conclusions from a descriptive statistical analysis of New York City zoning decisions by analyzing city services, housing market, homeownership, voting, income, and racial demographic variables (Category B2).¹¹² The authors also conducted a multivariate regression to disprove the hypothesis that local voters are more powerful than real estate developers in suburbs as compared to cities when it comes to rezoning (Category B3 and hypothesis testing article).¹¹³ Other Category B2 and B3 articles used facility-level data from the Toxic Release Inventory to assess the effectiveness of voluntary EPA pollution control programs,¹¹⁴ or a combination of demographic and environmental data to assess the effects of state environmental standard-setting.¹¹⁵ Professor Richard Revesz’s rigorous 1997 study of the influence of political ideology on judicial decision making in environmental cases is by far the most highly cited article in our study, and a clear example of both a Category B1 and Category B3 approach.¹¹⁶

A few Category B3 articles do not employ data from any other category. Professors Howard Chang and Hilary Sigman interrogated data on cost recovery shares from the EPA’s accounting databases related to the

109. *Id.* at 204 n.164.

110. *See, e.g.*, Dean Lueck & Jeffrey A. Michael, *Preemptive Habitat Destruction Under the Endangered Species Act*, 46 J.L. & ECON. 27 (2003) (a widely cited study documenting that the proximity of timberlands to known endangered owl locations corresponds to earlier timber harvesting).

111. *See* George, *supra* note 1, at 147 (determining empirical legal scholarship using statistical phrases such as “statistical significance” and “quantitative”).

112. Vicki Been et al., *Urban Land-Use Regulation: Are Homevoters Overtaking the Growth Machine?*, 11 J. EMPIRICAL LEGAL STUD. 227, 252–54 (2014).

113. *Id.* at 259.

114. *See* Robert Innes & Abdoul G. Sam, *Voluntary Pollution Reductions and the Enforcement of Environmental Law: An Empirical Study of the 33/50 Program*, 51 J.L. & ECON. 271, 276–81 (2008); Toffel & Short, *supra* note 49, at 620.

115. *See* Scott R. Saleska & Kirsten H. Engel, “Facts Are Stubborn Things”: *An Empirical Reality Check in the Theoretical Debate over the Race-to-the-Bottom in State Environmental Standard-Setting*, 8 CORNELL J.L. & PUB. POL’Y 55, 66 (1998).

116. Revesz, *supra* note 13.

Comprehensive Environmental Response, Compensation, and Liability Act.¹¹⁷ They tested the theory that the government would recover more in actions under joint and several liability than it would under individually apportioned liability.¹¹⁸ We did not count the information taken from the EPA databases as falling into Category B1 because the authors did not code or qualitatively analyze a government decision; instead, the authors used the quantity of money recorded in the database as having been recovered by a government decision.¹¹⁹ The article did not fall into category B2 because the quantity of a financial penalty did not meet our definition of nonlegal data. It is one of the only four clear Category B3 articles that did not fall within the scope of any of our other categories.

III. DISCUSSION AND RECOMMENDATIONS

Our most important result is that only a small number of articles can fairly be characterized as part of the rigorous, new empirical law movement. The seventy-three articles we identified as meeting both our empirical and environmental law definitions are a drop in the bucket of each of those categories. Overall, law journals publish between four hundred and five hundred environmental law articles each year.¹²⁰ Though it is not as straightforward to estimate what proportion of empirical law scholarship the seventy-three articles constitute, Diamond and Mueller, employing a definition for “empirical” similar to our study, estimated that nearly half of all law review articles included some empirical content.¹²¹ By that rough measure, environmental law scholarship underperforms in empirical research relative to legal scholarship on the whole. However, as we discussed in the beginning of Part II, our narrow search scope undercounts empirical research that does not label itself as such or employ conventional methods of presenting data.

Could the culture of environmental law scholarship have limited researchers? Michael Faure suggests that environmental lawyers do not use available data on the effectiveness of environmental laws because the results of that research are not published in journals tailored to lawyers.¹²² However, we have no reason to believe that the culture of environmental law is any more parochial than other fields that have embraced empirical research more readily. Instead, a closer look at the published empirical scholarship and characteristics of environmental law may offer some hints to explain the relatively low

117. 42 U.S.C. §§ 9601–9675 (2012); Howard F. Chang & Hilary Sigman, *An Empirical Analysis of Cost Recovery in Superfund Cases: Implications for Brownfields and Joint and Several Liability*, 11 J. EMPIRICAL LEGAL STUD. 477 (2014).

118. Chang & Sigman, *supra* note 117, at 501–02.

119. *Id.* at 483–85.

120. Breggin et al., *supra* note 19.

121. Diamond & Mueller, *supra* note 4.

122. Michael Faure, *Effectiveness of Environmental Law: What Does the Evidence Tell Us?*, 36 WM. & MARY ENVTL. L. & POL’Y REV. 293, 295 (2012).

proportion of empirical studies. This does not mean that environmental scholarship has too few empirical studies relative to other fields, many of which may have an even smaller proportion of published empirical work. The relatively small sample size of the published empirical environmental law scholarship counsels caution in drawing too many conclusions about what is distinctive about empirical environmental law based solely on the coding of the articles. Yet, we can offer additional observations about our results despite the limitations in our search method, which required that articles self-identify as “empirical” and excluded several studies that otherwise fall within an empirical framework.

A. Describing the Legal Landscape

In their survey of environmental law professors, Owen and Professor Caroline Noblet found that their subjects who engage in interdisciplinary research do so because they “hope to make their work more practical and useful.”¹²³ Empirical approaches typically emerge from interdisciplinary academic work but could be used by non-scholars, such as advocates, agency officials, and legislators.¹²⁴ The scope of environmental law and the range of disciplinary approaches, mostly borrowed from the social sciences, preclude detailed recommendations of study designs for particular statutory programs or common dispute categories. However, we can venture some suggestions for empirical research agendas to inform and test common approaches to environmental law.¹²⁵

As with most fields of legal scholarship, environmental law articles are often normative, argumentative, or theoretical.¹²⁶ While employing some positive presumptions about the world, such claims are often peripheral to the central point of the article. Our least controversial suggestion is that articles that are mostly about positive law, such as ones that identify a dominant type of a rule,¹²⁷ should employ more empirical methods. Environmental law scholarship encompasses a diverse range of methods.¹²⁸ Good scholarship

123. Dave Owen & Caroline Noblet, *Interdisciplinary Research and Environmental Law*, 41 *ECOLOGY L.Q.* 887, 891 (2014).

124. *Id.* at 918–19.

125. Korobkin, *supra* note 12, at 1043 (explaining three aims of empirical work: describe the contours of law as implemented by the government (including judicial interpretations); understand causal connections; and evaluate the merits of reform proposals).

126. Compare John P. Dwyer, *The Pathology of Symbolic Legislation*, 17 *ECOLOGY L. Q.* 233, 234–36 (1990) (argumentative), with Robert J. Goldstein, *Green Wood in the Bundle of Sticks: Fitting Environmental Ethics and Ecology into Real Property Law*, 25 *B.C. ENVTL. AFF. L. REV.* 347, 430 (1998) (normative), with Zygmunt J.B. Plater, *From the Beginning, a Fundamental Shift of Paradigms: A Theory and Short History of Environmental Law*, 27 *LOY. L.A. L. REV.* 981 (1994) (theoretical).

127. See, e.g., Peter A. Appel, *Wilderness, the Courts, and the Effect of Politics on Judicial Decisionmaking*, 35 *HARV. ENVTL. L. REV.* 275, 277–78 (2011).

128. Fisher et al., *supra* note 3, at 231–34.

employs methods well-tailored to answer questions posed.¹²⁹ Empiricism is, at its core, about bringing rigor to assertions describing the world. Therefore, descriptive scholarship is an area where greater reliance on systematic, quantitative methods would yield rewards.

Doctrinal analysis has always sought to describe the law, usually as implemented by courts. Empirical research can augment doctrinal legal scholarship by providing a finer grained, quantitative analysis of relevant cases. Of particular interest are empirical studies that question the descriptive accuracy of generally accepted “black letter law.”¹³⁰ For instance, Professor Peter Appel’s analysis of judicial ideology and Wilderness Act decisions¹³¹ contradicted the conventional wisdom that liberal judges favor more environmental protection and conservative judges less.¹³² He found that the decisions overall had a pro-wilderness bent that defied predictions based on the traditional legal or attitudinal models of judicial review.¹³³ Though doctrinal scholarship will continue to generate important explanations and critiques of court and agency reasoning, empirical scholarship will illuminate how important such reasoning is to outcomes. Often, legal scholarship gravitates toward unusual case outcomes or novel reasoning. These phenomena are important and often point the way toward reform. However, they can present a deceptive picture of how courts and agencies typically work through adjudication. For instance, Professors James Krier and Stewart Sterk contrasted the dominant doctrinal descriptions of takings law as defined by the U.S. Supreme Court with the positive finding that the vast majority of judicial adjudications fail to rely on those doctrines.¹³⁴ Instead, most courts generally provide “less protection than the Court insists they must. When regulation is at issue, state courts, like the Supreme Court, appear content to leave local officials accountable to voters, not to judges.”¹³⁵ In this manner, systematic, quantitative analysis can improve the accuracy of doctrinal research.

Even purely descriptive empirical research can help pinpoint whether environmental law makes a difference in the quality of the ambient environment. One of us has previously described the Whiggish narratives of “progress” toward the present that often accompany agency reports on ambient

129. *Id.*

130. *See, e.g.,* Korobkin, *supra* note 12, at 1044.

131. Appel, *supra* note 127.

132. *See id.*; Czarnecki, *supra* note 90, at 768; Revesz, *supra* note 13, at 1717–18.

133. Appel, *supra* note 127. Appel’s conclusions are questioned by Joseph M. Feller, *Have Judges Gone Wild? Plaintiffs’ Choices and Success Rates in Litigation against Federal Administrative Agencies*, 44 ENVTL. L. 287, 289–93 (2014).

134. Krier & Sterk, *supra* note 36, at 40 (concluding that Supreme Court doctrine “supports property rights with rhetoric of symbolic importance but little, if any, operational significance”).

135. *Id.* at 94.

environmental quality.¹³⁶ For instance, the 1989 Council on Environmental Quality annual report boasted that

the experience of the past two decades . . . suggests that Americans in 2010 will respond to environmental problems with energy, creativity, and a deep-seated sense of responsibility for future generations. Americans believe strongly that environmental quality is an essential component of their long-term health and economic prosperity. They have demonstrated that they have the will to protect environmental quality and the capacity to act. The lessons of the past 20 years can give all Americans hope for the future.¹³⁷

These narratives often emphasize decreases in pollution emissions, but may not link them to ambient or exposure measures. Changes in ambient environmental quality or exposure may be prompted more by economic and meteorological cycles than by environmental law. Available data may limit the ability of empirical research to tease out the relationship between implementation of environmental law (measured outputs) and environmental quality (outcomes, or “measures of merit”). This is one reason to perform randomized field experiments,¹³⁸ though they may not be feasible for answering many questions in environmental law.

Until researchers collect better data, existing sources may provide some insights. Environmental law scholars can build on the already strong presence of quasi-experimental approaches we found in the existing literature. Regression analysis to support causal inferences is of special concern in this method of research.¹³⁹ A major contribution to environmental law would be to gather data, some readily available—such as the timeline of Title V Clean Air Act permits from draft to finalization¹⁴⁰ or site closure documents¹⁴¹—and test causes of delay. Our findings suggest that environmental law scholars are adept at interrogating existing data to look for causal patterns. Refining these methods, as described below, would provide a more credible map to the factors that correspond with environmental law successes and failures.

136. Robert L. Fischman, *Predictions and Prescriptions for the Endangered Species Act*, 34 ENVTL. L. 451, 469 (2004) (“The Whig narratives generally follow the same outline: Dramatic environmental degradation (e.g., flaming rivers, oil-slicked beaches, killer smog) led to governmental action that abated the worst offenders.”).

137. COUNCIL ON ENVTL. QUALITY, ENVIRONMENTAL QUALITY: THE TWENTIETH ANNUAL REPORT OF THE COUNCIL ON ENVIRONMENTAL QUALITY 13 (1989).

138. See Green & Thorley, *supra* note 76, at 54–56.

139. See generally Epstein & King, *supra* note 11 (providing a primer on empirical research design and implications as applied to legal scholarship).

140. Such information can often be accessed on government websites. See, e.g., *Region 5 Electronic Permits*, EPA, <https://www.epa.gov/caa-permitting/region-5-electronic-permits#mipermits> (last updated June 13, 2017).

141. Such information can often be accessed on government websites. See, e.g., *Virtual File Cabinet*, IND. DEP’T OF ENVTL. MGMT., <http://vfc.idem.in.gov/DocumentSearch.aspx> (last visited Feb. 20, 2017).

B. Existing Data (Category B)

Without readily accessible, relevant databases, environmental law scholars are left to build their own datasets, a daunting proposition, or be more creative about what existing data may suggest indirectly. Most of the published empirical environmental studies analyze existing data (Table 5). Existing legal databases, such as Westlaw and Lexis, continue to grow in scope and remain important sources.¹⁴² Many critical sources of existing data reside in government documents spread across multiple agencies with varying recordkeeping practices and search algorithms. Some, such as permits, contain excellent proxy measures for pollution control, and are discussed below. Others, such as environmental analyses in NEPA¹⁴³ and ESA¹⁴⁴ documents, contain rich details about the ambient environment and effects of the full range of human interventions. Canvassing those effects and methods of mitigating environmental damage by systematically organizing the content holds promise as a project that could expand the empirical dimension of legal document coding.

For example, Professor John Ruple and Mark Capone dug into draft, final, and supplemental environmental impact statements to extract surprisingly fine-grained information.¹⁴⁵ The information allowed for exploratory data analysis not just of environmental impacts of resource management decisions but also estimates of jobs created and air emissions that would result from alternative management options.¹⁴⁶ More impressive still, they were able to document elusive effects of various kinds of NEPA compliance, such as the connection between accelerated completion schedules for draft environmental statements and the need for supplemental statements.¹⁴⁷ Though NEPA is nearly fifty years old, their work is path-breaking. It illustrates how relatively simple research designs can contribute to better understanding of laws whose impacts have long been the subject of speculation.¹⁴⁸

Environmental law can learn from the efforts of other specialties to make data available for researchers. Civil procedure scholars have long made use of the federal Public Access to Court Electronic Records website.¹⁴⁹ It collects case filings and docket information but may be prohibitively expensive for researchers outside of the Federal Judicial Center.¹⁵⁰ Some legal fields employ

142. See, e.g., Appel, *supra* note 127, at 294.

143. National Environmental Policy Act, 42 U.S.C. §§ 4321–4370(f) (2012).

144. Endangered Species Act, 16 U.S.C. §§ 1531–1541 (2012).

145. Ruple & Capone, *supra* note 94.

146. *Id.* at 972–73.

147. *Id.* at 962.

148. See generally Joseph L. Sax, *The (Unhappy) Truth About NEPA*, 26 OKLA. L. REV. 239 (1973).

149. PUBLIC ACCESS TO COURT ELECTRONIC RECORDS, <https://www.pacer.gov/> (last visited Sept. 30, 2017).

150. FEDERAL JUDICIAL CENTER, <https://www.fjc.gov/> (last visited Sept. 30, 2017). The Federal Judicial Center publishes empirical research based on the Public Access to Court Electronic Records

data curated by public agencies. For instance, criminal law empirical research mines FBI crime statistics,¹⁵¹ the U.S. Sentencing Commission datasets,¹⁵² and the Transactional Records Access Clearinghouse,¹⁵³ which collects information from federal law enforcement generally through Freedom of Information Act¹⁵⁴ requests. A similar, searchable database containing content from all NEPA and ESA analyses would fertilize empirical analysis.

Other law fields that are further ahead in commitment to empirical research have consortia that collect their own data and provide it to researchers. These efforts to build databases represent a tremendous investment of time and money to sustain a scholarly agenda founded on quantitative analysis. For instance, the Consumer Bankruptcy Project has compiled its own, very productive, proprietary database from court files, supplemented by written questionnaires completed by debtors.¹⁵⁵ Co-investigators divide responsibilities for data collection and then obtain access to the entire database. Important findings have emerged as a result.¹⁵⁶ The Stanford Securities Class Action Clearinghouse collects detailed information about prosecution, defense, and settlement of federal class action securities fraud litigation.¹⁵⁷ Some progress is evident in compiling environmental compliance databases, but they have yet to play as important a role in environmental law scholarship.¹⁵⁸ An advantage to pooling information into shared databases (besides relieving researchers of reinventing the laborious assembling process for each study) is that it promotes

database. *See, e.g.*, EMERY G. LEE III & THOMAS E. WILLGING, THE IMPACT OF THE CLASS ACTION FAIRNESS ACT OF 2005 ON THE FEDERAL COURTS: FOURTH INTERIM REPORT TO THE JUDICIAL CONFERENCE ADVISORY COMMITTEE ON CIVIL RULES (2008), <https://www.fjc.gov/sites/default/files/2012/CAFA0408.pdf>. Judge Posner advocates for more empirical studies using data from the Administrative Office of U.S. Courts. RICHARD A. POSNER, DIVERGENT PATHS: THE ACADEMY AND THE JUDICIARY 275 (2016).

151. *Uniform Crime Reporting*, FED. BUREAU OF INVESTIGATION, <https://ucr.fbi.gov/> (last visited Sept. 30, 2017).

152. *Interactive Sourcebook of Federal Sentencing Statistics*, U.S. SENTENCING COMM'N, <http://isb.ussc.gov/Login> (last visited Oct. 25, 2017).

153. *About Us*, TRANSACTIONAL RECORDS ACCESS CLEARINGHOUSE, <http://trac.syr.edu/aboutTRACgeneral.html> (last visited Sept. 30, 2017).

154. 5 U.S.C. § 552 (2012).

155. *See* Katherine Porter, *Appendix: Methodology of the 2007 Consumer Bankruptcy Project*, in BROKE: HOW DEBT BANKRUPTS THE MIDDLE CLASS 235, 235–44 (Katherine Porter ed., 2012) (explaining the methods for the 1981, 1991, 2001, and 2007 iterations of the Consumer Bankruptcy Project).

156. *See, e.g.*, Robert M. Lawless et. al., *Did Bankruptcy Reform Fail? An Empirical Study of Consumer Debtors*, 82 AM. BANKR. L.J. 349, 385 (2008) (explaining the decline in bankruptcy filings that strongly suggested 2005 legislation failed to meet its principal goal of reducing the number of can-pay debtors).

157. *About Us*, STANFORD LAW SCHOOL SECURITIES CLASS ACTION CLEARINGHOUSE, <http://securities.stanford.edu/about-the-scac.html> (last visited Sept. 30, 2017).

158. Mark A. Cohen, *Monitoring and Enforcement of Environmental Policy*, in INTERNATIONAL YEARBOOK OF ENVIRONMENTAL AND RESOURCE ECONOMICS 1999/2000: A SURVEY OF CURRENT ISSUES 44 (Henk Folmer & Tom Tietenberg eds., 1999) (cited by Vandenbergh, *supra* note 5, at 139 n.307 (illustrating how the challenge of gathering and analyzing environmental compliance data may be overcome)).

repeated investigations and iterative sharpening of analytical tools and understanding. Empirical environmental law scholarship seldom probes the same database multiple times with different perspectives. Other fields gain insights by fine-tuning studies as new problems and promising methods of analysis emerge from prior studies.

Our study examined many articles that employed existing databases to persuasive effect, but the frustrating truth is that environmental data are far less easily available than economic information. For antitrust, contract, and corporate law, economic questions are central to legal objectives. However, economic data only go so far in measuring environmental law objectives, such as promoting “public health and welfare”¹⁵⁹ or conserving ecosystems upon which imperiled species depend.¹⁶⁰ When ultimate values cannot be directly or easily measured, empirical research relies on proxy variables to indicate how well objectives have been fulfilled. The relationship between the proxies and the ultimate objectives may be “vague and under-theorized.”¹⁶¹ Linking the two is critical to produce empirical research that realizes the potential benefits supporting this trend in legal scholarship.

In some cases, such as data on effluent discharges under pollution control permits, the proxy measures may be good indicators of ultimate goals.¹⁶² Still, only seventeen of the thirty-two Category B2 (quantitative analysis of nonlegal data) articles examined data on the physical environment. The articles were split almost evenly between land-use and natural resources issues, and pollution control issues. The relatively large proportion of empirical environmental law studies that employed quasi-experimental techniques (52 percent of the articles in our study) to wring insights from existing data suggests that there are a fair number of researchers adept with those statistical tools to make the most of newly compiled datasets.

Even better information about environmental quality will be of limited general use except in those instances where quasi-experimental designs can overcome synergistic effects. Mello and Zeiler recommend addressing these issues in health law through fixed-effects or difference-in-difference models.¹⁶³ But those sophisticated tools may be difficult to employ in most situations and beyond the skills of many environmental law scholars. Collaboration with scholars skilled in other fields and techniques offers enormous potential for overcoming the design challenges. Other authors have recommended that environmental law scholars advance interdisciplinary partnerships by developing “interactional expertise with other disciplines (both scientific and social scientific) so that . . . legal scholarship is based on a sound understanding

159. 42 U.S.C. § 7401(b)(1) (2012).

160. 16 U.S.C. § 1531(b) (2012).

161. Fischman, *supra* note 45, at 130.

162. *E.g.*, Glicksman & Earnhart, *supra* note 101, at 484.

163. Mello & Zeiler, *supra* note 52, at 665.

of environmental problems.”¹⁶⁴ Collaboration should be a two-way street to ensure that environmental law scholarship does not blindly accept unexamined assumptions of other disciplines. In addition to other scholars, some public entities, such as the EPA’s National Center for Environmental Research, may engage in specific projects to generate data exploring synergistic effects, but they seldom focus on legal issues.¹⁶⁵

The outcomes we coded as Category B3 illustrate what is possible with quasi-experimental methods. For instance, Professors Cary Coglianese and Jennifer Nash employed multivariate regression analysis to untangle the relationship between enrollment in a special program to go beyond regulatory pollution control requirements and real reductions in pollutant emissions.¹⁶⁶ Comparing states with similar demographics but different environmental laws is probably the best target for quasi-experimental studies to explore how the variance in the “treatment” (laws) may lead to different outcomes.¹⁶⁷ Even here, though, the technical challenges of fixed-effect or difference-in-difference analysis will often require legal scholars to partner with researchers from other fields.

The rise of “big data” may drive a substantial shift in the information both agencies and scholars rely upon in reaching conclusions. Big data refers not only to the increase in volume and speed of acquisition of data accessible through the internet—it also refers to collecting in one place a variety of inputs, such as ambient chemical concentrations, water flows, biological observations, and farming practices in watershed modeling.¹⁶⁸ Big data embraces “new techniques in data analytics and new infrastructures for translating those data into governmental policy and practice. . . . [O]ver the next fifteen years or so big data will drive a major shift in the underlying knowledge practices of environmental law.”¹⁶⁹ The EPA views these new tools as transforming how it gathers data and conducts analysis. It expects to employ “[b]usiness intelligence tools, geospatial tools and visualization tools” for “insight from disparate data sources.”¹⁷⁰ Though Professor William Boyd speculates that

164. Fisher et al., *supra* note 3, at 232.

165. *About the National Center for Environmental Research (NCER)*, EPA, <https://www.epa.gov/aboutepa/about-national-center-environmental-research-ncer> (last updated July 20, 2017). One example of a rare contribution to the legal literature is cited by Glicksman & Earnhart, *supra* note 55, at 321 n.13 (citing NAT’L CTR. FOR ENVTL. RESEARCH, *Corporate Environmental Performance and the Effectiveness of Government Interventions*, EPA, https://cfpub.epa.gov/ncer/abstracts/index.cfm/fuseaction/display.rfatext/rfa_id/135 (last updated Apr. 10, 2000)).

166. Coglianese & Nash, *supra* note 23, at 44–48.

167. See, e.g., Kotchen & Grant, *supra* note 106 (finding that saving time reduces electricity used for lighting, but it prompts increases for heating and cooling).

168. Stephen Harper, *Big Data’s Big Handprint*, ENVTL. FORUM, Mar.–Apr. 2017, at 23.

169. William Boyd, *Environmental Law, Big Data, and the Torrent of Singularities*, 64 UCLA L. REV. DISCOURSE 544, 546–47 (2016).

170. *EPA’s Cross-Agency Data Analytics and Visualization Program*, SEMANTIC COMMUNITY, http://semanticcommunity.info/Data_Science/Data_Science_for_EPA_Big_Data_Analytics#EPA.E2.80.9

such a turn toward big data will increase reliance on opaque algorithms, it seems certain to open up new sources of information and new methods of analysis to scholars.¹⁷¹ On the other hand, the presidential transition in 2017 illustrated the vulnerability of big data sources maintained by public agencies. As the Trump Administration removed or limited access to existing databases, researchers encountered difficulty capturing the information lurking behind proprietary interface code.¹⁷² Though the internet made government information more widely available, it also made data vulnerable to centralized decisions to modify or obstruct it from public view.

Owen offers especially helpful suggestions for how spatial analysis can improve environmental law scholarship.¹⁷³ Quasi-experiments could employ geospatial tools to analyze how law affects development patterns in different areas subject to different legal regimes.¹⁷⁴ They could also examine land-use changes before and after regulatory interventions. Few legal researchers have the expertise to engage in such studies by themselves. However, collaborations already exist for such studies, and need perspectives to better address policy concerns. Owen explains:

While an economist's perspective has obvious value, there are ways in which lawyers could contribute to this sort of work. Environmental lawyers may not be trained in quantitative analysis or GIS [geographic information systems], but they are taught to understand, at least at a qualitative level, how particular regulatory provisions fit within broader environmental law systems, how environmental law evolves and changes, what roles environmental law assigns to different actors, and how different institutions tend to respond to their roles. That legal perspective could help interdisciplinary research teams identify important research questions, develop hypotheses, flag potentially confounding variables, and interpret results.¹⁷⁵

Beyond spatial data, environmental modeling generally suffers from relatively weak understandings of how the law operates to mediate the relationship between human and natural systems.¹⁷⁶ Environmental law scholars can both improve literature outside of law journals in this way and also return to legal scholarship to explain “how legal rules might generate

9s_Cross-Agency_Data_Analytics_and_Visualization_Program (last updated May 2, 2017) (quoted in Boyd, *supra* note 169, at 552).

171. Boyd, *supra* note 169, at 565–68.

172. Amy Harmon, *Activists Rush to Save Government Science Data—If They Can Find It*, N.Y. TIMES, Mar. 7, 2017, at D1, D3.

173. Dave Owen, Mapping, Modeling, and the Fragmentation of Environmental Law, 2013 UTAH L. REV. 219, 227–81 (2013).

174. *E.g.*, Been et al., *supra* note 112, 247–50.

175. Owen, *supra* note 173, at 279.

176. *Id.*; see, e.g., William Blomquist & Elinor Ostrom, *Deliberation, Learning, and Institutional Change: The Evolution of Institutions in Judicial Settings*, 19 CONST. POL. ECON. 180, 188–96 (2008) (discussing, without the nuance of legal analysis, the role of adjudication in shaping institutions charged with natural resources management).

environmental consequences and . . . how environmental change generates legal responses.”¹⁷⁷

C. *New Data (Category A)*

Generating new data through anything other than coding legal documents was far less common in empirical environmental law scholarship than the use of existing data. This probably reflects the expense and unfamiliarity with data generation methods in the legal academy. Categories A1 and A2 are well matched to conventional environmental law approaches to scholarship. We expect these methods to grow in empirical rigor as legal researchers turn to quantitative techniques for enhancing qualitative case studies and interview-based descriptions.¹⁷⁸ In this manner, a small change in adopting quantitative techniques can transform existing conventional scholarship into empirical contributions.¹⁷⁹

In particular, a well-designed survey can constitute a kind of experiment probative of correlations between law and effects if the samples and treatments are truly random.¹⁸⁰ Particularly where general public attitudes are relevant, inexpensive survey tools, such as Amazon’s “Mechanical Turk,” can support a wide range of research.¹⁸¹ Surveys can help gauge how law might cause a person to change attitudes or behaviors. Most of the survey methods in empirical environmental law focus not on the public generally but on particular roles, such as the corporate manager or the agency enforcement attorney. Besides selection bias, the danger in relying on such surveys for assertions about the role of laws or procedures is that respondents may want to convey a viewpoint at odds with actual behavior.

Experiments allow researchers to limit sources of variation that may impact dependent variables by random assignments of treatment. Controlling for dependent variables can be difficult where they are hard to measure. For example, understanding the influence of critical habitat designation in recovery of endangered species by analyzing just the designations and recoveries would be frustrated by many dependent variables having to do with differences between species, their habitats, and the demographic contexts of their locations. Though difficult to pull off, valid experiments yield the most probative test of causal relationships by minimizing the inferential problems that limit the usefulness of many surveys and existing databases. We found experimental

177. Owen, *supra* note 173, at 279.

178. See generally Mintz, *supra* note 27, at 10,391 (using interviews to analyze changes in EPA enforcement approaches).

179. See, e.g., Ackerman et al., *supra* note 58, at 1227–29 (empirical analysis of attempts to control pollution in Delaware River); Fred O. Boadu et al., *supra* note 59, at 117–20 (empirical analysis of institutional change to manage an aquifer).

180. Chilton & Tingley, *supra* note 68, at 178.

181. Adam J. Berinsky et al., *Evaluating Online Labor Markets for Experimental Research: Amazon.com’s Mechanical Turk*, 20 POL. ANALYSIS 351 (2012).

designs completely absent from empirical environmental law. Others have found experimental designs absent from empirical health law and international law scholarship.¹⁸² As with international law, federal environmental law may lack enough variation to make quasi-experimental observations useful. On the temporal level, infrequent events, such as extinctions or major releases of toxic substances, may also frustrate quasi-experimental attempts to determine causative relationships. Though experiments are likely to be the most expensive type of empirical method, they may nonetheless steer agencies away from even more expensive mistakes, and could help agency decisions better withstand judicial review.¹⁸³ This is particularly true where the agency is employing assumptions in drawn-out rule makings applicable to large numbers of regulated entities, where getting the incentives right the first time is crucial.

Models for experimental designs from other fields could be adapted to environmental law.¹⁸⁴ Laboratory experiments in the social sciences frequently generate useful data because of the precise control that can be exercised over the dependent variables. For example, a laboratory can randomly expose people to different scripts or videos, only some of which would address an environmental law issue. If the researchers then asked the subjects their preferences about the issue, then the correlations would not be confounded by self-selected awareness of the issues. In examining decision making (e.g., energy conservation) in response to stimuli (e.g., awareness of environmental impacts or incentives), experiments can measure the responses and identify factors that account for differences.¹⁸⁵

Of course, the artificial setting of a laboratory may fail to capture relevant signals in the context of real-world decision making. Field experiments are useful because they occur *in* the relevant environment where subjects actually make choices. The tradeoff is simply that investigator control is more limited than in the laboratory. However, if environmental scholars want to know how inspections affect pollution emissions, the best setting would be to observe the effects in the field, based on a random assignment of inspectors. In natural resources law, agencies already employ field experiments through adaptive management in situations of great uncertainty. In adaptive management,

182. See Mello & Zeiler, *supra* note 52, at 660 (finding no experimental designs in empirical health law scholarship); Gregory Shaffer & Tom Ginsburg, *The Empirical Turn in International Legal Scholarship*, 106 AM. J. INT'L L. 1, 3–5 (2012) (finding no experimental designs in empirical international law scholarship).

183. We categorize the analysis of disparate state approaches to environmental law to be quasi-experiments.

184. We have adapted the ideas for experimental international law offered by Chilton & Tingley, *supra* note 68, at 222–34.

185. See, e.g., Shahzeen Z. Attari et al., *Energy Conservation Goals: What People Adopt, What They Recommend, and Why*, 11 JUDGMENT & DECISION MAKING 342, 343–50 (2016).

government action itself constitutes the experiment.¹⁸⁶ Adaptive management employs an iterative cycle of setting goals, devising experimental treatments, monitoring the effects of the treatments, and modifying the treatments in reaction to the effects observed. What makes this line of research especially important is that the most challenging problems in environmental law require actions even in the face of uncertainty—for instance, in the impacts of climate change on ecological services. Studying the adaptive management experiments undertaken by agencies creates a field laboratory for understanding both the results of their experiments and the iterative techniques employed.¹⁸⁷ Empirical legal scholars are already studying this type of governmental experimentation under the rubric of resilience.¹⁸⁸ There are few experiments more important. Federal resource management agencies have bet the bank on the effectiveness of adaptive management.¹⁸⁹ But monitoring the outcomes of decisions based on cost-benefit analysis or environmental impact analysis almost always falls short of what is needed to refine the accuracy of the analytical tools used in the analyses. A high priority for environmental law must be to build into implementation the monitoring that can determine whether the models employed in the front-end analyses accurately predicted outcomes. Generating such new data as part of a permit, project, or regulation would do more than any other reform to generate information and better steer environmental law through empiricism. In addition, scholars can productively turn adaptive management back on agencies to explore how administrative culture, structure, and procedure may adapt through learning-by-doing.¹⁹⁰ Closer observation and better design of regulatory adaptation would yield real improvements in environmental law.

D. Policy Recommendations

Almost half (thirty-five of seventy-three) of the empirical environmental law articles made specific policy recommendations. For our purposes, policy includes traditional legal revision of statutes and doctrines as well as regulatory and administrative changes. This is our most surprising result because the predominant focus of environmental law research is practical questions of policy relevance. One reason for the shortfall may be our narrow approach to coding. To count as a policy recommendation, we required articles to at least

186. As with other empirical insights in legal research, roots of this notion lie in the social sciences. See, e.g., Donald T. Campbell, *Reforms as Experiments*, 24 AM. PSYCHOL. 409, 428 (1969) (arguing that policy reforms should be studied as social experiments).

187. See Fischman & Ruhl, *supra* note 21, at 273–74.

188. See generally Humby, *supra* note 25 (analyzing resilience and adaptive governance to better understand adaptive change).

189. Ruhl & Fischman, *supra* note 24, at 443 (“Since 1993, each of the major federal resource management agencies has made a policy commitment to employ adaptive management.”).

190. See generally Alejandro E. Camacho, *Can Regulation Evolve? Lessons from a Study in Maladaptive Management*, 55 UCLA L. REV. 293 (2007).

suggest consideration, if not actually propose, a *specific course of legal or administrative action* to address the consequences of some empirical finding. Therefore, we did not count some articles that offered policy critiques, such as Coglianesi and Nash's analysis of the EPA's Performance Track program, even though it contained a detailed assessment of the effectiveness of a government program.¹⁹¹ Overall, however, authors were more likely to recommend further research or offer only observations than to craft and propose solutions.

In our experience, the norms of legal scholarship generally embrace policy recommendations, even where they may not be directly or strongly linked to empirical evidence. In fact, the lack of direct or strong support grounded in observations is a key criticism of some forms of empirical scholarship.¹⁹² It may well be that the intensive focus on data and quantitative methods characteristic of empirical environmental law counteracts the typical norms of environmental law scholarship. Empirical environmental investigations may be less apt to venture into the speculative art of policy recommendations. The norm of parsimony rules positive research in science. Outside of legal scholarship, empirical descriptions that identify new avenues for research are perfectly adequate justifications for a study. Legal publications should carve out space for such research, which may be foundational to subsequent, practical applications. However, to connect with the broader audience of environmental law scholars, empirical investigators eventually will need to link their work more clearly to law reform proposals. Designing questions and methods that succeed in producing probative results will be critical to that success.¹⁹³

One clue in explaining the relatively small number of empirical environmental law articles may be a dearth of hypotheses to test. Our results revealed that forty-one articles out of seventy-three engaged in explicit hypothesis testing. If, compared to other fields, environmental law lacks theories with predictive value, then there is relatively little work to be done with empirical methods. It also means that the theories cannot be applied confidently in crafting recommendations. Hypothesis testing and policy recommendations are also related. Policy recommendations require expanding or generalizing from a narrow, retrospective study to a broad, prospective proposal. Without a confirmed or refuted hypothesis, it is difficult to extend research confidently into the realm of policy. Zeiler's observations about empirical legal scholarship generally are apt for environmental law:

Empirical validation helps us move from a conversation in the pages of academic literature to the application of science in the form of evidence-

191. Coglianesi & Nash, *supra* note 23.

192. Fischman, *supra* note 45, at 123; *see also* Kathryn Zeiler, *The Future of Empirical Legal Scholarship: Where Might We Go from Here?*, 66 J. LEGAL EDUC. 78, 81 (2016) ("Likely few would dispute the claim that the average quality of empirical work published in law reviews lies somewhere below that of work published in peer-reviewed journals.").

193. Zeiler, *supra* note 192.

based policy. Theory is useful. Theory backed by a single, methodologically sound empirical study is better. We get closer to the ideal, however, when the theory we wish to apply is supported by a collection of methodologically sound empirical studies from a variety of contexts using a number of different methods and different data samples drawn from relevant populations. While robust empirical verification cannot guarantee that some adopted policy will work as intended, it can help guide us toward policies with the best chance of fulfilling their promise.¹⁹⁴

Professor Elinor Ostrom made a similar point about the importance of developing “empirically supported” theories.¹⁹⁵

The barriers to greater empirical research in environmental law run deep—into the under-theorized foundations of environmental law.¹⁹⁶ Without sharpening theories, scholars will share less common ground. They will have fewer hypotheses to test and weaker prescriptions to make. As early as 1981, Professor Christopher Stone lamented the disconnect between empirical research in law, heavily influenced by the availability of grants and fashion in social science, and legal theory in need of testing.¹⁹⁷

Therefore, our paradoxical suggestion for improving empirical contributions to environmental law is *more theoretical scholarship* to ensure that empirical investigations can support policy recommendations. Better predictive theories, combined with fastidious research design to test them, will yield the greatest improvements in environmental law scholarship seeking to reform policies. While available databases may tempt empiricists, a study whose results do not bear on legal effectiveness is not as valuable as one whose results do. Even where effectiveness studies cannot pinpoint causation, they may still contribute to the literature by ruling out certain reforms or creating new hypotheses to be tested in subsequent research. Empirical studies, though, seldom settle theoretical disputes. Two of the most prominent theories generating hypotheses tested in the empirical environmental law literature, environmental racism and race-to-the-bottom federalism, remain stubbornly in contention.

CONCLUSION

The historian Daniel Boorstin warned that “the great menace to progress is not ignorance but the illusion of knowledge.”¹⁹⁸ In environmental law, untested

194. *Id.*

195. ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION 25 (1990).

196. By contrast, environmental economics has for generations employed clear, consistent theories of regulation.

197. Stone, *supra* note 13, at 1155 (“The data that the rest of law scholarship might need, or even find useful, do not orient empiricists’ thinking.”).

198. DANIEL J. BOORSTIN, CLEOPATRA’S NOSE 7 (1994).

assumptions result in misspent resources and real menace to human health or ecological integrity. This undermines public trust in regulatory agencies, which can result in resource curtailment and further environmental degradation, thereby complicating the process of appropriately assigning blame and identifying effective solutions. Spurred on by developments in other legal fields and integration of social science scholars into law faculties, environmental law scholarship has made halting progress in employing empirical methods, particularly in the past decade. Empirical environmental law research can move scholarship beyond crafting good arguments, the dominant mode of law review articles, to contributing new knowledge about how law works. Theory will remain important. Indeed, we speculate that the scarcity of testable theories stunts the generation of specific law reform proposals. Empirical research bridges theory and policy recommendations. Recommendations that shape law reform are the ultimate achievements for practical scholarship. However, purely descriptive empirical articles remain useful additions to the knowledge commons, shaping understanding of environmental law.

Though the relative dearth of empirical methods in environmental law scholarship may reflect challenges in adapting research methods commonly used in other fields, it says nothing about the value of the existing work. Like all categories of scholarship, empirical research varies in quality. We expect that empirical investigations will grow more common in environmental law research. On the whole, such a development will offer greater opportunities to improve the effectiveness of environmental law. But misapplication of statistics, limited rigor of results, and unrepresentative databases may undermine the ultimate goal of improving scholarly contributions to environmental law reform. Peer review and other techniques of quality assurance, including scholarly reviews of the rigor of published studies, will be needed to optimize the probative value of empirical research. We recommend that empirical legal scholars collaborate with colleagues in their institution's social science departments to improve study design and execution. This cross-fertilization would also help empirical law scholarship reach a wider audience of policy makers who may not use or have access to traditional law journals and the databases for searching them. It would surely also improve the quality of legal analysis in the vast nonlegal scholarship that addresses effectiveness of various environmental governance regimes.

Scholars have long lamented the hurdles to interdisciplinary and empirical research in legal scholarship.¹⁹⁹ However, other legal fields of study have surmounted those hurdles. We hope that this review of empirical environmental law starts a discussion among scholars to generate intersecting research agendas. A collective consideration of the issues involved in empirical research

199. See, e.g., Deborah L. Rhode, *Legal Scholarship*, 115 HARV. L. REV. 1327, 1351–57 (2002); David M. Trubek, *Comments on the Bok Report: A Strategy for Legal Studies: Getting Bok to Work*, 33 J. LEGAL EDUC. 586, 586 (1983).

may facilitate the vetting of key topics that could benefit the most from empirical methods. It may promote information sharing and coalesce consortia that can build new databases. A community of empirical environmental law investigators could sponsor workshops that improve access to data and the methods used to wring insights from systematic observations about the operation of law. The traditional model of a lone legal scholar producing great articles may be supplemented by a newer model of interdisciplinary teams of researchers compiling and analyzing information. Teamwork is the norm in natural science, which is the paradigm of advancing understanding through empiricism.

This initial attempt to assess the role of empirical research in environmental law scholarship is but a first step. Subsequent research may attempt to replicate our findings and monitor scholarly output in subsequent years to see whether the increase in empirical work of the past decade persists or grows. Another important topic for future study is to determine whether and how legal decision makers, such as agency regulators or resource managers, actually consider empirical scholarship in implementing environmental law.

Finally, we suggest a series of meetings to begin the process of formulating an agenda for environmental law research. Dissenters or researchers who simply prefer to work alone can pursue their own course. But the benefits of establishing a research agenda through dialogue between professors and others (e.g., agency decision makers) who can make use of empirical research remain strong. Deliberative discussion may open up new ideas for testable theories, create database pools, and borrow from empirical successes in other fields. Teams will be needed to wrestle data into useable form and tackle design challenges that might otherwise thwart policy-relevant results. A stronger empirical strand of environmental law scholarship will strengthen the field by connecting otherwise disparate areas of research. It can help a notoriously varied hodgepodge of topics cohere into a mature field of study.

