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Ecosystem Services and the Potential Role for Markets

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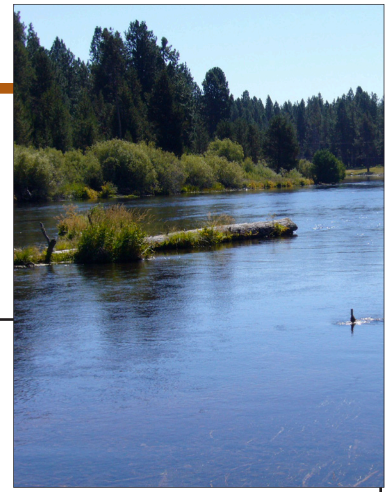

Summary

Ecosystems sustain human life in many ways—by purifying air and water, protecting us from floods and the sun's harmful ultraviolet rays, and many more. These sustaining qualities are sometimes called **ecosystem services**.

Encouraged by the success of "regulatory markets" such as those for SO_2 trading and fishery catch-shares, some groups have embraced direct "**markets for ecosystem services**" (MES) as a better way to promote conservation.

Many ecosystem services, however, are not well suited to a market-based approach. Many, such as clean air, are **nonrival, nonexcludable** public goods. Nonrival means that many people can enjoy them without using them up. Nonexcludable means that people cannot be forced to pay for them. These characteristics make it impractical to create an effective direct market. Most people are unwilling to pay for something they can get for no cost.

Given this problem, some supporters of MES have suggested using public funds to pay landowners whose properties provide ecosystem services. This strategy is known as "**payments for ecosystem services**" (PES). This alternative, however, can require substantial public funds, and would likely become even more expensive over time. While there are specific situations where PES may be the best or only option, it has serious potential shortcomings in terms of effectiveness, efficiency, and sustainability.

A fundamental issue with MES and PES is what they imply about property rights. Both approaches presume landowners have absolute property rights to do whatever they want with their land, so that a "user pays" approach would be required. This is the opposite of the assumption that private property rights are limited by the needs of society—a "polluter pays" view that has been supported in many cases by U.S. courts.

A shift to "user pays" would severely limit policy options for protecting the environment. More options exist when property rights favor the public's right to ecosystem services.

The most promising of these options are "**regulatory markets**"—the very type of market that has demonstrated success. With this kind of policy, government sets an overall limit on pollution or resource extraction (SO_2 emissions, fishing, water use, etc.). Within this overall limit, people can buy and sell rights to extract resources or pollute. The U.S. SO_2 emissions market is one successful example. Similar markets could be created for other rights to extract resources or pollute.

These are not markets for ecosystem services themselves. But, they do protect the environment. By doing so, they indirectly protect ecosystem services, often at the lowest possible cost.

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Ecosystem Services and the Potential Role for Markets

Ecosystem services have been defined as the "conditions and processes through which ecosystems, and the species that make them up, sustain and fulfill human life" (Daily 1997). Examples include purification of air and water, nutrient cycling, maintenance of biodiversity, protection from the sun's harmful ultraviolet rays, flood protection, climate stabilization, provision of fish, and many others.

Over the past few years, interest has grown in the idea that markets for ecosystem services (MES) can foster environmental conservation and ecosystem restoration. Supporters of MES point to cases where market mechanisms have been used successfully as a cost-effective way to achieve environmental goals. Examples include the U.S. SO_2 emissions allowance program, carbon trading, fishing quotas, water markets, and water quality trading.

These examples, however, involve *regulatory markets*, whereby a limit has been placed on the aggregate level of resource extraction (fisheries) or damage (pollution). Rights to extract or pollute are then allocated through markets. More recently, the idea that ecosystem services themselves could be bought and sold in markets—and thus be better protected—has gained currency among environmental groups, other nongovernmental organizations (NGOs), and government agencies. Indeed, an Office of Environmental Markets was recently created within the U.S. Department of Agriculture (USDA 2008).

Some advocates argue that these markets would also generate financial benefits for landowners, make land stewardship profitable, increase landowners' competitiveness in national and international markets, and support rural jobs and economic development (see, for example, Collins and Larry 2007, USDA 2008, Duraiappah 2006). Indeed, the USDA (2008) states:

> "Our Nation's farms, ranches and forests provide goods and services that are vital … to society—clean water and air, wildlife habitat, carbon storage, and scenic landscapes. Lacking a formal structure to market these services, farmers, ranchers and forest landowners are not generally compensated for providing these critical public benefits. Market-based approaches to conservation are proven to be a cost-effective method to achieve environmental goals and sustain working and natural landscapes. Without financial incentives, these ecosystem services may be lost as privately-owned lands are sold or converted to development."

In light of the recent interest in this topic, this publication examines and assesses the potential benefits and limitations of markets for ecosystem services in relation to regulatory markets and other policy tools.

Advantages and limits of markets

The benefits of markets as a way to allocate scarce goods and services derive mainly from their potential efficiency, as compared to direct government regulation or other centralized allocation mechanisms. Market mechanisms often have lower costs than command-and-control regulations because they provide decentralized incentives and efficient responses.

The best-known large-scale environmental regulatory market in the U.S. is the SO_2 emissions trading program, which is estimated to have reduced costs by $1 billion annually (Carlson et al. 2000). The leaded gasoline phase-down in the 1980s is estimated to have lowered compliance costs by $250 million per year (Nichols 1997). Beginning in 1994, California's South Coast Air Quality Management District has used a cap-and-trade program to reduce nitrogen oxide and SO_2 emissions in the Los Angeles basin, with an estimated cost savings of $58 million per year (Anderson 1997).

The success of these programs and the magnitude of their advantages depend on many factors, including the degree to which they satisfy two sets of core criteria. The first relates to the need for robust, or *non-attenuated*, property rights. Property rights are non-attentuated if they are: (a) completely specified, (b) individually owned, (c) transferable, and (d) enforced (Randall 1987). The second set of criteria relates to the efficiency of competitive markets. Efficient markets require: (a) many buyers and sellers, (b) full information, (c) homogeneous products, (d) costless transactions, (e) low barriers to entry and exit, and (f) no externalities (third-party effects). More specific ways to judge the promise of market competition and robust property rights as they relate to ecosystem services are discussed below.

Ecosystem goods and services: A framework for supply and demand

Evaluating alternative approaches for protecting ecosystem services first requires us to identify different kinds of ecosystem services and the ways in which changes in ecosystems affect human welfare.

One way of classifying ecosystem services identifies *core ecosystem processes*, including production, decomposition, nutrient cycling, water cycling, weathering/erosion, ecological interactions, and evolutionary processes (Balmford et al. 2011). These core processes in turn generate the beneficial *ecosystem processes* identified by the columns in Table 1 (page 4). These columns represent the things ecosystems "do," such as controlling erosion, purifying air, and providing habitat for animal and plant species.

These ecosystem processes in turn give rise to *ecosystem benefits* or *"services,"* such as food, fresh water, raw materials, energy, property,

Table 1. Relationship between ecosystem processes and ecosystem benefits.

Ecosystem benefits \ Ecosystem processes	Biomass production: primary	Biomass production: secondary	Pollination	Biological control	Other ecological interactions	Formation of species habitat	Species diversification	Genetic diversification	Waste assimilation	Soil formation	Erosion regulation	Formation of physical barriers	Formation of pleasant scenery	Air purification	Regional/local climate regulation	Water regulation (timing)	Water purification (quality)	Water provisioning (quantity)	Global climate regulation	Unknown processes
Crops			Dark	Dark				Dark	Medium	Dark	Medium	Light			Medium	Dark	Medium	Dark	Dark	Medium
Livestock	Dark							Dark								Light	Medium	Medium	Light	Medium
Marine fisheries	Dark	Dark		Light	Dark	Dark	Dark	Light	Light	Light	Medium					Light	Medium	Light	Medium	Medium
Inland fisheries	Dark	Dark		Medium	Dark	Dark	Dark	Medium	Light	Light	Medium						Dark	Dark	Dark	Medium
Wild animal products	Dark	Dark		Light	Medium	Dark	Dark	Light											Light	Medium
Drinking and industry water																Medium	Dark	Dark	Dark	Medium
Hydroelectric energy											Medium					Dark	Light	Dark	Medium	Medium
Wild plant fibers	Dark		Light	Light	Medium	Dark	Medium	Light											Light	Medium
Wild medicinal plants	Medium		Light		Medium	Dark	Dark	Medium											Light	Medium
Nature-related outdoor activities	Medium	Medium		Light	Light	Medium	Medium		Medium		Light	Light	Dark	Light	Light		Medium	Light	Medium	Medium
Avoided injury, property loss	Medium	Light										Dark				Dark	Light	Light	Dark	Medium
One-time use benefits	Light	Light		Light	Medium	Medium	Dark	Dark											Medium	Medium
Non-use benefits	Medium	Medium	Light	Light	Medium	Dark	Dark	Medium					Medium						Medium	Medium
Unknown benefits	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	

Source: Balmford et al. (2011). Shading represents the importance of the corresponding link between ecosystem processes (columns) and ecosystem benefits (rows). Darker shading indicates a stronger relationship.

health, psychological well-being, and knowledge (the rows in Table 1). These rows represent the services ecosystems "provide" to humans. The relationships between ecosystem processes and ecosystem benefits or services are indicated in Table 1 by shaded squares; a darker shade represents a more important link.

In considering whether market mechanisms have the potential to produce and allocate ecosystem services, it is important to note one critical distinction between two very different types of ecosystem services, and also to consider the interconnection between the two. The first type of benefit is the consumption or enjoyment of public goods such as clean air, scenic views, or water filtration and flood control. Many of the ecosystem benefits in Table 1 are public goods.

The second type of benefit involves actions to extract resources (mining, fishing, forestry) or dispose of waste products (air and water pollution). This category also includes "displacement" of environmental resources, referring primarily to land development that replaces natural ecosystems with buildings, roads, or other built capital. Most of these benefits involve private goods and services that individuals can acquire and sell in markets. The relationship between these two types of ecosystem benefits is that the second type often adversely affects the first type.

This fundamental distinction between the public and private goods and services provided by ecosystems is illustrated in Figure 1. The private activities that take advantage of certain kinds of ecosystem goods and services are shown on the left side, and the public goods corresponding to many other kinds of ecosystem services are on the right side.

Most environmental problems occur when these private actions (left side of Figure 1) degrade or adversely affect other ecosystem services (right side of Figure 1). For example, activities such as waste disposal and resource extraction are private activities. These activities frequently damage or degrade one or more ecosystem processes which, in turn reduces the level of ecosystem services available to the public. This "spill-over" effect on other individuals is also known as an *externality*.

As public goods, many ecosystem services are susceptible to what is known as the *free-rider problem*, whereby individuals benefit from actions for which they do not pay the full social cost. For example, we all benefit from clean air without having to pay for it individually. Conversely, individuals can damage ecosystem services through actions shown on the left side of Figure 1 without having to bear the entire cost of that damage.

Ronald Coase's framework for evaluating externalities and property rights provides a useful starting point for considering the potential of market mechanisms to efficiently allocate ecosystem services (Coase 1960). In Coase's formulation, the actions of one individual or group have adverse consequences for another individual or group.

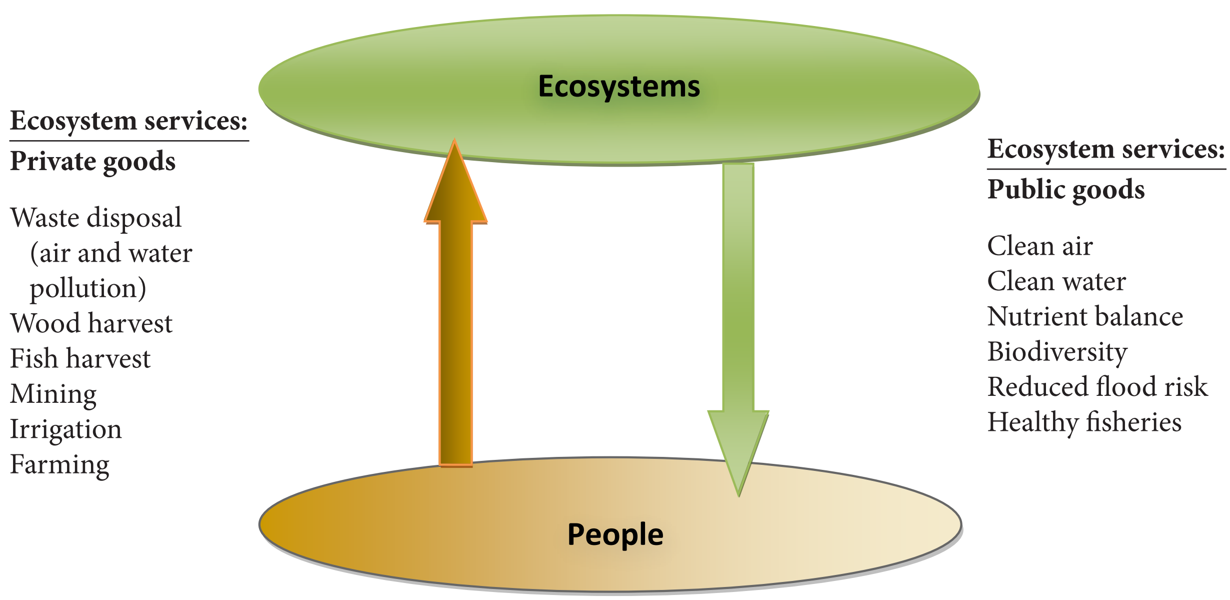

Figure 1. Two types of human interactions with ecosystems.

Coase's attention was focused on the choice between two opposing rights: the right of one party to generate a negative externality versus the right of the other party to be free of such external harm. Coase recognized the reciprocal nature of these rights; permitting either party to exercise his right affects the ability of the other to exercise his own right. Thus, the externality can move in either direction.

In an environmental context, this kind of problem arises when two conditions are met: (1) an environmental resource such as an ecosystem is degraded by one or more individuals for purposes of resource extraction or waste disposal, and (2) these actions cause other individuals to suffer a loss of ecosystem services. Consider, for example, an activity by one property owner that creates pollution, thus affecting another property owner's right to enjoy clean air and water. Coase observed that one could assign the property rights to either actor (polluter or pollutee). If transaction costs are zero, the initial assignment of property rights should have no effect on efficiency. In either case, the parties could be expected to bargain toward an efficient allocation.

Coase's framework is illustrated in Figure 2. Going from left to right, the horizontal axis represents the level of environmental damages (Q_{ED}) caused by private actions on the left side of Figure 1. Going from right to left, it represents the level of ecosystem services (Q_{ES}).

The downward-sloping marginal private benefit curve (MPB) represents the benefit to the extracting or polluting individual of resource

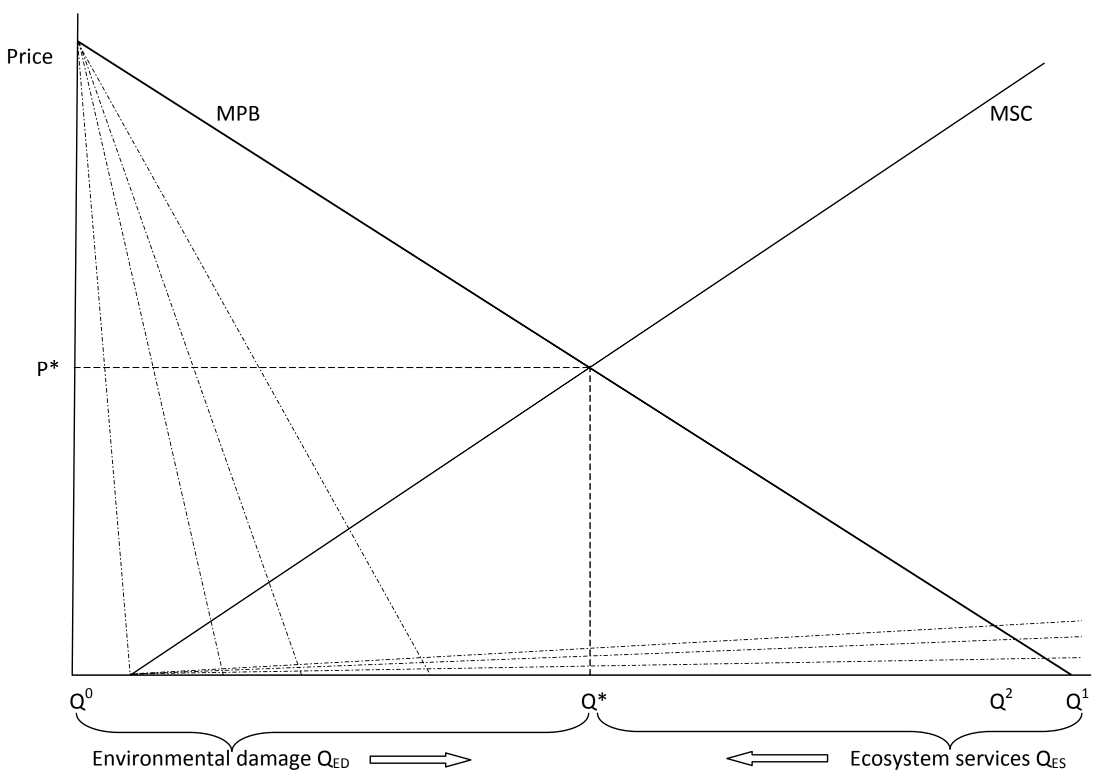

Figure 2. Framework for evaluating market potential for "polluters" versus "users" of ecosystem services.

extraction or pollution. The upward-sloping marginal social cost curve (MSC) represents the costs associated with a loss of ecosystem services as Q_{ED} increases. This MSC is suffered by consumers as ecosystem services are degraded or damaged. In this generalized framework, the optimum is where MPB=MSC. At this point, environmental damage is Q^*, corresponding to a level of ecosystem services of $Q_{ES}=Q_1-Q^*$.

According to Coase, property rights could be assigned either to the polluter (so that bargaining would begin at Q^1) or to those who consume ecosystem services (so that bargaining would begin at Q^0). In a world with zero transaction costs and costless bargaining, an efficient allocation (Q^*) could be achieved via bargaining from either starting point.

In nearly all realistic settings, however, transaction costs are so high that bargaining to Q^* will not occur, and the situation will remain at its starting point, either Q^0 or Q^1. Furthermore, because of the free-rider problem, individual actions on the left of Figure 1 are not self-regulating. Thus, damage to ecosystem services often is inefficiently high, and an efficient market will not emerge independently. In these cases, government intervention of some kind may be warranted, such as regulation or limitations on commercial fishing or landowners' property rights.

In the real world, the relative balance between rights of polluters and rights of pollutees varies in different circumstances. The first possibility is *open access*, where no property rights have been assigned or enforced for either the polluter or user (pollutee). Open access also means that no government regulations or other mechanisms exist to reduce the level of environmental harm (Q_{ED}) or to enhance the supply of ecosystem services (Q_{ES}). In this case, the polluter is under no requirement to reduce pollution, so we expect ecosystem services to be undersupplied (pollution at Q^1). A variation on this situation is one in which the public's right to undamaged or undiminished ecosystem services is recognized but is neither monitored nor enforced in specific cases. This situation will also lead to Q^1 as the level of environmental damage.

The second possibility is a property right orientation favoring the polluter. In this case, we also expect an outcome of Q^1, since polluters have no incentive to reduce damages to ecosystem services.

The third possibility is one in which users of ecosystem services have a right to undamaged or undiminished ecosystem services. If this situation occurs in a world with high transaction costs, and if these property rights are monitored and effectively enforced by government, then we expect the outcome to be an absence of pollution, or Q^0 in Figure 2.

Each of these alternatives has implications for the range of possible policy tools, and they imply different entitlements or endowments of rights among groups. These alternative implicit or explicit entitlements lead to differences in the direction of potential compensation (for example, see Bromley 2009).

Alternative approaches for enhancing supply of ecosystem services

If we assume that ecosystem services are currently undersupplied ($Q_{ES}<Q^*$), how can their supply be increased? Traditionally, governments have used regulatory approaches to limit pollution of air and water or to restrict certain land uses. These regulatory or "command-and-control" approaches may have advantages, but they can also be costly due to their "one-size-fits all" design.

In contrast, incentive or market-based approaches have been promoted as a way to achieve desired environmental goals with more flexibility, and thus frequently at a much lower cost. Below we explore three variations on the market-based idea that are relevant to the debate surrounding MES: voluntary actions, market mechanisms (regulatory markets and MES), and publicly funded payments for ecosystem services.

Voluntary actions

Even where there is no incentive to reduce damage to ecosystem services, we sometimes see voluntary actions to improve the environment. In some cases, individuals, despite the lack of significant direct benefits, choose to act individually to increase ecosystem services.

These voluntary acts include donations to charitable organizations, environmentally responsible behaviors and consumer preferences, voluntarily provided public goods, "green markets," and actions characterized as "corporate responsibility." They can develop in situations where government policies for environmental protection are believed to be too weak. Internationally, we observe this kind of volunteerism when users residing in one country cannot influence government action to protect ecosystem services in another country—especially with respect to protecting biodiversity in poor countries.

Voluntary actions, however, tend to be limited in scope and can be expected to have only a small effect, perhaps moving from Q^1 to Q^2 in Figure 2. Anecdotal evidence must be interpreted with caution, given the complicating effects that government involvement may have on volunteerism. Typically, the incentive to free ride is greater than the impulse to take voluntary action. As in the case of national security, individual benefits from ecosystem services tend to be very small relative to social benefits. In this situation, voluntary actions and charitable contributions are an inadequate way to achieve an efficient supply of a public good.

Indeed, efforts to promote volunteerism have achieved only small improvements. In an analysis of seven major programs of this kind in the U.S., Europe, and Japan, Morgenstern and Pizer (2007) concluded that voluntary programs have a real but limited quantitative effect, typically on the order of 5 percent.

An environmental example is The Freshwater Trust, a successful NGO in Oregon that buys or leases water rights, mostly from farmers, to enhance and protect in-stream ecosystem services. Relying primarily on donations and grants, The Freshwater Trust spends on average more than $300,000 annually to augment in-stream flows with about 30,000 acre-feet of water. However, this amount represents less that 0.5 percent of in-stream water needs in Oregon, according to the Oregon Water Resources Department.

Nevertheless, voluntary actions can be significant in some cases. For example, donations remain a major source of funding for public radio in the U.S. Nevertheless, public radio also represents an excellent opportunity for free riding. Indeed, only about 10 percent of listeners typically become paying members (Brunner 1998).

The level and contribution of these voluntary acts are sensitive to changes in information, government policies, and technology, as well as other factors (Kotchen 2006, 2009). In some cases, voluntary actions may supplement government actions. In others, however, government actions may lead to reductions in voluntary provision of public goods or participation in green markets. In general, although voluntary actions can serve an important role in many cases, they are unlikely to achieve an optimal level of ecosystem services.

Market mechanisms

Returning to the Coasian framework described above, recall that in many cases there are two possible starting points from which government might consider introducing an environmental market. In the first, the polluter would have to pay to pollute, damage, or extract environmental resources.[1] In the second, the user or "pollutee" would have to pay to consume or use ecosystem services. These two alternatives correspond to the reciprocal nature of externalities first recognized by Coase.

Regulatory markets

Consider the possibility of a market for the private rights corresponding to environmental harms on the left side of Figure 1. The benefits of these actions accrue to individuals. The actions can be monitored and

[1]In the case of a "polluter pays" property rights orientation, whether polluters collectively actually pay government for these rights depends on how the rights or permits are initially allocated.

limits enforced. The demand for these rights, Q_{ED}, represents the sum of individuals' willingness-to-pay curves (shown in Figure 2 as dotted lines). Added together, they produce MPB. This "damage" side of Figure 1 is conducive to private rights that could be traded in markets. The right to emit carbon or SO_2, to catch fish, to fill in a wetland, or to cut trees are examples.

These individual property rights can be created in limited quantity by government and then traded among polluters or extractors in a market. We will refer to these types of market mechanisms as *regulatory markets* because they require government to limit "supply" by imposing and enforcing a limit on the level of pollution, environmental degradation, or resource extraction.

This is the mechanism used in cap-and-trade programs. In these cases, government creates scarcity of supply by setting an upper limit on the total allowed pollution or resource extraction. Within that limit, firms buy and sell pollution or extraction rights, depending on how much those rights are worth to them.

In an open access situation, or where pollutee rights to ecosystem services are unenforced, the initial condition will be a level of damage something like Q^2 in Figure 2. Government can establish an upper bound on the total allowed level of damage at Q*, thus creating scarcity of supply. Individuals may purchase (or sell) rights to pollute, resulting in a market among potential polluters. In a competitive market, we expect an equilibrium price (P*) for the fixed supply of Q* rights, with each polluter purchasing rights based on his or her willingness to pay. By reducing Q^2 to Q* efficiently, such a market can achieve an optimal level of ecosystem services at minimum cost.

Note, however, that these markets all involve limiting actions on the left side of Figure 1 as a way to indirectly enhance the ecosystem services on the right side of Figure 1. None creates a market in which ecosystem services are directly bought and sold.

In some cases, an environmental market of this kind encompasses actions that offset or mitigate environmental harms. For example, carbon emissions can be counteracted by planting additional trees to sequester carbon, wetland destruction can be mitigated by creating new wetlands elsewhere, and wastewater effluent that increases in-stream temperature can be offset by planting shade trees along a river. To the extent that these forms of "negative damage" or "negative pollution" represent low-cost ways to achieve the desired level of ecosystem services, expanding market mechanisms to include them can lower the overall cost of achieving Q*.[2]

It is important to recognize, however, that the demand for mitigation or offsets in a market of this kind arises only because of the limited supply of rights to damage the environment imposed by government policy (e.g., limits on carbon emissions create the demand for offsets in the form of carbon sequestration). By allowing mitigation and offsets to "count" toward limiting the net level of damage, they become part of that market. They do not, however, represent markets for ecosystem services. Rather, they are indirect mechanisms to achieve compliance with a "polluter-pays" limit on environmental damages.

In several cases, regulatory markets have successfully and efficiently limited degradation of ecosystem services. Examples include SO_2 trading in the U.S., catch-shares in marine fisheries, water markets, and water quality trading. These successes provide a wealth of insights and lessons. For example, an evaluation of water market programs in the U.S., Australia, Chile, China, and South Africa (Grafton et al. 2010) focused on the conditions required for water markets to contribute to integrated water resource management. Satisfactory institutional underpinnings were seen as a necessary precondition. With that condition satisfied, efficiency was found to depend on the size of the market, the gains from trade, and the capacity of water storage. Additional factors include the nature of water rights, the quality of legal title to those rights, the breadth of the market, the stability of price formation, and the availability of price information. Similar criteria have been identified in studies of pollution trading and fishery catch-shares (Colby 2000, Tietenberg 2003). These and other evaluations of environmental markets stress the importance of clearly establishing initial allocation rights and limits, rules governing transferability, and procedures for monitoring and enforcement.

Markets for ecosystem services (MES)

Now consider a market corresponding to Coase's alternative property rights orientation, a market for Q_{ES}, where demand would come from ecosystem service users. This is the orientation assumed to underlie many recent efforts to promote MES programs. Rather than a market for the right to pollute, this market would involve buying and selling the right to consume ecosystem services—to enjoy clean air, flood control, scenic landscapes, water infiltration, or biodiversity.

This situation is not at all like the pollution permit example, however. Two key characteristics of ecosystem services create a very different situation. First, they are *nonrival*, i.e., their benefits can be enjoyed by

[2]When pollution or extraction activities create more than one type of damage, either across locations or over time, the design of environmental markets becomes more complicated. This problem also applies to offset and mitigation.

many individuals without reducing their availability to others. Second, in many cases, they are also *nonexcludable*, i.e., individuals cannot be excluded from "consuming" them.[3] Take, for example, the case of clean air. One individual's breathing does not significantly diminish the availability of clean air for others. Nor can government prevent individuals from breathing or charge a fee to do so.

The nonrival, nonexcludable nature of ecosystem services creates several problems for a market. First and foremost, government can't create scarcity or generate market demand for ecosystem services because individuals cannot be forced to purchase a right to consume them. Nor can they be denied access if they do not pay (except, of course, through generalized taxation of the public). Thus, individual marginal cost or willingness-to-pay curves (shown in Figure 2 as dotted lines) are aggregated vertically to produce MSC. Thus, relying on a market to allocate these public goods can be expected to fall victim to the free-rider problem and acute undersupply of the public good.[4]

This distinction between polluter-pays and user-pays scenarios stems from the distinction made earlier between the consumption of environmental public goods and the private actions that damage or degrade these public goods. Private actions are not only rival goods and services, but are also excludable (they can be limited by government controls). Conversely, environmental public goods are nonrival and nonexcludable, so free riding is likely to result in severe undersupply.

Thus, aside from a limited number of exceptions, markets for ecosystem services are unlikely to achieve an allocation that comes close to efficiency. The only apparent way that government can create demand for ecosystem services is through a publicly funded payments for ecosystem services program, as discussed on pages 13–19.

It is important to note that there are exceptions to the general conclusion that markets for ecosystem services cannot achieve desired outcomes, but they are rare.

For example, private firms sometimes find it in their interest to protect ecosystem services. Examples include ecotourism companies, hunting ranches, fishing clubs, and bioprospecting by pharmaceutical firms. These examples represent situations in which some aspects of these

[3]Examples of ecosystem services for which excludability makes some level of market activity possible include ecotourism, game parks, or other privately controlled resources such as artesian springs, lakes, etc.

[4]The public good aspect of ecosystem services has been noted elsewhere (e.g., Salzman 2005, Ribaudo et al. 2008, Murtough et al. 2002). However, the obstacle that public goods present for MES has not been fully recognized. Ribaudo et al., for example, formulate a list of ways to overcome barriers to market development, including reducing uncertainty and better market design, but these measures do nothing to alter the essential public goods problem.

public goods are excludable to some degree. However, in the case of bioprospecting, Simpson et al. (1996) concluded that potential pharmaceutical uses add very little value to a given acre of tropical forest. Thus, these private interests are likely to have a negligible effect on the protection of tropical forests and biodiversity.[5] Ecotourism can provide incentives to protect some of a forest's use value, but not its non-use value.[6]

One additional exception to these general observations is noteworthy. In rare cases, one or a very small number of users may control an ecosystem service. In this case, the free-rider problem typical of public goods may be surmounted. For example, in the 1980s, the French mineral water company Vittel (now part of Nestlé) saw its natural springs becoming contaminated by nearby agricultural practices. Vittel responded by buying some of the surrounding agricultural lands and by entering into contractual agreements with other nearby farmers, paying them to alter their agricultural practices in order to reduce contamination of the aquifer (Perrot-Maître 2006). This excellent example, however, represents a rare case in which an ecosystem service is consumed by one enterprise that has the ability to bargain (in a Coasian sense) with a small number of individuals whose actions are degrading that service.

Aside from private exceptions of this kind, there appear to be no documented cases of successful MES programs.

Publicly funded payments for ecosystem services (PES)

In recent years, interest has grown in publicly funded payments for ecosystem services (PES). Internationally, there are many examples of payments from high-income countries to low-income countries as a way to limit destruction of tropical forests (Antle and Stoorvogel 2008, Horan et al. 2008, Wunder 2008, Pattanayak et al. 2010). PES programs seem especially attractive in developing countries, where poverty alleviation is one of several motivating factors (see, for example, Corbera et al. 2009, Lipper et al. 2009, Bulte et al. 2008).

In light of the fact that MES proposals are unlikely to generate an optimal supply of ecosystem services, supporters of MES have also become interested in PES as a potential way to protect ecosystem

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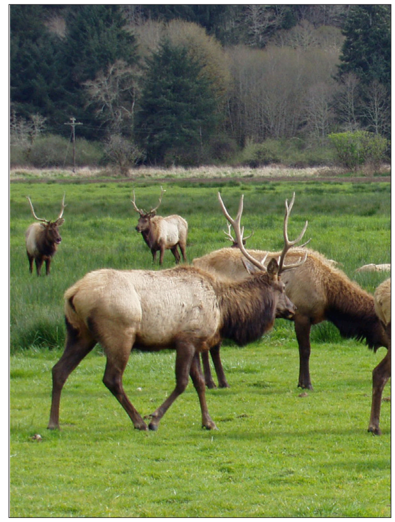
[5]These kinds of voluntary provision of public goods are noteworthy. It is important to recognize, however, that they are likely to arise in an open access or other baseline situation where ecosystem services are undersupplied, rather than in response to advocacy of markets for ecosystem services.

[6]Ribaudo et al. (2008) examined five case studies described as attempts to develop markets for environmental services. None of these represents an example of MES, however. Two are pollution markets (water quality trading and carbon emissions), one is mitigation (wetlands), one is for recreational value (hunting on private lands), and the last is volunteerism (ecolabeling).

services in the U.S. In contrast to a competitive market, a PES program likely would be a *monopsony*, or single-buyer market, with a government agency or other organization as the source of demand. For this and other reasons, PES approaches may be vulnerable to a number of sources of inefficiency. Several of these concerns are discussed here.



Additionality: an unobserved baseline

Under PES, governments typically pay for reductions in environmental harm. The baseline against which improvement is measured, however, is unobservable. Payments are based on the difference between (a) an observed level of pollution or damage, and (b) an unobservable baseline representing the level of pollution or damage that would have occurred in the absence of such payments.

Uncertainty about the baseline raises questions about the *additionality* of actions for which payments are made. In other words, would the action have happened anyway? If the answer is yes, the action is not "additional," i.e., the payment was unnecessary.

It can be difficult or impossible to know what individuals would do if payments were not offered. For example, if a payment is made to prevent cutting a stand of forest, we don't know whether the landowner would have cut the stand had the payment not been made. A program that pays for nonadditional protections represents (a) no gain in ecosystem services, (b) a program with low cost effectiveness, and (c) potentially large transfers of scarce public funds.

Several statistical analyses of PES case studies have been based on satellite images of changes in forest cover in numerous countries. None has found significant evidence that PES programs have slowed deforestation, in large part because the lands at high risk of deforestation were not covered by the programs (Blackman and Woodward 2010, Pattanayak et al. 2010). Indeed, recent analysis of Costa Rica's well-known PES program ("Pago por Servicios Ambientales," or PSA) estimated that less than 1 percent of lands enrolled in the payment program would have been deforested annually had there been no payments (Pfaff et al. 2008, Robalino et al. 2008).

In some cases, prospective "sellers" may act in ways that produce a stated baseline that represents more environmental harm than would actually occur without payments. For example, landowners might harvest forested lands in order to attract future payments for replanting. Or they might exhibit less care toward conservation or wildfire prevention if PES holds the promise of payments to restore degraded lands.

Leakage

Leakage—or indirect effects—is another problem. In the case of carbon sequestration, for example, leakage occurs when the decision to avoid deforestation in one location induces increased deforestation elsewhere, primarily due to price effects.

For the U.S. Conservation Reserve Program (CRP), which pays farmers to leave acreage unplanted, these effects are referred to as *slippage* and occur via two mechanisms. First, the farm-household receiving CRP payments may bring other land into production to replace the fallowed land. Second, if reduced production results in crop price increases, other farmers may bring additional land under cultivation. In an empirical study of this phenomenon, Wu (2000) suggested that for every 100 acres retired under the CRP program, 20 acres of noncropland were converted to cropland, offsetting 9 and 14 percent of the original reduction in water and wind erosion, respectively. Substitutions could also be induced via product, land, or labor markets.

In a PES program, price effects of this kind can lead not only to leakage, but also to increased taxpayer costs if they push product and land prices up. In the case of the CRP program, empirical estimates indicate increases in farmland prices of up to 14 percent in some regions (Wu and Lin 2010). These increases could feed back into the costs of future CRP contracts. In a study of the effects of creating Redwood National Park on the market for old-growth redwood lumber in 1968 and 1978, Berck and Bentley (1997) found that removal of these forests from the private timber supply raised the price of redwood lumber by 26 percent. With a PES approach, such price increases could result in increased program costs.

Nonmarket failures and public funds

A number of inefficiencies arise when PES or other programs use government funds to confer benefits on specific individuals or groups.

First, raising public funds to pay for the program via taxation is distortionary. Taxation often induces individuals or firms to change their behavior in order to reduce the amount of taxes they pay. By leading to behavior that is less than optimal in terms of productivity and resource allocation, the excess burden of taxation on the U.S. economy is estimated to range from $0.25 to $0.35 per dollar of revenue (Browning 1987). Thus, PES exacerbates the cost of environmental protection due to the excess burden of the additional taxes required. In contrast, specific environmental taxes can take advantage of a "double dividend"; revenues from taxes, fees, or auctioned marketable permits can be used to reduce the distortions of existing taxes (Jaeger 2011).

A second type of inefficiency is nonmarket failure (Wolf 1979). One example occurs when potential beneficiaries of a program lobby government to their own advantage. This type of activity is known as *rent seeking*. If individuals or groups can influence rule makers and/or the distribution of public funds in their favor, they can extract "rents" from the rest of society (Kreuger 1974, Rowley et al. 1988).

Three types of inefficiency can arise with rent seeking. First, resources are devoted to lobbying government rather than to productive activities. Second, interest groups may actually seek additional regulations if the expected benefits from such regulations exceed expected benefits in the absence of regulation (Runge 1992). Third, rent seeking and other political considerations may distort the distribution of payments in ways that address political objectives at the expense of environmental objectives. For example, Wu et al. (2003) demonstrated that in the case of stream habitat conservation, use of politically palatable allocation criteria may lead to the lowest possible benefits to society.[7]

A number of these problems are evident in the largest PES-type program in the U.S., the CRP program. The U.S. General Accounting Office has concluded that the CRP program "is an expensive way to reduce the environmental problems linked to agricultural production" (U.S. GAO 1992). In one analysis, it was estimated that the government paid between 70 and 100 percent more than necessary to retire 34 million acres of farmland under the program (Smith 1995).

Long-term issues

Two concerns raised by a PES approach may have long-term implications. The first is the likelihood that the costs of PES programs will rise over time in an economy with growing income and population. The second is the possibility that PES programs could alter public perceptions about landowner entitlements, making it more costly to protect the environment in the future.

In a growing economy, the output of goods and services increases due to productivity growth and population growth. Conversely, the planet's endowment of ecosystems is fixed. In most cases, an ecosystem's productivity at providing ecosystem services is also fixed. For these reasons, we expect the value (price) of ecosystem services to rise relative to the price of other goods and services (see Sterner and Persson 2008). This trend can be expected to raise the cost of ecosystem services and thus make PES programs more expensive over time.

[7]See also Salzman (2005) for a discussion of some of the challenges facing payments for ecosystem services programs.

The potential effect of population growth is illustrated in Figures 3 and 4. The left side of Figure 3 shows how an increase in population will add horizontally to the willingness to pay for the right to damage the environment. On the right side, we see how population growth will add vertically to the MSC (willingness to pay for ecosystem services). The optimal quantities and prices of ecosystem services are indicated at each population level. Note that the price increases as population increases.

In Figure 4, the payments (P•Q) required for a PES program to achieve this optimum are reflected by the shaded rectangle at each population

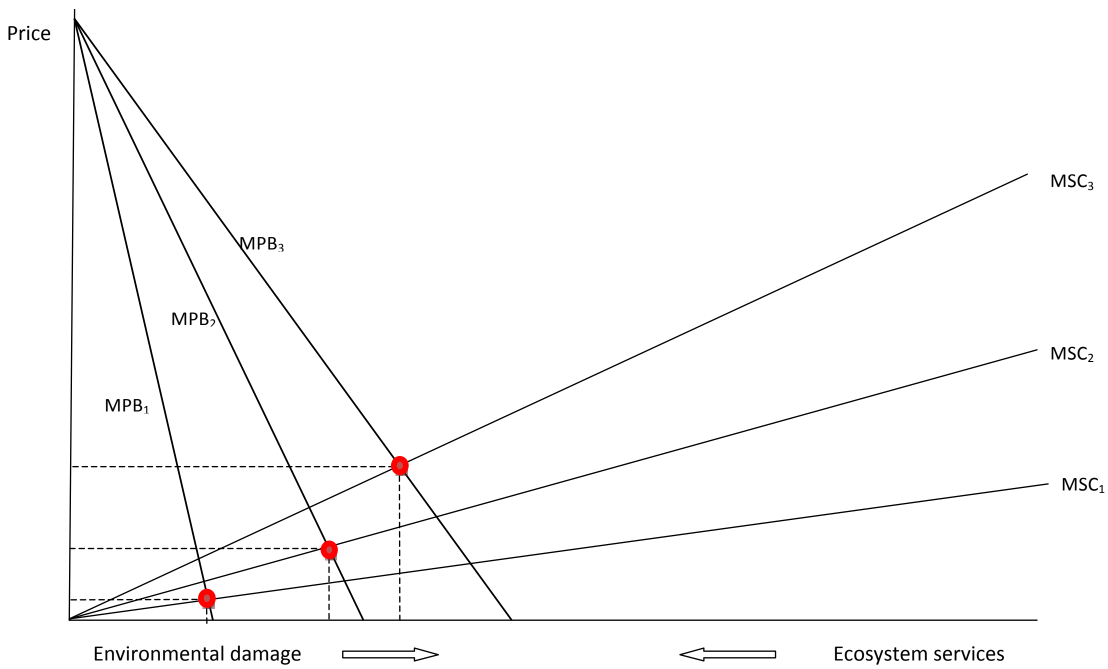


Figure 3. Population growth and the trajectory of optimal environmental allocations.

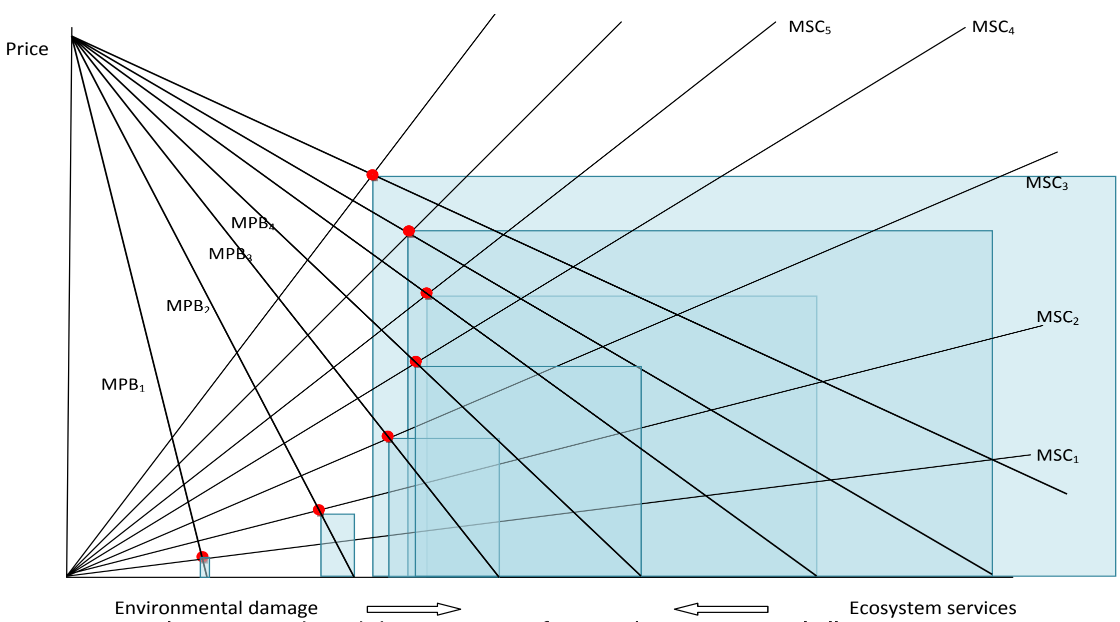


Figure 4. Population growth and the trajectory of optimal environmental allocations.

level. Note that the size of the shaded rectangle increases with increasing population.[8] The expectation of continuously rising costs reinforces the concern that it may be impossible to adequately fund such a program over the long term. Protecting ecosystem services in this way on a broad scale would eventually become fiscally infeasible.

To provide a sense of scale, Costanza et al. (1997) estimated that 17 of the world's ecosystem services were valued at $33 trillion per year in 1997, or nearly double the world's gross national product at that time. This $33 trillion estimate is controversial and should be interpreted with caution. Nonetheless, it does provide an order-of-magnitude indication of the value of the world's ecosystem services.

Specific examples provide additional evidence of the potential cost of PES programs. Protecting spotted owl habitat in the Pacific Northwest (6.9 million acres at a value of $117 billion) would cost about $5 billion annually to pay landowners for delayed harvests. The cost of reducing greenhouse gas emissions by half in the U.S. is estimated at $10 per ton, or $73 billion annually.

The second potential long-term effect of PES programs is their effect on public perceptions about entitlements and property rights. Payments are likely to be interpreted as an acknowledgment of landowners' rights and the necessity of a "user-pays" approach to conservation. The more PES programs are established, the more likely their implicit property rights orientation will become publicly accepted over time.

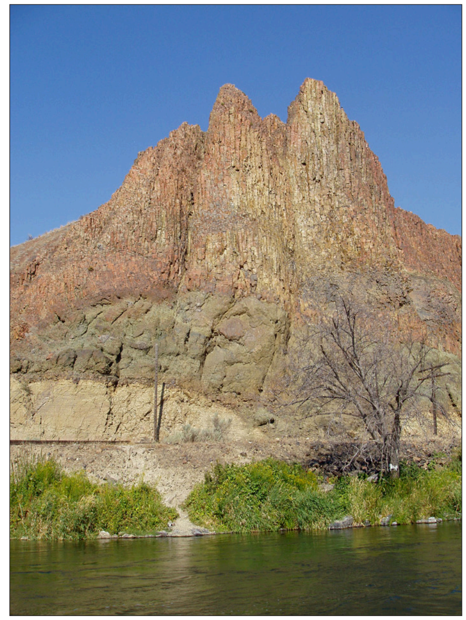
Public perceptions, in turn, are likely to affect politics and the courts (Freyfogle 2007). To the extent that PES programs reinforce the claims of *presumptive property rights* by landowners, they could erode the current state of property laws, which favor protecting the public's interests (see pages 20–22). As discussed below, such a trajectory could limit the tools at the government's disposal to protect the environment.

Exceptions

PES may have advantages over regulatory approaches in some situations. These cases may include transboundary and international situations, where consumers of ecosystem services are outside the jurisdiction of those whose actions damage the environment. In such cases, international treaties and bilateral payments may occur, with negotiations carried out by nongovernmental or government-sponsored international organizations. Indeed, these situations may be the best observable illustrations of Coase's bargaining solution. International examples also provide a way to overcome the free-rider problem: government can coordinate individuals' "willingness to pay" into

[8]In the case described, we see an increase and then a decrease in the optimal level of pollution, consistent with the Environmental Kuznets Curve (see Jaeger and Kolpin 2009).

collective demand so that government-to-government or government-to-private PES transactions can occur across international borders.



A second type of exception may be situations where equity considerations provide a strong argument for transfers of income to low-income groups. Although landowners are not typically among the poor in the U.S. or other high-income countries, this may not be the case in some developing countries where landowners (or land occupiers and users) may be poor.

In other cases, there may be public acceptance regarding a particular right of landowners or other resource users, or an equivalent political calculation that leaves policymakers with PES as the best option. Government payment programs to permanently "buy out" commercial fishermen represent one example in the U.S. New land use regulations are sometimes coupled with tax incentives to partially compensate landowners. Decisions to deny farmers their customary irrigation water have sometimes resulted in compensatory government payments, even in places (such as Oregon) where water rights are ultimately held by the state.

In one example in the western U.S, ranchers have recently been compensated when reintroduced wolves kill livestock. However, when coyotes kill livestock, no compensation is paid or expected. The distinction seems to be a perception that the coyote "externality" has always existed, whereas the risk caused by wolves is viewed as newly created by government policies (even though wolves were historically present).

Finally, PES may be preferable to regulation where regulation may create perverse incentives that exacerbate environmental harm. Consider, for example, a situation in which the presence of an endangered species triggers severe restrictions on land use. Landowners may undertake "preemptive" habitat destruction in order to avoid this risk (see Brown and Shogren 1998, Lueck and Michael 2003). In fact, they may be willing to incur significant costs to develop land or harvest timber prematurely as a risk-reducing strategy. Moreover, landowners may be unwilling to share information about habitat characteristics or the presence of species on their land, thus creating obstacles to good science and informed policymaking (Polasky and Doremus 1998).

Legal rights related to ecosystem services

The prospect of both MES and PES raises questions about property rights. What are the rights of landowners to curtail or interfere with ecosystem services as a result of their use of their own land? If landowners have the right to damage or degrade ecosystems, are they entitled to compensation for reducing or eliminating environmental harm?

In the U.S., those who advocate on behalf of developers and other landowners often argue that landowners possess absolute or intrinsic rights to do whatever they want with their land. Members of property rights movements argue that landowners' rights are primary or absolute. In this view, any restraint imposed on landowners' actions amounts to an infringement on those rights and thus is compensable. These arguments are sometimes based on the claim that private property exists primarily to protect individual liberty, a view held by John Locke, who stated that the more we protect property the more we protect liberty (see Freyfogle 2007, Bromley 2000).

Legal scholars and evidence from key U.S. court decisions, however, present a different picture of the origins and limits of landowners' rights. Ownership in general—whether for land or for other kinds of property—is understood to convey a "bundle of rights" that is limited. Drawing on the writings of David Hume, this view sees private property not as an intrinsic right but as a product of law and in the greater public interest. In other words, private property helps us collectively (see, for example, Freyfogle 2007).

In this view, property law evolves over time to reflect society's evolving judgment about the best way to serve society's collective interest. Indeed, the rights associated with ownership have evolved over time. For example, in the 1860s, the public had the right of trespass on private land, except for fenced areas or when interfering with what landowners were doing.

Several landmark cases suggest that governments have broad powers to regulate landowners' activities in the public interest. In the 1926 Supreme Court zoning case *Euclid v. Ambler Realty*, the Court gave zoning officials extraordinarily broad powers to regulate in the public interest (Freyfogle 2007). In a significant case in Washington State, the State Supreme Court ruled in 1949 against the Dexter family, who claimed the right to harvest timber on their land as they saw fit and thus without a permit from the state forester. The Court ruled that their property right under state law entitled them only to land uses that were not injurious to "the rights of the community"(*Washington v. Dexter*, 1949). The Court's ruling suggests that the Dexters' property rights were derived directly or indirectly from government and were inherently "held subject to those general regulations, which are necessary to the common good and general welfare" (*Washington v. Dexter*, 1949, cited in Freyfogle 2007).

Although these overarching questions about the purpose of property rights are fundamental to any discussion of landowner rights, much of that discussion has focused more narrowly on the "takings" clause of the fifth amendment of the U.S. Constitution. This clause requires compensation to landowners when government "takes" property to benefit the public good. It often is cited in relation to zoning, land use, and environmental regulations. Given the ambiguities in the takings clause itself, the courts have struggled to interpret it consistently (Callies 2000, Bromley 2000).

Although the courts have generally upheld the right of government to regulate land use, the application of the takings clause represents a special case and is frequently seen as the basis for disputing government restrictions. Key Supreme Court cases suggest, however, that the invocation of the takings clause should occur only when the entire value of a property is taken (leaving nothing of value for the landowner). For example, in *Lucas v. the South Carolina Coastal Council* (1992), the court found that changes in zoning laws rendered Lucas' two lots essentially worthless by prohibiting building on a coastal barrier island (Freyfogle 2007). As a result, the court required compensation to be paid to Lucas. Despite this apparent victory for landowners, the impact of the Lucas ruling on other takings challenges has been limited, since land use regulations rarely leave landowners with no economic value.[9]

Consistent with the court's interpretation in the Lucas case, the Supreme Court ruled in *Palazzolo v. Rhode Island* that no compensation was required. In that case, Palazzolo complained that new regulations to protect wetlands restricted development on 18 of his 20 acres of land. The Court ruled, however, that protecting wetlands was in society's interest, and that since Palazzolo could still build on 2 of his 20 acres, a Constitutional taking had not occurred (Freyfogle 2007).

Although the general guidance on regulatory takings from the Supreme Court is reasonably clear, these rules have been applied with some variation at the state and local levels. In a review of regulatory takings jurisprudence and recent U.S. Supreme Court decisions, David Callies (2000) found that the proper and consistent application of U.S. takings laws implies the following guidelines: (1) a taking of all economically beneficial use of private property requires compensation, and (2) the need for compensation in "partial takings" cases depends on the nature of the government interest in enacting a particular regulation, on the

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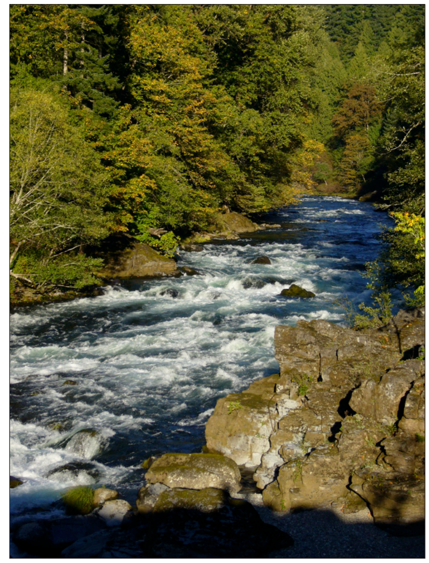
[9]Indeed, following the conclusion of the Lucas case and payments to him by the state, Lucas sold his lots to neighboring property owners for several hundred thousand dollars (as a way to expand their yards and ensure no future development), so the "zero value" assumption by the court was incorrect even in this case (Freyfogle 2007).

economic effect on the landowner, and on the landowner's reasonable and legitimate expectations based on what the landowner knew, or should have known, at the time of purchase (Callies 2000).



Callies also concluded that government conditions attached to the right to develop land (i.e., conditions accompanying a building permit) must pass a three-part test: (1) Does the condition promote a legitimate state interest? (2) Does an essential connection exist between the state interest and the permit condition? (3) Are the demands placed on the developer by the conditions proportional to the projected impact of the development? (Callies 2000).

In sum, legal history and U.S. jurisprudence indicate that there is no legal basis for the claim that landowners have absolute rights, or that these rights include the right to damage or degrade ecosystem services that emanate from their lands. To the extent that those ecosystem services constitute a public interest and contribute to the common good, U.S. courts have frequently ruled that landowners do not have a right to cause such harm. Indeed, regulations reflecting this position are common in both urban and rural areas of the U.S., e.g., residential and urban zoning rules, open space and farmland protections, and controls on draining wetlands or obstructing views.

Discussion

The range of options available for ensuring the efficient and sustainable provision of ecosystem services is much broader when property rights reflect the public's interest. Both command-and-control regulations and regulatory markets are based on a property rights orientation that sees landowner rights as limited by the rights of the broader public. These kinds of market-based mechanisms have demonstrated their efficiency at limiting environmental damage, thereby preserving ecosystem services.

In contrast, programs promoting markets for ecosystem services imply a property rights orientation based on landowners' having absolute rights. Because of the nature of ecosystem services as public goods, market demand will be limited by the free-rider problem, so that markets are unlikely to achieve adequate supply of these services. The assumption that landowners have the right to do whatever they want with their property then leaves only two options: voluntary actions and PES. Neither of these options can be expected to achieve cost-effective environmental protection. Voluntary approaches typically generate less than 10 percent of the desired level of funding, and multiple sources of inefficiency have plagued attempts at PES schemes.

The critical issue is the implied reversal in property rights away from the public interest (polluter pays) and toward the right of private interests

Table 2. Policy tools available for protecting ecosystem services under alternative property rights.

Policy tools	Rights held by the public (polluter pays)	Private rights (user pays)
Regulatory command-and-control	Yes	No
Regulatory markets (tradable permits)	Yes	No
Offset markets	Yes	No
Direct markets for ecosystem services	Not feasible	Not feasible
Monopsony or government payments (PES)	Yes	Yes
Voluntary actions	Yes	Yes

to degrade the environment (user pays). Such a shift in property rights orientation represents not only a large transfer of wealth from the public to private landowners, but also greatly constrains the tools available for assuring the provision of ecosystem services at socially desired levels.

Much of the recent advocacy of MES by NGOs and some government agencies has overlooked these implications of promoting MES. Given the significance of such a profound shift in property rights orientation, discussions of MES should explicitly address this issue, rather than leaving it as an unacknowledged by-product of promoting MES.[10]

Indeed, it is surprising that some environmental organizations are advocating MES approaches. This advocacy is in sharp contrast to the polluter-pays stand taken by environmental groups toward landowner compensation in the 1990s, when the Sierra Club viewed takings compensation proposals as "an overt and calculated attack on the environment" and "an assault on the guiding principle of virtually all laws governing air, water, and waste disposal"(Braile 1994, Clifford 1994). Glenn Sugameli (1997) of the National Wildlife Federation argued that paying compensation to landowners for environmental restrictions would "impose massive costs on taxpayers" and "cause an inability to enforce protections for people, private property, and public resources."

Table 2 compares the menu of policy options available when ecosystem services property rights are held by the public or by private individuals. A far wider range of options is possible with public-interest property rights. A private property rights approach eliminates most of the promising options and leaves only options with major shortcomings: voluntary actions, which can only play a minor secondary role, and PES

[10]It is noteworthy that Ecuador's recently adopted constitution signals a shift in the other direction by explicitly giving nature "the right to exist, persist, maintain and regenerate its vital cycles, structure, functions and its processes in evolution."

schemes, where the empirical evidence suggests limited effectiveness and high cost.

As seen in Table 3, the options available under a "polluter pays" approach include those with greater potential for efficiency and long-term sustainability. The comparison in Table 3 makes a strong case for maintaining a public-interest orientation of property rights, except in cases where circumstances warrant otherwise. These circumstances include:

- Where explicit property rights or national sovereignty have been established. This situation includes international cases, especially when the public in a high-income country collectively offers payments to low-income countries in order to protect globally valuable ecosystems. It also includes domestic cases in which property rights favoring landowners have been clearly established by courts or legislatures.
- Where equity considerations provide a strong argument for an approach that results in transfers of income to low-income groups. Although landowners are not typically among the poor in the U.S. or other high-income countries, this is not the case in many developing countries, where landowners (or land occupiers and users) may be poor.

Table 3. Characteristics of policy tools available for protecting "public good" ecosystem services under alternative property rights.

	Rights held by the public (polluter pays)	Private rights (user pays)
Efficiency		
Potential regulatory market efficiency	High	Not applicable
Potential for effective direct demand	Very low	Very low
Monitoring and enforcement costs	Yes	Yes
Potential inefficiencies from leakage	Depends on scope of regulatory market	Likely to be high
Potential inefficiencies from lack of "additionality"	No	Yes
Outcomes		
Enforceable levels of ecosystem services processes	Yes	No
Public funds requirements	Not significant	Potentially very high
Outcome dependent on sustained funding	No	Yes
Possible perverse incentives	Yes (preemptive harvest)	Yes (additionality)

It is important to clearly distinguish between special circumstances where a private rights or "user pays" approach may be warranted and other incentive-based situations we observe. These special circumstances are *not* reflected in the following:

- They do *not* represent regulatory markets such as SO_2 trading, fishery catch-shares, or water quality trading. These markets are created when government imposes a limit on ecosystem damage and allows polluters or resource users to trade rights to those damages.
- They are *not* examples of offsets, which are a variant of regulatory markets. These expanded markets not only control actions that damage ecosystem services, but also include actions that improve or augment the provision of ecosystem services (e.g., carbon sequestration, shading streams to improve water temperature).
- They are *not* voluntary donations, such as those practiced by groups such as The Nature Conservancy. Voluntary actions can occur under either property rights orientation.
- They do *not* represent exceptional circumstances where a single (or very few) ecosystem services user is able to overcome the free-rider problem and become a monopsony. As in the case with Vittel mineral water, such a single user can buy ecosystem services from all relevant providers.

Some advocates of MES/PES view these tools as ways to raise the incomes of farm and forestland owners, create jobs, and revitalize rural communities. PES programs, however, are generally not likely to have those effects. Government transfers that require landowners to refrain from harming the environment are unlikely to create jobs because they cause landowners to do less rather than more. If land is idled by PES, some landowners' incomes might increase, but the number of absentee landowners might also increase. Indeed, PES proposals to return irrigation water to in-stream use have been vigorously opposed by agricultural groups, who fear the accelerated demise of their communities.

Only in cases where government programs involve paying to restore previously damaged ecosystems might we expect to see significant positive local-economy effects if these activities are labor intensive (e.g., restoration of riparian zones or eroded beaches, enhancing streams with woody debris).

For these reasons, it seems prudent to begin environmental policy discussions by recognizing the effect of society's overall property rights orientation on the set of potential policy tools. Legal rulings in the U.S. have given government broad authority to intervene when landowners' actions harm the public's interest. That general legal background is conducive to a "polluter pays" framework (even where permits are given away) and to the possibility of using markets for rights to damage the environment as a way to achieve environmental goals cost effectively.

Conclusions

Based on these observations, we can draw the following conclusions.

- For those critical ecosystem services that are public goods, there is little evidence that direct market mechanisms (MES) can achieve desired levels of supply or that they will provide efficiency gains over alternatives such as regulation. Because individuals cannot be forced to pay to use these services, there is no practical way to create a market for them beyond the very low levels achievable by voluntary donations. Exceptions include monopsony examples such as Vittel mineral water or government-coordinated payments in international situations.
- Governments or NGOs could choose to pay for ecosystem services (PES). However, this approach has serious shortcomings, and the empirical evidence raises serious questions about its effectiveness, efficiency, and sustainability. PES programs are based on an unobserved baseline, so they may lead to unnecessary and costly payments for actions that would have happened anyway. Such programs are also subject to leakage, whereby environmental protection in one place may lead to additional degradation elsewhere. Furthermore, the transfer of public funds to certain individuals or groups may encourage the use of private resources for unproductive activities such as lobbying. By relying on public funds, PES programs are likely to increase social costs through increased taxation. Finally, these kinds of programs may become prohibitively expensive over the long term.
- Proponents of MES and PES approaches appear to have overlooked their profound implications with regards to property rights. Both approaches imply a shift in property rights, away from the assumption that private property rights are limited by the needs of society and toward a view that landowners have an absolute right to do whatever they want with their land. Such a shift would severely limit the range of policy options available to government for environmental protection. It would eliminate those options that, in most cases, have the potential for achieving society's environmental goals in a low-cost, sustainable way.
- Given these comparisons, a property rights orientation in favor of the public's interest has significant advantages in most situations. It would allow the use of markets based on a polluter-pays approach. These markets, such as the U.S. SO_2 emissions market, involve government-imposed limits on private actions that damage the ability of ecosystems to provide ecosystem services. Government can then create a regulatory market in which individuals and firms buy and sell rights to extract resources or pollute. The evidence suggests that these tools can lower the overall cost of compliance through market exchanges and offsets among polluters. By protecting ecosystem processes, ecosystem services are thereby indirectly protected.

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