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CUMULATIVE IMPACTS: DEATH-KNELL FOR COST-BENEFIT ANALYSIS IN ENVIRONMENTAL DECISIONS

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INTRODUCTION

The ground is shifting beneath property and environmental law.¹ A new reality is undermining the assumptions those laws are based upon. We have long assumed we can tolerate the endless growth of small increments of environmental damage in the pursuit of economic growth. But now, the mounting cumulative impact of the human enterprise is threatening the long-term habitability of the biosphere. To maintain a functioning biosphere in which humans can prosper, the law must turn its attention to the problem of cumulative impacts. The law will have to abandon its use of cost-benefit analysis to justify individual environmental impacts and instead adopt the goal of maintaining the functioning ecological systems that we are so dependent upon.

Scientists from around the world are reporting that ecosystems in virtually all regions of the Earth are being degraded at unprecedented rates. Just a few recent examples reveal the depth and scope of these reports. In 2005, a study compiled by over 2000 scientists from ninety-five countries demonstrated that 60% of global ecosystem services are "being degraded or used unsustainably," including fresh water supplies, capture fisheries, air and water purification, and the regulation of natural hazards and pests.² In 2007, the United Nations concluded that current environmental trends threaten human development and overall wellbeing.³ It established that humanity's overuse of ecological resources is degrading many elements of the environment;⁴ that thresholds of sudden irreversible change are now being crossed, causing the collapse of fisheries, dead zones in the sea, regional climate

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1. By "property and environmental law" I mean to refer to all our laws that control the impacts that people may have on the environment, both by altering their own lands and by externalizing impacts onto the lands of others or the commons. Some of the themes of this article are adapted from Joseph H. Guth, *Law for the Ecological Age*, 9 VT. J. ENVTL. L. 431 (2008), available at <http://www.vjel.org/index.php>.

2. MILLENNIUM ECOSYSTEM ASSESSMENT, ECOSYSTEMS AND HUMAN WELL-BEING: SYNTHESIS, at 2 (2005) [hereinafter ASSESSMENT], available at <http://www.millenniumassessment.org/documents/document.356.aspx.pdf>. The Millennium Ecosystem Assessment is an evaluation of the world's ecosystems and human well-being that was carried out between 2001 and 2005 under the auspices of the United Nations; *Id.* at ii-ix.

3. U.N. ENV'T PROGRAMME [UNEP], GLOBAL ENVIRONMENT OUTLOOK-ENVIRONMENT FOR DEVELOPMENT GEO-4 [hereinafter UNEP], at 6 (2007), available at <http://www.unep.org/geo>. This report was prepared by over 400 scientists and environmental policy makers.

4. *Id.* at 202 box 6.1.

change, and loss of species; and that it is difficult to know exactly where other thresholds may lie or when they may come upon us.⁵ The World Wildlife Fund and its collaborators have estimated that biodiversity in their index of 4,000 populations of 1,477 vertebrate species has declined by 27% in the last thirty-five years.⁶ They have also calculated that, according to their measure of humanity's growing "Global Ecological Footprint," by the 1980s we had reached the capacity of the biosphere to provide resources and absorb waste and by 2003 had overshot that capacity by 25%.⁷

These reports also reveal the cause of our ecological problems: the cumulative impact of the myriad human activities that comprise the human ecological footprint. Billions of people acting individually and together in economic enterprises contribute to ecological degradation by causing a wide variety of impacts on the Earth: climate disruption from greenhouse gas emissions, deforestation (for logging and agriculture), degradation of productive land (from desertification, erosion and other processes), loss of freshwater watercourses and unpolluted water supplies for human use, depletion of marine fisheries (through over-fishing and destructive practices), discharges of toxic pollution (into air, water and land), biotic impoverishment from loss of species, and over-fertilization with nitrogen leading to dead zones in the seas.⁸

The United States is suffering from these same human activities and consequences. Scientists have documented extensive degradation of ecosystems across the Nation.⁹ Americans have among the very largest per capita ecological footprints of all populations in the world.¹⁰ Despite the environmental laws passed in the United States and the resulting improvement in some problems, serious environmental problems have persisted and worsened.¹¹

Scientists are also explaining clearly that human beings are utterly dependent on a biologically functioning biosphere, and that to survive and prosper we need the very ecological systems that we are so quickly degrading. As the Millenium Ecosystem Assessment Synthesis begins:

5. *Id.* at 362–63.

6. WORLD WILDLIFE FUND [WWF], ZOOLOGICAL SOCIETY OF LONDON & GLOBAL FOOTPRINT NETWORK, 2010 AND BEYOND: RISING TO THE BIODIVERSITY CHALLENGE [hereinafter WWF], at 4 (2008), available at http://www.wwf.org.uk/filelibrary/pdf/2010_and_beyond.pdf.

7. WWF, *supra* note 6, at 1 (Figure 2), 8–9.

8. See JAMES GUSTAVE SPETH, THE BRIDGE AT THE EDGE OF THE WORLD – CAPITALISM, THE ENVIRONMENT, AND CROSSING FROM CRISIS TO SUSTAINABILITY 19–38 (Yale University Press 2008) [hereinafter SPETH]; see also WWF, *supra*, note 6, at 2–3 (classifying varied human impacts into five categories: habitat loss, overexploitation of species, pollution, spread of invasive species or genes and climate change); UNEP, *supra* note 3, at xxii, xxiii (classifying human pressures on the environment into categories of land use, resource extraction, external inputs (such as fertilizers, chemicals, irrigation), emissions (of pollutants and waste), and modification and movement of organisms).

9. See REED F. NOSS ET AL., ENDANGERED ECOSYSTEMS OF THE UNITED STATES: A PRELIMINARY ASSESSMENT OF LOSS AND DEGRADATION (1995) (unpaginated document), available at <http://biology.usgs.gov/pubs/ecosys.htm> (reporting "more than 30 critically endangered, 58 endangered, and more than 38 threatened ecosystems" in the United States).

10. WWF, *supra* note 6, at 3 (Table 1), 14–15, 16, 18, 19, 28.

11. SPETH, *supra* note 8, at 71–78 (outlining current environmental problems in the U.S.); see also Mary Christina Wood, *Nature's Trust: Reclaiming an Environmental Discourse*, 2006 Bioneers Conference Keynote Address, 25 VA. ENVTL. L. J. 431, 432–36, 440–47 (2007) (outlining failure of U.S. environmental law).

Everyone in the world depends completely on Earth's ecosystems and the services they provide, such as food, water, disease management, climate regulation, spiritual fulfillment, and aesthetic enjoyment.¹²

Plainly, our property and environmental laws are not adequately protecting the Earth's ecological systems. As longtime leading American environmentalist James Gustave Speth puts it, despite our current laws "we are losing the planet."¹³ There is widespread agreement that the U.S. and international legal systems are simply not up to the task of controlling the mounting cumulative environmental impacts lying at the root of U.S. and global ecological degradation.¹⁴ The question is why.

The theme of this article is that current American property and environmental law is not designed to maintain the ecological integrity of the biosphere. Instead, it is designed to promote the permanent growth of economic activity on the presumption that the social benefits of such activity outweigh whatever damage it might cause. Accordingly, the legal system generally seeks to prevent environmental damage only where the particular activity causing that damage can be shown not to promote net social welfare. This legal structure permits all other increments of ecological damage to accumulate indefinitely. With no legal constraint on its cumulative scale, this mounting ecological damage inevitably must surpass the Earth's ability to assimilate damage and then degrade the ecological integrity of the biosphere. To contain cumulative environmental impacts the American legal system will have to implement a wholly different structure for environmental decision-making. It will have to prioritize not economic growth, but maintenance of the integrity of the ecological systems that we depend on for so much.

This article proceeds by first outlining the environmental decision-making structure that is widely incorporated into both the common law and much of our federal statutory law (Section I). It then explores the ability of the law to adopt instead a principle or standard of environmental integrity and defend that standard against invasion by cumulative impacts. It turns out that the older, pre-industrial common law and some of our current environmental statutes contain examples of such standards that demonstrate that such a legal structure can be effective to control cumulative impacts (Section II). Finally, it turns to several proposals for such

12. See ASSESSMENT, *supra* note 2, at 1; EDWARD O. WILSON, *THE CREATION: AN APPEAL TO SAVE LIFE ON EARTH* 26–36, 62–69 (W. W. Norton 2006) (discussing the deep biological dependence of human beings on the Earth).

13. SPETH, *supra* note 8, at 78. See also Board of the Millennium Ecosystem Assessment, "Living Beyond Our Means: Natural Assets and Human Well-being," Millennium Ecosystem Assessment at 5 (2005), available at <http://www.precaution.org/lib/livingbeyondourmeans.050315.pdf> (introducing "bottom line" of Millennium Assessment: "Human activity is putting such strain on the natural functions of Earth that the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted").

14. See, e.g., SPETH, *supra* note 8, at 85–86 (growing cumulative environmental threats with ever-larger environmental consequences cannot be controlled by current U.S. system for environmental protection); ASSESSMENT, *supra* note 2, at 99 (recommending that environmental decision-making consider cumulative effects); UNEP, *supra* note 3, at 111, 467 (explaining that tipping points are reached when cumulative effects reach thresholds of unsustainable damage, and concluding that existing environmental institutions have been unable to keep up with increasing cumulative environmental degradation); WWF, *supra* note 6 at 2–3, 14–15, 23, 24 (outlining many components of the human ecological footprint and the many steps that must be taken to reduce it).

a decision-making structure (Section III). My goal is to help stimulate the ongoing development of an entirely new environmental decision-making structure that can contain the growth of cumulative impacts.

I. ENVIRONMENTAL DECISION-MAKING AND COST-BENEFIT ANALYSIS IN THE UNITED STATES

When environmental interests come into conflict with economic interests, the law provides a decision-making structure for prioritizing those interests and resolving the conflicts. Each time a conflict is resolved, this decision-making structure furthers the balance of interests that the law is designed to promote. By defining acts that are allowed and disallowed to economic actors, the law provides a set of rules that governs and shapes the economy, including the degree to which the environment will be protected.¹⁵ The law's decision-making structure is based on social priorities and goals, but it also incorporates assumptions about the world and society that are very often left unstated. The emerging reality of cumulative ecological impacts requires that we revisit the goals and assumptions that are embedded in our current law's prevailing structure for making environmental decisions.

This section first provides a general overview of the structure of our system of property and environmental law (Subsection A), and then demonstrates in more detail how that structure is embodied in the federal environmental statutes (Subsection B) and the modern common law (Subsection C).

A. General Overview -- The Overarching Structure Of U.S. Environmental Decision-Making

Our current property and environmental law, including both federal statutes and the common law, is intentionally designed to promote unending growth in economic activity. It harbors the presumption that economic activity generally provides a net benefit to society despite any accompanying damage it may cause. Grounded almost invisibly in this starting presumption, most of our property and environmental laws permit interference with economic activity only where that starting presumption is proved false, that is, where a particular activity can be demonstrated to fail to provide a net benefit to society. These laws for the most part do not forbid damage to human health or the environment. Rather, even when fully enforced they permit protection of human health or the environment only where the benefits of doing so can be proved to outweigh the costs.¹⁶ The theory is

15. See DANIEL W. BROMLEY, *SUFFICIENT REASON: VOLITIONAL PRAGMATISM AND THE MEANING OF ECONOMIC INSTITUTIONS* 3–84 (Princeton University Press 2006) (discussing in depth how legal and other social institutions (especially property rights) are antecedent to the economy and govern market behavior); Guth, *supra* note 1, at 431, 442–44 (discussing how law governs the shape of the economy by determining balance of social interests to best further a particular vision of the public welfare).

16. Poor enforcement of many of our environmental laws remains pervasive. See CLIFFORD RECHTSCHAFFEN & DAVID L. MARKELL, *REINVENTING ENVIRONMENTAL ENFORCEMENT AND THE FEDERAL AND STATE RELATIONSHIP* (Environmental Law Institute 2003). But the issues being addressed by this article stem from the fundamental structure of these laws and would obtain even if they were fully enforced.

that this structure ensures that the legal system will not intervene in the economy unless the intervention will increase net social welfare. So it is that cost-benefit analysis has become the legal system's primary tool for deciding when economic activity may be regulated in the interest of protecting human health and the environment.

The allocation of the burden of proof to government and plaintiffs has an enormous impact on environmental decision-making. Because of this allocation, the law permits damage to the environment not just when it appears cost-benefit justified. It also permits such damage whenever regulators and plaintiffs cannot carry their cost-benefit burden of proof. In cases of doubt or missing information, the law defaults to its starting presumption: it allows the damaging activity to continue. This allocation of the burden of proof transforms doubt and missing information into a barrier to legal protection of human health and the environment. This explains why industrial interests are rationally motivated under our legal system to invest in the manufacture and spread of doubt and confusion.¹⁷

A simple diagram can represent the law's prevailing structure for resolving conflicts between economic and environmental interests, as well as the economy this legal structure promotes. Figure 1 illustrates ever-growing social benefits produced by an exponentially growing economy (upper line). It also illustrates the growth in the accompanying cumulative environmental damage that the law permits by imposing on government and plaintiffs a cost-benefit burden of proof (lower line). This lower line might be thought of as depicting the growth in society's ecological footprint. Excluded from the drawn lines are economic activity and ecological damage that the law is designed to prohibit. What remains, and is depicted in Figure 1, is the theoretical economy promoted by our legal system, in which both economic activity and the legally-permitted accompanying damage grow forever, thus providing never-ending growth in net social welfare (the spread between the two lines).

17. DAVID MICHAELS, *DOUBT IS THEIR PRODUCT* (Oxford University Press 2008); David Michaels, *Doubt Is Their Product*, *SCI. AM.*, June 2005, at 96-101; *RESCUING SCIENCE FROM POLITICS – REGULATION AND THE DISTORTION OF SCIENTIFIC RESEARCH* (Wendy Wagner & Rena Steinzor eds., Cambridge University Press 2006); CARL F. CRANOR, *TOXIC TORTS – SCIENCE, LAW AND THE POSSIBILITY OF JUSTICE* (Cambridge University Press 2007).

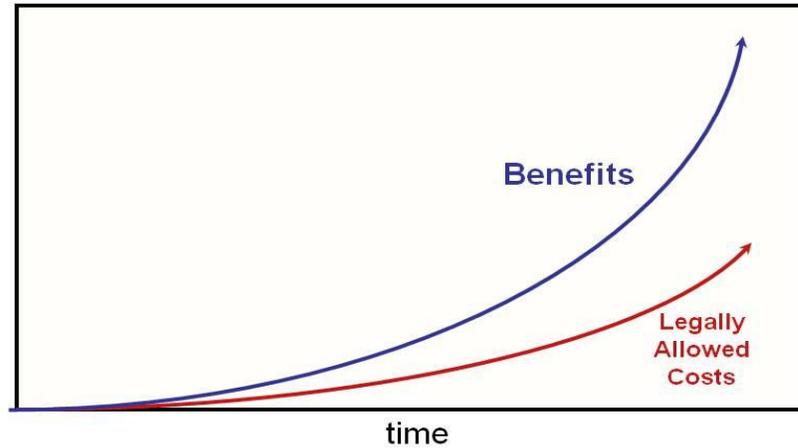


Figure 1: The law promotes all economic activity having a net benefit, allowing both benefits and costs to grow forever as the economy grows

To be sure, this simple drawing does not illustrate many important problems of property and environmental law in the real world. First, our methods for evaluating costs and benefits are deeply flawed, which limits the ability of the legal system to fulfill its promise of policing net-damaging activities. Some hold that these problems are so severe that economic growth in the United States is no longer increasing true human welfare.¹⁸ Second, both the benefits and the damage are depicted as unitary quantities applying to all of society, which masks the unequal distribution of costs and benefits among social groups. This corrosive inequality is giving rise to the growing movement for environmental justice. Third, damage to the Earth is depicted as a cost to humans that can be justified by greater benefits to humans. This focus on human welfare distracts us from the moral and ethical dimensions of our obligation to preserve and respect nature quite apart from its role in our own welfare.

Nevertheless, Figure 1 does broadly depict the goals and assumptions embedded in the prevailing structure of our current environmental and property law. It also serves to reveal a flaw in that structure. That flaw is rooted in the implicit assumption that the total scale of ecological damage may grow without limit. What is missing from this environmental decision-making structure is any recognition that the Earth has a finite and limited ability to sustain ecological damage, and that exceeding this limit will inevitably degrade the Earth's ecological integrity. The

18. See, e.g., JOHN TALBERT ET AL., THE GENUINE PROGRESS INDICATOR 2006 A TOOL FOR SUSTAINABLE DEVELOPMENT 19 (2006), available at <http://www.rprogress.org/publications/2007/gpi%202006.pdf> (concluding that the U.S. economy has been stagnant since the 1970s if environment and social determinants are considered).

reasons for these limits are plain. The Earth has a finite physical size, so that environmental damage becomes concentrated as it accumulates. The deep interconnection between the various constituents of the biosphere causes our various impacts to interact, each compounding the effects of the others. Moreover, species and ecosystems can be replenished only very slowly if at all, so that their losses accumulate with the passage of time.

A simple diagram can depict this ecological limit, too. Figure 2 includes a horizontal line that represents the finite limits of the Earth's ability to sustain ecological damage. This is a limit that our current legal system is utterly blind to.

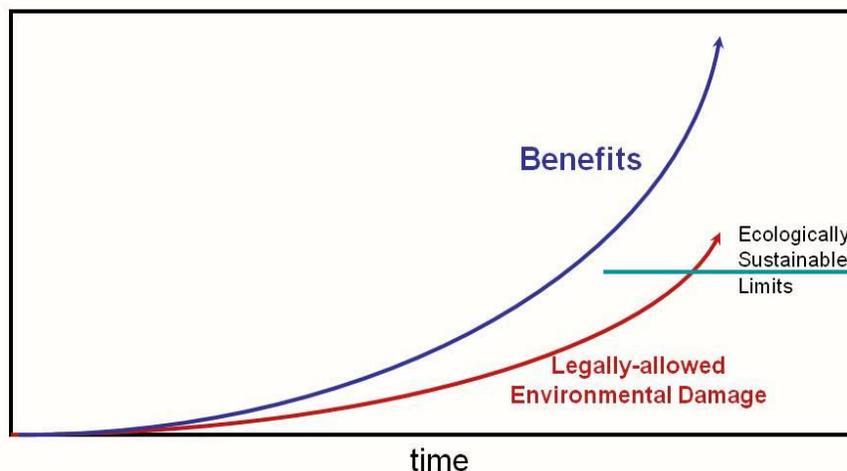


Figure 2: As the economy grows, cumulative environmental damage must eventually surpass the Earth's ecologically sustainable limits

Thus we see the fatal flaw inherent in our system of environmental decision-making. Routinely allowing all environmental impacts except those proved to fail a cost-benefit test, it permits those impacts to grow without limit even when their cumulative effect results in ecological overshoot. Many of these impacts occur not because they actually satisfy the law's cost-benefit test but because whenever we do not know enough, the law's default structure permits them to continue. Even when cost-benefit analysis can effectively evaluate impacts when we are far below ecological limits, it cannot do so once we exceed those limits. Each incremental impact, if taken alone in an empty world, might have caused cost-benefit justifiable harm or even, in many cases (such as carbon emissions), no harm at all. But under conditions of ecological overshoot each incremental impact contributes to a total loss that is immeasurable. Indeed, the permanent loss of the ecological integrity of the Earth, since we need it to survive and prosper, might fairly be considered an

infinite loss. This immeasurable or infinite loss simply cannot be meaningfully allocated among the various increments of damage. For how can the cost to humanity of the ecological devastation of the Earth be allocated among the particular carbon emissions, filling of particular acres of wetlands, destruction of particular fisheries, felling of particular stands of trees or the fertilizer contributions of particular farmers to dead zones in the sea? How can the value of individual species be calculated when the loss of each contributes to the unraveling of the web of life? How can liability for making the Earth uninhabitable to us be allocated among the thousands or millions of small increments of damage?

To maintain the ecological integrity of the Earth, we need a new decision-making structure designed not to promote endless growth in net benefits, but to accommodate the ecological limits of the biosphere, the horizontal line of Figure 2. Before thinking through what that new structure might look like, let us examine more closely the decision-making structure embedded in our current law, beginning with the federal environmental statutes and then turning to the common law.

B. Environmental Decision-Making Under the Federal Environmental Statutes

The federal environmental statutes of the 1970s and 1980s represented a landmark effort by the federal government to remedy the common law's manifest inability to protect the environment.¹⁹ As many commentators have observed, however, these laws do not approach preserving the environment in an integrated, comprehensive, ecologically oriented way. Rather, each statute is focused on a specific environmental medium, such as air or water, or on a specific issue, such as contamination of drinking water or cleanup of hazardous waste sites.²⁰ The statutes and their implementing regulations define and address narrowly-defined environmental problems in isolation, medium-by-medium, chemical-by-chemical, and industry-by-industry. This fragmented system has issued a continual stream of regulations, standards and permits, each addressing particular chemicals, particular sources of air or water emissions, particular waste clean-up requirements or particular contamination levels deemed acceptable in drinking water, air or food. Emissions of a pollutant from a single facility can be subject to multiple laws, causing pollution to seem to "seek out the path of least regulatory resistance rather than the path where it might cause the least harm or be controlled at the least cost."²¹

The decision-making structure that prevails in these laws further fragments their approach to protecting the environment. Regulators must apply to each proposed measure a legal test specified by the particular authorizing statute. These

19. See ROBERT V. PERCIVAL ET AL., ENVIRONMENTAL REGULATION—LAW, SCIENCE AND POLICY 60–95 (Aspen Publishers 2003) (outlining environmental history of common law and federal statutes); RICHARD J. LAZARUS, THE MAKING OF ENVIRONMENTAL LAW 47–97 (University of Chicago Press 2004) (history of federal environmental law).

20. See PERCIVAL ET AL., *supra* note 19, at 88–94 (outlining federal environmental statutes); LAZARUS, *supra* note 19, at 67–75 (outlining federal environmental statutes).

21. LAZARUS, *supra* note 19, at 170; see also PERCIVAL ET AL., *supra* note 19 at 93.

legal tests almost always apply to each measure in isolation, without regard to the background context of overall human or environmental health.

For example, many federal statutes explicitly require agencies to demonstrate that each regulation, each specific step they wish to take to protect the environment, will provide benefits that outweigh the costs.²² The Toxic Substances Control Act of 1976 (TSCA) provides a case in point.²³ In order to regulate a commercial chemical under TSCA, the burden of proof is on the Environmental Protection Agency (EPA) to provide “substantial evidence” on a chemical by chemical basis that (1) the chemical presents or will present an “unreasonable” risk to health and the environment, (2) the benefits of regulation outweigh both the costs to industry of the regulation and the lost economic and social value of the product, and (3) the EPA has chosen the least burdensome way to eliminate only the unreasonable risk.²⁴ TSCA requires the EPA to consider economic factors as well as environmental and human health effects in determining whether a risk is “unreasonable.”²⁵ This burden must be carried independently for each chemical that EPA seeks to regulate under TSCA.

Many other statutes employ various other formulations for requiring that costs and benefits be taken into account, such as, for example, by authorizing environmental protection only “to the extent feasible,” authorizing only “technology-based” standards based on current technology, or requiring that costs be “considered.”²⁶

Some of the federal environmental statutes are ambiguous about the extent to which costs may limit environmental protection. But the growing expectation throughout the U.S. government is that agencies may employ cost-benefit analysis to justify their regulations, and indeed some commentators have argued that courts should recognize a legal presumption that they will do so.²⁷ As far as the White House is concerned, Executive Order 12,866 resolves all doubt as to the approach

22. See PERCIVAL ET AL., *supra* note 19, at 344–45, Fig. 4.1– Summary of Federal Laws Authorizing Regulation of Toxic Substances (outlining cost-benefit balancing tests in legal standards of Federal Food, Drug and Cosmetics Act, the Federal Insecticide and Rodenticide Act, the Toxic Substances Control Act and the Consumer Product Safety Act); Cass R. Sunstein, *Cost-Benefit Default Principles*, 99 MICH L. REV 1651, 1666–67 (2001) (outlining statutory standards requiring costs-benefit analysis, discussing Toxic Substances Control Act, Safe Drinking Water Act, Federal Insecticide, Fungicide and Rodenticide Act).

23. Toxic Substances Control Act, 15 U.S.C. §§ 2601–2629 (2000).

24. *Id.* §§ 2618(c)(B), 2605(a).

25. *Id.* § 2605(a), (c); see also *Corrosion Proof Fittings v. E.P.A.*, 947 F.2d 1201 (5th Cir. 1991) (analyzing TSCA burdens of proof). For discussion of TSCA and its various burdens of proof, see Joseph H. Guth et al., *Require Comprehensive Safety Data For All Chemicals*, 17 NEW SOLUTIONS 3, 233–58 (2007), an earlier version of which is available at <http://www.louisvillecharter.org/paper.safetydata.shtml>.

26. See Sunstein, *supra* note 22, at 1663–68 (outlining statutory standards requiring costs to be taken into account); PERCIVAL ET AL., *supra* note 19, at 344–45, Fig. 4.1– Summary of Federal Laws Authorizing Regulation of Toxic Substances (outlining feasibility- and technology-limited standards of Occupational Safety and Health Act, Safe Drinking Water Act and Clean Water Act).

27. See Sunstein, *supra* note 22, at 1665–66, 1716 (urging presumption, arguing that all branches of U.S. government have now concluded that cost-benefit analysis is desirable and that many courts now permit or even expect administrative agencies to employ cost-benefit analysis unless Congress has explicitly forbidden it). See also RICHARD L. REVESZ & MICHAEL A. LIVERMORE, *RETAKING RATIONALITY- HOW COST-BENEFIT ANALYSIS CAN BETTER PROTECT THE ENVIRONMENT AND OUR HEALTH* 12–13 (Oxford Univ. Press 2008) (arguing that cost-benefit analysis is both inevitable and desirable).

federal administrative agencies shall take. This Presidential Executive Order, signed by President Clinton, commands all federal agencies to propose or adopt regulations, including environmental regulations, under their legislative authorities only if they can show that the benefits of the regulation justify the costs (unless a particular statute requires otherwise).²⁸ This broad application of cost-benefit balancing to implementing federal laws originated with President Reagan, who intended it to restrain what he saw as the excessive power of the administrative state, particularly under the federal environmental laws of the 1970s.²⁹ It has continued under every president since then, including under President George W. Bush, who issued slight revisions to Clinton's E.O. 12,866.³⁰

The Office of Information and Regulatory Affairs (OIRA), an office within the White House Office of Management and Budget (OMB), actively enforces E.O. 12,866, and ensures that wherever legally possible, agencies demonstrate each of their regulations is cost-benefit justified.³¹ While OIRA and EPA sometimes come into conflict over cost-benefit evaluations, those conflicts are over issues of how to conduct those analyses, not whether they should be conducted at all.³² The EPA routinely performs cost-benefit analyses of its regulations and has developed its own set of guidelines for doing so.³³

In a few statutes, Congress has clearly required a different approach. In these cases, Congress has required agencies to establish certain health- or environmentally-based standards without balancing costs.³⁴ Unfortunately, these limited exceptions are highly fragmented and invariably focus on one discrete issue or chemical at a time. One example is the primary National Ambient Air Quality Standards (NAAQS) of the Clean Air Act, each of which specifies maximum levels of a specific pollutant in ambient air so as to protect public health with an adequate margin

28. Exec. Order No. 12866 (September 30, 1993), 3 C.F.R. 638, 638 (1993), reprinted in 5 U.S.C. § 601 (2000). "Regulatory Planning and Review," § 1(b)(6) ("Each agency shall . . . propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs") (available at: <http://www.archives.gov/federal-register/executive-orders/pdf/12866.pdf>). See also REVESZ & LIVERMORE, *supra* note 27, at 31–39, 151–69 (recounting history of Clinton Executive Order 12,866).

29. See REVESZ & LIVERMORE, *supra* note 27, at 21–30, 151–69 (recounting history of Reagan Executive Order 12,291, 46 Fed. Reg. 13,193 (Feb. 17, 1981)).

30. REVESZ & LIVERMORE, *supra* note 27, at 39–45, 151–69 (recounting implementation of Exec. Order No. 12,866 and revisions in 2007 under President George W. Bush).

31. See "Regulatory Analysis," OMB Circular A-4, Office of Management and Budget (September 17, 2003) (providing detailed guidance to all federal agencies on conduct of regulatory cost-benefit analysis under Exec. Order No. 12,866) (available at <http://www.whitehouse.gov/omb/circulars/a004/a-4.pdf>). OMB's extensive ongoing evaluation of regulations under E.O. 12,866 before they are promulgated and after they issue is reflected in its Annual Reports to Congress on the Costs and Benefits of Federal Regulations (compiled at: <http://www.whitehouse.gov/omb/legislative/index.html>). See also REVESZ & LIVERMORE, *supra* note 27, at 21–45 (providing extensive history of the OIRA and OMB influence over administrative agencies, especially the EPA).

32. See REVESZ & LIVERMORE, *supra* note 27, at 21–45 (discussing conflicts between the OIRA and EPA).

33. Environmental Protection Agency, Guidelines for Preparing Economic Analyses (2000), available at <http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/guidelines.html>; see REVESZ & LIVERMORE, *supra* note 27, at 10, 32, 50, 95–96 (discussing EPA use of its guidelines).

34. See, e.g., PERCIVAL ET AL., *supra* note 19 at 344–45, Fig. 4.1. -- Summary of Federal Laws Authorizing Regulation of Toxic Substances (outlining health-based tests in Clean Air Act and Federal Food Drug and the Cosmetics Act).

of safety.³⁵ However, each NAAQS, and only six have been established, relates only to the health effects of a single pollutant taken alone and without regard to the background environmental context or cumulative impacts of other kinds of pollution and environmental degradation.³⁶ Moreover, costs may be taken into account in compliance programs, including when fashioning and enforcing plans to bring non-attainment regions into compliance with a NAAQS.³⁷

Another example can be found in the Clean Water Act, which requires development of “water quality standards” that apply to ambient waters.³⁸ These comprise water quality “criteria” that define limits of specific toxic and non-toxic pollutants necessary to protect designated water “uses” (such as drinking, fishing or recreation).³⁹ However, each water quality standard applies to a specific pollutant taken in isolation and does not evaluate the cumulative impact of each pollutant on the environment. Only one hundred or so water quality criteria have been developed and relatively few of the tens of thousands of pollutants discharged into the Nation’s waters have even been tested for aquatic toxicity.⁴⁰

A third example is the Endangered Species Act (ESA), which protects endangered or threatened species without regard to cost-benefit balancing.⁴¹ But the ESA applies only to individual species and then only once regulators can prove that they are “endangered” or “threatened” as defined under the Act.⁴²

Taken as a whole, then, the federal environmental statutes are not directed toward an overarching goal such as preservation of ecological integrity.⁴³ Instead, with some exceptions, they are deeply committed to a highly fragmented, cost-benefit-driven evaluation of each individual action proposed by the government to protect human health and the environment.

Commentators are riven by the role of cost-benefit analysis in this decision-making enterprise. Professors Frank Ackerman and Lisa Heinzerling, for example, have argued that current governmental methods of cost-benefit calculations are biased against protection of human health and the environment and have revealed

35. Clean Air Act, 42 U.S.C. §§ 7401–7671(q) (2000). See *Whitman v. American Trucking Ass’n*, 531 U.S. 457 (2001) (NAAQS are to be set without regard to costs); Sunstein, *supra* note 22, at 1651, 1664 (discussing NAAQS, and citing cases confirming that they are to be based on public health alone).

36. See *e.g.*, PERCIVAL ET AL., *supra* note 18, at 501–21 (discussing the NAAQS for criteria pollutants (particulate matter, sulfur dioxide, carbon monoxide, NOX, ozone and lead and possible eventual application of health-based standard to additional pollutants); See also, EPA description of NAAQS for criteria air pollutants at <http://www.epa.gov/air/urbanair/>.

37. See *Whitman v. American Trucking Ass’n*, 531 U.S. 457 (2001) (discussing various decisions within the CAA, besides setting the NAAQS, that take cost into account); Sunstein, *supra* note 22, at 1695–96 (2001) (describing cost considerations in design of State Implementation Plans under the Clean Air Act).

38. Clean Water Act, 33 U.S.C. §§ 1251–1387 (2000).

39. See PERCIVAL ET AL., note 19, *supra* at 637–42 (outlining the Clean Water Act water quality standards, criteria and uses).

40. *Id.* at 639, 641.

41. Endangered Species Act, 16 U.S.C. §§ 1531–1544 (2000). *Tenn. Valley Auth. v. Hill*, 437 U.S. 153 (1978) (Endangered Species Act does not require consideration of costs); Sunstein, *supra* note 22, at 1697–98 (discussing lack of cost-balancing in the ESA).

42. See PERCIVAL ET AL., *supra* note 19, at 858–64 (overview of ESA).

43. See PERCIVAL ET AL., *supra* note 19 at 93 (noting federal environmental laws lack any unifying objective).

weaknesses in the justifications supplied for many of those methods.⁴⁴ They have concluded that many of the most important values of human health and the environment cannot be monetized for use in cost-benefit analysis, and that we need a different environmental decision-making method grounded in democratic participation, holistic evaluation of costs and benefits, recognition of moral concerns, a precautionary approach and a deeper concern for environmental justice and the future.⁴⁵

Thomas McGarrity, Sidney Shapiro and David Bollier have also demonstrated the shaky foundations underlying many cost-benefit methods.⁴⁶ They have called attention to its starting assumption that government should determine the economically efficient level of harm and questioned why the law should not place responsibility on industry to avoid harm or provide compensation for harm it causes.⁴⁷ They have called for environmental decision making to adopt a precautionary focus on preventing harm, to place the burden on those externalizing risk onto others to justify why those risks are acceptable, to address the sources of pollution, to promote radical technology forcing, to focus on costs in the context of analyzing alternatives, to make polluters pay for the damage they cause and to take seriously environmental justice and a concern for the future.⁴⁸

And yet, other prominent commentators broadly favor the cost-benefit enterprise. For example, Professor Cass Sunstein generally supports its use to implement the environmental statutes while recognizing agencies may have reasons to avoid it in limited circumstances.⁴⁹ Professor Richard Revesz and Michael Livermore have recently described a detailed program to correct what they call the current anti-regulatory bias in the way cost-benefit analysis is conducted.⁵⁰ But they favor its use because they believe it enables the net benefits of regulation to be maximized and ensures that regulations will increase the overall net wealth of society.⁵¹ They regard regulation, including environmental regulation, as “equivalent to governmental spending,” and see cost-benefit analysis as a tool for making government accountable for prioritizing and “spending” limited resources efficiently.⁵²

Improving the methodology of cost-benefit analysis would no doubt elevate protection of the environment under our current statutory structure. But such efforts to “fix” cost-benefit analysis ignore the larger, central problem inherent in the federal environmental laws taken as a whole. Particularly as they are interpreted

44. FRANK ACKERMAN & LISA HEINZERLING, *PRICELESS: ON KNOWING THE PRICE OF EVERYTHING AND THE VALUE OF NOTHING* (The New Press 2004).

45. *Id.* at 205–34.

46. See THOMAS O. MCGARITY ET. AL., *SOPHISTICATED SABOTAGE: THE INTELLECTUAL GAMES USED TO SUBVERT RESPONSIBLE REGULATION*, (Environmental Law Institute 2004).

47. Henry A. Waxman, *Foreward* to MCGARITY ET. AL., *supra* note 46, at x; MCGARITY ET. AL., *supra* note 46, at 141–48.

48. THOMAS O. MCGARITY ET. AL., *supra* note 46, at 217–51.

49. See Sunstein, *supra* note 22, at 1715–16 (supporting the legal application of the default assumption that agencies should use cost-benefit analysis unless Congress clearly forbids it, though acknowledging agencies may sometimes have reasons not to).

50. See REVESZ & LIVERMORE, *supra* note 27.

51. *Id.* at 10, 12, 14.

52. *Id.* at 12–13.

today, with a few exceptions these fragmented laws are grounded solidly in an overarching decision-making structure that places the burden of proof on government to justify individual steps to protect the environment on a cost-benefit basis, allowing all other increments of ecological damage to accumulate without limit.

These laws do not permit regulators broadly to take account of what is happening to the world around them. They embed regulators in a decision-making structure that may seem scientific but in fact is profoundly unscientific because it prevents them from responding to the ever more detailed findings by the world scientific community that we are overshooting the Earth's ecological capacities. Rooted in the assumption that ecological overshoot does not occur, our current statutes are incapable of containing the cumulative scale of ecological damage. Their approach to environmental protection is firmly based in the conception of the world as an empty one rather than as the full one that is in fact arising all around us. It is an approach that has become outdated because it is based on assumptions that are no longer valid.

What about that other pillar of the legal system, the common law? As we will see in the next section, the modern common law harbors the same overarching decision-making structure as that embedded in the federal environmental statutes. Indeed, the modern common law served as the original structural blueprint for many of those statutes.

C. Environmental Decision-Making Under the Modern Common Law

The common law retains a central role in resolving private disputes and remains a vital component of the American legal system for protecting the environment.⁵³ Common law doctrines constitute fundamental principles of American property and environmental law that for the most part have not been displaced by the federal environmental statutes.⁵⁴ They continue to provide background laws that apply wherever gaps in legislation remain.⁵⁵ They also form a baseline of "background principles" of property rights for determining whether legislation constitutes an impermissible "taking" under the Fifth Amendment of the U.S. Constitution.⁵⁶ This role of the common law may grow even more significant in the future, as some commentators have warned of emerging constitutional limitations on federal power to protect the environment.⁵⁷

53. Guth, *supra* note 1, at 470–88 (discussing role of common law in U.S. legal system).

54. See Alexandra B. Klass, *Common Law and Federalism in the Age of the Regulatory State*, 92 IOWA L. REV. 545, 547–51 (2007).

55. *Id.* at 557–64.

56. See Michael C. Blumm & Lucas Ritchie, *Lucas's Unlikely Legacy: The Rise of Background Principles as Categorical Takings Defenses*, 29 HARV. ENVTL. L. REV. 321 (2005) (reviewing the role of background principles in Takings jurisprudence).

57. One potential limitation is threatened by a narrow Supreme Court interpretation of the authority granted to Congress under the Commerce Clause, upon which most environmental laws are based. See Klass, *supra* note 54, at 576–79 (suggesting greater reliance on state common law in view of potential impact on federal legislation of recent Commerce Clause cases). A second arises from a lurking narrow view of the power of federal courts to adjudicate environmental disputes under the Supreme Court's standing jurisprudence. See, e.g., *Massachusetts v. EPA*, 127 S. Ct. 1438, 1463–78 (2007) (Roberts, C.J., dissenting) (four Justices agree that global warming does

Legal historians have documented the rise of the common law's modern liability doctrines during the nineteenth and twentieth centuries to accommodate and promote the industrial revolution.⁵⁸ Negligence and nuisance apply broadly to many different circumstances, including cases arising from damage to human health and the environment. These doctrines do not define as tortious all harm to human health and the environment. Negligence,⁵⁹ for example, requires damaged plaintiffs to prove that defendants created an "unreasonable" risk of harm in order to make them liable for the damage they cause.⁶⁰ Risks are defined as "unreasonable" not in a moral sense, but in cost-benefit terms that compare the social utility of the particular challenged act to the risks of resulting harm. As the modern law of negligence is commonly stated:

Where an act is one which a reasonable man would recognize as involving a risk of harm to another, *the risk is unreasonable and the act is negligent if the risk is of such magnitude as to outweigh what the law regards as the utility of the act* or of the particular manner in which it is done.⁶¹

Similarly, nuisance, the quintessential environmental tort, now recognizes an act as tortious only where plaintiffs carry their burden of proof to show that the defendant's intentional acts are "unreasonable." As in negligence, "unreasonable" is defined explicitly by a cost-benefit test:

[a]n intentional invasion of another's interest in the use and enjoyment of land is *unreasonable* [and therefore a nuisance] if

not present the kinds of injuries that confer standing on a state to challenge the EPA's failure to regulate greenhouse gases under the Clean Air Act). Third, the Takings Clause of the Fifth Amendment has been established by the Supreme Court as a potential brake on legislation that diverges substantially from the structure of property and environmental rights established by the common law. For discussion of this issue, see Guth, *supra* note 1, at 474-79.

58. See MORTON HORWITZ, *THE TRANSFORMATION OF AMERICAN LAW 1780-1860*, at 63-108 (Oxford University Press 1992) (1977) (recounting the history of the transformation from *sic utere tuo* to modern negligence and nuisance law); ERIC T. FREYFOGLE, *THE LAND WE SHARE: PRIVATE PROPERTY AND THE COMMON GOOD* 65-77 (2003); RESTATEMENT (SECOND) OF TORTS § 822 cmt. b (1979) (summarizing historical development of nuisance law). See also Guth, *supra* note 1, at 450-57 (outlining findings of legal historians).

59. RESTATEMENT (SECOND) OF TORTS § 281 (1965) (providing typical statement of the rule of negligence that now applies in the states).

60. *Id.* § 282; see also W. PAGE KEETON ET AL., *PROSSER AND KEETON ON TORTS* § 30, at 164-65 (West 5th ed. 1984) (negligence requires failure to protect against "unreasonable risks").

61. RESTATEMENT (SECOND) OF TORTS § 291 (1965) (emphasis added). See also KEETON ET AL., *supra* note 60, at 173 ("[T]he standard of conduct which is the basis of the law of negligence is usually determined upon a risk-benefit form of analysis: by balancing the risk, in the light of the social value of the interest threatened, and the probability and extent of the harm, against the value of the interest which the actor is seeking to protect, and the expedience of the course pursued."). The proposed Restatement (Third) of Torts retains this same basic definition of negligence. RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL HARM (Proposed Final Draft No. 1, 2005) § 3 cmts. e, h (requiring cost-benefit balancing in test for negligence); § 26 cmt. 1, § 28 (burden of proof on plaintiff to show defendant could have avoided damage cost-effectively).

(a) *the gravity of the harm outweighs the utility of the actor's conduct*⁶²

Thus, the definitions of tortious acts under negligence and nuisance, as applied to protecting the environment, are constructed broadly around the same assumptions as the federal statutes and employ the same overarching decision-making structure.⁶³ These doctrines implicitly presume that economic activity is to the net benefit of society even where it damages the environment, and view conduct as tortious only where plaintiffs can prove that environmental damage could have been avoided cost-effectively. As under the federal statutes, evaluation of environmental impacts is extremely fragmented; it occurs only when specific acts by defendants are challenged in specific court cases. Moreover, by placing the burden of proof on plaintiffs, the common law also resolves cases of doubt and missing information in favor of economic actors, allowing their damaging activities to continue and rewarding confusion and ignorance.⁶⁴

Environmental damage frequently results from actions by multiple defendants. The modern common law rules, by focusing on whether an individual's acts were "reasonable," are often difficult to apply to multi-defendant cases. Classic conundrums are familiar to all students of torts: who should be liable when two defendants wrestle over a gun that discharges and strikes the plaintiff, or when multiple defendants independently happen to wound the plaintiff who subsequently dies of the combined injuries? Courts have developed the concept of "concerted action," under which multiple persons acting with a common purpose in a joint enterprise to commit a tortuous act can each be held liable for the full damages caused by the act; some courts have been willing to impute concerted action and common pur-

62. RESTATEMENT (SECOND) OF TORTS § 826(a) (1979) (emphasis added). Section 826(b) provides a second test whereby "unreasonableness" can be found if the harm is "serious" and the defendant can afford to pay compensation. This second test would create liability even if the defendant's actions have a net social utility, but only if the enterprise would remain economically viable. Even so, very few courts have adopted the principle of section 826(b) and others have explicitly rejected it. See PERCIVAL ET AL., *supra* note 19, at 69–73; WILLIAM M. LANDES & RICHARD A. POSNER, *THE ECONOMIC STRUCTURE OF TORT LAW* 49 (1987); GERALD W. BOSTON & M. STUART MADDEN, *LAW OF ENVIRONMENTAL AND TOXIC TORTS* 68–73, 93–96 (2nd ed. 2003). While the balancing test of nuisance is not identical to that of negligence, the essential point is that in all American jurisdictions today, nuisance law places the burden of proof on damaged plaintiffs and requires a balancing of the interests of the person harmed, of the actor and of the community. See RESTATEMENT (SECOND) OF TORTS § 826, cmt. c (1965); KEETON ET AL., *supra* note 60, at 629–32.

63. The modern common law imposes other burdens of proof on plaintiffs through legal rules relating to "duty," "proximate causation," "foreseeability," to the "special injury rule" under nuisance, and others. See Guth, *supra* note 1, at 450–69 (further discussing how modern tort law insulates defendants from liability in order to promote economic growth).

64. The common law was designed for and applies to virtually all human activities, many of which do not implicate ecological degradation, including accidents, medical malpractice, etc. Perhaps the current law is appropriate for many of those situations. It is their application to the environment despite the problem of rising cumulative impacts in a finite biosphere that this article challenges. The reader will note that the common law does retain remnants of strict liability in the doctrines of trespass and "abnormally dangerous," and "ultrahazardous" activities. But courts have narrowly circumscribed the applicability of these doctrines, so that today they are unable to significantly redress environmental harm. See BOSTON & MADDEN, *supra* note 62, at 21–26, 106–18 (discussing limitations of modern doctrines of trespass and strict liability under "abnormally dangerous" and "ultra hazardous" theories).

pose when defendants merely know of the acts of others, though most have not.⁶⁵ Courts sometimes permit “joinder” of defendants, so that two or more defendants can be sued in the same action, usually only if they act in concert though sometimes more liberal joinder rules apply.⁶⁶ Courts also sometimes will make multiple defendants jointly and severally liable for the whole damage and place the burden of apportionment on them, but where apportionment is not possible they often refuse to award damages at all.⁶⁷

But most importantly, for an actor to be held liable, the actor’s conduct must not only be tortious (i.e., have been “unreasonable” under the test of negligence or nuisance), but it must meet the legal test for having “caused” the plaintiff’s harm. The traditional rule of causation is that the tortious conduct must be a necessary cause of the plaintiff’s harm (that is, “but-for” the actor’s tortious conduct the harm would not have occurred).⁶⁸ Courts recognize that there may be multiple, even many, “but-for” causes of a particular harm, and courts typically impose liability for each but-for cause that is also tortious, even if it would have been insufficient by itself to cause the harm.⁶⁹

In addition, courts often will impose liability for tortious conduct that is not a but-for cause if it is what is called a “multiple sufficient cause” – thus, where there are multiple causes of a harm and each by itself would have been sufficient to cause the harm, liability may attach to each tortious “multiple sufficient cause” (even though each sufficient cause is not a but-for cause).⁷⁰

65. KEETON ET AL., *supra* note 60, at 323–24, 346.

66. KEETON ET AL., *supra* note 60, at 324–28.

67. KEETON ET AL., *supra* note 60, at 348–52.

68. See RESTATEMENT (SECOND) OF TORTS § 431 (1965) cmt. a (stating general rule that to be a legal cause of another’s harm, an actor’s negligence must have been necessary for the harm to have occurred); see also RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL HARM § 26, § 26 cmt. b (Proposed Final Draft No. 1, 2005) (to be a “factual cause” of physical harm to persons or property, as a general rule conduct must be a “but-for” cause of the harm).

69. RESTATEMENT (SECOND) OF TORTS § 431 cmt. a (1965). While the Restatement (Second) of Torts § 431 arguably requires a legal cause to be not just a but-for cause but also a “substantial factor” in bringing about the harm, the proposed Restatement (Third) of Torts clarifies that every but-for cause is a “factual cause” of the harm. RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL HARM § 26, § 26 cmts. b, c (Proposed Final Draft No. 1, 2005) (discussing ambiguity in Restatement (Second) of Torts §431; and stating that while there may be many “but-for” causes of a harm, including those that are tortious, innocent and even unknown, liability attaches to each tortious “but-for” cause). See, e.g., *Town of Sharon v. Anahama Realty Corp.*, 123 A. 192, 193 (Vt. 1924) (one defendant’s dam and the other’s piers combined to divert unusually high winter ice flows onto town’s road but neither alone would have caused damage; both defendants found liable because damage would not have occurred but for the acts of each).

70. RESTATEMENT (SECOND) OF TORTS § 432(2) (1965); § 432 cmt. d (citing example of liability for each of two independent fires that coalesce, each sufficient on its own to have burned plaintiff). The comments to the proposed Restatement (Third) of Torts explain that Restatement (Second) of Torts § 432(2) is ambiguous as to liability for each multiple sufficient cause and that only a handful of cases explicitly invoke this section. RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL HARM § 27, §27cmts. a, b (Proposed Final Draft No. 1, 2005). The proposed Restatement (Third) of Torts itself, however, strongly supports liability for all multiple sufficient causes. *Id.* See also *Barrett v. Mount Greenwood Cemetery Ass’n*, 42 N.E. 891, 892 (Ill. 1896) (even though there were other polluters, drainage from each cemetery would alone contaminate stream and render it unfit for agriculture, household use, and ice); *Lawton v. Herrick*, 76 A. 986, 990 (Conn. 1910) (upstream mill deposited pomace that disrupted ice operations of downstream ice operation; that others also fouled the stream was no defense); *New Jersey v. City of New York*, 283 U.S. 473, 481, 483 (1931) (though New York City argued that numerous others discharged waste onto New Jersey shores, the Court accepted its special master’s findings that these were “negligible” in comparison with City’s discharges); *Woodland v. Pontneuf-Marsh Valley Irrigation Co.*, 146

But neither of those types of cases applies to the causation of ecological degradation (or global warming) by cumulative small impacts. Each such impact is neither a but-for cause (because degradation (or warming) would still occur if the individual impact ceased) nor a multiple sufficient cause (because each impact by itself would not cause degradation (or warming)). The inapplicability of these rules of causation to the modern problem of cumulative small impacts has made many modern environmental problems all but intractable under the decision-making structure of the modern common law.

This is illustrated by an important case from 1973, in which the Northern District of Illinois was faced with massive pollution causing the eutrophication of Lake Michigan by multiple polluters, only a few of which were sued by the plaintiffs.⁷¹ Taken alone, the defendants' sewage discharges may not have been able to cause eutrophication of the lake, and the defendants contended that they could not be held liable because the law required such causation. The court rejected this contention, arguing that since there were many polluters, the rule urged by defendants would make it "impossible to impose liability on any polluter."⁷² Because the defendants contributed a "significant portion of the total nutrient input to the lake," the court concluded they could be enjoined.⁷³ For this decision, the court was able to find "not much authority squarely on point," and indeed relied on a single case from 1896.⁷⁴ Though clearly concerned with the problem posed by cumulative small impacts, the court was forced to admit that there were "de minimus" contributors to the lake's eutrophication that the common law simply could not hold liable.⁷⁵

The current common law is even less effective when every defendant is responsible only for an incremental contribution rather than a "significant portion" of the harm, as a very recent case makes all too clear. In *California v. General Motors Corp.*, California's Attorney General sued six automakers on the theory that the greenhouse gas emissions from their cars, which constituted 30% of U.S. emissions and 20% of California emissions, created a nuisance by contributing to global warming.⁷⁶ No automaker contributes more than a small percentage of global carbon emissions, and even enjoining all defendants from contributing further to Cali-

P. 1106, 1107 (Idaho 1915) (where defendant argued that overflow from his canal did not alone cause damage because six other canals also overflowed onto plaintiff's crops, court affirmed jury instruction that the defendant would not be responsible for water over which it had no control, but "is liable, if at all, only for such damage as you may find it actually caused to plaintiff's crops through negligently allowing waters of the Portneuf river, brought through its laterals for irrigation purposes, to escape upon plaintiff's lands"); *Northup v. Eakes*, 178 P. 266, 269 (Okla. 1918) (where several parties discharged oil into a stream that then ignited and burned down plaintiff's barn, the court found "that the act of the defendant in negligently discharging crude oil, a highly inflammable substance, into the stream above plaintiff's barn was the proximate cause of the injury, for the reason that the injury done by the floating oil ought to have been foreseen, in the light of all the surrounding circumstances").

71. *Illinois v. City of Milwaukee*, No. 72 C 1253, 1973 U.S. Dist. LEXIS 15607 (N.D. Ill. 1973), *aff'd in relevant part and rev'd in part*, 599 F.2d 151 (7th Cir. 1979), *vacated on other grounds*, 451 U.S. 304 (1981).

72. *Id.* at *21-22.

73. *Id.* at *21.

74. *Id.* at *23 (citing *Barrett v. Mount Greenwood Cemetery Ass'n.*, 42 N.E. 891 (Ill. 1896). The reason the court could not find helpful modern authority is that each defendant's conduct was neither a but-for cause nor a multiple sufficient cause of the lake's eutrophication. See *supra* note 70 for more information on the *Barrett* case.

75. *Id.* at *22.

76. *California v. Gen. Motors Corp.*, No. C06-05755 (MJJ), 2007 U.S. Dist. LEXIS 68547, at *3 (N.D. Cal. 2007).

ifornia or even U.S. emissions would not materially reduce the problem of global warming – the epitome of a modern cumulative impacts problem.

Here the Northern District of California was confronting perhaps the most significant single environmental threat facing the world today. Yet the court dismissed the case, based in part on a finding that the common law provided no tools for resolving the cumulative impacts problem. The court questioned whether defendants' actions are "unreasonable" (i.e. tortious), and stated that the common law of nuisance was unable to address the threat and left the court:

without guidance in determining what is an unreasonable contribution to the sum of carbon dioxide in the Earth's atmosphere, or in determining who should bear the costs associated with the global climate change that admittedly result from multiple sources around the globe. Plaintiff has failed to provide convincing legal authority to support its proposition that the legal framework for assessing global warming nuisance damages is well-established.⁷⁷

Prominent torts commentator Dean Prosser has concisely explained the theoretical difficulty that cumulative small impacts pose for the modern common law:

A very troublesome question arises where the acts of each of two or more parties, standing alone, would not be wrongful, but together they cause harm to the plaintiff. If several defendants independently pollute a stream, the impurities traceable to each may be negligible and harmless, but all together may render the water entirely unfit for use. *The difficulty lies in the fact that each defendant alone would have committed no tort.* There would have been no negligence and no nuisance, since the individual use of the stream would have been a reasonable use, and no harm would have resulted.⁷⁸

^{77.} *Id.* See also *Connecticut v. Am. Elec. Power Co.*, 406 F. Supp. 2d 265, 274 (S.D.N.Y. 2005) (dismissing nuisance suit to enjoin greenhouse gas emissions by electric power utilities on grounds that a federal court should not make the significant policy decisions required to resolve the suit "because they are reserved to the political branches of government").

^{78.} See KEETON ET AL., *supra* note 60, at 354–55 (emphasis added). This treatise cites several authorities for the proposition that a contributor of a harmless impact might nevertheless be held liable if he or she knew or should have known that others had created a situation where any additional impact would result in unreasonable damage. *Id.*; see also RESTATEMENT (SECOND) OF TORTS § 840E cmt. b (1979) (citing same proposition). Unfortunately, this rule has been poorly developed; indeed the cases cited by the treatise date mostly from the turn of the twentieth century or earlier, and many sound not in modern negligence and nuisance but in the old common law rule of *sic utere tuo* (see further discussion, *infra*). KEETON ET AL., *supra* note 60, at 354–55 (citing *Woodyear v. Schaefer*, 57 Md. 1 (1881); *United States v. Luce*, 141 F. 385 (C.C.D. Del. 1905), which are discussed further, *infra*). Moreover, with ecological degradation resulting from impacts from many sources simultaneously, it is difficult to see how priority could be granted to some defendants rather than others so as to attribute knowledge and therefore negligence to any particular defendants. In metaphorical terms, when it comes to the modern prob-

Indeed, some prominent advocates of the current general structure of tort law admit that modern nuisance law fails to prevent cumulative small impacts, and go so far as to call this problem “insoluble in common law theory.”⁷⁹

Thus we see that judges and commentators alike struggle mightily with the problem of cumulative incremental impacts. The reasons they struggle are all too clear. In part, courts struggle to apply traditional rules of causation to harm that results from cumulative small impacts that are neither necessary nor sufficient causes of the harm. But more important is the law’s central concept of tortious action that imposes liability only on individual acts that can be proved to fail the cost-benefit test of net social utility. By focusing on the reasonableness of each individual’s acts, the modern common law is doctrinally incapable of imposing liability on defendants whose acts cause little or no harm when taken alone, regardless of their cumulative impact. Such defendants have, in the words of Dean Prosser, simply committed no modern tort.

II. CONTAINING CUMULATIVE IMPACTS IN ENVIRONMENTAL DECISION-MAKING

Legal writers have long called for the law to recognize ecological limits and to be reoriented so as to address environmental problems from an ecological perspective.⁸⁰ For the law to do this, it will have to adopt a new decision-making structure

lem of ecological degradation we cannot in practice identify any particular straw to blame for breaking the camel’s back.

79. See WILLIAM M. LANDES & RICHARD A. POSNER, *THE ECONOMIC STRUCTURE OF TORT LAW* 52 (1987). The proposed Restatement (Third) of Torts sets forth a helpful approach to the causation aspect of this “insoluble” problem, if courts adopt it. It suggests an analytical structure for cases in which harm is “overdetermined” and results from many contributing causes, some or all of which are neither necessary nor sufficient to cause the harm. These individual contributing impacts should be viewed as elements of “multiple sufficient causal sets,” in which each sufficient causal set is sufficient to cause the harm and each impact that is a necessary element of at least one such set is deemed a “factual cause” of the harm. RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL HARM § 27; cmts. f, g; Reporters’ Note to comments f, g (Proposed Final Draft No. 1, 2005) (explaining “multiple sufficient causal set” analysis; acknowledging that to date few courts have explicitly adopted this approach, but finding support in a line of asbestos cases in which all defendants who exposed plaintiff to asbestos were found liable). Under this analytical structure, it appears that each contribution to ecological degradation could be deemed a “factual cause” of the degradation and each source of carbon emissions could be deemed a “factual cause” of global warming. *But see* RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL HARM § 36. cmt. b (Proposed Final Draft No. 1, 2005) (providing for possibility of no liability for “trivial” factual causes of an overdetermined harm). Even if courts adopt this approach to causation, however, the essential, insoluble problem with the modern common law remains: liability attaches not to all “factual causes” of harm, but only to *tortious* conduct, that is, conduct that can be proved to fail the cost-benefit test that remains at the core of the doctrines of negligence and nuisance. See RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL HARM § 3 and cmts. e, h (requiring cost-benefit balancing in test for negligence) (Proposed Final Draft No. 1, 2005).

80. See, e.g., THOMAS BERRY, *THE GREAT WORK* 7, 58, 60–62 (1999) (calling for legal system, for the sake of human survival, to envisage its primary task as preserving and enhancing the community of all living species); CORMAC CULLINAN, *WILD LAW – A MANIFESTO FOR EARTH JUSTICE* 83–135 (2003) (calling for development of an Earth Jurisprudence grounded not in human interests but in the well-being of the planet as a whole); FREYFOGLE, *supra* note 58, at 203–27, 229–30 (calling for the development of a new “Private Property for an Ecological Age,” where the law would take account of today’s variety of harms and natural variations in the land); Lynda L. Butler, *The Pathology of Property Norms: Living Within Nature’s Boundaries*, 73 S. CAL. L. REV. 927, 1001–04 (2000) (describing how common law can restrict private land uses according to their cumulative impact on natural systems); GUTH, *supra* note 1, at 488–512; David B. Hunter, *An Ecological Perspective on Property: A Call for Judicial Protection of the Public’s Interest in Environmentally Critical Interests*, 12 HARV. L. REV. 311

that reflects a new set of goals and assumptions. It will have to envision and shape not an economy that pursues endless growth in net benefits, but one that will continue to develop while accommodating rather than undermining the ecological systems our welfare ultimately depends upon.⁸¹ Environmental law should be built on the assumptions that human welfare is critically dependent upon on an ecologically functioning biosphere and that we must constrain our cumulative environmental damage to an ecologically sustainable scale.

The essential first step is for the legal system to adopt as an overarching objective the maintenance of the ecological integrity of the biosphere. Under such a governing principle, the law would not evaluate each increment of damage through a particularized cost-benefit analysis. Instead the law would recognize a standard of ecological integrity that it would protect from invasion by environmental impacts large and small.

Our legal system already harbors examples of decision-making structures that establish a principle or standard of environmental quality or human health and do not rely on cost-benefit balancing. These examples, which will be discussed in some detail below, show that such legal principles or standards can enable the legal system to contain the growth of cumulative impacts.

The suggestion to adopt an overarching legal principle or standard of ecological integrity can be discerned in the cost-benefit literature discussed earlier in this article. Ackerman and Heinzerling as well as McGarity et al., scholars who are deeply troubled by the cost-benefit analysis, have called for alternative methods of decision-making, and recommend what they call a precautionary approach that focuses on avoidance of harm and places the burden of proof on industrial interests to show they are not causing undue harm.⁸² Similarly, Professor Sunstein has written that cost-benefit analysis may not be appropriate where a particular law seeks to prevent “irreversible” and “catastrophic” damage, such as species loss under the Endangered Species Act, because in such cases lawmakers have decided that the losses protected against are too important to warrant economic balancing; in such cases a precautionary approach, or what Sunstein calls a “rights-based” approach,

(1988) (calling for law to recognize the ecological value of land); David S. Wilgus, Comment, *The Nature of Nuisance: Judicial Environmental Ethics and Landowner Stewardship in the Age of Ecology*, 33 MCGEORGE L. REV. 99, 125–29 (2001) (common law should recognize interconnectedness of nature and that we are reaching the carrying capacity of the land; nuisance law should be guided by principles of ecology, ecological preservation, and maintaining the land as shared heritage of all).

81. See HERMAN E. DALY, BEYOND GROWTH: THE ECONOMICS OF SUSTAINABLE DEVELOPMENT 31–60 (1996) (distinguishing “development” (defined as improvement in quality of products but within a fixed ecological impact) from economic “growth” (defined as quantitative increase in total scale of throughput)). See also WILLIAM McDONOUGH & MICHAEL BRAUNGART, CRADLE TO CRADLE – REMAKING THE WAY WE MAKE THINGS (2002) (explaining how products can be designed from the outset so as not to cause damage to the Earth at any point in their lifecycle).

82. E.g., FRANK ACKERMAN & LISA HEINZERLING, PRICELESS: ON KNOWING THE PRICE OF EVERYTHING AND THE VALUE OF NOTHING 223–29 (2004) (calling for better ways of making decisions); THOMAS O. MCGARITY ET AL., SOPHISTICATED SABOTAGE: THE INTELLECTUAL GAMES USED TO SUBVERT RESPONSIBLE REGULATION 218–22 (2004). See also Joseph L. Sax, *Property Rights and the Economy of Nature: Understanding Lucas v. South Carolina Coastal Council*, 45 STAN. L. REV. 1433, 1452 (1993) (stating that law should accommodate “the economy of nature” by redefining land ownership in terms of usufructuary rights, in which a landowner “does not have exclusive dominion of her land; rather, she only has a right to uses compatible with the community’s dependence on the property as a resource”).

may be more appropriate.⁸³ And Revesz and Livermore have expressed discomfort with the use of cost-benefit tools, particularly discounting, to value harm that extends to future generations, suggesting that in such cases society should develop an alternative decision-making structure grounded in a conception of sustainable development.⁸⁴

We must recognize, however, that the ecological degradation we now face cannot reasonably be characterized as comprising just a few isolated problems that threaten “irreversible” or “catastrophic” effects or impacts on future generations. It results from the cumulative effect of all our myriad impacts on the Earth. We cannot solve this problem by exempting a few discrete impacts from cost-benefit balancing. We must subject *all* our actions to a new decision-making structure designed to defend and maintain the ecological integrity of the Earth.

One expression of a legal principle of preserving ecological integrity is the recognition and establishment of environmental rights. Various forms of environmental rights have been proposed and sometimes even incorporated into the law. For example, legal scholars have called for the recognition and creation of human rights to a clean environment within constitutions, including the United States constitution,⁸⁵ and some states have adopted such provisions.⁸⁶ Some writers have called for rights of future generations to a clean environment.⁸⁷ Still others have urged that our ethical responsibilities to the natural world transcend purely human interests and require creation of rights in nature, including not just biological spe-

83. Sunstein, *supra* note 22, at 1651, 1697–98 (2001) (society might find “rights-based thinking,” which forbids balancing an interest against costs, appropriate for certain “irreversible” environmental losses); Cass R. Sunstein, *Irreversible and Catastrophic*, 91 CORNELL L. REV. 841, 894–96 (2006) (discussing a form of precautionary approach rather than current cost-benefit analysis for events that may be “irreversible” and “catastrophic”); Cass R. Sunstein and Arden Rowell, *On Discounting Regulatory Benefits: Risk, Money and Intergenerational Equity*, 74 U. CHI. L. REV. 171, 188–90, 203 (2007) (suggesting that use of discounting in cost-benefit analysis should be altered in the case of catastrophic future events, such as global warming). *See also* Richard A. Posner, *Efficient Responses to Catastrophic Risk*, 6 CHI. J. INT’L L. 511 (2006) (proposing modified cost-benefit approaches in cases of catastrophic risk, such as global warming).

84. REVEZ & LIVERMORE, *supra* note 27, at 107–17. *See also* Richard L. Revesz, *Environmental Regulation, Cost-Benefit Analysis, and the Discounting of Human Lives*, 99 COLUM. L. REV. 941, 1015–18 (1999) (urging that determining our responsibilities to future generations should avoid debates over discounting and instead focus on equitable distribution, prevention of catastrophic harms and preservation of unique natural resources).

85. *See, e.g.*, Dan L. Gildor, *Preserving the Priceless: A Constitutional Amendment to Empower Congress to Preserve, Protect, and Promote the Environment*, 32 ECOLOGY L.Q. 821 (2005) (advocating addition of environmental rights to the U.S. Constitution). Another example is the Seventh Generation Amendment, also called The Common Property Amendment, available at <http://www.protecttheearth.net/Seventh%20Generation.htm>.

86. *E.g.*, PA. CONST. art. I, § 27 provides: “The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment.” *See also* MONT. CONST. art. II, § 3.

87. Edith Brown Weiss, *In Fairness to Future Generations: International Law, Common Patrimony, and Intergenerational Equity* (2nd prt. 1992) (defining principles of intergenerational equity). *See also* Science & Environmental Health Network and International Human Rights Clinic at Harvard Law School, *Models for Protecting the Environment for Future Generations* (2008) (proposing legal rights and guardians for future generations) (2008) (available at: http://www.law.harvard.edu/programs/hrp/documents/Models_for_Protecting_the_Environment_for_Future_Generations_lr.pdf).

cies and individual organisms, but also ecological entities such as forests and rivers.⁸⁸

Recognizing and establishing these kinds of rights is a critical and valuable step, one that requires care if the rights are to be effective.⁸⁹ But even once such rights are recognized, the real legal work has only just begun. What remains is the central problem in any system of legal rights: defining the scope of these rights as they inevitably come into conflict with other rights and interests. Such conflicts are usually resolved by judges in constitutional litigation, though the fate of environmental rights in such cases is today uncertain at best. This problem is illustrated by a recent case in which the Pennsylvania Supreme Court considered the environmental rights enshrined in the Pennsylvania Constitution.⁹⁰ The state constitution expressed Pennsylvanians' far-reaching rights to a healthy environment, the importance of future generations, and the state's public trust obligations.⁹¹ The court, however, was unwilling to fully enforce these rights according to these aspirational terms, and instead balanced them with other interests. As the court said:

[T]he responsibility of government to protect the environment from private injury is . . . clear. PA. CONST. Art. I, § 10 provides that:

The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment. Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people.

*In this case, we are required to weigh the governmental obligation to protect the environment against the individual right to do as one wishes with property one owns.*⁹²

88. See, e.g., BERRY, *supra* note 80 (calling for legal system to recognize rights of all living things); CULLINAN, *supra* note 80; CHRISTOPHER D. STONE, SHOULD TREES HAVE STANDING, reprinted in SHOULD TREES HAVE STANDING AND OTHER ESSAYS IN LAW, MORALS AND THE ENVIRONMENT 1–48 (Oceana Publications 1996).

89. Besides political hurdles to their adoption, Constitutional rights must be carefully structured to provide not just adequate substantive rights, but also to define, *inter alia*, who they shall be enforceable against, who has standing to enforce them, whether they are fundamental, how to resolve conflicts with other rights, and whether they are self-executing or need legislation to implement them. See Science & Environmental Health Network and International Human Rights Clinic at Harvard Law School, Model Provisions to Amend State Constitutions for the Purpose of Establishing Environmental Rights for Present and Future Generations in *Recalibrating the Laws of Humans with the Laws of Nature: Climate Change, Human Rights, and Intergenerational Justice* (Climate Legacy Initiative, forthcoming 2009) (to be available at: <http://www.vermontlaw.edu/x4128.xml>).

90. *Machipongo Land & Coal Co. v. Commonwealth*, 799 A.2d 751 (Pa. 2002).

91. *Id.*

92. *Id.* at 754–55 (emphasis added).

The court found that the Pennsylvania statute at issue may have constituted a taking that impermissibly invaded existing landowner property rights, and reversed and remanded on this question.⁹³ Thus, faced with what it characterized as a conflict between constitutional environmental rights and traditional property rights, the court reverted to the law's prevailing structure for resolving this conflict. Even though Pennsylvania environmental rights seem clear on their face, they did not in this case force a redefinition of how the law should resolve environmental conflicts. For Pennsylvania's environmental rights, or any other aspirational constitutional environmental rights, to effectively stem the onslaught of cumulative impacts, courts will have to strike a far different balance between those rights and other interests.

While work to establish effective environmental rights can and must continue, both the common law and legislation are quite capable of defining and enforcing standards of environmental integrity and human health. The following subsections, focusing first on the common law and then on federal environmental statutes, show that the law can use such environmental principles or standards to contain the growth of cumulative impacts.

A. Cumulative Impacts Under The Early Common Law

In 1849, one William E. Woodyear began operating a flourmill along Gwynn's Falls in the City of Baltimore, at a site where a mill had been operating already for over fifty years.⁹⁴ Various industrial operations continued to be built along Gwynn's Falls and a tributary called Gwynn's Run until, by 1881, "a hundred other butchers, together with brewers, hair manufacturers and soap boilers" were located upriver in the vicinity of Woodyear's mill.⁹⁵ The stage was set for a classic cumulative impacts conflict.

As time passed, the increasing amount of blood, entrails, offal, dead animals and "other offensive matter from various other sources" discharged into Gwynn's Run by these enterprises began to interfere with the operation of Woodyear's downriver mill.⁹⁶ Finally Woodyear, whose employees started becoming physically ill from the river's stench and at times were forced to stop the flow of water to the mill, empty the contents of the mill dam and even shut down the mill,⁹⁷ could take no more. He chose to sue one Henry Schaefer, who had built a slaughterhouse in 1874 on Gwynn's Run,⁹⁸ charging him with creating a common law nuisance that decreased the value of Woodyear's mill and deprived him of the comfortable and reasonable enjoyment of it.⁹⁹ He sought an injunction restraining Schaefer from discharging any "blood, entrails or offal" into Gwynn's Run.¹⁰⁰

93. *Id.*

94. *Woodyear v. Schaefer*, 57 Md. 1, 1881 LEXIS 2, *4-5 (Ct. App. MD 1881).

95. *Id.* at *1.

96. *Id.* at *5, *7, *8.

97. *Id.* at *5, *7.

98. *Id.* at *8.

99. *Id.* at *5-6.

100. *Id.* at *6.

There was a trial before the circuit court sitting in equity, which decided in favor of the defendant, Schaefer. Woodyear appealed to the Maryland Court of Appeals, which reversed and remanded for the trial court to enjoin Schaefer.

According to the Court of Appeals, the evidence at trial established the “offensive condition” of the river and “the air at the mill to be at times so offensive as to be practically unbearable.”¹⁰¹ Yet it also showed that Schaefer’s slaughterhouse contributed only “comparatively moderate quantities” of cow’s blood,¹⁰² which Schaefer described as “not exceeding fifteen buckets full, upon an average, per week, which blood cannot be seen or detected in the waters of the said run over one hundred yards below the slaughter-house.”¹⁰³ The Court of Appeals concluded Schaefer’s discharges were simply one contribution along with a large number of others that together were causing Woodyear “serious injury and grievance.”¹⁰⁴

The Court of Appeals framed the legal question presented by the case in terms that clearly define the problem of cumulative impacts:

[C]an a Court of equity intervene to stop [Schaefer] from committing the acts which constitute such an inconsiderable part of the wrong complained of, and which if stopped, would leave the appellant still suffering from almost as great a grievance as he is now subject to?¹⁰⁵

The court first found that Woodyear had a prescriptive riparian right to free and unobstructed use of the water for the purpose of operating the mill because his mill and the mill preceding it had operated on Gwynn’s Falls for over 50 years.¹⁰⁶ The court then rejected Schaefer’s plea that he was not responsible for the nuisance, and in doing so, followed reasoning that we might hope courts will soon resurrect and apply to the modern problem of ecological degradation:

The extent to which [Schaefer] has contributed to the nuisance, may be slight and scarcely appreciable. Standing alone, it might well be that it would only, very slightly, if at all, prove a source of annoyance. And so it might be, as to each of the other numerous persons contributing to the nuisance. Each standing alone, might amount to little or nothing. But it is when all are united together, and contribute to a common result, that they become important as factors, in producing the mischief complained of. And it may only be after from year to year, the number of contributors to the injury has greatly increased, that sufficient disturbance of the appellant’s rights has been caused to justify a complaint.

101. *Id.* at *7.

102. *Id.* at *7.

103. *Id.* at *6.

104. *Id.* at *7.

105. *Id.* at *7.

106. *Id.* at *7–8.

One drop of poison in a person's cup, may have no injurious effect. But when a dozen, or twenty, or fifty, each put in a drop, fatal results may follow. It would not do to say that neither was to be held responsible.

*In that state of facts, as in the one presented by this case, each element of contributive injury is a part of one common whole, and to stop the mischief of the whole, each part in detail must be arrested and removed.*¹⁰⁷

The court asserted that if Woodyear still suffered from pollution of the river after Schaefer stopped his discharges he would be entitled to sue for an injunction against all other contributors to the nuisance.¹⁰⁸ The court rejected Schaefer's argument that the injunction would be ruinous to many businesses and devalue a large amount of investment capital. It explained that industry elsewhere was able to adapt to this rule of law, that Schaefer's slaughterhouse and the other businesses had profited from the damage they externalized onto the community, and that many businesses like Woodyear's, as well as the community as a whole, would benefit from the injunction.¹⁰⁹ The court observed that "no other remedy" was equal to the problem at hand, and concluded:

[Schaefer] and those situated like him, must learn to act upon the maxim: *sic utere tuo ut alienum non laedas*.¹¹⁰

Legal scholars have shown that the doctrine cited by the Court of Appeals, "*sic utere tuo ut alienum non laedas*" ("use your own so as not to injure another"), was for centuries the core common law legal doctrine in America and in England for resolution of property and environmental disputes.¹¹¹ As William Blackstone explained it, neighbors were expected not interfere with each other's use of their own land because "it is incumbent on a neighboring owner to find some other place to

107. *Id.* at *9–10 (citations deleted) (emphasis added).

108. *Id.* at *12.

109. *Id.* at *13.

110. *Id.*

111. This passage and footnote are adapted from Guth, *supra* note 1, at 431, 494–511 (Spring 2008) (available at <http://www.vjel.org/index.php>). See HORWITZ, *supra* note 58, at 32 (Harvard University Press 1977) (discussing historical prevalence of *sic utere tuo*); ERIC T. FREYFOGLE, *THE LAND WE SHARE: PRIVATE PROPERTY AND THE COMMON GOOD*, 67–69 (Island Press 2003) (same); WILLIAM J. NOVAK, *THE PEOPLE'S WELFARE: LAW & REGULATION IN NINETEENTH-CENTURY AMERICA*, 42–50 (The University of North Carolina Press 1996) (broad applicability of *sic utere tuo*). The common law did surely contain many other complex procedural and substantive rules. See HORWITZ, *supra* note 58, at 32–74 (discussing prescription, waste, just compensation); KEETON, W. PAGE et al., *PROSSER AND KEETON ON TORTS*, § 6 (pp. 28–31); § 28 (pp. 160–61); § 86 (pp. 616–619) West, 5th Edition (1984) (outlining early forms of action); John G. Sprankling, *The Antiwilderness Bias in American Property Law*, 63 *U. CHI. L. REV.* 519, *passim* (1996) (discussing waste, adverse possession, possession as notice to purchaser, good faith improver doctrines). But these rules were comparatively narrow in effect. The principle of *sic utere tuo* functioned as the law's essential principle for adjudicating liability and, together with its overarching goal of *salus populi suprema lex est* ("the welfare of the people is the supreme law"), formed the common law's "blueprint," its fundamental property rights structure, for governing America's pre-industrial economy. NOVAK, *THE PEOPLE'S WELFARE*, at pp. 42–50.

do that act, where it will be less offensive.”¹¹² The principle of *sic utere tuo* was built around the presumption that material damage to property was socially undesirable, and it imposed a rule of strict liability without regard to the social utility of the interfering activity.¹¹³

The court in *Woodyear v. Schaefer* applied the doctrine of *sic utere tuo* to protect Woodyear’s prescriptive riparian right to a water flow sufficient to operate his mill. The court enjoined Schaefer’s discharges even though taken alone they caused an “inconsiderable” portion of the damage to Woodyear’s interests. Thus, the court protected Woodyear’s property interests from interference, regardless of the costs and benefits or impact on “a hundred” other enterprises.

The property interest the court protected in *Woodyear v. Schaefer* was the riparian right to a source of water that was not so polluted as to interfere with one’s historical use. Other cases also protected this interest from the cumulative impacts of multiple polluters.¹¹⁴ The common law similarly defended other valued interests as well. For example, courts protected from cumulative impacts prescriptive rights to a certain volume of water flow.¹¹⁵ They protected from cumulative invasion the “paramount” public right to navigation on navigable waters.¹¹⁶ In some situations they protected landowners from cumulatively excessive and offensive odors.¹¹⁷ And even when the newly arising balancing doctrines of negligence and nuisance applied, the U.S. Supreme Court recognized the sovereign power of States to “stand on their extreme rights” and insist on abatement of pollution emanating from other States.¹¹⁸

112. Blackstone, William, *Commentaries on the Laws of England*, vol. III, 217–18, (University of Chicago Press 1765–69) (1979), discussed and quoted in HORWITZ, *supra* note 58, at 31; FREYFOGLE, *The Land We Share*, at 68.

113. HORWITZ, *supra* note 58, at 70, 85; FREYFOGLE, *supra* note 58, at 69–70.

114. E.g., *The Lockwood Co. v. Lawrence*, 77 Me. 297, 306; 1885 Me. LEXIS 64, 16 (1885) (enjoining discharges by three upstream sawmills even though no discharge alone would interfere with plaintiff’s prescriptive right to operate cotton mill and there were other dischargers on the river, because for a court sitting in equity “it is enough to know that [a defendant] has contributed, and is continuing to contribute to a nuisance, without ascertaining to what extent, and to restrain him from contributing at all”); *Warren v. Parkhurst*, 45 Misc. 466, 466; 92 N.Y.S. 725, __; 1904 N.Y. Misc. LEXIS 522, 2 (Sup. Ct. 1904) (enjoining 26 upstream mills for discharging sewage causing stench even though the damage caused by each acting alone was “nominal”).

115. *Hillman v. Newington*, 57 Cal. 56, 64; 1880 Cal. LEXIS 492, 15 (1880) (enjoining and holding eight defendants liable, and apportioning damages, for total water use that deprived plaintiff of his prior appropriation right to certain water flow, even though it was probable that no defendant alone used enough water to deprive plaintiff of his rights).

116. *California v. Gold Run Ditch and Mining Co.*, 66 Cal. 138, 149; 4 P. 1152, 1157; 1884 Cal. LEXIS 713, 23 (1884) (enjoining defendants from discharging mining waste even though there were other dischargers and trial court was “unable to say” defendants’ discharges alone interfered with the public’s “paramount and controlling” right to navigate the river, stating “all persons engaged in the commission of the wrongful acts which constitute the nuisance may be enjoined”).

117. See, e.g., *United States v. Luce*, 141 F. 385, 415; 1905 U.S. App. LEXIS 4900, 84 (C.C.D. Del. 1905) (enjoining odors that were offensive to government quarantine station and hospital emanating from defendant’s fish factory despite other factories nearby, stating: “The principal question after all is whether the defendants . . . [are] duly observing the precept, *sic utere tuo ut alienum non laedas*? On the evidence and the authorities clearly they are not.”).

118. *Georgia v. Tennessee Copper Co.*, 206 U.S. 230, 238–39; 27 S. Ct. 618, 618–20; 51 L. Ed. 1038; 1907 U.S. LEXIS 1158, 14–16 (1907) (opinion by Holmes, J.) (remanding for order to abate factory emissions in Tennessee, observing that Georgia had sovereign right to protect its air and forests from damage by emissions coming from another State, “whatever domestic destruction they have suffered,” without a balancing of the various considerations that would be relevant in a private dispute).

The interests that the common law protected in this way were framed in functional terms that courts could use to prevent invasions of the protected interest. For example, Woodyear's right to a water flow suitable for the operation of his mill protected him from cumulative impacts from various sources – including different kinds of offensive matter discharged by both slaughterhouses and various other sources. The law did not set up separate, fragmented standards for each separate kind of material, as much of our law does today, for it was focused on protecting Woodyear's more broadly defined social interest.

The legal structure of *sic utere tuo* and the various interests protected under it by the common law has been largely overturned by the modern doctrines of negligence and nuisance.¹¹⁹ The central issue for us is not so much whether those principles should be resurrected in anything like their ancient form, for the substantive interests they were designed to protect are not as important today as they once were. It is that the common law once protected certain property and environmental interests by defining an overarching standard that could not be invaded by cumulative impacts rather than by applying a fragmented balancing test to each individual impact. Under rules of law that were focused on protecting defined interests, rather than on whether a defendant's acts provided a net benefit to society, the law was able to protect those interests from the cumulative impact of individually harmless acts.

B. Cumulative Impacts In Federal Environmental Legislation

The federal government has begun to recognize the problem of cumulative impacts, though in limited ways. Some small administrative efforts are underway. For example, the U.S. EPA is developing a framework for performing risk assessments of the cumulative impact of multiple chemical exposures.¹²⁰ The White House Council on Environmental Quality has begun to develop methods for evaluating cumulative impacts in Environmental Impact Statements and Environmental Assessments of government actions under the National Environmental Policy Act of 1969 (NEPA).¹²¹ These are welcome efforts, but they are being undertaken entirely within the context of the existing statutes. They do not, as they could not,

119. See Guth, *supra* note 1, at 431, 450–57 (available at <http://www.vjel.org/index.php>) (outlining legal scholarship on common law transformation to modern structure of negligence and nuisance).

120. See U.S. ENVTL. PROT. AGENCY, FRAMEWORK FOR CUMULATIVE RISK ASSESSMENT, EPA/630/P-02/001F (2003) (discussing the EPA's newly developed framework for cumulative risk assessment); NAT'L CTR. FOR ENVTL. ASSESSMENT, U.S. E.P.A., CONSIDERATIONS FOR DEVELOPING ALTERNATIVE HEALTH RISK ASSESSMENT APPROACHES FOR ADDRESSING MULTIPLE CHEMICALS, EXPOSURES AND EFFECTS (EXTERNAL REVIEW DRAFT) 1–2 (2006) (explaining that “[t]he purpose of [the] report is to describe information and risk assessment approaches that can be used to implement the basic cumulative risk concepts” set out in other EPA reports).

121. See COUNCIL ON ENVTL. QUALITY, CONSIDERING CUMULATIVE EFFECTS UNDER THE NATIONAL ENVIRONMENTAL POLICY ACT 49–57 (1997) (setting forth methods for evaluating cumulative impacts under NEPA), available at <http://www.nepa.gov/nepa/ccenepa/sec5.pdf>; see also 40 C.F.R. § 1508.7 (2007) (explaining that CEQ regulations define cumulative effects as impact on environment resulting from past, present, and future incremental impacts).

dislodge the goals, assumptions and burdens of proof embedded in the decision-making structure of the federal environmental laws.

However, far more importantly, existing environmental laws contain examples of environmental or health standards that reflect a concern with cumulative impacts. This subsection will very briefly discuss five examples: (1) the Clean Air Act National Ambient Air Quality Standards, (2) the Clean Water Act Water Quality Standards, (3) the Endangered Species Act, (4) cap-and-trade systems, and (5) an emerging program to address cumulative impacts under California's environmental justice legislation. The reader will no doubt be aware of other examples of such federal and state laws, and of efforts to implement precautionary approaches to decision-making.¹²² This discussion is intended not to be comprehensive but to show that such legal structures exist in current legislation and that they can be effective to control cumulative impacts.

1. Clean Air Act National Ambient Air Quality Standards

One example is the primary National Ambient Air Quality Standards (NAAQS) of the Clean Air Act, which were introduced earlier.¹²³ Each NAAQS defines a health-based standard of air quality for a particular pollutant without regard to cost (though determining the proper standard is typically difficult and fraught with controversy).¹²⁴ When regions are out of compliance with a NAAQS, states must develop a State Implementation Plan for bringing the region into compliance.¹²⁵ Under acceptable State Implementation Plans, states must inventory existing emissions, project their future growth, decide what control strategies to employ, and then allocate emissions reductions among the sources.¹²⁶ While the Clean Air Act permits consideration of costs and benefits in many of these implementing decisions and many regions continue to struggle to come into compliance, the law requires eventual attainment of each NAAQS in every region of the country.¹²⁷

NAAQSs have only been established for six pollutants, each intended to ensure the air is safe for human health with respect to that single pollutant. This system does not ensure that the cumulative impact of air pollution as a whole poses no environmental threat. But each NAAQS functions as a health-based environmental standard that applies regardless of how many sources of the relevant pollutant are present in each region. Under this legal structure, cost-benefit analysis may not be

122. States, counties and cities have begun to experiment with precautionary laws focused on avoiding harm to human health and the environment and searching for less damaging alternatives. See "Precautionary Policy Clearinghouse" of Be Safe for compilation of laws, ordinances and policies reflecting precautionary principle at <http://www.besafenet.com/ppc/>. Also, methods for selecting safer alternatives and avoiding environmental harm are under active development. See Mary O'Brien, *Making Better Environmental Decisions—An Alternative To Risk Assessment* (MIT Press 2000); Nancy J. Myers and Carolyn Raffensperger, eds., *Precautionary Tools for Reshaping Environmental Policy* (MIT Press 2006).

123. See *supra* note 34 and accompanying text.

124. See *supra* note 34 and accompanying text.

125. See PERCIVAL ET AL., *supra* note 19, at 521–26 (2003) (outlining State Implementation Plans).

126. *Id.*

127. *Id.*; see *supra* note 34 and accompanying text.

used to justify excessive cumulative emissions if a region is failing to meet the NAAQS. For each pollutant subject to a NAAQS, that standard constrains the cumulative impact of that pollutant within each region.

2. Clean Water Act Water Quality Standards

A second example is the water quality standards that apply to ambient waters under the Clean Water Act, which were introduced earlier.¹²⁸ Like the NAAQSs, water quality standards specify the levels of particular pollutants that are intended to be safe for the ambient environment, in this case for designated water uses. When a water body or segment of a river is out of compliance with a water quality standard for a toxic pollutant, then a state must develop a control strategy that will produce a reduction in the emissions among all the relevant dischargers to achieve compliance with the standard.¹²⁹ Similarly, when a water quality standard for a nontoxic pollutant is not met in a water segment, states must establish the Total Maximum Daily Loading (TMDL) of the pollutant and develop a comprehensive assessment of the reductions that will be necessary among all the dischargers to achieve that TMDL.¹³⁰

There are many difficulties, both legal and technical, with implementing these provisions of the Clean Water Act.¹³¹ This program does not ensure that water pollution cumulatively does not contribute to harm to human health or the environment. But for each water quality standard, the law determines a water-quality-based permissible cumulative discharge of a particular pollutant and then allocates it among the dischargers. Under this decision-making structure, the law's focus is on the health of the water body or stream segment, not on the costs and benefits of individual industrial discharges. Each standard is intended to prevent excessive cumulative emissions of the pollutant subject to that standard.

3. The Endangered Species Act

A third example is the Endangered Species Act (ESA), which protects threatened and endangered species without regard to cost-benefit balancing, as introduced earlier as well.¹³² Once regulators can demonstrate that species are "endangered" or "threatened" as defined under the Act, the ESA requires the Secretary of the Interior to develop and implement a recovery plan for the species, requires all federal agencies to ensure that their actions are not likely to jeopardize the existence of the species or result in the adverse modification or destruction of critical

128. See *supra* note 34 and accompanying text; Clean Water Act, 33 U.S.C. §§ 1251–1387 (2000).

129. See PERCIVAL ET AL., *supra* note 19, at 650 (outlining Clean Water Act provisions for water quality standards for toxic pollutants).

130. *Id.* at 662.

131. *Id.* at 637–73 (outlining complexities, legal and technical issues in implementing Clean Water Act water quality standards).

132. See *supra* note 34 and accompanying text; Endangered Species Act, 16 U.S.C. §§ 1531–1544 (2000).

habitat, and prohibits other parties from a variety of activities that would harm the species, including by modifying habitat.¹³³

While this statute permits protection only of individual endangered or threatened species, it does establish the goal of preserving those species, and seeks to eliminate each source of harm to the species and their critical habitats until that goal is achieved. One of the most famous cases in modern environmental law, which enjoined completion of the Tellico Dam to save the endangered snail darter, established that saving a species can involve extensive short-term costs, costs that simply would not be incurred under the typical cost-benefit decision-making structure incorporated into most of our environmental law.¹³⁴

4. Cap-and-Trade Systems

A fourth example is cap-and-trade systems for controlling individual pollutants. One of these is the Clean Air Act's cap-and-trade system for sulfur dioxide¹³⁵ and another is the recent legislative proposal for regulating carbon dioxide emissions.¹³⁶ This approach sets a cap on total emissions of a particular pollutant, and then allocates through a variety of mechanisms a finite number of permits to discharge defined increments of the pollutant. Ideally, the cap would define a cumulative level of emissions that will not contribute to ecological degradation. In reality, existing economic interests will often be taken into consideration in setting the cap, and these may lead to a cap set too high to protect the environment. But the main point for this article is that whatever level is chosen in view of all the various competing interests, once a cap is set, a cap-and-trade system is a clear example of defining a standard that the law can protect against ever-growing cumulative impacts. Once a particular level of cumulative pollutant emissions is defined under a cap-and-trade regime, the law then focuses solely on allocating a fixed number of permits and forbids all additional emissions.

5. Cumulative Impacts Under the California Environmental Justice Statutes

Finally, a broader, more ambitious approach is underway in California. Between 1999 and 2001 the California adopted three state laws requiring California Environmental Protection Agency ("Cal/EPA") to address the problem of environmental justice.¹³⁷ Under these laws, Cal/EPA must, among other things, con-

133. See PERCIVAL ET AL., *supra* note 19, at 858–60, 866–69, 892–94, 904–906 (overview of ESA).

134. Tennessee Valley Authority v. Hill, 437 U.S. 153 (1978) (affirming injunction against completion of Tellico Dam to preserve snail darter).

135. 42 U.S.C. § 7651(a)–(e) (2000).

136. See, e.g., McCain-Lieberman Climate Stewardship and Innovation Act of 2005, S. 1151, 109th Cong. (2005); PEW CTR. ON GLOBAL CLIMATE CHANGE, SUMMARY OF MCCAIN-LIEBERMAN CLIMATE STEWARDSHIP AND INNOVATION ACT OF 2005, *available at* http://www.pewclimate.org/policy_center/analyses/s_1151_summary.cfm.

137. These bills have been incorporated into California law in Government Code, Section 65040.12 (Title 7, Division 1, Chapter 1.5, Article 4), and Public Resources Code, Sections 71110-71116 (Division 34, Part 3). See summary of these three laws in "Recommendations of the California Environmental Protection Agency (Cal/EPA) Advisory Committee on Environmental Justice to the Cal/EPA Interagency Working Group on Environmental

duct its programs, policies, and activities, and promote enforcement of all health and environmental statutes, so as to “ensure the fair treatment of people of all races, cultures and income levels.”¹³⁸ As Cal/EPA has worked to comply with this mandate, a central issue has become the disparate “cumulative impacts” experienced by different populations within the state.¹³⁹ One of the four strategies that Cal/EPA has defined in developing its Environmental Justice Action Plan is to develop guidance on assessing, preventing and reducing disparities in cumulative impacts.¹⁴⁰ A second issue, which forms a second of the four strategies Cal/EPA has defined, is to develop “precautionary approaches” to decision-making.¹⁴¹

To help it develop a framework to assess cumulative impacts, Cal/EPA has formed a workgroup called the Cumulative Impacts and Precautionary Approaches (CIPA) Workgroup.¹⁴² During the CIPA workgroup’s introductory meeting on June 5, 2008, Dr. Amy Kyle of the University of California, Berkeley, Principal Academic Investigator supporting the Workgroup, summarized the project. Dr. Kyle identified Cal/EPA’s central task as moving from the traditional focus on single chemicals, agents or other stressors to a focus on what is happening in communities, populations, and population segments as a result of the cumulative effect of all such stressors.¹⁴³ It applies to *all* Cal/EPA health and environmental programs, not just a handful of individual chemicals. After reviewing some of the technical and analytical issues in evaluating cumulative impacts, the plan to develop case studies and the role of the various entities involved in Workgroup project, Dr. Kyle preliminarily suggested several possible elements of a new approach for managing cumulative impacts. One is to “minimize accumulation of impacts in all decisions.”¹⁴⁴

While this California program has just begun, for our purposes the point is clear: by defining a standard of “fair treatment” for all people in California, the law enables and very likely requires the state to assess and to control the distribution of cumulative environmental impacts.

Justice, Final Report,” at 3–7 (Cal/EPA 2003), *available at* <http://www.calepa.ca.gov/EnvJustice/Documents/2003/FinalReport.pdf>.

138. Intra-Agency Environmental Justice Strategy, at 2 (Cal/EPA 2004), *available at* <http://calepa.ca.gov/EnvJustice/Documents/2004/Strategy/Final.pdf> (summarizing legislative mandate).

139. See “Recommendations,” *supra* note 129, at 13, 15, 16, 23–26, 28, 31. Cal/EPA’s working definition of cumulative impacts is: “Cumulative impacts means exposures, public health, or environmental effects from the combined emissions and discharges in a geographic area, including environmental pollution from all sources, whether single or multi-media, routinely, accidentally, or otherwise released. Impacts will take into account sensitive populations and socio-economic factors, where applicable and to the extent data are available.”; See “Office of Environmental Health Hazard Assessment and the California Integrated Waste Management Board Call for Applications to the Cumulative Impacts and Precautionary Approaches Work Group,” at 1 (Cal/EPA 2007), *available at* <http://oehha.ca.gov/pdf/CIPAWorkgroupSolicitation.pdf>.

140. “Environmental Justice Action Plan,” at 2, 4 (Cal/EPA 2004), <http://calepa.ca.gov/EnvJustice/ActionPlan/>.

141. *Id.* at 2, 4.

142. The author is a member of the CIPA Workgroup. A general outline of the workgroup’s charge and membership can be found at <http://oehha.ca.gov/ej/cipa012908.html>.

143. Amy Kyle, Project Elements – Assessing and Addressing Cumulative Impacts and Precautionary Approaches, Presentation Before the CIPA Workgroup 4 (June 5, 2008), *available at* <http://www.oehha.org/ej/pdf/Kyle061308.pdf>.

144. *Id.* at 35.

III. TOWARD DEFINING A STANDARD OF ECOLOGICAL INTEGRITY

The examples of legal standards we have just examined were mostly designed for isolated environmental or health problems (the California environmental justice statutes do implicate cumulative impacts broadly, but they seek to remedy unfair distribution of impacts rather than contain those impacts to a defined scale.) To control the broader problem of cumulative impacts, the legal system must develop a standard or principle designed to protect the integrity of entire ecological systems and the biosphere as a whole.

This will not be a simple task. We cannot in practice try to recover a world unaffected by human beings, for that world is gone. Nor can we impose a rule of strict liability for literally every impact on the environment. That would make it impossible for people to live on the Earth, for we cannot exist without having some effects on the world to which we belong.

But a standard need not be so absolute. The environmental and health standards discussed above all allow some level of emissions, discharges or effect on the environment, just not so much as to invade the protected interest or standard as the law defines it. These are not rules of zero impact. Rather, each essentially defines a balance of interests, though that balance is very different from the one struck by the majority of our current property and environmental law. We need to define a standard of ecological preservation that allows us to live on the Earth, but proscribes degradation of the ecological systems we need to survive and prosper.

Ultimately, a principle of preservation of ecological integrity must be defined in terms of ecological science. For in ecology we can discover how to evaluate ecological systems, what impacts the Earth can tolerate and what we need to maintain and protect from degradation. Ecologists have done much of this work already. For example, Aldo Leopold defined “land health” as the “capacity for self-renewal in the soils, waters, plants, and animals that collectively comprise the land.”¹⁴⁵ To Leopold, “a thing is right when it tends to preserve the integrity, stability and beauty of the biotic community.”¹⁴⁶ Wendell Berry has taught that “land health” is the “one value” that upholds the entire web of life, and that the law must discourage land uses that threaten land health.¹⁴⁷ More specifically, the Swedish government has defined sixteen environmental quality goals and numerous environmental quality indicators that it believes should be achieved and maintained over the long term.¹⁴⁸ The Natural Step organization has defined four principles of sustainability that are designed to allow people to pursue economic activity while

145. ALDO LEOPOLD, *Conservation: In Whole or in Part?* [1944], in *THE RIVER OF THE MOTHER OF GODS AND OTHER ESSAYS BY ALDO LEOPOLD* 318 (Susan L. Flader & J. Baird Callicott eds., 1991).

146. ALDO LEOPOLD, *A SAND COUNTY ALMANAC* 224–25 (Oxford Univ. Press 1968) (1949).

147. See FREYFOGLE, *supra* note 58, at 151–56 (discussing Wendell Berry’s ideas and advocacy).

148. See Environmental Objectives Secretariat, Swedish Environmental Objectives Portal, <http://www.miljomal.nu/english/about.php> (follow “Objectives” hyperlink; then follow “The 16 Environmental Objectives”) (last updated Sept. 9, 2008).

respecting the ecological limits of the Earth.¹⁴⁹ Noss et al. have described the various elements of the “degradation in the structure, function or composition of an ecosystem.”¹⁵⁰ Ecologists and ecological economists have identified forms of “critical natural capital” whose ecological function cannot be replaced by other forms of capital and should be carefully managed.¹⁵¹ UNEP’s 2007 *GEO-4 Report* describes many elements of the environment that are being degraded but that are important for human welfare.¹⁵² The United Nations 2005 *Millennium Ecosystem Assessment* describes many global ecosystem services that are important to human beings and yet are being degraded or used unsustainably.¹⁵³ Within this field reside the scientific principles that can give specific content to the concept of preserving the ecological integrity of the Earth.

Once the law defines a standard for preserving the Earth’s ecological integrity, a decision-making structure must be constructed that will protect this goal. As we have seen in the examples in the last section, whenever the chosen standard is being threatened, all and not just a few contributing actions must be proscribed or limited. The burden of proof must be allocated. In this new legal structure it must be placed on those whose actions pose a threat to the environment, because cumulative impacts can never be contained if impacts are permitted in all cases of doubt or missing information. While such fundamental redesign of our legal system may seem complex, legal writers have begun to develop various proposals for new decision-making structures answering this call. Here are six ideas that have arisen already:

- Commentator James Olson has proposed that the common law should require those who have impaired or are seeking to impair any aspect of the global commons that is critical to human needs and ecological sustainability to bear the burden of proof to justify their conduct.¹⁵⁴
- Professor Bruce Pardy has proposed a statute that would define a limit to a society’s total ecological impact in terms of permissible

149. See The Natural Step’s Principles of Sustainability, available at (<http://www.naturalstep.org/com/What%5Fis%5Fsustainability/>) (including not subjecting nature to increasing extraction of materials, production of materials or degradation).

150. See NOSS ET AL., *supra* note 9.

151. The Sustainable Scale Project, Critical Natural Capital, available at <http://www.sustainablescale.org/ConceptualFramework/UnderstandingScale/MeasuringScale/CriticalNaturalCapital.aspx> (last visited Feb. 28, 2008); J.B. Ruhl, Making Nuisance Ecological 17–18 (Fla. St. U. College of Law, Public Law Research Paper No. 216, 2006), available at <http://ssrn.com/abstract=931248>.

152. United Nations Environment Program, *supra* note 3, *passim*, available at http://www.unep.org/geo/geo4/report/GEO-4_Report_Full_en.pdf.

153. REID ET AL., *supra* note 2, at 6–11, available at <http://www.millenniumassessment.org/documents/document.356.aspx.pdf>.

154. James M. Olson, *Shifting the Burden of Proof: How The Common Law Can Safeguard Nature and Promote an Earth Ethic*, 20 ENVTL. L. 891, 900 (1990).

types of ecological change, and then proscribe individual behavior that, if extended to all people in society, would exceed that limit.¹⁵⁵

- I have previously proposed an “ecological tort,” a legal rule of the common law that would presumptively impose liability for impacts on the environment that may contribute to ecological degradation. I have also discussed other elements of such a legal regime, including defining a threshold level of environmental impacts that would trigger placing the burden of proof on defendants, a definition of who should have standing to assert this rule of law, and a temporary affirmative defense for those engaged in a meaningful search for less damaging alternatives.¹⁵⁶

- The Science & Environmental Health Network has proposed a Model State Environmental Quality Act for review of government action, which would place the burden of proof on proponents of a project seeking government approval to demonstrate that their project will not contribute to ecological degradation or unfair treatment of any subpopulation.¹⁵⁷

- Edith Brown Weiss has proposed that environmental rights be granted to future generations, and the Science & Environmental Health Network and the International Human Rights Clinic at Harvard Law School have developed a package of model constitutional provisions and implementing legislation that places the burden of proof on current generations to demonstrate that their actions do not contribute to ecological degradation either now or in the future.¹⁵⁸

- One final, far-reaching example was recently proposed by the World Wildlife Fund and its collaborators in their Living Planet Report 2006. Concluding that the human footprint has exceeded the Earth’s biocapacity, they propose that a massive cap and trade system be created to manage humanity’s global footprint. They propose that global and regional footprint caps be established, that rights to contribute to this footprint be allocated according to vari-

155. Bruce Pardy, *In Search of the Holy Grail of Environmental Law: A Rule to Solve the Problem*, 1 MCGILL INT’L J. SUST. DEV. L. & POL’Y 29 (2005), available at <http://jsdlp.mcgill.ca/en/content/1-1/>.

156. Guth, *supra* note 1, at 494–511(2008), available at <http://www.vjel.org/journal/pdf/VJEL10068.pdf> (defining “ecological degradation” as “biotic impoverishment and decline in the self-sustaining and self-renewing capacity of the biosphere”).

157. Joseph H. Guth, *Model State Environmental Quality Act of 2007*, <http://www.sehn.org/lawpdf/ModelStateEQA2007.pdf> (proposal by the Science & Environmental Health Network of a new model National Environmental Protection Act (NEPA) focusing on the burden of proof, cumulative impacts and environmental justice).

158. See generally *supra* notes 92, 94.

ous principles of fairness among the world's peoples and that the caps then decline to sustainable levels.¹⁵⁹

These proposals represent the profound transformation in our legal system that we need if we are to preserve the Earth. They reflect the paramount value to humanity of an ecologically functioning biosphere. They redirect the law toward the goal of containing cumulative impacts. They reject a legal structure that evaluates the costs and benefits of each increment of environmental damage. They place the burden of proof on parties whose acts threaten the environment. They set forth new legal structures for all levels of the American legal system. They include model provisions that can be incorporated into state and federal constitutions. Environmental statutes can be built around them, and they can be used to reshape Executive Order 12,866 (and therefore the interpretation of our current statutes to the extent possible) around the problem of cumulative impacts. And they are entirely suitable to be adopted by judges as they bring the common law up to date in tort cases, including the global warming cases discussed in the previous sections.

CONCLUSION

The American government and legal system bear a duty to respond to the rise of cumulative impacts. The growing human ecological footprint has made untenable the assumptions on which our current environmental decision-making structure is based. The central goal of property and environmental law must shift from promoting endless growth in net benefits to maintaining the ecological systems we need to survive and prosper.

By adopting such a new goal, the law would transform the shape of the economy. If the law contains the permissible scale of cumulative environmental impacts, the economy would become one that continues to develop but accommodates rather than undermines the ecological systems our welfare ultimately depends on. Cost-benefit analysis might remain useful as we seek less damaging alternatives in a quest to reduce the scale of cumulative impacts, but it could no longer be used to justify limitless increments of ecological degradation.

The key step in establishing such a new decision-making structure within the law is to define a principle or standard of ecological integrity that would enable the law to contain the growth of cumulative impacts. We can expect to struggle with this task for many years. It is an element of the "Great Work" that constitutes one of humanity's greatest historical challenges.¹⁶⁰ But if we want to preserve the ecologically functioning biosphere that we depend upon for so much, we are going to have to define within the law what it is we want to preserve or we will lose it forever to the mounting tsunami of cumulative impacts.

159. WORLD WILDLIFE FUND, ZOOLOGICAL SOCIETY OF LONDON & GLOBAL FOOTPRINT NETWORK, LIVING PLANET REPORT 2006, at 25 (2004), available at http://assets.panda.org/downloads/living_planet_report.pdf.

160. BERRY, *supra* note 80, (outlining the profound transformation in virtually all human institutions that will be necessary for us to adopt a less-destructive, more benign presence on the Earth).