Applying Global Experience for People-Oriented Results

Ecosystem Services:

What Do We Know and Where Should We Go?

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Key Concepts of This Paper

- **The concept of ecosystem services, its history, and its definition**
- **The relationship between biodiversity and ecosystem services**
- **The development of mechanisms and incentives for conserving ecosystem services**

A more focused definition of ecosystem services may help us properly appreciate their unique characteristics and the special challenges of conserving them. This clarity is a prerequisite for the development of appropriate, practical approaches and mechanisms for institutionalizing and financing their conservation.

Introduction

Interest in ecosystem services is growing rapidly, and development donors, government agencies, and conservation organizations are jumping on the "bandwagon." This concept has the potential to contribute something new to sustainable economic development and to the conservation of nature and biodiversity across multiple-use landscapes. But, along with the dramatic rise in interest, there is considerable confusion about the concept of ecosystem services. There is real danger that this confusion could lead to inflated expectations and disillusionment before this promising concept can develop to its full potential.

Lack of a clear and focused definition of ecosystem services will impede development of effective incentives and mechanisms for conserving them. Ecosystem services have ecological, economic, and governance characteristics that distinguish them from other types of benefits from nature, and we must pay attention to these special characteristics in order to develop practical mechanisms for their conservation.

Lack of conceptual clarity about the relationship between biodiversity and ecosystem services is also common. Some recent studies seem to treat biodiversity as a type of ecosystem service, rather than recognizing that it is the source of all ecosystem services,

Another concern is that one mechanism commonly proposed for conserving ecosystem services, "payments for environmental (or ecosystem) services," or PES, has itself become somewhat of a bandwagon concept. PES schemes are only one possible mechanism for financing the conservation of ecosystem services. Ecosystem services are valuable and need to be conserved somehow, whether or not the appropriate and effective means is a PES mechanism.

Payments mechanisms are being developed and tested mainly in cases involving watershed services and carbon sequestration — only two of the many possible ecosystem services that must be conserved. While such payment mechanisms have great promise to contribute to landscape-scale conservation and sustainable development, they also have limitations, and must be applied selectively and carefully.

Defining Ecosystem Services

Although the concept of ecosystem services is receiving increasing attention, it is not always clearly and carefully defined. In some recent cases, the phrase seems to be used almost as a synonym for "biodiversity" itself, or to refer to any and all types of goods, services, and other benefits that ecosystems provide to human societies.

Ecosystem services are the benefits to humans that result from ecosystem functions and processes, such as:

- Major biogeochemical and nutrient cycles (e.g., of water, carbon, nitrogen, phosphorus)
- Natural pest control by predators in food webs
- Pollination by insects, bats, and birds
- Decomposition of biomass, wastes, and pollution
- Soil formation, retention, and maintenance of soil fertility
- Climate regulation.

Ecosystem services are the benefits to humans resulting from ecosystem functions and processes.

This definition of the concept began with the 1970 Study of Critical Environmental Problems (SCEP), and its report, *Man's Impact on the Global Environment* (MIT Press, Cambridge, Mass.). The SCEP discussed environmental services that would decline if there were a "decline in ecosystem function." The definition of ecosystem services as the benefits to humans of ecosystem functions and processes was carried forward in many important publications for the next three decades (e.g., Ehrlich, Ehrlich, and Holdren, 1977; Ehrlich and Ehrlich, 1981; Markandya, et al., 2001). In 2000, the Ecological Society of America published a fact sheet on Ecosystem Services that illustrates this definition (Box 1).

BOX 1: SOME SERVICES ECOSYSTEMS PROVIDE:

- Moderate weather extremes and their impacts
- Disperse seeds
- Mitigate drought and floods
- Protect people from the sun's harmful ultraviolet rays
- Cycle and move nutrients
- Protect stream and river channels and coastal shores from erosion
- Detoxify and decompose wastes
- Control agricultural pests
- Maintain biodiversity
- Generate and preserve soils and renew their fertility
- Contribute to climate stability
- Purify the air and water
- Regulate disease-carrying organisms
- Pollinate crops and natural vegetation

Ecological Society of America, 2000, Fact Sheet on Ecosystem Services www.esa.org/teaching_learning/pdfDocs/ecosystemservices.pdf

Ecosystem services are one of three general types of benefits from nature: ecosystem goods or products; ecosystem services; and non-material benefits. The latter are actually psychological, emotional, or aesthetic benefits, often highly conditioned by culture.

Table 1: Examples of Three Types of Benefits and Values from Nature

Ecosystem Products	Ecosystem Services	Non-material Benefits
Food	Biogeochemical/nutrient cycling	Recreational
Fiber	Seed dispersal	Scientific
Building materials	Soil formation and retention	Educational
Fuel	Soil fertility maintenance	Spiritual
Medicines	Climate regulation	Historical
Ornamental plants and pets	Decomposition of wastes and pollution	Cultural
	Natural pest control by predators	

Each of these three general types of benefits has unique ecological, economic, and governance characteristics, so they must be distinguished from one another as we move toward the development of mechanisms for their conservation.

Ecosystem services represent a new "frontier" in our efforts to properly value and conserve nature. In general, ecosystem services have been ignored and undervalued compared with direct material (i.e., ecosystem products) and non-material benefits. Reasons for this include the fact that ecosystem services are generally indirect benefits, they are often the result of more or less "invisible" ecological processes operating at large spatial scales, and they have often been available for free. Although we should not ignore the value of ecosystem products or the non-material benefits of nature, we must recognize more explicitly the value of ecosystem services in order to motivate their conservation.

A more focused definition of ecosystem services will emphasize their unique ecological, economic, and governance characteristics and help us develop practical mechanisms for their conservation.

The long-standing, focused definition of ecosystem services as the benefits from ecological functions and processes has recently become somewhat blurred. For example, the Millennium Ecosystem Assessment (2005) used the term "ecosystem services" as an umbrella term to refer to all three general types of benefits from nature, not just the benefits resulting from ecological processes. The motivation for doing so was most likely to emphasize, in general terms, the diverse values of natural ecosystems and wild species. Although the Millennium Ecosystem Assessment (MA) still recognized the old, traditional distinctions among these three distinct types of benefits or values, they all were relabeled "services" (see Table 2). Unfortunately, this well-intentioned lumping of three distinct categories of benefits under the general term "services" has been confusing to some people. It has, in some cases, led to a lack of attention to the unique ecological, economic, and governance characteristics of each of the three types of benefits from nature, and this, in turn, could be impeding the search for practical approaches and mechanisms for conserving the different types of benefits.

Table 2. Millennium Ecosystem Assessment (MA) Terminology for the Three Distinct Types of Benefits of Nature

Type of Benefit	MA Terminology
Ecosystem products or goods	"Provisioning Services"
Ecosystem services	"Regulating Services"
Non-material benefits (psychological, emotional, aesthetic, cultural)	"Cultural Services"

Biodiversity and Ecosystem Services

Biodiversity is not itself an ecosystem service, but rather the source of ecosystem services.

Lack of conceptual clarity about the relationship between biodiversity and ecosystem services is also common. Some recent studies seem to treat biodiversity as a type of ecosystem service (Chan, et al., 2006; Wertz-Kanounnikoff, 2006), rather than recognizing that it is the source of all ecosystem services.

Biological diversity is the diversity of species, the diversity of the genes they contain, and the diversity of the ecosystems they create. How does biodiversity provide ecosystem services? The diverse species in a given environment interact with each other and the physical environment to create ecosystems. Ecological processes and functions emerge from these systems, and we benefit from these system-level processes. Examples of ecological functions include:

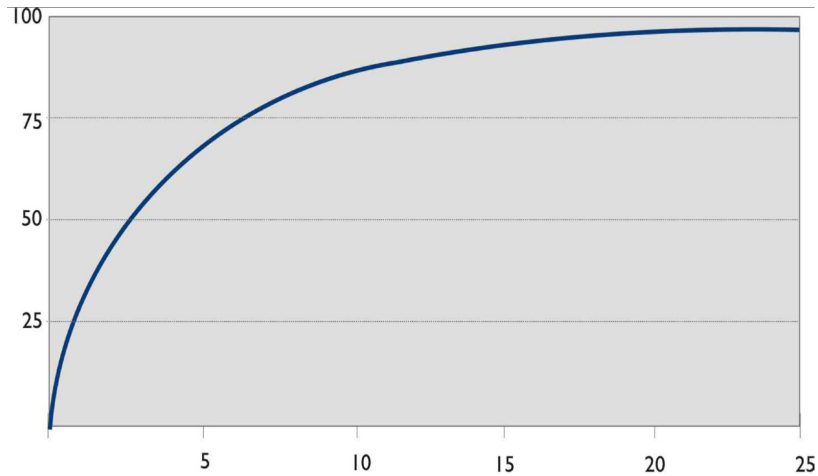
- **Food webs**: energy flows from eaten to eater in complex pathways
- **"Biogeochemical" (or "nutrient") cycles:** materials cycle through food webs and cycle back to the physical environment (e.g., water cycle, carbon cycle, nitrogen cycle)
- **Photosynthesis**: plants capture and store solar energy

Biodiversity, therefore, is not itself an ecosystem service, but rather the source of ecosystem services — and also of the two other types of benefits of nature discussed above. Because biodiversity is the source of ecosystem services, it is logical to argue that conserving biodiversity is a necessary means of conserving ecosystem services.

The role of **species diversity** (one aspect of biological diversity) in maintaining ecological processes and functions is not well understood scientifically, and is an active topic of scientific research. However, studies often show a positive relationship between the number of species in an ecosystem and the level and stability of ecological processes (Balvanera et al., 2006; Diaz, et al., 2006; Swartz et al., 2000). Ecosystem processes often seem to increase rapidly with an increase in species when species diversity is low, but then the rate of change levels out (see Figure 1). This is most likely because many species in species-rich ecosystems are somewhat functionally similar or redundant.

Studies often show a positive relationship between the number of species in an ecosystem and the level and stability of ecological processes.

Figure 1. Generalized relationship between species diversity and ecological functioning



These and other studies show that the correlation between species richness and ecological functioning is not a simple, one-to-one relationship. Some species, or types of species, generally contribute more to certain ecosystem functions than others. Exactly which species contribute the most to which ecological function is not always easy to determine. For example, the suite of pollinator species in a given ecosystem (insects, bats, and birds) creates the ecological process of pollination, of course, but some pollinator species make a larger contribution than other species. Their loss from the system has a larger impact on the process than loss of a less effective or less generalized pollinator species.

It would be a mistake to conclude that a diversity of functionally similar species is not important to the long-term maintenance of ecosystem functions and services. In the case of rapid environmental change or loss of a species that may be contributing a lot to a given function, redundant species can compensate and help stabilize the function. The presence of functionally-similar species in ecosystems is probably very important for ecological resilience. Given the current scientific uncertainty about the relationship between species diversity and each of the many ecosystem processes or functions, a strong argument can be made for taking a precautionary approach, and supporting efforts to conserve the full complement of native species in each ecological landscape.

Developing Mechanisms for Conserving Ecosystem Services

The basic steps for analyzing the benefits provided by ecosystems and designing effective mechanisms to conserve them are:

1	2	3	4	5	6	7
Categorizing	Selecting	Understanding	Understanding	Understanding	Applying	Developing
the benefits potentially available in an ecosystem	one or more ecosystem services (or other benefits) for attention	the ecological characteristics of each selected service (or other benefit)	the economic characteristics of each selected service (or other benefit)	governance characteristics of each selected service (or other benefit)	valuation methods to each selected service (or other benefit)	mechanisms for conserving each selected service (or other benefit)

This process is not necessarily as time-consuming and resource-intensive as might be imagined. Given the rapidly growing interest in ecosystem services, with many people looking for quick results, it is essential to bring clarity of thought and appropriate rigor to the process from the beginning. This can be done in an iterative way. ARD is developing a rapid assessment tool that will provide structure for designing mechanisms to conserve ecosystem services and for building monitoring and adaptive learning processes into the design.

Table 3 (on page 10) illustrates the conceptual framework underlying the seven steps above. The columns of the table lay out a stepwise information-gathering and analytical process. Each column, or "step," leads to a series of questions. In this paper, these steps will be discussed below only in relation to ecosystem services. However, similar steps would be needed to analyze and develop mechanisms for the conservation and sustainable use of any of the three general types of benefits provided by ecosystems: ecosystem products, ecosystem services, and non-material psychological/ emotional benefits.

Table 3. Conceptual Framework of Effective Mechanisms for Creating Incentives for Conserving Ecosystem Services

Type of Benefit	Ecological Characteristics	Economic Characteristics	Governance Characteristics	Valuation Methods	Possible Economic and/or Incentive Mechanisms
Ecosystem Products	• properties of single species • population dynamics of species are simpler and more predictable than the behavior of whole systems • cultivation or domestication sometimes possible to increase production	• usually consumable, "rival" • often substitutable (i.e., another species often able to provide the same or similar product or benefit) • direct monetary economic valuation often possible • may be necessities, or may be only amenities	• often "excludable" (i.e. individual or group can own, limit access) • can be either private goods or common pool resources	Generally based on "revealed preference approaches" of conventional economic valuation, such as market pricing, or production value (the value of inputs from natural ecosystems or wild species toward marketed ecosystem products)	• sustainable use of wild species • natural resource-based enterprises (including grazing) • eco-labeling or "green" certification of products to obtain premium market prices or increase market share
Ecosystem Services	• properties of whole ecosystems, not only single species (i.e., system-level, "emergent" properties) • response and behavior of ecosystems often unpredictable due to scale and complexity • species diversity often positively correlated with the rate, output, or stability of an ecosystem process	• may be non-consumable, "non-rival" • substitution often impossible or expensive because of scale and complexity • amenability to monetary/economic valuation generally low to medium; indirect or non-market valuation methods often used • often necessities for life, although not always recognized as such by non-scientists, decision makers and the public	• may not be "excludable" because of large scale; • usually have characteristics of common pool resources, club goods, or public goods, depending on service and scale	Generally based on "stated preference" approaches such as contingent valuation, or "cost-based" approaches such as avoided cost or replacement cost	• payments for ecosystem services (PES) mechanisms based on private markets & "beneficiary pays" models • government–based schemes (payments, subsidies), & policy and/or regulatory incentives, rewards, & disincentives • "command-and-control" mechanisms
Non-material Psychological or Emotional Benefits	• no direct ecological properties because these are non-material benefits	• sometimes "rival," sometimes "non-rival" • substitution often possible • amenability to monetary economic valuation generally low to medium (except can be high for some recreational uses); indirect or non-market valuation methods often used • not generally necessities but rather amenities or quality-of-life benefits • highly conditioned by culture, and vary from culture to culture	• usually have characteristics of club goods or public goods	Often based on "non-monetizing valuation or assessment" methods (e.g., ranking or rating, group-based methods) or "stated preference" approaches (e.g., contingent valuation); some recreation examples (tourism, skiing, etc.) can based on "revealed preference" approaches (market pricing, travel cost, hedonic methods)	• sustainable nature-based tourism and ecotourism • public scientific & educational nature reserves; • traditional sacred forests or other sacred areas

***❶ CATEGORIZING** the benefits potentially available in an ecosystem*

The first column of Table 3 reflects the need to categorize the types of benefits available from nature in a given ecological landscape, and the users and beneficiaries of each. This step is always needed as a first step in order to avoid confusing the different types of benefits, and to motivate the careful thinking about the ecological, economic, and governance characteristics needed to develop mechanisms for their conservation.

***❷ SELECTING** one or more ecosystem services for attention*

Examples of ecosystem services have already been discussed. Each service has its own specific ecological characteristics, economic characteristics, and governance characteristics, as well as possible mechanisms for its conservation. Water cycle services and carbon sequestration have received by far the greatest attention. Pollination and natural pest control are now gaining attention as well. In some places, the flood, storm, and tsunami damage control benefits of natural ecosystems may be important kinds of "services." Depending on the place, one or a few ecosystem services may be the most important ones on which to focus attention.

All ecological processes — and therefore ecosystem services — are to some extent linked and interdependent. Because of this interdependence, "bundling" of several ecosystem services, and developing conservation mechanisms for several at the same time, may make sense in some cases. In the analysis needed to develop conservation mechanisms for different services, however, they must first be "unbundled" so their ecological, economic, and governance characteristics can be determined. Only after that can appropriate and effective mechanisms to motivate their conservation be developed.

***❸ UNDERSTANDING** the ecological characteristics of each selected service*

Each ecosystem service has its own unique ecological characteristics, and in each case a basic scientific understanding of the ecological process or function that provides the service is a necessary foundation for its management and conservation. Some of the questions to ask are referenced in the bullets in the second column of Table 3. For example, what is the ecological scale of a particular service in this landscape? (How big is the watershed, for example, or how far can native pollinators fly from their natural habitats to pollinate agricultural crops?) How is this service related to aspects of biodiversity, such as species diversity? Which species contribute most to this service? How well do we understand the ecology of this process/service? How do human actions influence this service, and how resilient is it to environmental changes caused by people? In any given case, some applied ecological research, even if it is only quick and superficial, may be needed to answer some of these questions.

❹ ***UNDERSTANDING the economic characteristics of each selected service***

Some general economic characteristics that distinguish ecosystem services from ecosystem products and from non-material values are listed in the third column of Table 3.

A key economic characteristic is whether the service in question is consumable, or "rival," meaning that once it has been used by one person, it cannot be used again by another person. Another key characteristic is whether technological substitution for this service is possible and, if so, what is the cost? Other economic questions about a particular type of ecosystem service are: Is it a necessity, and, if so, is it recognized as such by the public and/or by decision makers? How amenable is this service to monetary economic valuation?

❺ ***UNDERSTANDING the governance characteristics of each selected service***

Some general governance characteristics that distinguish ecosystem services from ecosystem products and non-material values are listed in the fourth column of Table 3. A key governance characteristic is whether the service in question is "excludable," meaning that an individual or a group can limit access to the service and prevent others from benefitting from it. The ability to exclude some people from using a benefit of nature reflects the exercise of social or political power, and exclusion generally comes about through institutions, and laws, rules, regulations and their enforcement.

The economic and governance characteristics of an ecosystem service (or other benefit of nature), in particular the properties of "rivalness" and "excludability," combine to determine what kind of economic "good" it is – in other words, what kind of property regime best describes it (Table 4). Ecosystem services are seldom rival and excludable, although those conditions are not impossible. These qualities make them less likely to be private goods in economic terms. Ecosystem services typically have characteristics of common pool resources, public goods, or club goods.

Table 4. Types of Economic Goods Defined by Rivalness and Excludability (with typically used examples)

	Excludable (can limit access)	**Non-excludable (cannot or do not limit access)**
Rival (consumable, usable only once)	**Private Good** Examples: food, wood, clothing	**Common Pool or Open Access Resource** Examples: water, open-ocean fish
Non-rival (not consumed, can be "used" more than once)	**Club Good** Examples: cable TV, private ecotourism lodge	**Public Good** Examples: air, climate regulation

Both common pool resources and public goods have their own governance and institutional challenges, which merit more in-depth discussion than this paper allows. Public goods, especially, can face economic challenges with financing mechanisms.

Although this scheme used for distinguishing types of economic goods by economists, tenure and property rights specialists may seem clear-cut, in practice it is not. Technological or governance changes can change excludability (e.g., establishing and enforcing rules for the use of common pool resources). For non-material values of nature, rivalness can be culturally defined (e.g., for some people, a crowded wilderness area loses its "wilderness" value). All ecological processes are rate-limited, so ecosystem services can experience scarcity if demand (rate of use) is high.

❻ ***APPLYING valuation methods to each selected service***

Although ecosystem services are a very valuable aspect of nature, as pointed out in the U.S. Agency for International Development's Biodiversity Guide (USAID, 2005), most are not readily valued in monetary terms. However, economists have developed a number of methods to provide estimates of value, some of which are listed in the fifth column of Table 3. For ecosystem services, the most commonly used and appropriate methods for valuation are "stated preferences" approaches such as **contingent valuation**, or "cost-based" approaches such as **avoided cost** or **replacement cost** (Farber, et al., 2006). In contingent valuation, for example, a sample of people might be asked, "How much would you be willing to pay for clean water that comes from this forested watershed above your city?" In avoided cost valuation, for example, an estimate is made of the value of the ecosystem service in terms of costs that would be required if it is not maintained, such as, "How much is X amount of carbon sequestration worth if it prevents 1 meter of sea level rise due to global warming, which would require Y quadrillion dollars to move cities, build dykes, etc. if not prevented?" Replacement cost valuation, on the other hand, would estimate how much it would cost to replace an ecosystem service in a given landscape, such as, "How much would it cost to replace the free pollination carried out on these coffee farms by wild bees and other pollinators, if wild pollinators were reduced by 90% because the natural habitats in which they live are converted to agriculture?"

Amenability to monetary economic valuation, and the corresponding type of valuation method, is inextricably linked to governance and economic characteristics. The type of property rights that are — or could be — associated with a particular ecosystem service, for example, will influence which valuation methods can be used. Excludable, rival goods are the easiest and most straightforward to value because they lend themselves to valuation through private markets. Non-excludable, non-rival goods — which include some ecosystem services — are, for the same reasons, the most difficult and least straightforward to value, because no one can really "own" them.

*❼ **DEVELOPING** mechanisms for conserving each selected service*

Every mechanism for motivating the conservation of a particular ecosystem service will require the following elements:

- Ecological management
- Economic incentives and disincentives
- Governance and institutional arrangements

Not surprisingly, these elements echo the "Nature, Wealth, and Power" framework USAID has developed for its natural resources management work in Africa and elsewhere (USAID, 2002).

The governance and economic dimensions of any mechanism for conserving ecosystem services are inextricably linked by all of the issues surrounding land and resource ownership, tenure, and property rights.

The first element, ecological management, requires answers to the questions about the ecological characteristics of the ecosystem service described in Step 3 (p. 11). Some applied ecological research is likely needed in most cases to understand and predict, to the extent possible, the behavior of the ecological process providing a given service under different scenarios of use and management.

The second requirement for any effective mechanism is that it has an economic dimension, and it creates economic incentives that motivate the conservation of the ecosystem service in question. Relevant economic information is discussed under Step 4 (p. 11).

Institutional arrangements and governance structures are another key element of effective mechanisms for conserving ecosystem services. In fact, the institutional/governance framework is often what enables economic incentives to function. Designing effective institutional arrangements, laws, and policies will require working with the spectrum of stakeholders in truly participatory ways. A legal framework and institutional mechanism for transferring payments from beneficiaries to those providing the service are needed in any kind of PES-like mechanism, whether private or public. And, if government-managed mechanisms (sometimes called "command-and-control") are needed to maintain an irreplaceable ecosystem service as a public good, those too require institutional and legal elements. Equity issues will often come into play, and work on governance will be required to solve conflicts.

A spatially explicit "mapping" of each ecosystem service to its source area is needed as background information for launching participatory planning processes that can optimize values for diverse stakeholders across "working," inhabited landscapes. Geographic information systems and modeling are being used and proposed for this purpose (e.g., Chan, et al., 2006; Naidoo and Ricketts, 2006; World Resources Institute, 2007).

PES schemes are only one possible mechanism for financing the conservation of ecosystem services.

To the extent that more than one ecosystem service comes from the same source area in the landscape, it may be possible to construct mechanisms for the conservation of more than one service at a time from the same area — such as for watershed services, carbon sequestration, and pollination services all based on the same area of forest. Such mechanisms for conserving "bundled" ecosystem services may be based on a bundled suite of "rewards" that could include payments, tax benefits, tenure security agreements, or other kinds of incentives from more than one beneficiary group.

Payments for Ecosystem Services

Perhaps the most common general model, or mechanism, that has been proposed for providing economic incentives for the conservation of ecosystem services is that of "payments for environmental (or ecosystem) services," often abbreviated PES (or Pagos por Servicios Ambientales, PAS, in Spanish). These terms are widely used, and each generates thousands of Google "hits." There is ongoing debate about the definition of PES mechanisms (Pagiola, et al., 2005; Wertz-Kanounnikoff, 2006; Wunder, 2005; WWF, 2006). In practice, very few, if any, operating PES schemes meet all the criteria of the stricter definitions of the concept, and a rather wide range of payments schemes are placed under this umbrella term.

In the most common model, areas of terrestrial or marine ecosystems provide an ecosystem service to users or "beneficiaries" of that service. The costs of conserving and managing those service-supplying areas in a manner that will maintain the particular ecosystem service must somehow be covered by payments from the beneficiaries to the owners or managers of the area supplying the service. This is often called the **beneficiary pays** model. The true costs include those for biophysical and ecological management (including monitoring) and also the costs of the governance and management institutions ("transaction costs") needed to make the system function.

In **private, market-based PES schemes**, ecosystem service beneficiaries and service providers enter into voluntary private contracts. In **public or government-based schemes** for PES (such as that of Costa Rica), the government acts on behalf of the beneficiaries of the ecosystem service(s), collecting taxes or fees from them and paying landowners or other managers for the conservation and management of the ecosystems providing the service(s).

It has been stated that "PES is a voluntary, negotiated framework, which distinguishes it from command-and-control measures," (Wunder, 2005), and that "PES systems promise to be more efficient than command-and-control approaches" (Pagiola et al., 2003). However, in many of the cases that are held up as models (e.g., Costa Rica, Catskills Watershed of New York City), regulation or public policy may provide the conditions to create a "market." So, while not exactly command-and-control, these are not strictly private, voluntary schemes either. Policy and regulatory incentives and disincentives may create opportunities for trading under regulatory caps and limits. In short, private- and government-organized mechanisms each have some advantages and disadvantages, and in many situations the practical solution may be a "hybrid" mechanism that combines elements of both.

Payments can be direct, in the form of cash, but may also be of other kinds, such as training and extension programs, tenure security agreements, tax benefits, subsidies, in-kind assistance, food-for-work programs, and other kinds of compensation (Winrock International, 2004).


Part of the flood plain of Southern Africa's Okavango River, an area with meandering channels that overfill their banks annually as a result of upstream rainfall.

The main message here is that many potentially effective economic-incentive mechanisms do not fit the narrow, complex definitions and criteria for PES used by some authors, and we should not restrict our thinking only to these narrow criteria and definitions.

PES mechanisms in watersheds, to conserve and maintain the hydrological cycle and the ecosystem service of stable flows of clean water, are among the most common forms of PES. In the watershed context, downstream water users pay upstream land managers to conserve natural forests or other natural vegetation, and to engage in land management practices that reduce erosion, stabilize flows, and maintain water are the reason that quantity and quality. The unique qualities of water are the reason that watershed services are a predominant example of an ecosystem service for which PES mechanisms have been developed.

- Water is the "product" of the water cycle operating in watersheds or catchments — areas on the landscape that catch precipitation and feed it into stream and river systems. This gives water some qualities of ecosystem products, such as bushmeat from duikers in Africa, which are also the products of an area of wild ecosystem on the landscape. Ecosystem products are much more likely to be amenable to monetization and trade in markets than are ecosystem services (see Table 3).
- Water is a necessity of life, for which there is no substitute (unlike duiker meat, for example, which is not a necessity and is substitutable). In this way it is more valuable than most other ecosystem products, which can be substituted, and some of which are amenities, not necessities.

PES mechanisms for ***carbon sequestration*** are beginning to develop, and in forms that are somewhat different from water/watershed PES schemes (see www.fs.fed.us/ecosystemservices/carbon.shtml). Since the carbon cycle is a global, atmospheric cycle, the biophysical scale is huge.

"Providers" of carbon sequestration can be in one country, whereas beneficiaries can be in another, halfway around the world. Thus, markets and trading may have different characteristics than for watershed services, which operate at a smaller spatial scale. Ecological characteristics of carbon cycling lead to other unique characteristics also.

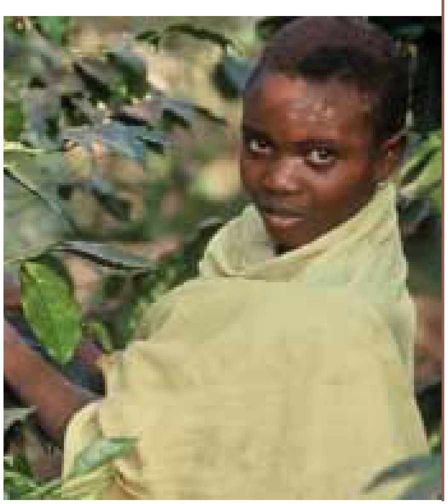
The economic value of **pollination services** from tropical forest in coffee-producing landscapes has been estimated in several parts of the world (Olschewski, et al., 2006; Ricketts, et al., 2004). This information could be used to structure a PES-type mechanism for conserving this ecosystem service. PES mechanisms could involve payments or other financial incentives from coffee farmers (the beneficiaries) to the owners and/or managers of the forests providing the service, conditioned on management of the forests as habitat for pollinators. Recognition of the value of wild pollinators should also provide economic motivation for integrated pest management (IPM) on coffee farms to reduce harm to pollinators and maintain their populations.

Many potentially effective economic incentive mechanisms do not fit the narrow, complex definitions and criteria for PES used by some authors, nor should we restrict our thinking to these narrow definitions and criteria.

Biological pest control by natural predators is another kind of ecosystem service of relevance to agriculture. In the Guanacaste Conservation Area in Costa Rica, the value of parasitic wasps and flies coming from the Guanacaste forests was estimated to make a contribution to IPM in nearby citrus orchards valued at $1 per hectare of natural ecosystem per year. The Del Oro Group, which owns citrus plantations in the area, signed a contract to make payments to the conservation area for the ecosystem service of biologicalpest control, paying the Guanacaste Conservation Area $1 per hectare per year, or $1,685 per year for the Conservation Area as a whole (Rojas and Aylward, 2003).

Other than for watershed ecosystem services, and to some extent carbon sequestration services, PES-like mechanisms for the conservation of the many other types of possible ecosystem services are very, very rare, and there is a great deal of experimentation and implementation needed to develop such mechanisms.

Ecosystem services should be conserved because of their irreplaceable value and contribution to sustainable development, livelihood and food security, economic growth, poverty alleviation and avoidance, and conflict prevention.



Summary and Conclusions

Interest in ecosystem services is growing rapidly, and this concept has the potential to contribute something new to the conservation of nature and biodiversity across multiple-use landscapes. There is considerable confusion about this concept and its definition, however, and there is danger that this confusion will lead to inflated expectations that cannot be met result in a rejection of the idea before its full potential can be realized.

Only by using a clear typology of the distinct benefits we derive from wild species and natural ecosystems is it possible to design appropriate and effective incentives and mechanisms for conserving those benefits. Ecosystem services are one of the three distinct types of benefits we obtain from nature. Ecosystem services can be defined as the benefits to humans resulting from ecosystem functions and processes. This focused definition of ecosystem services will emphasize their unique ecological, economic, and governance characteristics, underline the special challenges of conserving them, and help us develop practical mechanisms for their conservation. It also is important to understand the relationship between ecosystem services and biological diversity; biodiversity is not itself some kind of ecosystem service, but rather the source of all ecosystem services.

The seven basic steps for analyzing the benefits provided by ecosystems and designing effective mechanisms to conserve them can be used with each of the three general types of benefits of nature. In every landscape, functioning ecosystems can provide a suite of ecosystem goods, services, and non-material benefits which, if valued properly, can support the costs of their conservation and sustainable management.

Ecosystem services should be conserved because of their irreplaceable value and contribution to sustainable development, livelihood and food security, economic growth, poverty alleviation and avoidance, and conflict prevention. Many ecosystem services are public goods, and it could be argued that societies have a responsibility to maintain them. Depending on the ecosystem service and its value, government-mandated mechanisms may be appropriate for maintaining an irreplaceable public good.

PES schemes are one mechanism for financing the conservation of ecosystem services, and they have much unrealized potential. Although PES-like schemes are quite diverse, they are not always appropriate or effective, and they should not be seen as a panacea. Much work remains to be done, both conceptually and practically, to develop a robust methodology that can be easily used by government agencies, conservation organizations, and development donors to design mechanisms for maintaining ecosystem services.

Dr. Bruce Byers, an ARD Senior Associate, is a biodiversity conservation and natural resources management specialist with more than 20 years of experience. His work combines an academic background in ecology and conservation biology with extensive practical experience in both applied biological and social sciences. Dr. Byers has worked in more than 30 countries throughout the world.

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