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Disasters and Ecosystem Services Deprivation: From Cuyahoga to the Deepwater Horizon

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Keith Hirokawa
Assistant Professor of Law

DISASTERS AND ECOSYSTEM SERVICES DEPRIVATION: FROM CUYAHOGA TO THE *DEEPWATER HORIZON*

*Keith H. Hirokawa**

The term "ecosystem services" refers to the "wide range of conditions and processes through which natural ecosystems, and the species that are part of them, help sustain and fulfill human life."[1] Water filtering in wetlands, wildlife nursery functions in habitats, and carbon sequestering in vegetation are examples of the valuable services provided by functioning ecosystems. However, these examples also illustrate the types of ecosystem services that have generally been ignored or undervalued in the marketplace.[2] These services "have no market value for the simple reason that no markets exist in which they can be exchanged."[3]

Not long ago, Robert Costanza and his colleagues created a buzz by attempting to calculate the economic value of the world's ecosystem services.[4] They estimated that the annual value of selected ecosystem services throughout the world exceeded the global Gross National Product by 1.8 times, making it "abundantly clear . . . that ecosystem services provide an important portion of the total contribution to human welfare on this planet."[5] One of the main criticisms of Costanza's project alleged an inattention to detail: perhaps due to the breadth of the project, or a lack of information, Costanza's team admittedly projected general ecosystem services values onto similar ecosystems across the globe, without adjusting for particular locational differences in ecosystem

* Assistant Professor, Albany Law School. J.D., M.A., University of Connecticut; L.L.M., Lewis and Clark School of Law. I wish to thank Timothy Mulvaney for his characteristically insightful comments, as well as the research assistance of Anna Binau and Charles Gottlieb.

[1] Gretchen C. Daily et al., *Ecosystem Services: Benefits Supplied to Human Societies by Natural Ecosystems*, ISSUES IN ECOLOGY, Spring 1997, at 2.

[2] *See* James Salzman et al., *Protecting Ecosystem Services: Science, Economics, and Law*, 20 STAN. ENVTL. L.J. 309, 311 (2001).

[3] *Id.* at 312.

[4] Robert Costanza et al., *The Value of the World's Ecosystem Services and Natural Capital*, 387 NATURE 253, 253 (1997).

[5] *Id.* at 259.

types and functions.[6] The interesting question remains, of course, whether a more accurate and specific accounting would render Costanza's estimate unrealistically high or hopelessly low.

The recent oil spill from the *Deepwater Horizon* offers a significant opportunity toward answering this open question. On April 20, 2010, an explosion on the *Deepwater Horizon* oil rig resulted in the release of substantial amounts of oil into the Gulf of Mexico, threatening the viability of some of the world's most essential ecosystems.[7] Almost 90,000 square miles of federal waters were immediately closed to fishing.[8] Communities along hundreds of miles of shoreline, bayous, and bays scooped the consequences of this spill from their shores, as thousands combed the Gulf in search of wildlife victims to save. It is estimated that 4.9 million barrels of oil were released before the well was capped on July 15, 2010.[9] This incident has been labeled one of the worst human-caused environmental disasters in American history.[10] A $20 billion fund has been established to begin the recovery effort,[11] but given the importance of the Gulf's ecosystem services to the region, and to the world, there is some concern that the fund will be depleted too quickly.[12]

The response to the *Deepwater Horizon* disaster has launched a large-scale investigation into the character and needs of the living technology through which the Gulf of Mexico and its ecosystems

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[6] *See* Nancy E. Bockstael et al., *On Measuring Economic Values for Nature*, 34 ENVTL. SCI. & TECH. 1384, 1387 (2000); *see also* Costanza et al., *supra* note 4, at 258.

[7] John M. Broder, *Panel Wants BP Fines to Pay for Gulf Restoration*, N.Y. TIMES, Sept. 28, 2010, at A17.

[8] *NOAA Expands Fishing Closed Area in Gulf of Mexico*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., U.S. DEP'T OF COM. (June 2, 2010), http://www.noaanews.noaa.gov/stories2010/20100602_closure.html; *see also* Jefferson M. Angers, President, Center for Coastal Conservation, Hearing Before the National Commission on the BP Deepwater Horizon Oil Spill (July 12, 2010), *available at* http://www.joincca.org/media%20room/Gulf/president_spill_commission71210.pdf (discussing the impact of the oil spill on recreational and commercial fishing).

[9] Justin Gillis, *U.S. Finds Most Oil from Spill Poses Little Additional Risk*, N.Y. TIMES, Aug. 4, 2010, at A1.

[10] *See, e.g.*, RAY MABUS, U.S. NAVY, AMERICA'S GULF COAST: A LONG TERM RECOVERY PLAN AFTER THE *DEEPWATER HORIZON* OIL SPILL 78 (2010), *available at* http://www.restorethegulf.gov/sites/default/files/documents/pdf/gulf-recovery-sep-2010.pdf ("*Deepwater Horizon* was more than an order of magnitude greater than any other oil spill the nation has faced to date.").

[11] Mike Memoli & Peter Nicholas, *White House, BP Agree on Oil Spill Damage Fund; Company to Pay $20 Billion*, L.A. TIMES (June 16, 2010), http://articles.latimes.com/2010/jun/16/nation/la-na-bp-white-house-20100617.

[12] *BP Oil Spill Fund Could Be Collateralized by Drilling Revenues*, NEWS INFERNO (Aug. 12, 2010), http://www.newsinferno.com/accident/bp-oil-spill-fund-could-be-collateralized-by-drilling-revenues.

provide services that are essential to human well-being. With this in mind, this essay considers the relationship between environmental disasters and the process of valuing ecosystem services. Environmental disasters require us to confront and interact with a changed environment, particularly because they often compel a reconstruction of our understanding of nature and its processes, a reformulation of the value we perceive in nature, and a recasting of our approach to regulating the interaction of human activities and the environment. The ecosystem services approach provides critical insights in this endeavor, and through this approach, the *Deepwater Horizon* disaster can be understood as an opportunity. This essay begins with a discussion of the role of environmental disasters in the development of environmental law, and then introduces ecosystem services research as a method of calculating the ecological, social, and economic value of impaired resources. Finally, this essay considers the opportunities presented by the *Deepwater Horizon* disaster for ecosystem services research.

I. THE IMPORTANCE OF ENVIRONMENTAL DISASTERS: A BRIEF HISTORY OF ENVIRONMENTAL LAW

Environmental disasters have played a significant role in determining how we understand and value nature's services. Consider: it is possible (even if unlikely) that there was a time when a colorful surface sheen on the water, or a brownish tint, or even the complete absence of aquatic life, would not cause public alarm. At some point in the industrial culture, ugly and opaque was just how water appeared.[13] Flowing water transports trash, dilutes sewage and spent chemicals, and even absorbs odors and other unwanted materials, and, as such, proximity to water has historically proven an enormous asset for industrial activities.

In Ohio, the U-shaped Cuyahoga River passes through Akron and

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[13] *See* Jonathan H. Adler, *Fables of the Cuyahoga: Reconstructing a History of Environmental Protection*, 14 FORDHAM ENVTL. L.J. 89, 100–06, 113–15 (2002). *Time Magazine* identified the Cuyahoga River as "[a]mong the worst" of all the severely polluted rivers of the nation:

> No Visible Life. Some River! Chocolate-brown, oily, bubbling with subsurface gases, it oozes rather than flows. "Anyone who falls into the Cuyahoga does not drown," Cleveland's citizens joke grimly. "He decays." The Federal Water Pollution Control Administration dryly notes: "The lower Cuyahoga has no visible life, not even low forms such as leeches and sludge worms that usually thrive on wastes." It is also—literally—a fire hazard.

Environment: The Cities: The Price of Optimism, TIME, Aug. 1, 1969, at 51, *available at* http://www.time.com/time/magazine/article/0,9171,901182-1,00.html.

Cleveland on its way to Lake Erie. For decades, the Cuyahoga River received storm water overflows and raw sewage discharges, generally caused by inadequate sewage treatment facilities and misuse of those facilities.[14] The Cuyahoga had also provided waste removal service to some of the more prominent stalwarts to Cleveland's economic circumstances: Republic Steel, U.S. Steel, and Jones and Laughlin discharged solids, iron, oil, sulfates, ammonia, acids, and other hazardous materials; discharges from operations at Lamson and Sessions and Sonoco Products caused some sort of reddish tinge. Firestone, B.F. Goodrich, Goodyear Tire Division, Goodyear Aerospace Division, and Diamond Salt contributed discharges of heavy metals, high temperatures, oils, color, and other hazardous materials.[15] Industrial discharges were common and considered ordinary business operations.

On June 22, 1969, floating, oil-soaked debris ignited on the Cuyahoga River.[16] That the Cuyahoga River burned on this occasion may not be surprising, especially given that the river had burned several times prior to 1969.[17] What was significant, however, was the nation's strong reaction following the fire. In the months (and years) that followed, changes in the local, state, and federal regulation of environmental quality significantly transformed the manner in which the built environment is permitted to interact with the natural environment.[18]

The 1969 Cuyahoga River fire is not the only environmental disaster in environmental law's history—and as a factual matter, it is likely not even a significant one[19]—but it cannot be denied that the event did, in conjunction with a host of other disasters, act as a catalyst for change. Michael Allan Wolf reminds us:

> Disasters breed environmental law. One can easily trace the origins of several federal statutory schemes to specific

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[14] *See* GREAT LAKES REGION, FED. WATER POLLUTION CONTROL ADMIN., U.S. DEP'T OF INTERIOR, LAKE ERIE REPORT: A PLAN FOR WATER POLLUTION CONTROL 45 (1968) [hereinafter LAKE ERIE PLAN].

[15] *Id.* at 47.

[16] *See* Adler, *supra* note 13, at 96.

[17] *Id.* at 95.

[18] For instance, the Ohio Water Pollution Control Board imposed a building moratorium in the Cleveland area pending the development of a plan to control the regional sewer system. *Id.* at 118. Both the state of Ohio and the federal government soon began to adopt regulatory programs governing air, water, and land pollution. *Id.* at 119.

[19] Michael Scott, *Cuyahoga River Fire 40 Years Ago Ignited an Ongoing Cleanup Campaign*, CLEVELAND.COM (June 22, 2009), http://cleveland.com/science/index.ssf/2009/06/cuyahoga_river_fire_40_years_a.html ("Even after 40 years, maybe the most surprising thing about the June 22, 1969, Cuyahoga River fire is that it is remembered at all.").

> ecological calamities. While it would be an exaggeration to isolate one incident and identify it as the *sole cause* for a statute, we can legitimately ask whether the *United States Code* would have contained the Air Pollution Control Act of 1955 without the Donora, Pennsylvania disaster, and Los Angeles's poisonous smog; the Coastal Zone Management Act without the Santa Barbara oil spill; the Oil Pollution Act of 1990 without the *Exxon Valdez* debacle; or the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA") without Love Canal.[20]

The idea that disasters incentivize changes in environmental law is well-settled. Of course, people do not always die during environmental disasters, habitats do not always fail, and laws do not always follow, suggesting that there is no set formula for determining when a mishap will incite a change in pollution practices.[21] Nevertheless, disasters provide an important and continuing point of reference by compelling us to revise our *perceptions* on the value of nature and natural processes.

A few observations might help to contextualize the relevance and complexity of environmental disasters to environmental law in general, and the *Deepwater Horizon* in particular.[22] First, notwithstanding the existence of some institutional infrastructure intended to control pollution practices, environmental disasters are typically presaged by a legal structure that encourages the culpable activity. In the case of the Cuyahoga, for instance, federal legislation,[23] interstate cooperation,[24] and agency investigation[25]

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[20] Michael Allan Wolf, *Environmental Law Slogans for the New Millennium*, 35 U. RICH. L. REV. 91, 99 (2001) (citations omitted).

[21] Some go further, arguing that disasters have had the unfortunate effect of complicating environmental law. *See, e.g.*, Jerry L. Anderson, *The Environmental Revolution at Twenty-Five*, 26 RUTGERS L.J. 395, 414 (1995) ("Environmental regulation is also needlessly complicated because it developed as Congress reacted to the environmental crisis of each particular year."); Wolf, *supra* note 20, at 101 ("Time will tell whether politicians inside the beltway will be able to resist the temptation to federalize and bureaucratize the next ecological disaster."); Amy J. Wildermuth, *The Legacy of Exxon Valdez: How Do We Stop the Crisis?*, 7 U. ST. THOMAS L.J. 130, 131 (2009) (discussing the "triage approach" of environmental law).

[22] A complete teleological analysis of the relationship between environmental law and environmental disasters is beyond the scope of this essay. However, some have endeavored to explain the relationship between environmental disasters and environmental law. *See, e.g.*, Molly J. Walker Wilson & Megan P. Fuchs, *Publicity, Pressure, and Environmental Legislation: The Untold Story of Availability Campaigns*, 30 CARDOZO L. REV. 2147 (2009).

[23] The 1948 passage of the Water Pollution Control Act largely left pollution and environmental health standards to the states, but promised funds to study the status and condition of the Great Lakes. Water Pollution Control Act, Pub. L. No. 845, §§ 1–2, 62 Stat. 1155, 1155–56 (1948) (codified at 33 U.S.C. § 1251). The subsequent Water Quality Act of

identified the sources of the Cuyahoga's pollution problems. However, although these combined efforts may have signified a new direction in environmental governance, they were inadequate to save the Cuyahoga River. The water quality challenges of the Cuyahoga River resulted from *permitted* discharges that were largely protected from adverse litigation.[26]

Second, environmental disasters are not generally preceded by ignorance of the risk. Indeed, long before the Cuyahoga River caught fire in 1969, it was clear that dramatic action was needed to clean the Cuyahoga River. As Joe G. Moore, Commissioner of the Federal Water Pollution Control Administration wryly noted: "Man is destroying Lake Erie. Although the accelerating destruction process has been inadvertent, it is as positive as if he had put all his energies into devising and implementing the means. After two generations the process has gained a momentum which now requires a monumental effort to retard."[27] At this time, the City of Cleveland wisely maintained a "swim if you must" beach bathing program.[28] What seems to distinguish environmental disasters is that an awareness of potential consequences did not result in

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1965 vested responsibility for this program in the Federal Water Pollution Control Administration ("FWPCA"). Water Quality Act of 1965, Pub L. No. 89-234, § 2, 79 Stat. 903, 903–904 (codified at 33 U.S.C. § 1251).

[24] The Governor of Ohio convened the five Lake Erie states in 1965 in a productive and collaborative effort to anticipate the ongoing water quality hazards and formulate a response. *See* LAKE ERIE PLAN, *supra* note 14, Foreword.

[25] In 1966, the FWPCA inventoried the industrial pollution sources and identified forty-one permitted industrial dischargers, ranging from the overflowing septic systems to the "three 'giants' of the steel industry." LAKE ERIE PROGRAM OFFICE, GREAT LAKES-ILLINOIS RIVER BASINS PROJECT, FED. WATER POLLUTION CONTROL ADMIN., U.S. DEP'T OF THE INTERIOR, STATEMENT ON WATER POLLUTION IN THE LAKE ERIE BASIN 6-6 (1966) [hereinafter STATEMENT ON WATER POLLUTION]. The FWPCA also inventoried unpermitted discharges, identifying industries that enjoyed the ease of storm sewers for waste disposal, and finding that Akron's active industrial growth was not supported by a single permit. *Id.*

[26] Ohio law provides that "[n]o person shall cause pollution or place or cause to be placed any sewage . . . industrial waste, or other wastes in a location where they cause pollution of any waters of the state." OHIO REV. CODE ANN. § 6111.04(A)(1) (LexisNexis 2010). This statute also vests authority in the Water Pollution Control Board to grant permits. OHIO REV. CODE ANN. § 6111.03(J)(1) (LexisNexis 2010). However, the Board adopted "a relatively hands off approach" to enforcement of permit limits. Adler, *supra* note 13, at 117. In addition, the statute preempted nuisance suits "in cases where the water pollution control board has issued a valid and unexpired permit." Ohio Rev. Code Ann. § 6111.04 (West 2000); *see also* Adler, *supra* note 13, at 113–19 (discussing how Ohio seemed to protect permitted facilities from nuisance actions and other local efforts).

[27] LAKE ERIE PLAN, *supra* note 14, Foreword. The Lake Erie Plan further noted that, while most harbors experience some occasional oil spills, in the Lake Erie basin some industrial facilities were discharging oil "intentionally and conspicuously," a circumstance that was recognized to be "not only disgraceful," but also a major health and wildlife hazard. *Id.* at 58.

[28] STATEMENT ON WATER POLLUTION, *supra* note 25, at 6-4.

sufficient preparation, or even investigation into the tools that might be needed to effectively respond.[29] More importantly, perhaps, the possibility of disaster did not prepare us for the deprivation of the resource.

Third, environmental disasters have proved valuable in forcing a reassessment of the value of "common practices" and common knowledge. Although environmental disasters are not necessarily unique in this regard, as environmental law has proven innovative even without crisis,[30] it is clear that disasters are effective drivers in tasking industries with scrutiny of their common practices. The Cuyahoga River, for instance, was essential in supporting industry, commerce, and population growth, and for much of the river's length, the riverfront of the Cuyahoga was considered *useful* for taking domestic and industrial wastes.[31]

A fourth feature of environmental disasters is that they pose significant informational opportunities. Although disaster-driven environmental law might not be ideal, natural resource disasters have a great deal to offer to our understanding of the value of natural resource processes. Of course, disasters relocate science from the lab and into the field, where our understanding of ecosystem functionality is relevant, and where research on ecosystem impacts is tangible. More importantly, however, is that our acute understanding of the relationships between human well-being and the state of the environment arises from *changes* in ecosystems.[32] As such, disasters sharpen our focus in a way that the study of functioning ecosystems may not. Disaster, especially when related to the sudden deprivation of natural capital and essential services, provides an incentive to engage in an analysis of the services that are lost, or for which artificial services are needed. Disaster forces us to experience deprivation of ecosystem services,

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[29] *See, e.g.*, Mark Eliot Shere, *The Myth of Meaningful Environmental Risk Assessment*, 19 HARV. ENVTL. L. REV. 409, 413–14 (1995) (arguing that "environmental risk assessment as currently practiced is anything but scientific, objective, and credible" and "[t]he hard fact is that quantitative risk assessment generates numbers that are meaningless").

[30] *See generally* Keith H. Hirokawa, *At Home with Nature: Early Reflections on Green Building Laws and the Transformation of the Built Environment*, 39 ENVTL. LAW 507 (2009) (discussing the emergence of green building regulations in the absence of a compelling crisis).

[31] *See* Paul Svedersky, *"People" Benefits from a Cleaner Cuyahoga*, 13 EPA J. 26, 26 (1987) (stating that pollution on the Cuyahoga River was viewed as a "sign of prosperity"); *see also* LAKE ERIE PLAN, *supra* note 14, at 47 (discussing the different industries and manufacturers that used the Cuyahoga River as a dumping ground for industrial waste).

[32] Costanza et al., *supra* note 4, at 255. *See also* Christopher L. Lant, *Natural Resource Sustainability from the Geographical Side of Ecological Economics*, 44 TULSA L. REV. 51, 53–54 (2008) (discussing how changes in the ecosystem affect human well-being).

and to evaluate the damages to ecosystems and the services they provide.[33]

II. ECOSYSTEM SERVICES

Ecosystems play important roles in human well-being.[34] As dynamic and complex systems of interaction between living organisms and non-living environment, "[e]cosystems provide basic life support for human and animal populations and are the source of spiritual, aesthetic, and other human experiences that are valued in many ways by many people."[35] The ecosystem services concept, however, provides a relatively new approach to understanding and valuing ecosystems that recognizes not only the commodity values of goods produced by ecosystems, but also the value of the essential services that ecosystems provide. A recent and timely report on the ecosystem services derived from the Mississippi River Delta is premised on this understanding of nature's value and our economic dependence on ecosystems:

> Economies need nature. Natural systems provide foundational economic goods and services including oxygen, water, land, food, climate stability, storm and flood protection, recreation, aesthetic value, raw materials, minerals, and energy. All "built capital" is made of natural capital, including cars, buildings and food. An economy also requires hurricane protection, a stable climate, waste assimilation and other natural services. No economy can function without nature's provision of economic goods and services.[36]

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[33] *See* Robert Costanza et al., *The Value of Coastal Wetlands for Hurricane Protection*, 37 AMBIO 241, 241 (2008) ("Coastal wetlands reduce the damaging effects of hurricanes on coastal communities by absorbing storm energy in ways that neither solid land nor open water can."). Hence, when the levees broke during Hurricanes Katrina and Rita, the resulting damages suggested that the effectiveness of levees might be reconsidered. Given that the levees were largely intended to substitute for the services provided by the preexisting coastal wetlands, it made sense to question whether the benefits of the engineered solution outweighed the costs of removing the natural hurricane protection provided by coastal wetlands.

[34] Daily et al., *supra* note 1, at 2; Costanza et al., *supra* note 4, at 253; CARLOS CORVALAN ET AL., MILLENNIUM ECOSYSTEM ASSESSMENT, WORLD HEALTH ORGANIZATION, ECOSYSTEMS AND HUMAN WELL-BEING: HEALTH SYNTHESIS 2 (2005), *available at* www.who.int/globalchange/ecosystems/ecosys.pdf.

[35] SCIENCE ADVISORY BD., U.S. ENVTL. PROT. AGENCY, VALUING THE PROTECTION OF ECOLOGICAL SYSTEMS AND SERVICES: A REPORT OF THE EPA SCIENCE ADVISORY BOARD 8 (2009), *available at* http://yosemite.epa.gov/sab/sabproduct.nsf/WebBOARD/SAB-09-012/$File/SAB%20Advisory%20Report%20full%20web.pdf.

[36] DAVID BATKER ET AL., EARTH ECONOMICS, GAINING GROUND: WETLANDS, HURRICANES

Recognizing the importance of ecosystem services, then, is pragmatically persuasive.

Ecosystem services analysis is also historically relevant. In the past, ecosystem services, and the accompanying ecological processes that produce such goods and services, have not been valued in the marketplace.[37] Clean air and water, for instance, as well as soil formation and climate regulation, "accrue directly to humans without passing through the money economy at all. In many cases people are not even aware of them."[38] Previously, consideration of capital included only manufactured stocks. Natural capital was thought to be inexhaustible, or at least, human productivity was thought to "operate[ ] at too small a scale relative to natural processes to interfere with the free provision of natural goods and services."[39] Moreover, one explanation for our ignorance of the value and importance of natural capital "has been the tenet of neoclassical economic theory that human-made capital is a near-perfect substitute for natural resources, and hence for the natural capital that generates the flow of natural resources."[40] Environmental disasters effectively punctuate the point that "we are . . . entering an era, thanks to the enormous increase of the human scale, in which natural capital is becoming the limiting factor."[41]

Proponents of the ecosystem services analysis contend that the otherwise "free" services provided by nature must be accounted for in an economic analysis to accurately reflect the costs of losing such services. As argued in the Mississippi River Delta analysis, acknowledging ecosystem services is *better economics*:

> Ecosystem functions, and the services they produce, result

AND THE ECONOMY: THE VALUE OF RESTORING THE MISSISSIPPI RIVER DELTA 7 (2010), *available at* http://www.eartheconomics.org/FileLibrary/file/Reports/Louisiana/Earth_Economics_Report_on_the_Mississippi_River_Delta_compressed.pdf.

[37] In addition to the scant attention given to ecosystem services by the market, the Environmental Protection Agency (EPA) has recently acknowledged that its regulation of environmental quality has largely omitted the analysis involved in the ecosystem services approach. SCIENCE ADVISORY BD., *supra* note 35, at 8 ("Despite the importance of these ecological effects, EPA policy analyses have tended to focus on a limited set of ecological endpoints, such as those specified in tests for pesticide regulation (e.g., effects on the survival, growth, and reproduction of aquatic invertebrates, fish, birds, mammals, and terrestrial and aquatic plants) or specified in laws administered by the Agency (e.g., mortality to fish, birds, plants, and animals).").

[38] Costanza et al., *supra* note 4, at 257.

[39] Robert Costanza & Herman E. Daly, *Natural Capital and Sustainable Development*, 6 CONSERVATION BIOLOGY 37, 39 (1992).

[40] *Id.* at 40.

[41] *Id.*

> from broad interactions across large landscapes (e.g., storm buffering) or, in some cases, the whole planet (e.g., climate and carbon sequestration). These interdependent systems make life possible; providing for climate, oxygen, nutrient cycles, water and energy flows, and the movements of seeds. This interdependence and tremendous scale of operation makes nature the best producer of these goods and services. It would be impractical and undesirable to attempt to set up human institutions, markets and factories to provide for global climate regulation, oxygen production and provision of water. It is far better economics to avoid wrecking productive natural systems, or to restore them when damaged, than attempt to displace or do without them.[42]

Whether the ecosystem services approach has improved upon economic theory in general is an interesting question,[43] but it cannot be doubted that this approach at least captures the value of previously unaccounted, ignored, and invisible functions of ecosystems. In the ecosystems services analysis, "we accept that our largely nonmarketed ecological wealth underpins our marketed economic wealth."[44]

When we value ecosystem resources in reference to the costs and benefits of changes in ecosystem circumstances, we acquire a fuller and deeper understanding of the reasons for repairing ecosystem damage and avoiding future disasters.[45] Indeed, it is typically the case that "the value of ecosystem services becomes apparent only after such services are diminished or lost, which occurs once the natural processes supporting the production of these services have been sufficiently degraded."[46] Here, then, is where the ecosystem

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[42] BATKER ET AL., *supra* note 36, at 26.

[43] *See, e.g.*, Bockstael et al., *supra* note 6, at 1385 (discussing the problems associated with aggregation and scale).

[44] John Porter et al., *The Value of Producing Food, Energy, and Ecosystem Services within an Agro-Ecosystem*, 38 AMBIO 186, 186 (2009).

[45] Such circumstances "have value insofar as they either change the benefits associated with human activities or change the costs of those activities." Costanza et al., *supra* note 4, at 255; *see also* Gretchen C. Daily et al., *Ecosystem Services in Decision Making: Time to Deliver*, 7 FRONTIERS ECOLOGY & ENV'T 21, 23 (2009) ("The main aim in understanding and valuing natural capital and ecosystem services is to make better decisions, resulting in better actions relating to the use of land, water, and other elements of natural capital.").

[46] COMM. ON ASSESSING & VALUING THE SERVS. OF AQUATIC & RELATED TERRESTRIAL ECOSYSTEMS, NAT'L RESEARCH COUNCIL OF THE NAT'L ACADEMIES, VALUING ECOSYSTEM SERVICES: TOWARD BETTER ENVIRONMENTAL DECISION-MAKING 154 (2005), *available at* http://www.nap.edu/openbook.php?isbn=030909318X. As noted, it is with ecosystem changes that public policy is most concerned:

> [I]n a policy context, economic valuation is not concerned with quantifying the value of

services approach can be cast as an opportunistic feature of environmental disaster: the information that we gather about ecosystem processes and services is especially helpful for valuing *lost* ecosystem services, and when focusing on ecosystem changes, the damage that environmental disasters cause to human well-being can be subjected to a useful accounting.

III. INFORMATIONAL OPPORTUNITIES PRESENTED BY THE *DEEPWATER HORIZON* SPILL

The long-term ecosystem impacts from the *Deepwater Horizon* spill remain unknown. As such, current response efforts and ecosystem restoration plans are subject to the contingencies that accompany uncertainty. Like the Cuyahoga fire, the incident is benefitted by an infrastructure of information, technology, and procedure. But, also like the Cuyahoga fire, this infrastructure may ultimately prove inadequate to protect our interests in the Gulf. The problem apparent in the response to the *Deepwater Horizon* spill has been a general lack of understanding of the potential costs of ecosystem services deprivation.[47] The hope, apparent in the commentaries both preceding and following the disaster, is that an ecosystem services analysis will be prioritized so that the full value of the Gulf's services plays a role in the assessment of the various risky activities permitted in the Gulf.[48]

The Gulf of Mexico houses a diverse network of interconnected and immensely productive ecosystems that have proven essential to

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an entire ecosystem (unless the policy under consideration would effectively destroy the entire ecosystem); rather, it is concerned with translating the physical changes in the ecosystem and the resulting change in ecosystem services into a common metric of associated changes in the welfare (utility or "happiness") of members of the relevant population.

Id. at 42.

[47] *See* Alice Kenny, *BP Disaster Highlights Need to Value Ecosystem Services*, ECOSYSTEM MARKETPLACE (June 17, 2010), http://www.ecosystemmarketplace.com/pages/dynamic/article.page.php?page_id=7590&section=home ("The trouble is that we don't really know the full cost, and it's that lack of knowledge that makes such disasters possible.").

[48] *See, e.g.*, John Talberth & Stephen Posner, *Ecosystem Services and the Gulf Disaster*, WORLD RESOURCES INST. (July 7, 2010), http://www.wri.org/stories/2010/07/ecosystem-services-and-gulf-disaster; Rob Luke, *Unchartered Waters: Saving the Seas by Recognizing Their Economic Value*, ECOSYSTEM MARKETPLACE (Jan. 25, 2009), http://www.ecosystemmarketplace.com/pages/dynamic/article.page.php?page_id=7419&section=home; James W. Boyd, *How Do You Put a Price on Marine Oil Pollution Damages?*, 175 RESOURCES FOR FUTURE 21, 23 (2010), *available at* http://www.rff.org/rff/documents/resources-175_marinedamages.pdf ("Assessment based around ecological endpoints will lead to more coordinated, comprehensive, and cost-effective biophysical and economic analyses of damages.").

the Gulf's ecological, economic, and cultural sustainability. The Gulf boasts thousands of miles of coastal features and habitats, spanning the shores of five U.S. states (Alabama, Florida, Louisiana, Mississippi, and Texas) and six Mexican states. The Gulf's shoreline includes bays and bayous, beaches, marshes, forested wetlands, and mangroves that provide a wide range of ecosystem services to the region and to the world. The waters of the Gulf offer a variety of vulnerable habitat systems throughout the water column, including the floating Sargussum mat habitats, bottom habitats in geological features and coral reefs, and even the open waters, where oil may encounter planktonic eggs and larvae. The region enjoys billions in economic revenue from the Gulf's aesthetic value, productive fisheries, and recreational opportunities, all of which provide jobs and safety. Regional residents are protected through the natural infrastructure of the Gulf coast, including climate-absorbing coastal wetlands.

At the time of the *Deepwater Horizon* accident, the Gulf ecosystems already faced challenges by several persistent factors affecting ecosystem services in the area. The region has experienced a continuing threat to coastal habitats, especially (but not only) in coastal wetlands, due to a combination of natural stressors and human construction activities. The loss of barrier islands and shorelines from erosion has posed a significant threat to sensitive species survival[49] and tourism, and has greatly impaired the storm protection function provided by the barrier islands to coastal communities.[50] The nursery habitats found in the estuaries of the Gulf, which support the Gulf fisheries, have been challenged by ecosystem alteration and pollution.[51] Uncontrolled nutrient loads reaching the Gulf from the Mississippi River and Atchafalaya River drainage (among others), largely due to upstream land uses, have plagued areas in the Gulf with oxygen depletion, causing hypoxia, or "dead zones."[52] It is also generally recognized that

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[49] The region also offers an impressive array of species identified for protection under the Endangered Species Act ("ESA"), or protected under the Marine Mammal Protection Act. *Federally Listed Wildlife and Plants Threatened by Gulf Oil Spill*, U.S. FISH & WILDLIFE SERVICE (June 2010), www.fws.gov/home/dhoilspill/pdfs/FedListedBirdsGulf.pdf.

[50] Judith Perhay, *Louisiana Coastal Restoration: Challenges and Controversies*, 27 S.U. L. REV. 149, 157–58 (2000).

[51] John J. Fumero, *Environmental Law: 1994 Survey of Florida Law—At a Crossroads in Natural Resource Protection and Management in Florida*, 19 NOVA L. REV. 77, 79–80 (1994). *See generally* United States v. Holland, 373 F. Supp. 665, 667–68 (M.D. Fla. 1974) (noting that continued pollution would cause damage to fisheries that are dependent upon the Gulf's estuaries).

[52] *See* Nancy N. Rabalais et al., *Gulf of Mexico Hypoxia, A.K.A. "The Dead Zone,"* 33 ANN.

climate change impacts, including changes in temperature, precipitation patterns, and sea levels, are exacerbated along the coast.[53]

Even without these preexisting challenges, the *Deepwater Horizon* disaster has proven problematic. Studies have shown that the feeding and reproductive habitats of marine life are extremely vulnerable to the toxic effects of oil,[54] and other ecosystem functions may fare no better.[55] To understand the intricacies of the project, the range of ecosystem services might be separated into the four categories proposed in the Millennium Ecosystem Assessment, including: "*provisioning services* such as food, water, timber, and fiber; *regulating services* that affect climate, floods, disease, wastes, and water quality; *cultural services* that provide recreational, aesthetic, and spiritual benefits; and *supporting services* such as soil formation, photosynthesis, and nutrient cycling."[56]

The Gulf's *provisioning services* affect the entire nation's seafood markets and the region's economy.[57] In 2008, commercial fishermen in the Gulf of Mexico supported a commercial fishing harvest of 1.27 billion pounds of finfish and shellfish at a value of $659 million in landings revenue.[58] Unfortunately, the oil spill exacerbates an existing problem of overfishing, affecting a substantial portion of the Gulf fishery.[59] Recently, federal agencies have been rejecting

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REV. ECOLOGY & SYSTEMATICS 235, 236 (2002).

[53] Robert L. Glicksman, *Global Climate Change and the Risks to Coastal Areas from Hurricanes and Rising Sea Levels: The Costs of Doing Nothing*, 52 LOY. L. REV. 1127, 1135, 1140–41 (2006).

[54] COMMITTEE ON OIL IN THE SEA, NAT'L RESEARCH COUNCIL, OIL IN THE SEA III: INPUTS, FATES, AND EFFECTS 127–28 (2003), *available at* http://www.nap.edu/openbook.php?isbn=0309084385.

[55] One overriding dilemma, of course, is the current uncertainty about both the ecosystem services at issue and how to study them. As has been noted, "[s]o far, there are no good measures or accountability systems for most marine ecosystem services, so ecosystem service characterization, quantification, and modeling will be central to these efforts." Kai Chan & Mary Ruckelshaus, *Characterizing Changes in Marine Ecosystem Services*, 2 F1000 BIOLOGY REPS. 54 (2010), *available at* http://f1000.com/reports/b/2/54.

[56] WALTER V. REID ET. AL., MILLENNIUM ECOSYSTEM ASSESSMENT, ECOSYSTEMS AND HUMAN WELL-BEING: SYNTHESIS 5 (2005), *available at* http://www.maweb.org/documents/document.356.aspx.pdf.

[57] *See* Molly Line, *National Seafood Impact from Gulf Oil*, FOX NEWS (June 9, 2010), http://liveshots.blogs.foxnews.com/2010/06/09/national-seafood-impact-from-gulf-oil.

[58] NAT'L MARINE FISHERIES SERV., NAT'L OCEANIC & ATMOSPHERIC ADMIN., U.S. DEP'T OF COMMERCE, FISHERIES ECONOMICS OF THE UNITED STATES 2008: ECONOMICS AND SOCIOCULTURAL STATUS AND TRENDS SERIES 118 (2010), *available at* http://www.st.nmfs.noaa.gov/st5/publication/econ/2008/FEUS%202008%20ALL.pdf.

[59] *Oil Spill Activity: Sorting the Gulf Ecosystem*, NAT'L GEOGRAPHIC, http://www.nationalgeographic.com/educator-resources/oil-spills/activity/gulf-ecosystem (last visited Jan. 17, 2010).

older management techniques, such as single-species fisheries management, and adopting management planning to address the complex interrelations between ecosystems and species diversity.[60] This shift in analytical methods has exposed relevant information gaps, as noted in the recent update to *Our Living Oceans*:

> For all species, additional or improved fishery-dependent and fishery-independent data would improve the accuracy of statistical models used in stock assessments. For many species, insufficient data exist to perform stock assessments. Additional life history and biological data are also needed for many species. Additionally, information on species interactions (e.g. predator-prey dynamics) will be necessary to guide multispecies assessments and facilitate the movement toward ecosystem management.[61]

As we seek to close these informational gaps, an additional, unfortunate research opportunity concerns the cause of animal deaths detected since the spill—several thousand, including birds, turtles, dolphins, and even one sperm whale.[62] Although the toxicity of oil is well-known, there is less certainty about the role that oil played, and will continue to play, in sea life deaths following the spill.[63]

The Gulf's *regulating services* relate to the safety and security of a region that is already vulnerable to natural changes.[64] Oceans are essential for nutrient and waste cycling[65] and gas regulation,

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[60] *See, e.g.*, NAT'L MARINE FISHERIES SERV., NAT'L OCEANIC & ATMOSPHERIC ADMIN., U.S. DEP'T OF COMMERCE, REPORT TO CONGRESS: THE STATE OF SCIENCE TO SUPPORT AN ECOSYSTEM APPROACH TO REGIONAL FISHERY MANAGEMENT iii (April 2009), *available at* http://spo.nwr.noaa.gov/tm/TM96Web.pdf ("Traditional fisheries management focuses on single species, but this approach does not consider the reality and complexity of the marine environment. Fish, and the humans that harvest them, are part of a dynamic marine environment characterized by complex relationships between biotic and abiotic factors. Due to these complex relationships, human activities, including fishing, have direct and indirect effects on the ecosystem and such activities must be managed with these relationships in mind.").

[61] NAT'L MARINE FISHERIES SERV., NAT'L OCEANIC & ATMOSPHERIC ADMIN., U.S. DEP'T OF COMMERCE, OUR LIVING OCEANS: REPORT ON THE STATUS OF U.S. LIVING MARINE RESOURCES 161–62 (6th ed. 2009), *available at* http://spo.nwr.noaa.gov/olo6th-edition.htm.

[62] Shaila Dewan, *Animal Autopsies in Gulf Yield a Mystery*, N.Y. TIMES, July 14, 2010, http://www.nytimes.com/2010/07/15/science/earth/15necropsy.html; *NOAA Conducts Tests to Determine Fate of Whale Found Dead in Gulf of Mexico*: *Whale Not Found in Oiled Water, But Cause of Death Unknown*, NOAA (June 17, 2010), http://www.noaanews.noaa.gov/stories2010/20100617_whale.html.

[63] Dewan, *supra* note 62.

[64] *See* M. LYNNE CORN & CLAUDIA COPELAND, CONG. RESEARCH SERV. THE *DEEPWATER HORIZON* OIL SPILL: COASTAL WETLAND AND WILDLIFE IMPACTS AND RESPONSE 5 (2010), *available at* http://www.fas.org/sgp/crs/misc/R41311.pdf.

[65] Charles H. Peterson & Jane Lubchenco, *Marine Ecosystem Services*, *in* NATURE

including carbon dioxide absorption and atmospheric composition.[66] A recent report estimates that coastal wetlands benefit the United States with $23.2 billion in annual storm protection services.[67] Salt marshes and coastal wetlands, which help mitigate the effects of storms and floods, are at risk of being undermined by the loss of vegetation and stability from oil exposure.[68]

As a *cultural resource*, the Gulf provides history, recreation, and employment for millions of residents and visitors to the region: "Estuaries and coastal seas have been focal points of human settlement and marine resource use throughout history."[69] The National Marine Fisheries Service estimated that the Gulf region enjoyed approximately $12.5 billion in fishing trip and equipment expenditures in 2008, with an annual average of 22 million fishing trips made by 3.1 million anglers.[70] During this time, the commercial harvest supported $8.8 billion in seafood industry sales in Florida, Louisiana, and Texas.[71] The *Deepwater Horizon* spill has substantially interfered with commercial and recreational activities, and imposed expensive cleanup costs on already financially burdened national and local economies. Reports of oil-drenched beaches, both validated and unconfirmed, have devastated the tourism and recreational uses of the coast.[72] As of yet, it is unclear whether, and to what extent, the region will be forced to adapt to the deprivation of the Gulf as a resource.[73] Of course, BP's $20

SERVICES: SOCIETAL DEPENDENCE ON NATURAL ECOSYSTEMS 177, 181 (Gretchen C. Daily ed., 1997). "Nutrient cycling" consists of the "[s]torage, internal cycling, processing, and acquisition of nutrients," and includes nitrogen fixation and phosphorus cycling. Costanza et al., *supra* note 4, at 254, Table 1.

[66] Sara Curran et al., *Interactions Between Coastal and Marine Ecosystems and Human Population Systems: Perspectives on How Consumption Mediates This Interaction*, 31 AMBIO 264, 264 (2002); Peterson & Lubchenco, *supra* note 65, at 180.

[67] JOINT OCEAN COMM'N INITIATIVE, CHANGING OCEANS, CHANGING WORLD: OCEAN PRIORITIES FOR THE OBAMA ADMINISTRATION AND CONGRESS 5 (2009), *available at* http://www.jointoceancommission.org/resource-center/1-Reports/2009-04-07_JOCI_Changing_Oceans,_Changing_World.pdf.

[68] CORN & COPELAND, *supra* note 64, at 2.

[69] Heike K. Lotze et al., *Depletion, Degradation, and Recovery Potential of Estuaries and Coastal Seas*, 312 SCIENCE 1806, 1806 (2006).

[70] NAT'L MARINE FISHERIES SERV., *supra* note 58, at 120–21.

[71] *Id.* at 118.

[72] NATURAL RES. DEF. COUNCIL, TESTING THE WATERS: A GUIDE TO WATER QUALITY AT VACATION BEACHES: DEEPWATER HORIZON OIL SPILL 1 (2010), *available at* http://www.nrdc.org/water/oceans/ttw/gulf.pdf.

[73] As one interviewee stated, "[i]f they'd let us go out and fish today, we'd probably catch crabs, . . . [b]ut what's going to happen next year, if this water is polluted and it's killing the eggs and the larvae? I think it's going to be a long-term problem." *Evidence of Gulf Contamination in Blue Crab*, CBS NEWS (Aug. 9, 2010), http://www.cbsnews.com/stories/2010/08/09/national/main6756740.shtml; P.J. Huffstutter et

billion compensation fund[74] will provide temporary relief, but offers no assurances about the survival of Gulf ecosystem-dependent social and cultural practices.

Uncertainty about the Gulf's *supporting services* is also commanding attention during the response. Exposure to discharged oil can disrupt habitat functions, or otherwise cause displacement, due to avoidance of contaminated areas or loss of phytoplankton and other food sources.[75] The Gulf's estuaries and coastal wetlands provide nursery and refugium services for a substantial portion of the region's fisheries, and a habitat for migratory birds.[76] In addition to the likelihood that the continuation of these services will prove incompatible with oil exposure, and despite the miles of boom laid to contain oil away from coastal habitats, the use of dispersants to mitigate the effects of released oil may pose an enduring problem. It may be years before the impacts of dispersants are even detectable in the Gulf,[77] and at this point, it is essentially unknown what types of risks the dispersants pose.[78] As noted by the staff for the National Commission on the BP *Deepwater Horizon* Spill and Offshore Drilling, "[p]erhaps more than anything, the Deepwater Horizon experience with dispersants reveals the paucity of the kind of information that government officials need to make intelligent decisions about dispersant use in response to an oil spill."[79] It is questionable whether the use of dispersants, particularly at the volumes released, and under the current level of knowledge, may be

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al., *The Oysters Are Their World, and It's in Peril; The Oil Spill Sets Off a Chain of Events That Affects a Way of Life in Louisiana and Beyond*, L.A. TIMES, July 18, 2010, at A1 ("The oyster is to Louisiana what corn is to Iowa or oranges to Florida—part sustenance, part identity. The ingenuity of the region's chefs turned out oyster fritters, oysters Bienville and oyster po' boys. They gave birth to oysters Rockefeller, reportedly named after oil baron John D. Rockefeller—the only thing richer than the sauce. So in this state, the loss strikes like a bomb.").

[74] *BP Establishes $20 Billion Claims Fund for Deepwater Horizon Spill and Outlines Dividend Decisions*, BP (June 16, 2010), http://www.bp.com/genericarticle.do?categoryId=2012968&contentId=7062966.

[75] *Effects of Oil on Wildlife and Habitat*, U.S. FISH & WILDLIFE SERV. (June 2010), *available at* http://www.fws.gov/home/dhoilspill/pdfs/DHJICFWSOilImpactsWildlifeFactSheet.pdf.

[76] *Id.*

[77] Eli Kintisch, *An Audacious Decision in Crisis Gets Cautious Praise*, 329 SCIENCE 735, 736 (2010).

[78] *See* U.S. ENVTL. PROT. AGENCY, UNDERSTANDING OIL SPILLS AND OIL SPILL RESPONSE 13 (1999), *available at* http://www.epa.gov/oem/content/learning/pdfbook.htm.

[79] NAT'L COMM'N ON THE BP DEEPWATER HORIZON SPILL & OFFSHORE DRILLING, THE USE OF SURFACE AND SUBSEA DISPERSANTS DURING THE BP DEEPWATER HORIZON OIL SPILL 19 (Staff Working Paper No. 4, 2010), *available at* http://www.oilspillcommission.gov/sites/default/files/documents/Updated%20Dispersants%20Working%20Paper.pdf.

part of the disaster, rather than part of the remedy.[80]

Given even this brief introduction to the ecosystem services at risk, it should seem clear that successful restoration of the Gulf ecology and economy will require an immense information-gathering exercise. However, the federal response may be aided by a discrete pocket of tools that direct attention to an understanding and management of ecosystem function. First, there is some recent legal infrastructure that requires ecosystem analysis. Since at least 1996, federal agencies engaged in fisheries management have been required to identify essential fish habitat for managed species under the Magnuson-Stevens Fishery Conservation and Management Act.[81] In addition, implementation of the Oil Pollution Act of 1990,[82] which was adopted in response to the *Exxon Valdez* spill[83] and authorizes the assessment and recovery of natural resources damages, provides a basis for ecosystem valuation and restoration.[84] Second, BP has pledged $500 million to fund independent research into the effects of oil in the Gulf of Mexico Research Initiative.[85] Third, at the request of the Obama administration, Secretary of the Navy, Ray Mabos, released a long-term recovery plan for the Gulf, which recognized, as a fundamental premise, that "[t]he economy and the environment of the Gulf Coast are inextricably linked."[86]

Successful employment of these tools will ultimately depend upon how well the restoration efforts integrate the basic premise of ecosystem services research: the market value of the Gulf's fisheries is dependent upon the values we attribute (and by extension, the efforts we extend) to a range of ecosystem services and the ecosystem processes that support them. Perception is an important driver in this process, and is primarily challenged by the historical bias in favor of commodity valuation. However, ecosystem services

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[80] *Id.*

[81] Magnuson-Stevens Fishery Conservation and Management Act, Pub L. No. 94-265, 90 Stat. 331 (1976) (codified at 16 U.S.C. § 1853(a)(7)), *amended by* Sustainable Fisheries Act, Pub. L. No. 104-297, § 108(a)(3), 110 Stat. 3559, 3574 (1996).

[82] Oil Pollution Act of 1990, Pub. L. No. 101-380, 104 Stat. 484 (codified at 33 U.S.C. § 2701).

[83] *See* S. Rep. No. 101-99, at 2 (1989), *reprinted in* 1990 U.S.C.C.A.N. 722, 723–24 (explaining how the *Exxon Valdez* spill demonstrated that "oil pollution from accidental tanker spills is a real and continuing threat to the public health and welfare and the environment").

[84] Oil Pollution Act § 2706(e)(1) (codified as amended at 33 U.S.C. § 2706(e)(1)).

[85] *BP Pledges $500 Million for Independent Research into Impact of Spill on Marine Environment*, BP (May 24, 2010), http://www.bp.com/genericarticle.do?categoryId=2012968&contentId=7062370; Shaila Dewan, *The Spill's Money Squeeze*, N.Y. TIMES, Sept. 13, 2010, at A16.

[86] MABUS, *supra* note 10, at 75.

research can enrich this perspective with an understanding of the value of non-commodity features of ecosystems.[87] Employing an ecosystem services approach will direct the restoration process, as well as subsequent regulatory developments, towards the importance of functional ecosystems in the creation of economic value.

IV. CONCLUSION

In part, environmental law is what happens when the quality of the environment falls so far below an acceptable level that a sea change is the reasonable and unobjectionable choice.[88] Fire on the Cuyahoga was not our first human-caused environmental disaster. It is beyond certainty that the *Deepwater Horizon* will not be the last. It is important to recognize that environmental disasters offer constructive opportunities to identify systemic defects and past practices that threaten human well-being by depriving us of essential ecosystem services. Hence, although the practice of disaster-driven regulation casts a long shadow over our foresight, it is worth noting that environmental disasters can also *compel* a more searching inquiry into the ecological consequences of a given activity.[89] What we get from environmental disasters materializes in the context of knowledge about ecosystems, and a drive toward more certainty in our environmental management decisions.

If we approach the *Deepwater Horizon* disaster wisely, it will be with an eye to understanding and capturing the values provided by otherwise invisible ecosystem processes that were impaired by the incident. In the case of the Cuyahoga, it was the (relatively) easy task of recognizing that the river should have served as more than a waste depository. The Gulf of Mexico poses more sophisticated ecosystem services questions, in part because past disasters have already influenced our perception of the value of ecosystem

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[87] Robin Kundis Craig, *Valuing Coastal and Ocean Ecosystem Services: The Paradox of Scarcity for Marine Resources Commodities and the Potential Role of Lifestyle Value Competition*, 22 J. LAND USE & ENVTL. L. 355, 390–91 (2007) (discussing the problematic relationship between science and public perception of ecosystem value).

[88] The catalyst for disaster-initiated laws has been referred to as "green capital," suggesting that disasters are tools for use in battle, rather than opportunities to engage in information gathering. *See* Jay Schoenfarber, *Capitalizing on Environmental Disasters: Efficient Utilization of Green Capital*, 9 TUL. ENVTL. L.J. 147, 147 (1995).

[89] *See* RICHARD J. LAZARUS, THE MAKING OF ENVIRONMENTAL LAW 62–63 (2004) (discussing publicized environmental threats and the manner in which the public was forced to reconsider perceptions of cause and effect in the environment).

processes,[90] but also because the scale of the Gulf disaster seems so daunting. The place to begin, however, is clear: the Gulf recovery effort presents an opportunity to value ecosystem services deprivation, to understand the ecosystem processes that provide these services, and to focus on restoring functional ecosystems so that their full value can be realized.

[90] *But see* MABUS, *supra* note 10, at 79 (indicating that the specific locational, ecological, and economic factors make lessons from past spills "of limited value").