Seminar

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Background and History: Ecosystem Services

Speaker

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Healthy ecosystems provide a variety of critical services for society, from clean water to carbon sequestration to pollination (Daily 1997). We have long recognized specific "ecosystem services," and have both designed policies to protect them and used them to justify protecting and restoring the environment (Thompson 2008). For example, the United States created national forests in the late 19th century specifically to secure two ecosystem services that healthy forests provide: "favorable conditions of water supply," and a "continuous supply of timber" (Organic Administration Act of 1897).

Various cities, such as San Francisco and Seattle, have long protected their watersheds in order to ensure clean drinking water for their populations (Thompson 2000b, 295). However, while our environmental policies have long recognized the importance of specific ecosystem services, recent scientific scholarship has emphasized the pervasiveness and large economic importance of such services, documented their decline, and urged their use to animate and drive domestic and global environmental policy (e.g., Kareiva et al. 2011; Daily and Matson 2008; Millennium Ecosystem Assessment 2005; Costanza et al. 1997).

This paper provides an introduction to the ways in which this recent scholarship could improve environmental policy. As explained below, ecosystem services provide policy-makers and practitioners with a comprehensive framework for building on and enhancing, rather than replacing, traditional approaches to solving environmental challenges. Policy-makers and practitioners have long enjoyed a suite of tools for addressing environmental issues: prescriptive regulation, redefinition of property rights, market mechanisms and other financial incentives, direct governmental acquisition and management of environmental amenities, and social persuasion (Salzmann and Thompson 2010, 44–52). Looking at environmental challenges through the framework of ecosystem services can help justify the use of these tools in settings where the policy case today might be weak (e.g., by showing that the benefits of prescriptive regulation outweigh the societal costs). More important, the framework can help inform better use of the tools (e.g., by identifying those lands that would be most valuable to conserve) and showing new ways to use them (e.g., by creating new ecosystem-service markets).

This paper begins by providing a brief introduction to ecosystem services. In the section "Alternative Frameworks for Environmental Intervention," it turns to how the concept of ecosystem services fits within the standard justifications used for protecting and enhancing the environment. "Traditional Management Approaches" reviews the major tools traditionally used to manage the environment and considers how a better understanding of ecosystem services might improve such tools. Building on this background, "How Thinking in Terms of Ecosystem Services Might Help" then looks comprehensively at how ecosystem services might provide for better environmental management. "Potential Issues and Challenges" concludes with a discussion of several challenges to the use of an ecosystem-service framework in environmental policy and practice.

A BRIEF INTRODUCTION TO ECOSYSTEM SERVICES

Ecosystem services are the contributions that ecosystems make to human well-being — both goods, such as food and freshwater, and services, such as flood reduction and carbon sequestration. Because ecosystems contribute to the production of these goods and services in much the same way that human, financial, and manufactured capital produce other goods and services, the literature on ecosystem services sometimes refers to ecosystems as "natural capital." The terms "ecosystem services" and "natural capital" both refer to the fact that nature itself provides valuable goods and services to society, and that human well-being thus depends on the protection of nature, and the terms are often used interchangeably.

An increasingly accepted typology, originally suggested by the Millennium Ecosystem Assessment, divides ecosystem services into four basic categories (Millennium Ecosystem Assessment 2003, 56–60):

1) *Provisioning services:* goods, such as food or freshwater, that ecosystems provide and humans consume or use
2) *Regulatory services:* services, such as flood reduction and water purification, that healthy natural systems, such as wetlands, can provide
3) *Cultural services:* intangible benefits, such as aesthetic enjoyment or religious inspiration, that nature often provides
4) *Supporting services:* basic processes and functions, such as soil formation and nutrient cycling, that are critical to the provision of the first three types of ecosystem services

Studies have contended that these ecosystem services provide vast economic value to society. In an early and controversial study, Costanza and colleagues (1997) estimated that ecosystem services provided between US $16 trillion and US $54 trillion per year in value, likely outstripping the yearly global GDP at the time of US $19 trillion. While economists faulted the Costanza study's methodology, all agree that the economic value of ecosystem services is vast (e.g., Heal 2000; Pearce 1998).

Over the last decade, scientists and other researchers have promoted the concept of ecosystem services and studied how it might help improve environmental management. A major global study, the Millennium Ecosystem Assessment, examined the state of ecosystems and ecosystem services throughout the world and found that most ecosystem services declined in the last half of the 20th century, while only four services (crops, livestock, aquaculture, and carbon sequestration) improved (Millennium Ecosystem Assessment 2005).

Both global and domestic environmental agencies have launched research programs to study the relevance of ecosystem services to their work (e.g., U.S. Environmental Protection Agency 2006). A growing number of research universities and non-governmental organizations have created programs to help measure, value, and evaluate ecosystem services, such as The Natural Capital Project, a joint venture among Stanford University, The Nature Conservancy, the World Wildlife Fund, and the University of Minnesota (Kareiva et al. 2011).

As already noted, ecosystem services are not a new concept, although terms such as “ecosystem service” and “natural capital” are of recent vintage. The recent surge in studies and scholarship surrounding ecosystem services, however, has dramatically increased attention to the concept in policy circles. As a result, an increasing number of governments have explicitly incorporated ecosystem services into their laws and policies (Thompson 2008). Current scholarship on ecosystem services has also changed the way in which policy-makers and others now think about the concept. Rather than looking at ecosystem services on an individual basis, recent scholarship has emphasized that ecosystems can provide a large range of different services. The scholarship also has increasingly sought to value the services, and to develop new, easily replicable methods of valuing them for public and private purposes (Kareiva et al. 2011). This in turn has helped highlight the tremendous value that ecosystem services provide humans, including value that is directly translatable into economic terms. The rest of this paper examines how the current wave of interest in ecosystem services may influence environmental policy.

ALTERNATIVE FRAMEWORKS FOR ENVIRONMENTAL INTERVENTION

The frameworks used to justify environmental interventions help explain the tools that policy-makers and practitioners have used to protect the environment. They also provide insight into how the concept of ecosystem services might help, or hinder, environmental protection. Three frameworks historically have dominated discussions: market failures, sustainable development, and environmental rights. While these frameworks are often reinforcing, they also can cut against each other in some settings, with one or another framework providing support for a policy intervention while the others militate against. The frameworks also can point to very different solutions even where intervention appears justified (Salzman and Thompson 2010, 28–29), and they are likely to lead people to see ecosystem services in very different lights.

Market Failures

The first framework, “market failures,” takes an unabashedly utilitarian approach to the environment. The goal is to maximize economic benefit to society, and the government should intervene where the market fails to adequately account for environmental benefits. Economists have identified a number of such failures, e.g., public goods, the tragedy of the commons, and externalities (Tietenberg and Lewis 2008, 65–88). Many environmental amenities, including important ecosystem services, are “public goods” shared by everyone and difficult to privatize. As a result, in a market economy no one has a strong incentive to contribute to their protection. For example, everyone benefits from clean air, but because the benefits are shared, there is no market for clean air; except for charitable contributions to environmental organizations, no one voluntarily pays to protect and clean up the air. Absent policy interventions, the result in a market economy will be dirty air.

Air pollution is also an example of the concept called the “tragedy of the commons,” which holds that where a resource is commonly held by everyone, each individual has a personal incentive to use and abuse the resource until its value is collectively impaired or destroyed. Because air is shared in common, for example, companies and individuals in a market economy pump carbon into it, even though that will lead to climate change. Where a fishery is open to all, fishermen often overfish until it collapses. If everyone overlying a groundwater

aquifer is entitled to pump from it with no restriction, they will overdraft the aquifer until water tables drop to a level where pumping groundwater is no longer economical.

A final way to see how environmental problems result from market failures is through the framework of "negative externalities." In making decisions in a market economy, businesses and individuals take private benefits and costs into account. However, where their actions result in a cost or benefit to someone whom they cannot charge, they will not consider that externality in making their decisions. Discharging carbon dioxide into the air contributes to climate change, but businesses and drivers have no economic reason to consider that cost because the marketplace does not force them to pay it.

Psychologists and policy experts also have shown that people suffer from many cognitive biases that prevent them from making decisions that will maximize their long-term welfare where various environmental issues are involved (Thompson 2000a). For example, imagine a fisherman trying to decide how many fish to catch in a year. As noted, if the fishery is open to all, the tragedy of the commons will lead to overfishing. However, if there is any uncertainty regarding the sustainable fishing level, over-optimism is likely to lead the fisherman to overestimate the number of fish it is safe to catch, even if the problem of the commons can be overcome. The fisherman is also likely to assume that any overfishing that occurs is the result of someone else's fishing practices, not his own.

The growing literature on ecosystem services meshes nicely with the utilitarian perspective that underlies the market-failure framework. By emphasizing the instrumental value of nature to humans, the concept of ecosystem services helps explain why it is important to protect and restore ecosystems. However, knowing that ecosystems provide valuable services to society does not solve market failures; it simply highlights the reason for doing so. As noted above, most ecosystem services are public goods and thus very difficult to protect through private markets (Thompson 2012). By providing insights into the value of conservation and environmental protection, however, the concept of ecosystem services can help policy-makers determine what and how much to regulate.

Sustainable Development

The concept of sustainable development provides an alternative framework for environmental intervention that shares a common lineage with much that has been written on ecosystem services (Tallis et al. 2008, 9458). Sustainable development begins with the premise that resources and environmental amenities are essential to meeting societal needs, but are finite in quality and sometimes fragile. For economic development to be sustainable, government therefore must ensure that each generation meets its needs in ways that do not exhaust resources or destroy the life-support systems of the planet (including natural capital). Otherwise, future generations will not be able to meet their needs.

Sustainable development thus stresses intergenerational equity and the critical importance of natural resources and ecosystem services (Pearce 1988). Unfortunately, neither markets nor political systems have fully accounted for the needs of future generations. Because of the time value of money, markets discount benefits to future generations. And the frequency of democratic elections drives politicians to focus more on the needs of current voters than the future needs of children or the unborn. Sustainable development calls for the use of longer time horizons in making decisions that affect the environment and resources.

Because sustainable development recognizes that natural resources are not inexhaustible and that ecosystem services are fragile, under its framework, governments should manage resources that are non-renewable, such as groundwater and fisheries, to avoid over depletion and collapse. Governments also should protect areas such as forests that provide services, such as carbon sequestration and dependable water flows that are critical to meeting the needs of not only the current but also future generations. Ecosystem services are thus a cornerstone of sustainable development. Because nature provides services that are central to human well-being and productive activity, any society that tries to develop at the expense of its natural environment will not be sustainable in the long run.

Environmental Rights

A third framework looks at environmental issues from the perspective of human rights (Nash 1989). Under this framework, the respective economic benefits and costs of improving or protecting the environment are largely irrelevant. Instead, environmental protection is a human right that all members of society have an obligation to protect. Under this perspective, looking at the environment through a utilitarian framework is both wrong and potentially dangerous.

The environmental rights perspective is embodied in the 1972 Stockholm Declaration of the United Nations Conference on the Human Environment, which states the "common conviction" that people have a "fundamental right to freedom, equality, and adequate conditions of life, in an environment of a quality that permits a life of dignity and wellbeing," as well as a "solemn responsibility to protect and improve the environment for present and future generations" (Sohn 1973). A handful of nations, as well as several states in the United States, also explicitly provide for environmental rights in their constitutions (Thompson 2006; Hayward 2005; Thompson 1996).

Most international and constitutional rights to environmental protection are anthropocentric; they focus on rights that current and future generations of humans have to a healthy and livable environment. However, some environmental advocates and philosophers have argued that environmental rights exist independently of the rights and interests of humans. Under the framework of "biocentric rights," plants and animals also have rights that must be protected. Under an even broader "ecocentric" perceptive, nature as a whole, not just individual species, has rights that humans should protect (Salzman and Thompson 2010, 30–31).

This final framework is not necessarily inconsistent with greater emphasis on ecosystem services. Understanding how humans benefit from ecosystem services, for example, can help explain why humans have a right to an environment that continues to produce such services. However, the recent emphasis on measuring and valuing ecosystem services creates a tension within a rights-based approach, which holds that society should protect ecosystems because it's the moral thing to do, not because of the economic value of ecosystem services or other elements of the environment. Indeed, as discussed in more detail in "Potential Issues and Challenges," below, trying to place a value on nature might actually undermine people's environmental rights by suggesting that society should protect nature only when the value of the protection outweighs the costs (Redford and Adams 2009, 785–786).

TRADITIONAL MANAGEMENT APPROACHES

Ecosystem services do not provide a totally new approach to managing the environment. The general categories of tools that we use to manage the environment today are likely to remain the same in the future. However, the concept of ecosystem services provides an approach for improving and expanding a number of the traditional tools, which fall into at least five broad categories: prescriptive regulation, property rights, financial incentives, direct governmental acquisition and protection of environmental amenities, and persuasion. As described in more detail in "How Thinking in Terms of Ecosystem Services Might Help," ecosystem services provide a useful framework for rethinking and improving tools in all five of these categories.

Prescriptive Regulation

Often labeled "command and control," prescriptive regulation directly dictates what individuals and organizations can and cannot do, typically by restricting activities or actions that could harm the environment (Salzman and Thompson 2010, 47). Most major environmental laws in the United States, ranging from the Clean Air Act to the Endangered Species Act, use prescriptive regulation. Some prescriptive measures regulate processes (e.g., by mandating that farmers use best management practices), while others mandate particular performance standards but leave it up to the regulated entities to determine how to meet those standard (e.g., the Endangered Species Act requires only that activities not "take" an endangered species).

The value of ecosystem service concepts to prescriptive regulation depends in part on how the government sets its standards. Standards are often set by government based on human welfare considerations or through balancing the benefits and costs. For example, so-called "secondary" ambient air-quality standards under the U.S. Clean Air Act must be sufficient to protect the public welfare (42 U.S.C. § 7409(b)), and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) prohibits the use of pesticides that present an "unreasonable risk to man or the environment" (7 U.S.C. §§ 136(bb) and 136a(c)(5)). In these cases, the ability to measure and value ecosystem services could provide a more rigorous means of setting regulatory standards and, in some cases, help justify stronger governmental regulations.

The pervasiveness of ecosystem services also suggests that laws aimed at protecting individual services, such as the Endangered Species Act, may be too narrowly focused, leading to the protection of land, water, or other resources that do not maximize the entire suite of services. In other cases, however, the government sets standards based on technological or economic feasibility. For example, the U.S. Clean Water Act sets pollution-discharge standards based largely on available technology (Sax et al. 2006, 1018–1023). In these cases, knowing the value of ecosystem services would not affect the regulatory standards.

Governments increasingly have sought ways to make prescriptive regulation more flexible and reduce its costs. "Cap-and-trade" systems are one such approach, in which the government sets an overall standard for pollution or resource consumption, then allows private entities to determine how to allocate the limited amount of permitted pollution or resource consumption through market trades. Water markets and carbon markets are examples of cap-and-trade systems. Mitigation is another mechanism commonly used to make regulations more flexible, by allowing people to engage in activities that are harmful to the environment only if they mitigate the injury through some form of compensatory behavior. For example, the United States sometimes allows wetlands to be modified or destroyed if the action is mitigated by restoring, enhancing, or creating wetlands elsewhere.

Ecosystem services can help improve such mechanisms by providing a metric for determining when two actions are equivalent. The ability to judge equivalency is central to cap-and-trade systems, mitigation, and similar flexible approaches (Salzman and Ruhl 2000). If, for example, the government must decide whether to permit a wetland to be developed in return for restoring a wetland elsewhere, it needs to know whether the two wetlands are at least approximately equivalent in terms of the benefits they provide. Comparing the wetlands might be difficult in the abstract, but measuring and valuing the ecosystem services generated by each can provide the government with a meaningful and effective way to compare them.

Property Rights

Where environmental degradation results from the tragedy of the commons, a potential solution is to reconfigure property rights either publicly or privately. For example, oil and gas production in the United States can lead to overpumping because all private landowners overlying a petroleum reservoir share a common right to pump oil and gas from the reservoir. A frequently employed solution is unification of the reservoir, which designates a single entity to manage petroleum extraction and then divide profits among the overlying owners. Similarly, a potential solution to overfishing is to award one group the exclusive right to fish a particular area, often referred to as territorial use rights in fisheries, or TURF (Christy 1992). A growing number of countries are also assigning individual quota shares to fishermen, to give them a financial stake in the sustainability of their fisheries (Costello et al. 2008).

Ecosystem services do not suggest improvements to property-rights approaches, but the importance of property rights to solving some forms of environmental problems suggests that policy-makers should consider how property rights might be used to help protect ecosystem services. For example, landowners might be able to increase water availability by retaining forests, protecting areas of groundwater recharge, or eliminating phreatophytes from river banks. In many parts of the world, however, landowners have no formal right to the water they protect or "produce" through such measures, undermining their ability to request payment from water consumers for adopting them. Reconfiguring water rights to reward such behaviors could thus help promote sustainable water flows (although other market failures, from lack of information to free riders, might still undermine any effort to establish a market incentive) (Thompson 2008, 477–478).

Financial Incentives

Economists have long pushed the use of financial incentives to improve environmental behavior, ranging from taxes and fees on bad behavior to subsidies or other positive incentives for good behavior (Hahn and Stavins 1992). In practice, few governments have made active use of taxes and fees to encourage good environmental behavior; while governments sometimes impose taxes or fees to help pay for regulatory programs, the amounts imposed have seldom provided a significant incentive to change behavior (Hahn 1989). By contrast, governments often subsidize environmentally beneficial behavior. For example, in the United States, the federal Farm Bill invested over US $4 billion per year in a wide variety of conservation and environmental payment programs during the first decade of the century (Cox 2008). Not surprisingly, policy-makers have found positive financial incentives an easier sell than taxes and other forms of negative incentives.

A broader and more complete understanding of ecosystem services can help justify the use of positive incentives. In using scarce governmental funds to promote particular environmental behavior, policy-makers generally would like to show that the funds generate equal or greater public benefits. Recognition that the preservation of forested lands will generate valuable ecosystem services has already led a growing number of national and local governments to set up programs that pay landowners to protect and manage the lands (payment for ecosystem services, or PES, programs) (Jack et al. 2008).

An improved understanding of ecosystem services could also enable the government to better direct incentives payments. Using the Farm Bill as an example again, most of its incentive programs are narrowly focused on a limited set of ecosystem types and services, even though well-managed agricultural lands can provide a wide variety of services. Moreover, many of the programs award incentives to individual farmers even when broader, landscape-scale or watershed-scale actions are needed to protect and enhance many services. If driven by and designed to protect a broader set of ecosystem services, the Farm Bill's conservation programs could deliver much higher value for every dollar spent than it does today (Goldman et al. 2008; Arha et al. 2008).

Greater understanding of ecosystem services could also help enable greater use of negative incentives. One of the major obstacles to using environmental taxes and fees is the ability to measure and value environmental harms. To ensure efficient behavior, "Pigouvian" taxes or fees should approximate the cost of the harm of the activity for which they are charged, but that cost has often been hard to estimate (Cropper and Oates 1992). An improved ability to measure and value ecosystem services thus could provide the foundation for the use of a broad set of fees or taxes (although political obstacles would still remain prominent).

Direct Governmental Acquisition and Management

A fourth means by which the government sometimes protects environmental amenities is by direct government acquisition (or retention) and management of the land or other resource that generates the amenities. Thus most governments acquire or set aside land to protect as public parks, forests, or other preserves. In the United States, four major national land agencies (the Forest Service, Bureau of Land Management, Fish and Wildlife Service, and National Park Service) manage over 600 million acres of land, almost half of which is actively managed for conservation (Thompson 2002, 247–248).

An enhanced understanding of ecosystem services once again can help improve a government's selection and management of environmentally valuable lands and resources (as well as justify governmental action). Governmental agencies often enjoy substantial discretion in managing public lands, partly because of the traditional difficulty in developing metrics for measuring and thus evaluating effective management. Ecosystem services, where measurable, can provide at least one set of metrics that are keyed to the reasons why nations often have established public holdings (Thompson 2008, 486–487).

Persuasion

The government also tries to influence behavior through persuasion, which can take several forms. One is to force individuals and organizations to reflect on their actions, and the possible effect of those actions on the environment, before moving forward. Most governments, for example, require some assessment of environmental impacts before allowing major actions that could significantly harm the environment (Wathern 1988). In other cases, governments provide information to help individuals or organizations make more informed and hopefully better decisions. California, for example, provides warnings to potential consumers of products known to carcinogenic or to contain reproductive toxins (Stephan 2002). Finally, governments often seek to influence behavior or social norms through marketing campaigns and educational programs. Examples include governmental efforts to encourage conservation of energy and water, to promote recycling, and to reduce tobacco use (Hastings and Saren 2003).

As discussed in the next section, the concept of ecosystem services may provide a new mechanism for helping the public understand why it is important to protect nature. For those individuals who care more about economic well-being than environmental equity, ecosystem services may provide greater resonance to traditional arguments for sustainable behavior.

HOW THINKING IN TERMS OF ECOSYSTEM SERVICES MIGHT HELP

As suggested in the previous section, increased understanding of ecosystem services can help promote environmental stewardship in a number of ways. This section considers three major possibilities: First, that ecosystem services may provide a conceptual shift in the way people think about conservation, increasing public support for conservation efforts. Second, that a better understanding of ecosystem services might improve governments' ability to measure the benefits of particular environmental actions, enabling better goal-setting and program evaluation. Finally, that ecosystem services might open up new opportunities for environmental markets.

Shifting People's Understanding of the Value of Conservation

Many policy advocates have hoped that greater appreciation for the extent and value of ecosystem services will lead to increased public and private support for conservation (e.g., Daily et al. 2009; Salzman et al. 2001). Although ethical considerations lead many people to protect the environment, more utilitarian considerations drive many others. By emphasizing the connection between the environment and human well-being, a better understanding of ecosystem services might convince more of the latter group that protecting the environment is valuable. More generally, a better understanding of the connection could lead to greater support for conservation measures.

This thesis finds some support in a range of governmental actions over the last two decades designed to protect ecosystem services. For example, a handful of national governments have created programs to conserve land for the ecosystem services that they produce. In the late 1990s, Costa Rica created a new program to pay landowners to protect forested land for a variety of ecosystem services, including hydrological services, carbon sequestration, biodiversity protection, and scenic beauty (Paglioa 2008). China is in the process of establishing vast ecosystem-service reserves.

At the local level, a growing number of cities in South America have established water funds to pay landowners in their watersheds to manage their lands in ways that do not threaten water quality. In the United States, cities such as New York and Boston also have

invested in land conservation in their watersheds in order to protect water quality and thereby avoid the need to filter water from those areas (Postel and Thompson 2005). Legislatures in both Hawai'i and Washington have adopted similar legislation.

Various U.S. states also have shown an increased interest in ecosystem services. For example, in 2006 Hawai'i's House of Representatives requested the Hawai'ian government to assess incentives for the conservation of private lands and "the public benefits of the ecosystem services provided by those lands," and to recommend opportunities for reforms. The House resolution emphasized the need to think of "the environment not as a 'free good,' but as a capital resource that will depreciate without appropriate care" (House Concurrent Res. No. 200, Haw. 23rd Leg.). The state's Department of Department of Land and Natural Resources responded with a report calling for a series of reforms, including a Hawai'i Fund for Conservation that would "link buyers and sellers of ecosystem services, standardize conservation credits and lower transaction costs for those who are considering investment in Hawai'i's biodiversity and ecosystem services" (Hawai'i Dept. of Land and Natural Resources 2007). In 2008, the Washington state legislature ordered a study of how ecosystem-service markets might promote conservation practices on agricultural and forestry lands (S.B. 6805, Wash. 60th Leg., 2008 Reg. Sess.).

One nonetheless can question how effective the effort to increase understanding of ecosystem services by the public and policy-makers has proven in encouraging new conservation measures that otherwise would not have been adopted. Most nations, including the United States, have adopted virtually no new policies in response to the increased attention to ecosystem services. The United States Code contains only two laws that even refer to ecosystem services: a provision of the 2008 Farm Bill that creates a new office in the Department of Agriculture to promote ecosystem-service markets (16 U.S.C. § 1845), and a directive that federal research on oceans and the atmosphere should include ecosystem services (33 U.S.C. § 893).

Members of Congress have mentioned ecosystem services approximately 40 times on the floor of either the House or Senate since 1985 (e.g., 157 Cong. Rec. E249, E1209), but the concept never appears to have played a major role in a debate over important legislation. Federal agencies have taken to the concept more readily; the term appeared 164 times in the Federal Record in 2011. However, most of these mentions dealt with research, not actual policy, and were far outnumbered by the 1,281 references to more standard concepts such as biodiversity. While states like Hawai'i and Washington have expressed interest in and studied how to promote the protection of ecosystem services, improved understanding of ecosystem services has yet to inspire any state to adopt new on-the-ground conservation measures.

Long-standing laws, rather than an emerging understanding of ecosystem services, have driven many local investments in ecosystem services. Consider, for example, the efforts by New York, Boston, and other cities to protect their watersheds. There is no evidence that such efforts stemmed from a new or improved understanding of ecosystem services by city officials. Instead, the United States Safe Drinking Water Act has long given cities the option of either protecting their watershed or filtering their water (42 U.S.C. §§ 300f–300j; 40 C.F.R. § 141.70–.75 (2007)). Given the cost of filtering, many large cities have chosen to protect their watersheds. A 2005 study of major water suppliers in California found that few had purchased new lands or conservation easements in the prior decade to protect their watersheds, in part because water suppliers had no sense of the actual value of the land conservation to their efforts to protect water quality (Thompson 2008; Postel and Thompson 2005).

There also are more theoretical reasons to question how much the concept of ecosystem services will dramatically shift policy debates in favor of greater conservation (Thompson 2008). First, many of the major ecosystem services of greatest interest to the public are not new to policy debates. Arguments for conservation have long rested on the importance of ecosystem services such as clean water, flood protection, and, more recently, carbon sequestration. Second, the concept of ecosystem services does not address the major structural problems standing in the way of increased conservation, including the diffuse nature of the public's interest in conservation and the concentrated opposition of major industrial interests such as mining, development, and agriculture.

How significant an impact the concept of ecosystem services will have on conservation policies throughout the world is therefore still an open question. Research on ecosystem services as a whole is still relatively new, and the general concept has only recently picked up momentum in public discussions. Current efforts to measure ecosystem services and value them in economic and other terms may prove particularly useful in convincing skeptics that ecosystem services are worth protecting. However, it is not yet clear whether new studies, models, and data are likely to sway votes and support for conservation from policy-makers who have not been swayed by more traditional arguments.

Providing Improved Measures of Environmental Benefits and Performance

Current studies of ecosystem services may hold greater promise for providing improved measures of environmental benefits and performance. Such measures are important in at least four contexts. First, measures of environmental benefits are important in justifying environmental regulations. In the United States, every president since Richard Nixon has required agencies to conduct cost-benefit

analyses before adopting major environmental regulations (e.g., Exec. Order 13563). A handful of U.S. environmental laws, such as FIFRA and the Toxic Substances Control Act, explicitly require the Environmental Protection Agency (EPA) to balance benefits and costs in setting appropriate regulations (Salzman and Thompson 2010, 35).

While cost-benefit analyses have long incorporated health benefits from environmental regulations, agencies have had a more difficult time quantifying and thus formally incorporating their ecological benefits (U.S. Environmental Protection Agency Science Advisory Board 2009). To the degree that agencies have been able to identify ecological benefits, they are generally included in cost-benefit analyses only as a qualitative factor. New research on measuring and valuing ecosystem services thus holds out the promise of allowing agencies to quantify more of the benefits of their regulations, and thus provide stronger justification for them. For this reason, the EPA's Science Advisory Board (2009) has recommended increased support for such research and its incorporation into cost-benefit analyses.

Second, the ability to measure and value ecosystem services also could help agencies better implement the regulatory and managerial discretion that they enjoy, as well as enable other branches of government to evaluate how well various programs are being carried out. Some statutes provide agencies with only general instructions regarding their actions. For example, the Multiple-Use Sustained-Yield Act instructs the Secretary of Agriculture to "develop and administer the renewable surface resources of the national forests for multiple use and sustained yield of the several products and services obtained therefrom," and notes that it is the "policy of the Congress that the national forests are established and shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes" (16 U.S.C. §§ 528, 529). Improved measurement and valuation of ecosystem services could help the Department of Agriculture in determining how to manage the national forests with maximum use and sustained yield in mind, and in making inevitable tradeoffs among uses. Similarly, courts could use ecosystem services to provide more concrete meaning to the general obligations of the public trust doctrine (Ruhl and Salzman 2007).

Third, the ability to measure and value ecosystem services could help encourage agencies that have historically focused their administration of particular laws on human-health concerns to pursue broader ecological benefits as well. For example, the EPA's administration of the Superfund program historically has focused on reducing and managing risks to human health from toxic substances. Evaluation and cleanups of Superfund sites seldom considered the impact of contamination on ecosystem services, or ways in which a restored site could benefit ecosystem services. More recently, however, improved understanding of ecosystem services has led some cleanup efforts to design plans that can increase the local supply of such services (Thompson 2006).

Finally, as discussed earlier, improved measurement and valuation of ecosystem services can help ensure that trading and mitigation systems do not accidentally reduce environmental protection. Where regulations are designed to protect ecological assets such as wetlands or habitat, trading or mitigation programs must be able to compare the assets that are involved in a trade or mitigation proposal. The ability to measure and, in some cases, value ecosystem services is critical to such comparisons (Ruhl et al. 2009).

Creating New Markets for Ecosystem Services

Some experts on ecosystem services have held out hope that a better understanding of ecosystem services and their value would lead to ecosystem-service markets that would promote increased conservation (e.g., Guteri 2005; Chichilnisky and Heal 1998). Investments made by public and private entities to protect ecosystem services have helped spur such hopes. As already noted, New York and other cities have spent money to protect their watersheds in order to ensure high water quality. Some water-dependent companies, such as Perrier-Vittel, have purchased lands to protect the quality of their water (Economist 2005). A few regions, such as Napa County, have invested in the restoration and protection of wetlands and other riparian lands for the flood protection they provide (Salzman et al. 2001). The rapid rise of carbon markets in Europe and other parts of the world has led entrepreneurs to wonder whether similar markets could develop in other ecosystem services. Hopes for ecosystem-service markets, in turn, have led a variety of governments to investigate options for promoting such markets (Thompson 2008).

In considering the opportunity for ecosystem-service markets, it is important to make two important distinctions. The first is between "spontaneous" markets (which do not need governmental pressure) and regulatory markets (which develop from regulatory pressure). Spontaneous ecosystem-service markets are attractive because they promise greater conservation investment without the need for political change. Perrier-Vittel's conservation of lands overlying one of its major groundwater sources is an example; the company invested in conservation because of the value of the services the land provided, not because of any governmental policy. Unfortunately, there are exceptionally few examples of spontaneous ecosystem-service markets. Nor should one expect many examples because, as noted earlier, ecosystem services are public goods for which robust private markets are unlikely to arise (except as a result of philanthropic spending) (Thompson 2012).

Governmental regulation drives most markets for ecosystem services. New York City invested in conservation in its Catskills watershed because of the Safe Drinking Water Act. Section 404 of the Clean Water Act, which restricts modification of wetlands, and its mitigation

program have driven markets for wetlands conservation in the United States (Fox et al. 2006). Climate laws, or the prospect thereof, have driven markets for carbon sequestration. In all of these cases, governmental regulation has been the catalytic force behind the ecosystem-service markets (Victor and House 2004). Rather than ecosystem services driving markets and new investments, governmental intervention leads to protection of the ecosystem services through markets. The question then arises whether ecosystem services could drive new governmental regulation that otherwise would not pass. Not surprisingly, legislatures have been more enthralled with the possibility that they could help promote spontaneous markets than with passing new regulations.

Another important distinction is between geographically large commodity markets (such as the market for carbon credits) and local heterogeneous markets (such as wetland banks under Section 404 of the Clean Water Act). Commodity markets involve trades among relatively comparable goods. As a result, they tend to have low transaction costs and a large volume. By contrast, trades in local heterogeneous markets require often difficult comparisons among goods or services. Such markets are often thin and have high transaction costs, leading to far fewer trades. Unfortunately, most ecosystem-service markets promise to be local and heterogeneous.

Markets will remain an important instrument for promoting environmental goals. However, for the reasons just discussed, it is unlikely that a growing appreciation for ecosystem services will lead to significant new markets absent governmental pressure, and thus to new private investments in the ecosystems that produce the services. The greatest opportunity lies in those services where a single entity receives a disproportionate share of the benefits. Spontaneous markets may arise in these situations because the service takes on more of the qualities of a private good. For example, major water suppliers may be the primary beneficiaries of watershed protection, which could help explain why a number of South American cities have begun to invest in water funds.

POTENTIAL ISSUES AND CHALLENGES

While the concept of ecosystem services offers potential policy advantages, integrating ecosystem services into environmental policies also poses a variety of both practical implementation challenges and political-ethical issues.

Practical Challenges

As suggested, the use of ecosystem services to advance conservation presents a number of practical challenges. The first is developing models and methods for predicting how particular policies will affect ecosystem services that are important to the public. Without "ecosystem production functions" that connect particular ecosystem characteristics with a flow of services, it is impossible to determine how particular policies will affect those services. Ecologists, who historically did not characterize ecosystems in ways that could directly translate to their services, are currently developing new models. If ecosystem services are to become a common motivator, such models must be able to determine, at relatively low cost, the impact of particular policy measures (U.S. Environmental Protection Agency Scientific Advisory Board 2009).

A second practical challenge is valuing ecosystem services. Because many ecosystem services are public goods that do not have active markets, valuation can be highly uncertain. Most valuation efforts to date, moreover, have been monetary. Non-monetary valuation is likely to be more relevant to many societies, but methods to produce non-monetary values are still in their infancy and often very controversial (U.S. Environmental Protection Agency Science Advisory Board 2009). All forms of valuation require active interdisciplinary collaboration.

Political-Ethical Issues

The current interest in using ecosystem services to promote conservation has drawn significant political-ethical criticism. For example, as noted earlier, ecosystem services emphasize the human values of ecosystems, and thus policies based on ecosystem services are likely to trumpet human values rather than broader notions of environmental ethics. For those who believe that society should protect the environment for biocentric or ecocentric reasons, focusing on ecosystem services may threaten to shift policy attention away from what they believe is the critical issue: what are society's obligations to nature?

Such a shift might not be a problem, at least in terms of ultimate consequences, if ecosystem-service arguments can accomplish the same quantity and quality of conservation as ethical arguments. Proponents of broader ethical arguments, however, may fear that ecosystem-service arguments may never be sufficiently convincing to a broad segment of the public, and that greater attention should instead be paid to promoting ethical arguments. These proponents may also fear that ecosystem-service arguments will not support the same type or degree of conservation as ethical arguments might (Redford and Adams 2009). For example, ecosystem-service arguments might support modified or engineered ecosystems that maximize the flow of services even if the ecosystems lose significant aspects of their

"naturalness" (e.g., native species). Ecosystem-service arguments similarly might provide only weak support, at best, for the conservation of apparently "unnecessary" parts of an ecosystem (i.e., those parts that do not appear to be necessary in order to provide significant ecosystem services). Ecosystem-service arguments might also justify the elimination of ecosystem characteristics that could be viewed as potentially harmful to humans.

A potential response to these concerns is that ecosystem services and environmental ethics can be complementary rather than competitive arguments (Thompson 2002). In theory, one could argue that policies should promote conservation because of both ecosystem services and environmental rights. The question is whether this is possible, or if an ecosystem-service argument is likely to crowd out arguments based on environmental ethics. Unfortunately, no empirical or experiential evidence currently provides an answer to this question. Proponents of ecosystem-service arguments believe that it is worth the risk to try a new approach to convincing the public of the importance of conservation. At least some environmental ethicists have their doubts.

Efforts to value ecosystem services monetarily heighten the tension. Placing a monetary value on ecosystem services assigns a numerical value to nature. More important, it would appear to buy into the same neoclassical framework that argues for subjecting environmental regulation to cost-benefit analysis. Monetary valuation thus would seem to directly conflict with ethical arguments for environmental protection. Placing a monetary value on ecosystem services would also suggest that some services (perhaps those that are close to human settlements) are more valuable than other services (Redford and Adams 2009).

Markets for ecosystem services pose particular problems for individuals who believe in environmental rights and obligations. First, the promise of ecosystem-service markets might undermine arguments for environmental regulation by suggesting that new or strengthened regulation is unnecessary. For example, if water funds can help protect watersheds, legislators may be less likely to support laws requiring watershed protection. This could be a particularly serious problem to the degree that regulation is more likely than markets to shape societal attitudes about conservation (Thompson 2002). Second, ecosystem-service markets may implicitly suggest that society should allocate ecosystem services based on ability and willingness to pay. Rather than rights, ecosystem services become commodities, much like cell phones or light bulbs.

Markets for ecosystem services similarly present a baseline problem: what services should landowners be required to provide even if they are not paid? Few would argue that society should pay landowners not to pollute a river running through their property; why then should society pay landowners to protect riparian lands that are important in providing high-quality water? From the perspective of the ethicist, should society pay landowners for something they have an ethical obligation to do?

CONCLUSION

The concept of ecosystem services holds out the promise of increasing and improving conservation in at least three ways. First, ecosystem services may provide a new and resonant argument for conservation by demonstrating the enormous value of conservation to society. Second, ecosystem services might provide a framework for better specifying the purposes of environmental management and for expanding its purposes. Finally, ecosystem services might provide the basis for new markets that could increase the funds flowing into conservation. Of these opportunities, the second currently appears to be the strongest. Moreover, recognizing and embracing all the potential benefits depends on being able to better measure and value ecosystem services.

Any effort to focus debate over environmental policies around ecosystem services, however, is likely to generate controversy. Ecosystem services focus on the human value of conservation, which some environmentalists fear may undercut ethical arguments. Efforts to put a monetary value on ecosystem services and to develop ecosystem-service markets increase the friction between these two very different perspectives on environmental policy.

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