

ECOSYSTEM SERVICES & NATURAL CAPITAL: RECONCEIVING ENVIRONMENTAL MANAGEMENT

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Over the last decade, “ecosystem services” and the “natural capital” from which these services flow have increasingly caught the interest of both environmental researchers and policy makers.¹ Ecosystems, if properly protected and maintained, provide a wide array of valuable services to humans, ranging from the purification of water to the sequestration of carbon to the provision of pollinating insects essential to agricultural crop production. Just as the economic health and sustainability of society requires attention to the stock of human capital and built capital, any society concerned about the sustainability of its economy and welfare must worry about the protection of its natural capital.

Exemplary of the growing interest in ecosystem services is the recently completed Millennium Ecosystem Assessment. Called for in 2000 by then United Nations Secretary General Kofi Annan, the Millennium Ecosystem Assessment surveys current and future trends in ecosystem services at a global level (finding that most ecosystem services have been declining at a rapid rate) and examines steps that might be taken to help protect such services.² In the United States, the federal Environmental Protection Agency (EPA) is now actively working to more fully integrate ecosystem services into its decision making.³ A number of universities and

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¹ One of the first comprehensive discussions of ecosystems services, and still one of the best guides to the breadth and importance of such services, is *NATURE'S SERVICES: SOCIETAL DEPENDENCE ON NATURAL ECOSYSTEMS* (Gretchen C. Daily ed., 1997).

² See *MILLENNIUM ECOSYSTEM ASSESSMENT BOARD, ECOSYSTEMS AND HUMAN WELL-BEING: SYNTHESIS* (Island Press 2005).

³ One of the major goals of EPA's Office of Research and Development is to help policy makers understand the impact of their choices on ecosystem

environmental organizations are promoting the protection of natural capital and developing tools with which to do so.⁴

This Article considers how the twin concepts of “ecosystem services” and “natural capital” can help inform and improve environmental policy, particularly land and water protection, in the United States and globally. As explained in Part I of this Article, “ecosystem services” are not a new concept; the law for over a century has recognized that ecosystems such as forests and wetlands provide human society with essential goods and services. Today’s broader and more sophisticated understanding of ecosystem services, however, may provide three overlapping opportunities for advancing environmental policy: (1) a new justification for the regulation and protection of land and water that appeals to a broader cross-section of society, particularly those more attuned to the economy than the environment; (2) the development of new economic markets for the protection of land and water; and (3) criteria that can be used to improve environmental policy by more fully accounting for the impacts of alternative policies on humans, evaluating inevitable tradeoffs among goals, and measuring policy success.⁵

Underlying the first of these opportunities is the possibility

services. See U.S. ENVTL. PROT. AGENCY, OFFICE OF RESEARCH AND DEVELOPMENT, RESEARCH PLANS, <http://www.epa.gov/ord/htm/multi-yearplans.htm> (last visited July 15, 2008). In October 2006, EPA issued an Ecological Benefits Assessment Strategic Plan to promote its ability to better measure and thus take into account the value of ecosystem systems. See U.S. ENVTL. PROT. AGENCY, ECOLOGICAL BENEFITS ASSESSMENT STRATEGIC PLAN, available at [http://yosemite.epa.gov/ee/epa/ermfile.nsf/vwAN/EE-0485-01.pdf/\\$File/EE-0485-01.pdf](http://yosemite.epa.gov/ee/epa/ermfile.nsf/vwAN/EE-0485-01.pdf/$File/EE-0485-01.pdf). EPA’s Science Advisory Board is also studying how to better value ecosystem services. See U.S. ENVTL. PROT. AGENCY, SCIENCE ADVISORY BOARD, COMMITTEE ON VALUING THE PROTECTION OF ECOLOGICAL SYSTEMS AND SERVICES (C-VPESS), <http://yosemite.epa.gov/sab/sabpeople.nsf/WebCommitteesSubcommittees/Committee%20on%20Valuing%20the%20Protection%20of%20Ecological%20Systems%20and%20Services> (last visited July 15, 2008).

⁴ Examples include the Natural Capital Project, which is a partnership among Stanford University, The Nature Conservancy, and WWF and the Katoomba Group, an international network trying to promote markets and payments for ecosystem services. See NATURAL CAPITAL PROJECT, www.naturalcapitalproject.org (last visited July 15, 2008); THE KATOOMBA GROUP, www.katoombagroup.org (last visited July 15, 2008).

⁵ Because the term “natural capital” simply describes the stock of ecosystem components that are needed to produce ecosystem services, I do not use the term in the rest of this Article but for simplicity purposes refer instead merely to “ecosystem services.”

that people who might otherwise be skeptical of protecting environmentally-sensitive lands and waters will become avid supporters once they realize that such protection provides a potentially large array of economically valuable services to them and society as a whole. Ecosystem services could provide an additional and hopefully convincing case for laws such as the Endangered Species Act designed to protect biodiversity or such as Section 404 of the Clean Water Act designed to protect particular types of ecosystems such as wetlands. As one article on ecosystem services confidently opined in 2001, “[u]nderstanding the role of ecosystem services powerfully justifies why habitat preservation and biodiversity conservation are vital, though often overlooked, policy objectives.”⁶ People may differ over the value of biodiversity or beauty, “but they are in firm accord over the high costs of polluted water and flooded homes.”⁷ Ecosystem services, in short, hold out hope for helping to break the political logjam.

A second potential benefit of better understanding ecosystem services is that the enhanced understanding could lead to private ecosystem-service markets and investments. Rather than being viewed as a “public good” that governments provide because it is the “right thing to do,” ecosystems could become valuable economic assets that people privately pay to conserve for the valuable services that the ecosystems provide. Many ecologists and policy advocates point to the example of New York City, which decided to protect the Catskills and Delaware watersheds from which the city obtains much of its drinking water because, as the story goes, protecting the watersheds was a cheaper method of protecting water quality than building and operating a large new water filtration facility.⁸ By developing better information on the scope and value of the ecosystem services that particular lands provide, many scientists, policy makers, and land owners hope to inspire similar investments by other entities or individuals benefiting from ecosystem services.

Finally, ecosystem services can provide a framework for more systematically taking into account the ecological impacts of

⁶ James Salzman, Barton H. Thompson, Jr. & Gretchen C. Daily, *Protecting Ecosystem Services: Science, Economics, and Law*, 20 STAN. ENVTL. L.J. 309, 312 (2001).

⁷ *Id.*

⁸ See, e.g., Graciela Chichilnisky & Geoffrey Heal, *Economic Returns from the Biosphere*, 391 NATURE 629 (1998).

alternative environmental policies, considering tradeoffs among different environmental goals, and measuring the effectiveness of environmental policies. Human health considerations have long dominated much of environmental policy. For example, although the Clean Air Act requires ambient air quality standards to protect both human health and human welfare,⁹ EPA has focused on the primary standards protecting human health.¹⁰ Cleanups under the Comprehensive Environmental Response, Compensation, & Liability Act (CERCLA)¹¹ have emphasized the reduction of health risks and generally not promoted the ecosystem services flowing from listed sites.¹² A greater emphasis on ecosystem services under these laws could help broaden and increase the laws' value to society. Other laws and concepts, ranging from the wetlands protections of Section 404 of the Clean Water Act¹³ to the public trust doctrine,¹⁴ set broad or vague goals that do not directly translate into clear and effective objectives and measures of success. In these cases, ecosystem services can provide a mechanism, linked directly to human well-being, for choosing among alternative policies and then measuring the effectiveness of the chosen policies.

Most ecosystem service articles have focused on the first two policy opportunities that ecosystem services provide—added justification for environmental regulation and markets for the ecosystem services. However, as discussed in Parts II and III of this Article, both opportunities remain largely unrealized. The concepts of ecosystem services and natural capital, despite growing discussion in policy debates, environmental NGOs, and the popular press, have yet to bring major new national support for protecting environmentally sensitive land. Markets for ecosystem

⁹ See 42 U.S.C. § 7409(b)(1) & (2) (2000) (requiring both primary standards to protect human health and second standards to protect public welfare, broadly defined to include effects on animals, wildlife, water, and visibility).

¹⁰ EPA has set a separate secondary standard only for sulfur dioxide. It has set no secondary standard for carbon monoxide. See ROBERT V. PERCIVAL ET AL., ENVIRONMENTAL REGULATION: LAW, SCIENCE, AND POLICY 503 fig. 5.6 (4th ed. 2003).

¹¹ 42 U.S.C. §§ 9601 et seq. (2000).

¹² See M.A. WILSON, ECOSYSTEM SERVICES AT SUPERFUND REDEVELOPMENT SITES: REVEALING THE VALUE OF REVITALIZED LANDSCAPES THROUGH THE INTEGRATION OF ECOLOGY AND ECONOMICS (2004).

¹³ 33 U.S.C. § 1344 (2000).

¹⁴ See JAMES SALZMAN & BARTON H. THOMPSON, JR., ENVIRONMENTAL LAW & POLICY 261–65 (2d ed. 2007).

services, outside of the growing market for carbon sequestration, are local and isolated and likely to remain so for the foreseeable future. Most beneficiaries of ecosystem services fail either to appreciate the importance of their protection or to invest in such protection.

After examining the reasons why the first two opportunities remain relatively stunted, Parts II and III examine steps that can be taken to bolster them. Better information on the economic and social value of ecosystem services, for example, can help efforts to use ecosystem services to justify existing or new environmental regulations. The art of valuing ecosystem services is still in its infancy, making it important to focus more research on developing more effective tools for doing so. New legislation, in turn, can encourage ecosystem-service markets by forcing the beneficiaries of ecosystem services to assess and invest in the sources of the services, by establishing needed baselines of protection, and by creating needed property rights and other market infrastructure. New institutions can also help overcome free rider and collective action problems among both potential buyers and sellers.

The final justification for focusing attention on ecosystem services—that they can provide broadened criteria for environmental regulation, help evaluate tradeoffs, and measure regulatory success—is perhaps the most important. By demonstrating the direct connection between ecological health and human well-being, ecosystem services can help elevate ecological protection to the same level of stature long enjoyed by health-based environmental provisions. By providing a way to measure the impact of ecological health on human well-being, ecosystem services also can provide more rigorous mechanisms for evaluating tradeoffs and the effectiveness of environmental laws and regulations.

I. A BRIEF OVERVIEW OF ECOSYSTEM SERVICES

Ecosystem services are the contributions that ecosystems make to human well-being.¹⁵ The Millennium Ecosystem

¹⁵ Definitions of ecosystem services are as varied as the authors who have written about them, but at their heart is the connection between ecosystem functions and human well-being. According to Professor Gretchen Daily, who has perhaps done more than any other scientist to promote the concept, ecosystem services are “the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life.”

Assessment divides ecosystem services into four broad, relatively well accepted categories:¹⁶

- **Provisioning Services.** First, ecosystems provide a variety of products that humans consume or use—e.g., food and fiber, fresh water, biofuels, and even various genetic resources. These ecosystem services are perhaps the best-known services to the public because they provide direct benefits to humans and are typically traded in the marketplace.
- **Regulatory Services.** Ecosystems also regulate the environment in which we live, reducing risks and allowing us to survive and thrive. Key regulating services include moderating water flows in ways that can reduce floods and recharge aquifers, reducing storm risks, regulating human diseases, purifying fresh water, improving air quality, enabling the pollination of crops, controlling pests, and sequestering carbon. Although these services are frequently immensely important to human health and well-being, members of the public are frequently unaware of the role of ecosystems in providing these services, and markets have historically not rewarded their provision.
- **Cultural Services.** Healthy ecosystems also contribute to human well-being in far more intangible ways—e.g., by enriching our spiritual and religious experiences, inspiring us aesthetically, offering recreational opportunities, educating us, and offering an important sense of place. Cultural services are likely to be closely linked to local communities and cultures and therefore vary considerably by region.
- **Supporting Services.** Finally, ecosystems support the basic processes and functions that are critical for the provision of the first three categories of services. These supporting services include soil formation and retention, the

Gretchen C. Daily, *Introduction: What Are Ecosystem Services?*, in *NATURE'S SERVICES: SOCIETAL DEPENDENCE ON NATURAL ECOSYSTEMS* 3 (Gretchen C. Daily ed., 1997). For an interesting analysis of how to define and categorize ecosystem services, see James Boyd & H. Spencer Banzhaf, *What are Ecosystem Services? The Need for Standardized Accounting Units* (Resources for the Future, Discussion Paper RFF DP 06-02, 2006), available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=892425.

¹⁶ See MILLENNIUM ECOSYSTEM ASSESSMENT, *ECOSYSTEMS AND HUMAN WELL-BEING: A FRAMEWORK FOR ASSESSMENT* 56–60 (2003).

production of atmospheric oxygen, nutrient cycling, and the provision of habitat for pollinators and other species. Supporting services differ from the first three categories of ecosystem services because they do not benefit humans directly but instead assure the provision of other services that provide direct benefit.

Policy makers and the public have recognized, understood, and pushed to preserve some ecosystem services for scores of years. The original nineteenth-century purposes of the national forest system, which protects large swaths of forest ecosystems, were provisioning services: “securing favorable conditions of water flows” and furnishing “a continuous supply of timber for the use and necessities of citizens of the United States.”¹⁷ When Congress expanded the purposes in the Multiple-Use Sustained-Yield Act of 1960,¹⁸ it emphasized the importance of forests for a broader set of provisioning services (“range, timber, watershed, and wildlife and fish purposes”) and cultural services (“recreation”).¹⁹ Congress chose in 1972 to protect wetland ecosystems in section 404 of the Clean Water Act not only for the provisioning and cultural services that wetlands provide, but also for their regulatory and supporting services. In that Act, Congress gave EPA the authority to prohibit the filling of a wetland that would have “an unacceptable adverse effect on municipal water supplies” (a regulatory service) or on “spawning and breeding areas” for fish (a supporting service).²⁰ At one level, the discussion of ecosystem services thus introduces nothing new to environmental policy discussions except a fancy term that ecologists find nifty, but many members of the public may find confusing.

Like many organizational constructs, however, the concept of ecosystem services provides a number of important values beyond a catchphrase. First, the concept leads us to inquire broadly into all of the services that an ecosystem might provide to the public and elevates into discussion some services, such as pollination, that have not been emphasized in the past. Rather than focusing on the most obvious services of a forest or wetland, we ask instead

¹⁷ See Organic Administration Act of June 4, 1897, 16 U.S.C. § 475 (2000).

¹⁸ 16 U.S.C. §§ 528 et seq. (2000).

¹⁹ *Id.*

²⁰ Clean Water Act, § 33 U.S.C. § 1344(c) (2000).

about all of the services that forests and wetlands may provide for society. Second, by emphasizing the multiple services that any given ecosystem provides, the concept also emphasizes the impossibility of surviving as a human race without ecosystem services.²¹ Third, by using economic terminology (“services,” “capital,” “products,” etc.), the concept emphasizes the connection between environmental regulation and economic prosperity. Finally, the concept has led ecologists, economists, and other scientists to study the services as a unified field, rather than isolated subjects, and to develop new models and techniques for trying to quantify and project the flow of services and their social value.

The best illustration of the scientific impact of a unified concept of ecosystem services is the previously mentioned Millennium Ecosystem Assessment in which more than 1,360 international scientists, over a four-year period ending in 2005, assessed the state of the world’s ecosystems, the consequences of ecosystem changes on human well-being, and the need for protecting and enhancing ecosystems.²² The Millennium Ecosystem Assessment found a dramatic change in the flow of ecosystem services over the last fifty years around the world. At a global level, ecosystems today are supporting a higher quantity of crops, livestock, and aquaculture than fifty years ago and, somewhat surprisingly, sequestering a larger quantity of carbon.²³ At the same time, however, a variety of ecosystem services have become seriously degraded, including wild fisheries, the provision and purification of fresh water, the regulation of natural hazards such as hurricanes, the support of pollination and regulation of agricultural pests, and spiritual, religious, and aesthetic values.²⁴ Overall, some 60 percent of the twenty-four separate ecosystem services studied by the Millennium Ecosystem Assessment are degraded compared to fifty years ago; many of the remaining services have undergone mixed impacts, improving in some

²¹ Scientists sometimes point to the failure of Biosphere 2, an effort to recreate life-supporting ecosystems within a 3-acre hermetically sealed greenhouse, as evidence of the critical role that healthy ecosystems play in ensuring that the Earth supports human life. See Joel E. Cohen & David Tilman, *Biosphere 2 and Biodiversity: Lessons So Far*, 274 SCI. 1150 (1996).

²² See ECOSYSTEMS AND HUMAN WELL-BEING, *supra* note 2, at v–viii.

²³ *Id.* at 7 tbl.1.

²⁴ *Id.*

regions but declining in others.²⁵ Moreover, destructive pressures on ecosystems, and thus the services they provide, are continuing to grow.²⁶

II. ECOSYSTEM SERVICES AS ADDED JUSTIFICATION FOR EXISTING OR EXPANDED ENVIRONMENTAL REGULATIONS

The concepts of “ecosystem services” and “natural capital” may provide a mechanism for convincing environmental skeptics of the need for laws such as the Endangered Species Act and section 404 of the Clean Water Act, as well as other public and private programs that seek to conserve healthy and well-functioning ecosystems.

By bridging the divide between those interested in the environment for ethical reasons and those focused on economic growth, ecosystem services might help break the logjam that currently plagues environmental policy efforts. Opponents of more rigorous ecological protections may choose to support such protections, not because it is the morally “right” thing to do, but because it makes economic sense. To convince opponents of the wisdom of ecological protection, however, more convincing approaches to measuring and valuing those services may be necessary.

A. *Can Ecosystem Services Change the Debate?*

Whether and how dramatically the concept of ecosystem services can change the debate over environmental regulation and policy is unclear. The idea of ecosystem services, and the important role that major environmental laws and programs often play in protecting them, is slowly working its way into the popular press. As early as 2002, USA Today published an article on the threat that extinctions posed for the ecosystem services upon which society is dependent.²⁷ A quick search on Google News finds that, in 2007, over seven hundred articles in such U.S. news publications as the Los Angeles Times, Dallas Morning News, Forbes, BBC News, and USA Today discussed the potential

²⁵ *Id.* at 6.

²⁶ *Id.* at 14, 16 fig.13.

²⁷ See Lisa Onaga, *Extinctions Threaten “Ecosystem Services”*, USA TODAY, May 3, 2002, available at <http://www.usatoday.com/news/science/aaas/2002-05-02-mammals.htm>.

importance of ecosystem services. Although journalists might be picking up on the idea of ecosystem services, however, the concept still has a long way to go in reframing public perceptions. In contrast to the 700-plus mentions of ecosystem services in 2007, over 76,000 articles used the term “biodiversity.”

Ecosystem service is also not yet a common concept in political circles, although it is making inroads into discussions of particular issues. In debates over the reauthorization of the national farm bill in 2008, for example, both the Department of Agriculture and individual members of Congress explicitly talked about the importance of farm conservation programs in protecting ecosystem services.²⁸ And in Washington State, a coalition of environmental organizations and farm groups helped pass a bill to study how ecosystem-service markets might promote increased conservation practices on agricultural and forestry lands.²⁹ Such references to ecosystem services in political debates, however, remain few and far between.

To date, moreover, the concept of ecosystem services does not appear to have increased U.S. political support for traditional regulatory or incentive measures designed to protect such services. Although funding for conservation programs increased under the 2008 national farm bill, for example, Congress made no mention of ecosystem services in choosing to increase the funding. Indeed, it is possible that Congress saw ecosystem services not as a reason for increasing governmental funding for conservation or mandating conservation, but as a potential means of increasing conservation without any affirmative federal action. In the one section of the farm bill explicitly dealing with ecosystem services, Congress ordered the Secretary of Agriculture to develop technical guidelines that might “facilitate the participation of farmers, ranchers, and forest landowners in emerging environmental service markets.”³⁰ For those who support national regulations or incentives, there is a risk that ecosystem-service markets

²⁸ See, e.g., U.S. DEPT. OF AGRICULTURE, CONSERVATION AND THE ENVIRONMENT (2006); Katherine Ellison & Buzz Thompson, *Sustainable Agriculture Should Become New Farm Bill Priority*, SAN JOSE MERCURY NEWS, July 26, 2007 (noting that a draft farm bill introduced by Senator Tom Harkin “was notable for using the term ‘ecosystem services’ for the first time” in Congressional discussions of the farm bill).

²⁹ S.B. 6805, 60th Leg., 2008 Reg. Sess. (Wash. 2008).

³⁰ The Food, Conservation, and Energy Act of 2008, Pub. L. No. 110-234, § 2709, 122 Stat. 923, 1081–82 (2008) (to be codified at 16 U.S.C. § 3845).

(discussed in the next section), rather than strengthening support for governmental actions, might actually undermine support for new or stronger governmental action by suggesting that governmental regulations or incentives are unnecessary.³¹

The concept of ecosystem services, which is in its political infancy, still has the potential for breaking logjams over ecological protection measures. By linking ecology with economics and self-interest, ecosystem services provide a strong message regarding the importance of environmental protection. Yet no one should expect that the concept of ecosystem services by itself will eliminate the current political polarization over environmental measures. First, to the degree that particular ecosystem services such as water purification or flood reduction provide strong support for particular regulatory measures, those services are likely to already be part of the political debate. As discussed in Part I, individual ecosystem services have long served as arguments for specific environmental laws and programs; the concept of ecosystem services simply broadens and unifies these previously separate arguments. Second, while providing a powerful normative argument for greater ecosystem protection, the concept of ecosystem services does not address the structural political obstacles to such protection, including the concentrated opposition of major interest groups such as mining, development, and agriculture. Finally, arguments regarding ecosystem services in the abstract may not be sufficiently convincing to overcome the clear economic costs of regulation. Proponents of government regulation may need to quantify the economic value of the ecosystem services flowing from land protection in order to convince traditional opponents of environmental measures that they should now support them.

B. *Quantifying and Valuing Ecosystem Services*

One step that can make ecosystem services a more effective argument for the ecosystem protection is thus to quantify and value those services in a way that is convincing even to traditional skeptics. With this in mind, EPA and other national, state, and

³¹ It is worth emphasizing, however, that no one in the farm bill debate suggested that Congress should reduce its support of conservation because of the possibility that private beneficiaries of ecosystem services might pay farmers for conservation measures.

local governmental agencies are working to advance methods of identifying, quantifying, and valuing the impact of regulations and actions on the flow of ecosystem services.³²

For national agencies, a major advantage to being able to value the impact of regulatory actions on ecosystem services is improved cost-benefit analysis. Executive Order 12866 requires national agencies such as EPA to prepare formal cost-benefit analyses for significant regulatory actions.³³ Executive Order 13422 imposes a similar requirement for regulations dealing with environmental, energy, or transportation management.³⁴ Some statutes, such as the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA),³⁵ also provide for informal cost-benefit balancing. While EPA and other national agencies have perfected their ability to value the health benefits of regulations, they have paid less attention to the benefits for ecosystem services. As a result, cost-benefit analyses of environmental regulations often quantify the health benefits in dollar terms but leave many of the ecosystem-service benefits unmonetized, unquantified, and sometimes even unmentioned.

Quantifying and valuing ecosystem services currently present a number of problems. First, few existing ecological models provide a mapping of environmental regulations or actions into effects on ecosystem services. Quantification of ecosystem services requires “ecological production functions” that can predict the flow of ecosystem services based on changes in various inputs such as acres and quality of wetlands, but ecologists’ ability to make such predictions remains rudimentary.³⁶ The complexity and

³² EPA is pursuing improvements through both its internal research program and its Science Advisory Board. See EPA sources, *supra* note 3. The Department of Agriculture has also formed an internal working group to examine how to more effectively value ecosystem services and integrate that value into its decision making. See U.S. DEP’T OF AGRICULTURE, COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE, ECOSYSTEMS: ECOLOGICAL GOODS AND SERVICES WORKING GROUP, http://www.csrees.usda.gov/nea/nre/in_focus/ecosystems_if_wrkgp.html (last visited Mar. 23, 2008).

³³ Exec. Order No. 12,866, 58 Fed. Reg. 51,735 (Sep. 30, 1993).

³⁴ Exec. Order No. 13,422, 72 Fed. Reg. 2,763 (Jan. 18, 2007).

³⁵ 7 U.S.C. §§ 136 et seq.

³⁶ See, e.g., NAT’L RESEARCH COUNCIL, VALUING ECOSYSTEM SERVICES: TOWARD BETTER ENVIRONMENTAL DECISION-MAKING (1989); Andrew Balmford et al., *Economic Reasons for Saving Wild Nature*, 297 SCI. 950 (2002) (finding in three hundred case studies a “paucity of empirical data” on changes in ecosystem services resulting from development or conversion of natural habitats).

variability of ecosystems also can make it difficult to develop ecological models with broad, universal application. Ecological relationships may vary considerably from location to location, so models must be parameterized for specific settings. Parameterization, however, is often difficult because individual ecosystems are complex and depend on a variety of site-specific variables. Ecosystems, moreover, are dynamic and often respond to impacts in a non-linear fashion, making it difficult to predict effects over time, particularly at the extremes.

If ecologists can quantify the change in ecosystem services resulting from a given regulation or action, economists in theory can place an economic value on the change. Economists have developed an array of well-tested methods to monetize ecosystem services that provide direct market value, non-market use value, or non-use values.³⁷ Economic valuation, nonetheless, presents several current problems. First, cultural services require non-use valuation, yet the principal methods for measuring non-use values—Contingent Valuation and Conjoint Analysis—are subject to significant controversy despite extensive use and experience.³⁸ Second, values typically depend on local conditions, yet only limited valuation information is generally available in a locality, and new valuation studies are often costly to perform. As a result, the most common means of valuing the ecosystem services in a specific location is to “transfer” valuation data developed for a different location. But “value transfer” is a difficult art that is appropriate only under limited and ideal conditions.³⁹

Current research, however, offers hope for improving our ability to quantify and value ecosystem services in the future. Ecologists, for example, have begun to develop ecological production functions that can better map environmental regulations

³⁷ See A. MYRICK FREEMAN, *THE MEASUREMENT OF ENVIRONMENTAL AND RESOURCE VALUES: THEORY AND METHODS* (2d ed. 2003).

³⁸ See, e.g., K.J. BOYLE & P.A. CHAMP, *A PRIMER ON NON-MARKET VALUATION* (2003); V.K. Smith, *Fifty Years of Contingent Valuation, in INTERNATIONAL YEARBOOK OF ENVIRONMENTAL AND RESOURCE ECONOMICS* (T. Tietenberg & H. Folmer eds., 2004/2005 ed., 2004).

³⁹ See, e.g., R. Brouwer, *Environmental Value Transfer: State of the Art and Future Prospects*, 32 *ECOLOGICAL ECON.* 137, 140 (2000) (“[N]o study has yet been able to show under which conditions environmental value transfer is valid.”); T. Muthke & K. Holm-Mueller, *National and International Benefit Transfer Testing with a Rigorous Test Procedure*, 29 *ENVTL. & RES. ECON.* 323 (2004).

to the flow of ecosystem services. Ecologists have already developed a number of simple models that can predict to at least some degree the impact of preserving or enhancing particular types of ecosystems on specific services, such as pollination and carbon sequestration.⁴⁰ More importantly, a number of research teams are now developing models that can predict changes in a wide array of ecosystem services based on data that is often available through Geographic Information Systems. For example, a team of scientists at Stanford, The Nature Conservancy, and WWF, under the moniker of the Natural Capital Project, is building a mapping tool that decision makers can use to project the impact of various land-use scenarios on ecosystem services in a given region.⁴¹ The mapping tool will ultimately project not only the flow of ecosystem services, but also the monetary value of many of those services.

C. *Conflicts Among Ecosystem Services*

Ecosystem services, as a unifying concept, will not necessarily support current environmental priorities. Environmentalists who wish to promote specific environmental goals, such as biodiversity, might find that an emphasis on ecosystem services will require refocusing current practices. Lands that promote biodiversity may not always maximize other ecosystem services, and lands that maximize a broad array of services may not necessarily be the lands with the greatest biodiversity. Ecosystem services, in short, can be in tension with each other, and a greater focus on ecosystem services as a broad class may not maximize traditional environmental goals.

One recent effort to quantify the ecosystem services from various parcels of land in the Central Coast ecoregion of California, for example, examined the relationship among seven services: biodiversity, carbon storage, crop pollination, flood control, forage production, outdoor recreation, and water provision

⁴⁰ See, e.g., HARNESSING FARMS AND FORESTS IN THE LOW-CARBON ECONOMY: HOW TO CREATE, MEASURE, AND VERIFY GREENHOUSE GAS OFFSETS (Zach Willey & Bill Chameides eds., 2007); Claire Kremen, *Pollination and Other Ecosystem Services Produced by Mobile Organisms: A Conceptual Framework for the Effects of Land-Use Change*, 10 *ECOLOGY LETTERS* 299 (2007).

⁴¹ See THE NATURAL CAPITAL PROJECT, *supra* note 4.

(measured by precipitation minus evapotranspiration).⁴² The study found that the seven services had “distinctly different spatial distributions, although some areas are of high value to multiple services and other areas are of low value to many.”⁴³ The relationships between the priority areas for biodiversity conservation and the priority areas for various other ecosystem services were all weak, and some were negative. Spatial correlations among the various ecosystem services were also low, “with nearly as many negative as positive ones.”⁴⁴ The highest correlations were between carbon storage and water provision, between recreation and water provision, and between recreation and flood control. Pollination and forage production had negative correlations with most other services.

Shifting the emphasis of land regulation from biodiversity protection to ecosystem services thus might lead to subtle, but important, changes. Areas of high biodiversity generally provide a variety of other ecosystem services.⁴⁵ However, if policy makers choose to conserve the lands that produce the greatest economic value in ecosystem services as a whole, those lands may not maximize the protection to biodiversity. Broad interest in ecosystem services, in short, can provide further justification for many current land-conservation laws and programs, but could also push policy makers to redistribute environmental effort in a way that, unless overall protection is increased, reduces rather than increases biodiversity protection.

III. ECOSYSTEM SERVICE MARKETS

Many academics and policy makers hope that greater knowledge of ecosystem services will also encourage companies, governments, and private individuals to invest in the protection of those ecosystems that benefit them. Proponents imagine a day when beneficiaries will pay landowners to conserve and manage their properties for a variety of ecosystem services, ranging from carbon sequestration to water purification to flood reduction to

⁴² Kai M.A. Chan et al., *Conservation Planning for Ecosystem Services*, PLOS BIOLOGY, Oct. 31, 2006, <http://biology.plosjournals.org/perlserv?request=get-document&doi=10.1371/journal.pbio.0040379>.

⁴³ *Id.*

⁴⁴ *Id.*

⁴⁵ *Id.*

crop pollination—where “people out of enlightened self-interest have worked out a system to make conservation mainstream.”⁴⁶ Looked at in slightly different terms, the goal is to encourage people to think of conservation as a “private good” that benefits them as any other good or service might and in which they should invest, rather than as a “public good” that should be supported by governmental funding or private donations because it is the environmentally “correct” thing to do.

A. *Increased Market Activity and Interest*

A growing number of cap-and-trade markets exist for ecosystem services. At a global level, efforts to mitigate climate change have generated increasingly robust markets for reductions in carbon emissions, both within and outside the formal structure of the Kyoto Protocol.⁴⁷ At the regional level, a number of states have created mitigation banks that reward property owners who protect or restore either wetlands or habitat for particular protected species; the banks are financed by land developers who wish to construct projects on other wetlands or habitat.⁴⁸ Regional habitat conservation plans under the Endangered Species Act also have frequently included programs, often funded by development fees, to pay for the protection of key habitat areas.⁴⁹ An increasing number of water quality trading initiatives around the United States seek to promote better land management efforts on farms and elsewhere in order to reduce non-point pollution.⁵⁰

In some cases, the beneficiaries of ecosystem services have also paid for the conservation of service-generating lands even though there is no organized market for the service. The best

⁴⁶ Fred Guteri, *Investing in Green*, NEWSWEEK, June 6, 2005, at 38, 39.

⁴⁷ David G. Victor & Danny Cullenward, *Making Carbon Markets Work*, SCI. AM., Sept. 24, 2007, at 70, 71–72.

⁴⁸ See, e.g., Jessica Fox et al., *Conservation Banking*, in 2 THE ENDANGERED SPECIES ACT AT THIRTY 228, 228–31 (J. Michael Scott et al. eds., 2006); J.B. Ruhl & R. Juge Gregg, *Integrating Ecosystem Services into Environmental Law: A Case Study of Wetlands Mitigation Banking*, 20 STAN. ENVTL. L.J. 365, 365–66 (2001).

⁴⁹ See, e.g., Barton H. Thompson Jr., *Managing the Working Landscape*, in 1 THE ENDANGERED SPECIES ACT AT THIRTY 101, 115–16 (Dale D. Goble et al. eds., 2006) (discussing the creation of regional habitat conservation plans to fulfill mitigation requirements of the Endangered Species Act).

⁵⁰ Dennis M. King, *Crunch Time for Water Quality Trading*, 20 CHOICES 71 (2005). Few of these initiatives, however, have produced actual trades. *Id.* at 71.

known and frequently cited example is New York City's decision, noted in the introduction, to protect the Delaware and Catskills watersheds from which it obtains much of its drinking water. Rather than build a new filtration facility projected to cost \$6 billion in capital costs and \$300 million annually in operating expense, New York committed in 1997 to invest some \$1.5 billion over ten years to restore and protect the watersheds.⁵¹ Within the first five years of its watershed protection efforts, the city purchased almost 14,000 hectares of land from 477 property owners, and another 1,000 hectares of conservation easements, to approximately double the protected buffer around its key reservoirs.⁵²

Although New York City's effort to protect the Delaware and Catskills watersheds is the best known example of a water supplier seeking to protect hydrological services, it is not the only effort. In the United States, a significant number of other cities, including Boston and Seattle, have invested in watershed protection rather than constructing expensive new filtration facilities.⁵³ Napa Valley, California, paid to create or restore some 500 acres of wetlands, along with various other restoration measures, in order to reduce downstream flood risks.⁵⁴ In Ecuador, the capital city of Quito operates a trust fund, known as Fondo del Agua or FONAG, that collects monies from various water users including the city and a hydroelectric producer and then uses the funds to protect the watershed through both acquisition of critical lands and improved agricultural practices.⁵⁵ In France, the Perrier-Vittel Water Company has tried to protect its water sources from pollution by paying for reforestation on local lands and helping farmers reduce their pollution.⁵⁶

The potential for ecosystem service markets and investments has also caught the eye of policy makers at both the national and state levels. As noted previously, the 2008 Farm Bill seeks to facilitate the development of such markets by the establishment of

⁵¹ Sandra L. Postel & Barton H. Thompson, Jr., *Watershed Protection: Capturing the Benefits of Nature's Water Supply Services*, 29 NAT. RESOURCES F. 98, 104–05 (2005).

⁵² *Id.* at 104.

⁵³ Salzman et al., *supra* note 6, at 329–31.

⁵⁴ *Id.* at 320.

⁵⁵ Postel & Thompson, *supra* note 51, at 101–02.

⁵⁶ *Are You Being Served?*, ECONOMIST, Apr. 23, 2005, at 91.

standards and procedures,⁵⁷ and Washington State has authorized a study of ecosystem services markets for agricultural and forest lands, as well a pilot project to prove the feasibility of such markets.⁵⁸ The study will determine the potential interest of landowners in participating in such markets, assess what services these suppliers might potentially produce for sale, and make recommendations for helping to launch and support such markets.

B. *Current Market Limitations*

Yet despite notable examples of service beneficiaries like New York City investing in ecosystem protection, most beneficiaries are still not investing in natural capital. A survey of major water suppliers in California in 2005, for example, found that very few of the suppliers had purchased any new lands or conservation easements in the last decade within the watersheds from which they pulled their supplies.⁵⁹ A separate study of water suppliers in California, Oregon, and Washington in the same time frame found that some of the suppliers were using the watershed lands that they did own in ways that actually undercut water quality—e.g., logging their lands.⁶⁰

Several factors may be undercutting a greater level of investments by service beneficiaries in the ecosystems that generate the services. The first critical obstacle has been a lack of information about the quantity and value of the services at a level of specificity and certainty needed to justify significant investments. In the study of California water suppliers, for example, most of the suppliers were aware of studies showing that watershed protection helps to preserve water quality, but they were unable to determine the exact level of threat posed by particular land-development projects or the value of avoiding that threat.⁶¹

⁵⁷ The Food, Conservation, and Energy Act of 2008, Pub. L. No. 110-234, § 2709, 122 Stat. 923, 1081–82 (2008) (to be codified at 16 U.S.C. § 3845).

⁵⁸ S.B. 6805, 60th Leg., 2008 Reg. Sess. (Wash. 2008).

⁵⁹ See Postel & Thompson, *supra* note 51, at 106–07 (discussing survey of water retailers in California that supply surface water to 50,000 or more customers).

⁶⁰ Elizabeth Herbert, *Forest Management by West Coast Water Utilities* (June 2004) (unpublished Ph.D. dissertation, U.C. Santa Cruz) (on file with U.C. Santa Cruz).

⁶¹ Postel & Thompson, *supra* note 51, at 106–07 (“Only one California water supplier, the City of Santa Cruz, had tried to place an economic value on watershed protection measures, and it was not confident that the value was

The managers of the water suppliers, however, often demanded such information before authorizing the often significant cost of buying and protecting the threatened watershed lands.

A second major obstacle has been the free-rider effect that has plagued so many other environmental issues. Protecting watershed lands, for example, can not only help preserve water quality but also generate a variety of other beneficial services, including reduced flood risks, recreation, and aesthetic vistas. Different people often benefit from each of these services, and different organizations frequently take responsibility for their provision. Each organization may be tempted to wait for another organization to take needed protective steps, rather than spending its own monies to protect the watershed. Each organization, in short, may be tempted to free ride on the investments of the others. The survey of California water suppliers found that many suppliers leave watershed protection measures to resource conservation districts or other land-management agencies rather than invest in protection themselves.⁶² Resource conservation districts, however, sometimes fail to consult actively or regularly with water suppliers, with the result that watershed lands that benefit multiple organizations and individuals are not protected.⁶³

The flip-side of the free-rider problem is a collective action problem. Where an ecosystem provides multiple services to a number of organizations, it often is difficult to coordinate payments from all the organizations (what is sometimes referred to as “bundling”) in order to protect the ecosystem. In many cases, the value of a single service (e.g., water quality) might not justify the cost of protecting the ecosystem, while the value of all of the services combined might far outweigh the cost. Water suppliers, however, may find it difficult to get together with other organizations, such as resource conservation districts or

accurate.”).

⁶² *Id.* at 106.

⁶³ *Id.* The problem is made worse by the organization of water suppliers that often divide responsibility in a way that reduces responsibility for watershed protection and ignores the connection between watershed protection and water quality. Water suppliers that own watershed lands “tend to separate water quality, which is typically overseen by engineers, from watershed protection, which is generally under the jurisdiction of biologists or other land-management experts. Although varying levels of coordination between the two groups occur, the separation of functions makes it more difficult to integrate a watershed’s natural purification services with particular water quality goals.” *Id.*

downstream flood-control districts, in order to jointly provide the level of funding needed for the conservation measures.

Another obstacle to market transactions can be a lack of well defined property rights. For example, invasions of exotic species that soak up water, as well as the uprooting of rain forests that encourage precipitation, may reduce groundwater recharge. Efforts to eliminate the invasives or to restore the natural habitat can increase groundwater recharge to the benefit of local water users. Yet in many states, neither the person taking such an action, nor the owner of the land, has a property right in the resulting groundwater.⁶⁴ As a consequence, no one may have an economic incentive to take action even if the net benefits of doing so are significant.

C. *Facilitating Ecosystem Service Markets & Investments*

1. *Legal Encouragement of Investment*

The law can play an important role in promoting ecosystem service markets and investments in four important ways. First, the law can encourage or require beneficiaries to invest in the protection of the ecosystem services that they are enjoying. For several reasons, beneficiaries may not invest without such legal or governmental intervention. They may not appreciate the risk that they face because they are ignorant of the role that ecosystem services play, do not see the threats to those services, or optimistically believe that the threats are unlikely to seriously impact the services that they receive. A water supplier, for example, may not believe that current development in its watershed actually poses a threat to its water quality. Even if the beneficiaries realize that services are threatened, the beneficiaries may not be able to sufficiently quantify and value the threats in order to justify the needed investment. As discussed earlier, watershed managers for water suppliers often are unable to

⁶⁴ See, e.g., *Se. Colo. Water Conservancy Dist. v. Shelton Farms, Inc.*, 529 P.2d 1321, 1325–27 (Colo. 1974) (holding that riparian land owner who removed phreatophytes (water consuming plants), and thereby freed up water in the Arkansas River, was not entitled to equivalent amount of water). In the western United States, such water often would be considered “salvaged”: water that would normally go to waste, but which has been made available for beneficial use. Salvaged water is subject to claims by prior appropriators, and may not be claimed by the landowner until prior appropriations have taken all the water to which they are entitled. *Id.*

demonstrate the benefits of watershed acquisition to the degree of specificity needed to convince senior managers to invest significant funds in protective measures. Finally, as noted above, beneficiaries may decide to ignore a threat and free ride on the anticipated actions of others.

Laws can encourage investments in ecosystem services by several means. One of the most important and direct means is to require the beneficiaries to protect the relevant ecosystem services. All of the current examples of significant ecosystem services markets are the result of such legal regulations. The Kyoto Protocol and fears of future climate legislation have driven markets for carbon sequestration;⁶⁵ the Clean Water Act has stimulated the development of market initiatives for local water quality;⁶⁶ the Endangered Species Act and section 404 of the Clean Water Act have generated conservation banks and wetlands banks.⁶⁷

Legal regulations have also stimulated other investments in ecosystem services. New York City decided to protect lands in the Catskills and Delaware watersheds because, under the national Safe Drinking Water Act and EPA's Surface Water Treatment Rule, water suppliers are required to filter their water unless they can show that they are protecting their watershed sufficiently to satisfy water quality standards.⁶⁸ Faced with the choice of an estimated \$6 billion filtration plant or protecting the watershed at a fraction of this cost, New York City not surprisingly chose watershed protection.⁶⁹ Whether the city would have invested similar sums in watershed protection absent the Safe Drinking Water Act mandate is uncertain. The Safe Drinking Water Act also has driven the actions of the other major cities that have invested in watershed acquisition and protection in recent years.⁷⁰

⁶⁵ David F. Victor & Joshua C. House, *A New Currency: Climate Change and Carbon Credits*, HARV. INT'L REV., Summer 2004, at 56–58.

⁶⁶ King, *supra* note 50, at 71. As noted earlier, few of the water quality initiatives have produced active trading. *Id.* One of the major reasons is that weak regulation of nutrient discharges has undermined the demand for water-quality credits. *Id.* at 73.

⁶⁷ Fox et al., *supra* note 48, at 115–16; Ruhl & Gregg, *supra* note 48, at 368–70.

⁶⁸ 42 U.S.C. §§ 300f–300j; 40 C.F.R. § 141.70–75 (2007).

⁶⁹ Salzman et al., *supra* note 6, at 315–16.

⁷⁰ Unfortunately, 97 percent of all water suppliers in the United States already filter their water. The Safe Drinking Water Act does not force these

A number of other types of laws can also stimulate ecosystem service markets and investments. Environmental assessment laws, for example, can force beneficiaries of ecosystem services to consciously evaluate threats to the services and thereby help the beneficiaries to realize the importance of protecting the relevant ecosystems. Turning to watersheds as an example once again, the Safe Drinking Water Act and a number of states require water suppliers to engage in water source analyses, identifying and assessing threats to their water sources.⁷¹ As the result of such assessments, water suppliers that have not focused on development threats in their watershed may realize that protective measures are needed. Environmental assessment laws, however, are not as effective as regulations in stimulating markets. While assessment laws can help overcome ignorance, myopia, and sometimes even optimism, they do not directly address valuation or free-rider problems.

The government can strengthen environmental assessment laws by pairing them with disclosure laws. Water suppliers, flood control districts, and other organizations benefiting from ecosystem services might face greater pressure to protect the services if forced not only to identify but also to reveal existing threats to their customers and the public. Much as publicly-released water-quality reports encourage water suppliers to maintain high water quality, for example, publicly-released watershed reports might also encourage water suppliers to invest in watershed protection.⁷²

The government can also encourage greater investment in ecosystem services by providing beneficiaries with financial assistance or incentives, thereby reducing the cost of protecting the ecosystem services. In this regard, one obstacle to ecosystem service markets can be governmental funding programs that provide monies for investments in built capital but not functionally equivalent natural capital. For many years, for example,

suppliers to protect their watersheds and, as discussed earlier, many have not engaged in any significant acquisitions of watershed lands. Postel & Thompson, *supra*, note 51, at 106.

⁷¹ 42 U.S.C. § 300j-13 (2000). See also U.S. ENVTL. PROT. AGENCY, SOURCE WATER PROTECTION: SOURCE WATER ASSESSMENTS, <http://cfpub.epa.gov/safewater/sourcewater/sourcewater.cfm?action=Assessments> (last visited July 23, 2008) [hereinafter SOURCE WATER PROTECTION].

⁷² States are required to make source assessments available to the public. SOURCE WATER PROTECTION, *supra* note 71.

governmental funds for water quality improvements supported the construction of filtration facilities but not watershed protection. Increasingly, however, governments are providing at least limited support for investments in natural capital.⁷³

2. *Laws Establishing Environmental Baselines*

Laws are also essential in establishing baseline flows of ecosystem services that landowners must preserve and for which beneficiaries therefore need not pay. Every society expects a minimum level of environmental protection without compensation from the beneficiaries of that protection. No one, for example, believes that water users should have to pay industrial facilities to stop polluting. Requiring beneficiaries to pay for such basic baseline conditions would raise significant equity issues.

Requiring beneficiaries to pay for all protective measures, including those below a minimum baseline, could also make it prohibitively expensive for beneficiaries to finance the protective measures. New York City's efforts to protect the Catskills and Delaware watersheds once again illustrate the concern. The city's efforts were significantly aided by a series of state laws giving the city substantial regulatory authority over the watersheds.⁷⁴ Although the city had to pay to acquire sensitive lands around reservoirs that required a high level of protection, New York City did not have to pay other landowners in the watershed to keep sanitation facilities and other high-polluting activities a minimum distance from waterways.⁷⁵ One study estimated that, if the city had enjoyed significantly reduced regulatory authority over the watershed, acquisition costs would have totaled \$2.7 billion rather than \$1.5 billion.⁷⁶ Although this figure is still less than the cost that New York City estimated that it faced if it constructed a new filtration facility, New York would have faced a more difficult task

⁷³ Salzman et al., *supra* note 6, at 321–26. For example, EPA has extended its revolving loan program for water quality investments so that the program now includes land conservation, in addition to traditional treatment facilities, but only ten percent of loans can be used to acquire conservation easements or fee interests in critical watershed lands. *Id.* at 317.

⁷⁴ COMM. TO REVIEW THE N.Y.C. WATERSHED MGMT. STRATEGY, NAT'L RESEARCH COUNCIL, WATERSHED MANAGEMENT FOR POTABLE WATER SUPPLY: ASSESSING THE NEW YORK CITY STRATEGY 121–26 (National Academy Press 2000)

⁷⁵ *Id.* at 122–23.

⁷⁶ *Id.* at 26; Postel & Thompson, *supra* note 51, at 104.

of financing efforts through rate increases and other measures.

3. *Laws Facilitating Transactions*

Laws can also play an important role in establishing the property rights, contract standards, and trading rules necessary for well-functioning ecosystem service markets, just as laws play a similar role for other forms of markets. As already discussed, inadequate property rights can sometimes prevent those who take steps to protect or increase ecosystem services from benefiting from those actions.⁷⁷ Laws awarding surface water or groundwater rights to individuals who increase the availability of such waters by removing invasive species or restoring natural land cover, for example, may be essential to encourage landowners to restore their watershed lands.

Laws establishing market infrastructure should minimize the transaction costs of ecosystem service investments. Markets for some current land types are restricted or involve unnecessary hurdles, making it difficult for individuals or organizations to acquire the land in order to protect ecosystem services. A number of states, for example, have held that only commercial interests can lease state trust lands.⁷⁸ Where possible, laws should open markets to all potential investors and minimize both restrictions and costs.

Many ecosystem service investments may also require long-term security. Current reforestation investments, for example, may not generate some services (such as water flow regulation or timber) for some years to come, and many of the resulting services may last for decades if not centuries. Beneficiaries paying for current reforestation may therefore want and need assurances that they will receive the resulting long-term benefits. The law can provide such assurances through the support or creation of contract rights, insurance, and other security mechanisms.

⁷⁷ See *supra* text accompanying note 64.

⁷⁸ Sally K. Fairfax, *State Trust Lands: The Culture of Administrative Accountability*, in ENVIRONMENTAL FEDERALISM 61 (Terry L. Anderson & Peter J. Hill eds., 1997). State trust lands were granted, usually contemporaneously with statehood, to be managed in trust by state governments for the benefit of schools and other public institutions. Environmentalists' recent attempts to outbid ranchers, who have traditionally used western state trust lands for grazing, and lease lands to manage them in their natural condition, have been blocked in several western states at the behest of entrenched political interests. *Id.*

4. *Facilitating Institutions*

New institutions and expanded institutional responsibilities can also help promote and support ecosystem service markets. As discussed earlier, beneficiaries of ecosystem services are sometimes tempted to free ride on others beneficiaries' potential investments. Beneficiaries also can find it difficult to get together in order to "bundle" the benefits of multiple ecosystem services. One suggested institutional method for overcoming such free-rider and collective-action problems is the creation of ecosystem service districts that have the power to tax multiple beneficiaries of ecosystem services in a given region and then use the resulting funds to protect the source of the services.⁷⁹ Special districts have long overcome collective action problems in the provision of capital investments and services such as irrigation water and flood control districts.⁸⁰ Ecosystem service districts would do the same by allowing the beneficiaries of ecosystem services in a region to vote to form an ecosystem service district that would then assess a tax based on the value to each beneficiary of the ecosystem services and invest the funds in ecosystem protection.

Institutional reform could also help on the sellers' side of ecosystem service markets. Many landowners are not aware of the ecosystem services that their land currently produces or could produce, of methods to improve the flow of services from their land, and of potential marketing opportunities. Conservation districts, which long provided farmers and ranchers with assistance in soil conservation, could help on all of these fronts. Conservation districts could promote markets, for example, by educating landowners about ecosystem services, providing technical assistance to landowners wishing to maximize the flow of services from their land, and acting as intermediaries in market transactions. If conservation districts did not want to play these

⁷⁹ See, e.g., Geoffrey Heal et al., *Protecting Natural Capital Through Ecosystem Service Districts*, 20 STAN. ENVTL. L.J. 333 (2001); see also Barton H. Thompson, Jr., *Markets for Nature*, 25 WM. & MARY L. REV. 261, 306–07 (2000) (describing the use of districts to solve analogous collective action problems); Barton H. Thompson, Jr., *People or Prairie Chickens: The Uncertain Search for Optimal Biodiversity*, 51 STAN. L. REV. 1127, 1177–78 (1999) (recommending steps governments could take to create markets for ecosystem services).

⁸⁰ See, e.g., Barton H. Thompson, Jr., *Institutional Perspectives on Water Policy and Markets*, 81 CAL. L. REV. 671, 686–98 (1993) (describing the history and function of irrigation districts).

roles, existing or new non-profit groups or other organizations could assist landowners in promoting and participating in ecosystem service markets.

IV. ECOSYSTEM SERVICES AS CRITERIA FOR BROADENED ENVIRONMENTAL LAWS AND AS MEASURES OF SUCCESS

The concept of ecosystem services also provides the opportunity to expand the functional reach of existing environmental laws, evaluate tradeoffs among alternative environmental policies, and measure their effectiveness in increasing human well-being. Many environmental laws, particularly those that are administered by EPA, have historically focused on human health, but are broad enough to also encompass ecological goals. Other environmental laws, particularly those that deal with land and other natural resources, are often vaguely framed, leaving substantial discretion to the administering agency. Ecosystem services can help improve performance under both categories of environmental laws.

A. *Moving Beyond Human Health*

To consider the benefit that the concept of ecosystem services can play in moving many traditional environmental laws beyond their historic emphasis on human health, consider the Comprehensive Environmental Response, Compensation, & Liability Act (CERCLA).⁸¹ Historically under CERCLA, EPA's efforts to clean up and redevelop Superfund sites focused on reducing and managing risks to human health from toxic substances, rather than maximizing the ecosystem services from the site. EPA would begin its cleanup efforts by assessing the degree and pattern of chemical contamination at a site; EPA would not collect information on the impact of the contamination on ecosystem services or on the potential ecosystem services that a restored site might generate. Cleanup plans, in turn, would focus on reducing the health risk to an acceptable level for human health, not on thinking about how cleanup and redevelopment efforts might maximize local ecosystem services. As a result, many Superfund sites that completed cleanup did not maximize local welfare, even though they were safe for human contact.⁸²

⁸¹ 42 U.S.C. §§ 9601–9675 (2000).

⁸² For a discussion of the opportunities that an ecosystem-based approach

This emphasis is not surprising. Human health concerns originally motivated the passage of CERCLA. More importantly, by the time CERCLA became law, health experts had developed standards to determine whether a site endangered human health. Ecologists had not developed similar standards to evaluate how contamination might have harmed the ability of a site to contribute valuable ecosystem services to the local population or to determine what cleanup standards would maximize the future value of those services. Ecological models and economic valuation techniques, however, now make such assessments possible. By focusing not only on human health but also ecosystem services, CERCLA can increase the contributions of Superfund cleanup and redevelopment efforts to overall human welfare.⁸³

EPA's cleanup efforts at the DuPage County landfill outside Chicago, Illinois, illustrates the advantages to local welfare of integrating ecosystem services into the cleanup of contaminated sites under CERCLA and similar laws. In both cleaning up and redeveloping the DuPage site, EPA considered a variety of cultural and supporting services, including habitat for hawks and other rare birds, hiking, boating, and other recreational uses. EPA's analysis led to the recognition that, given the relatively flat landscape, the landfill could be turned into a 150-foot hill that would provide refuge for both wildlife and humans. As a result of EPA's cleanup efforts, "a once dangerous area is now a community treasure, where visitors picnic, hike, camp, and take boat rides on the lake."⁸⁴ The site indeed is part of the Blackwell Forest Preserve.

B. *Measuring Success*

A final but valuable role for ecosystem services is in

offer for environmental cleanups and for a review of several relevant CERCLA case studies, see Wilson, *supra* note 12.

⁸³ Starting earlier this decade, EPA also broadened its activities under CERCLA to include a greater focus on land redevelopment. EPA's Land Revitalization Initiative of 2003, for example, "emphasizes that cleanup and reuse are mutually supportive goals and consideration of anticipated property reuse should be an integral part of EPA's cleanup decisions." U.S. ENVTL. PROT. AGENCY, OFFICE OF SOLID WASTE & EMERGENCY RESPONSE, LAND REVITALIZATION INITIATIVE, <http://www.epa.gov/landrevitalization/lrso.htm> (last visited Oct. 9, 2008).

⁸⁴ U.S. ENVTL. PROT. AGENCY, REDEVELOPMENT OF THE DUPAGE COUNTY LANDFILL SITE, WARRENVILLE, ILLINOIS, <http://www.epa.gov/superfund/programs/recycle/pdf> (last visited Oct. 9, 2008).

providing a measurable standard for both evaluating tradeoffs among alternative policies and measuring the effectiveness and success of those policies under statutes that provide broad or vague guidance. Section 404 of the Clean Water Act,⁸⁵ for example, seeks to protect wetlands, but gives little quantifiable guidance in how to measure whether the Corps of Engineers has successfully implemented the law—other than the relatively simplistic measure of pure acres of wetlands. Various federal land laws, including those governing national forests, mandate that federal agencies promote multiple uses, but provide little guidance on what this means or how varied uses are to be weighted.⁸⁶ The public trust doctrine requires states to manage trust lands, including tidelands and the beds of navigable waterways, to promote an assortment of trust goals with little attention again to how to evaluate alternative policies or measure whether the state is maximizing the contribution of trusts lands to these public goals.⁸⁷

Ecosystem services can provide a method of guiding the administration of these various laws and judging the effectiveness of that administration. Professors J.B. Ruhl and James Salzman, for example, have urged courts to treat public trust lands as “natural capital” and to require the government to use trust lands to promote ecosystem services.⁸⁸ The concept of ecosystem services could readily be incorporated in a similar fashion into other land or resource laws. Because ecosystem services link directly to human welfare, governmental agencies can ensure that such laws more fully promote human well being by evaluating tradeoffs among policies and measuring their success through their contributions to ecosystem services. The protection of ecosystem services, moreover, fits easily within the language, structure, and intent of many of these laws.

⁸⁵ 33 U.S.C. § 1344 (2000).

⁸⁶ See, e.g., Multiple-Use Sustained-Yield Act of 1960, 16 U.S.C. § 531(a) (2000) (defining multiple use of national forests); Federal Land Policy and Management Act of 1976, 43 U.S.C. § 1732(a) (2000) (charging the Secretary of the Interior to manage public lands under principles of multiple use and sustained yield).

⁸⁷ For a general overview of the public trust doctrine, see SALZMAN & THOMPSON, *supra* note 14.

⁸⁸ J.B. Ruhl & James Salzman, *Ecosystem Services and the Public Trust Doctrine*, 15 SE. ENVTL. L.J. 223, 230–39 (2007).

CONCLUSION

While we have long recognized that ecosystems provide valuable services to society, the concept of ecosystem services provides a broad, unifying structure around which to organize ecological and social research, as well as policy reform. As explained above, the concept of ecosystem services can play at least three roles in “breaking the logjam.” First, ecosystem services can provide another justification for environmental laws designed to protect ecosystems and their components. Second, ecosystem services can help drive new markets for ecosystem protection. Finally, ecosystem services can help expand the vision of existing environmental laws and provide a means of guiding and measuring the success of land and resource laws.

To take maximum advantage of the concept of ecosystem services, however, the federal government should take a number of critical steps described above:⁸⁹

- Federal agencies and research organizations should invest in the development of better methods for both quantifying and valuing the ecosystem services that flow from governmental regulations.
- The President should issue a new executive order calling for the integration of ecosystem service protection into the implementation of existing environmental laws and emphasizing the importance of including ecosystem service benefits in all federal cost-benefit analyses to the maximum extent possible. Federal agencies in turn should integrate ecosystem services into programs and activities.
- Congress should examine which ecosystem services are currently most at risk in the United States and, where laws currently do not provide for the effective protection of these services, develop laws that both promote and support markets for the services. As part of this legislative agenda, Congress also should consider whether new organizations are needed to facilitate such markets.
- Federal agencies should use ecosystem-service valuation

⁸⁹ States also have an important role to play. Many of the steps needed to ensure effective markets for ecosystem services (e.g., establishing property rights and passing laws that can help facilitate transfers and creating institutions that can both promote and support ecosystem service markets) are uniquely suited for state action.

both to evaluate tradeoffs among environmental policies and to measure the success of such policies.