Assessing the Economic Value of Ecosystem Conservation

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Executive summary

Valuation studies have considerably increased our knowledge of the value of ecosystems. Their usefulness has often been undermined, however, by a failure to properly frame them so as to address the specific question of interest. Unfortunately, environmental advocates in the media, government, business, and civil society have often seized on impressive but sometimes unsound valuation results and used them indiscriminately, and often inappropriately.

Valuation is not a single activity, and the seemingly simple question 'how valuable is an ecosystem?' can be interpreted in many different ways. It could be interpreted as asking about the value of the current flow of benefits provided by that ecosystem, for example, or about the value of future flows of benefits. It could also be asking about the value of conserving that ecosystem rather than converting it to some other use. These interpretations of the question are often treated as being synonymous, but they are in fact very different questions, and the answer to one will not be correct as an answer to the other.

This paper seeks to clarify how valuation should be conducted to answer specific policy questions. In particular, it looks at how valuation should be used to examine four distinct aspects of the value of ecosystems:

- **Determining the value of the total flow of benefits from ecosystems**. This question typically arises in a 'national accounts' context: How much are ecosystems contributing to economic activity? It is most often asked at the national level, but can also be asked at the global, regional, or local level.
- **Determining the net benefits of interventions that alter ecosystem conditions**. This question typically arises in a project or policy context: Would the benefits of a given conservation investment, regulation, or incentive justify its costs? It differs fundamentally from the previous question in that it asks about *changes* in flows of costs and benefits, rather than the sum total value of flows.
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Abbreviations

1 Introduction

In the early 1990s a fascinating ecological experiment was conducted in the deserts of Arizona, USA. Dubbed ‘Biosphere 2’ (‘Biosphere 1’ is our planet), this project was an attempt to create a closed but self-sustaining artificial ecosystem that would provide a small group of people with all the food, air, water and other raw materials needed to survive indefinitely, with sunshine the only external input. While the experiment failed in one sense, given that the inhabitants were forced to abandon their artificial home (due to rising concentrations of CO_2 in the artificial atmosphere), many valuable lessons were learned. Among these was a new appreciation of the complexity of the natural processes that support life on earth.

The benefits provided by natural ecosystems are both widely recognized and poorly understood vided by broad categories of ecosystems (for example, the benefits of forests in Mediterranean countries, see Case Study 1 below), or even of all ecosystems on the planet (see Box 4.2 below).

Valuation studies have considerably increased our knowledge of the value of ecosystems, as well as of the strengths and limitations of different valuation methods. Another, less desirable outcome, however, has been growing confusion among decision-makers and non-economists about the validity and implications of ecosystem valuation. Unfortunately, environmental advocates in the media, government, business, and civil society have often seized on impressive but sometimes unsound valuation results and used them indiscriminately, and often inappropriately.

Valuation is not a single activity, and the seemingly simple question 'how valuable is an ecosystem?' can be interpreted in many different ways. It could be interpreted as asking about the value of the current flow of benefits provided by that ecosystem, for example, or about the value of future flows of benefits. It could also be asking about the value of conserving that ecosystem rather than converting it to some other use. These interpretations of the question are often treated as being synonymous, but they are in fact very different questions, and the answer to one will not be correct as an answer to the other.

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Asking 'how valuable is an ecosystem?' also begs the question 'how valuable to whom?' The benefits provided by a given ecosystem often fall unequally across different groups. Ecosystem uses that seem highly valuable to one group may cause losses to another. Answering the question from the aggregate perspective of all groups (as is often the case in economic analysis), would thus give very different answers to answering it from the perspective of a particular group. Understanding the distribution of costs of benefits is also important when considering how to mobilize funds for conservation. Knowing that an ecosystem is valuable will not by itself ensure that it is conserved. Valuation can provide important insights into how conservation might be made financially sustainable—provided it is used the right way.

This paper seeks to clarify how valuation should be conducted to answer specific policy questions. In particular, it looks at how valuation should be used to examine four distinct aspects of the value of ecosystems:

- **Determining the value of the total flow of benefits from ecosystems**. This question typically arises in a 'national accounts' context: How much are ecosystems contributing to economic activity? It is most often asked at the national level, but can also be asked at the global, regional, or local level.
- **Determining the net benefits of interventions that alter ecosystem conditions**. This question typically arises in a project or policy context: Would the benefits of a given conservation investment, regulation, or incentive justify its costs? It differs fundamentally from the previous question in that it asks about *changes* in flows of costs and benefits, rather than the sum total value of flows.
- **Examining how the costs and benefits of ecosystems are distributed.** Different stakeholder groups often perceive very different costs and benefits from ecosystems. Understanding the magnitude and mixatieryJ-10.sts 005(3i-2.3(erceiandyts)]TJT0.0

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2 The importance of ecosystem services

There is growing concern worldwide about the destruction and degradation of natural ecosystems and the attendant loss of biodiversity. On average, almost 15 million hectares of forest were lost every year during the 1990s, mostly in the tropics (FAO, 2001). 35 percent of mangrove forests have ronment, interacting as functional units. It is important to note that this includes managed ecosystems such as agricultural landscapes, and even

A variety of instruments have been developed to help improve conservation. As noted, the initial approach was a regulatory one, which sought to restrict land uses in particular areas. This approach includes the establishment of protected areas and rules that prohibit farming on sloping land or the use of pesticides in riparian areas. More recently, there have been increasing efforts to use market-based instruments to promote conservation (Landell-Mills and Porras, 2002; Pagiola and others, 2002). These approaches seek to change the behavior of land users by changing their incentives, thus encouraging them to adopt more environmentally benign land uses and discouraging them from adopting more harmful land uses. These approaches include efforts to develop markets for the products of environmentally-friendly land uses, such as shade-grown coffee; the purchase of easements or direct payments for conservation on private lands; and 'trading' systems designed to compensate for damage in one place by improvements elsewhere.

Whatever approach is used, conservation has both costs and benefits. The costs include both the direct costs of implementing conservation measures, and the opportunity costs of foregone uses. The benefits of conservation include preserving the services that ecosystems are provi-ding—although it is important to note that not all conservation approaches conserve all services fully. The question thus immediately arises as to whether the benefits of a given conservation measure justify its costs.

and environmental economics literature.[3] Table 3.1 summarizes the main economic valuation techniques. Some are broadly applicable, some are applicable to specific issues, and some are tailored to particular data sources. A common feature of all methods of economic valuation of ecosystem services is that they are founded in the theoretical axioms and principles of welfare economics. Most valuation methods measure the demand for a good or service in monetary terms, that is, consumers' willingness to pay (WTP) for a particular benefit, or their willingness to accept (WTA) compensation for

Table 3.1: Main economic valuation techniques

Methodology	*Approach*	*Applications*	*Data requirements*	*Limitations*
Revealed preference methods				
Stated preference methods				

4 Valuing the total flow of benefits

Policymaking requires an accurate assessment of the state of the national economy at any point in time. Unfortunately, the information available is seriously incomplete. Despite the importance of ecosystem services to the economy, their contribution is hard to discern in the available statistics. The first approach to ecosystem valuation aims at clarifying the contributions that ecosystems make to economic activity. This approach is most appropriately used to answer questions such as: What benefits do protected areas provide to society? What is the contribution of ecosystem services to the national or a local economy and to the welfare of people living there? What are the benefits of specific ecosystems, such as forests?

Why are we doing this?

Policymakers receive a large number of indicators on the economic benefits generated by various sectors of the economy. The single most important indicator of an economy's size is Gross Domestic Product (GDP), that is, the total market value of all goods and services produced within the political boundaries of an economy during a given period of time, usually one year.[1]

Drawing the spatial and temporal links boundaries appropriately is a critical, but difficult step.

The typical approach to doing this kind of valuused. Should the same value be assigned to products that are not, in fact, used? The issue arises when we have an estimate of the average benefits from a resource and we need to apply it to a particular site. The example of NTFPs illustrates this. In a well-known study, Peters and others (1989) estimated the value of a hectare of forest in the Peruvian Amazon as being almost US$700/ha, based on the products that could potentially be harvested from it (including timber, rubber, fruits, and nuts). But only a small fraction of this potential production is actually harvested. Harvesting more would likely cause prices to plunge as supply increases.

Gross vs net value. Many studies fail to consider the cost of using services. A fruit hanging on the branch of a tree only becomes a valuable NTFP once it is harvested and brought to market. Doing so is not costless. Failure to consider these costs can result in a very substantial over-estimate of the potential value of the service. It is also important to incorporate these costs realistically. The study by Peters and others (1989), for example, assumed that harvest costs for NTFPs were a percentage of revenue. Under this assumption, harvest will clearly always be profitable. Yet it is not hard to imagine that, high transport costs stitutes). For other services, approaches such a CV can be used to elicit value information directly from users.

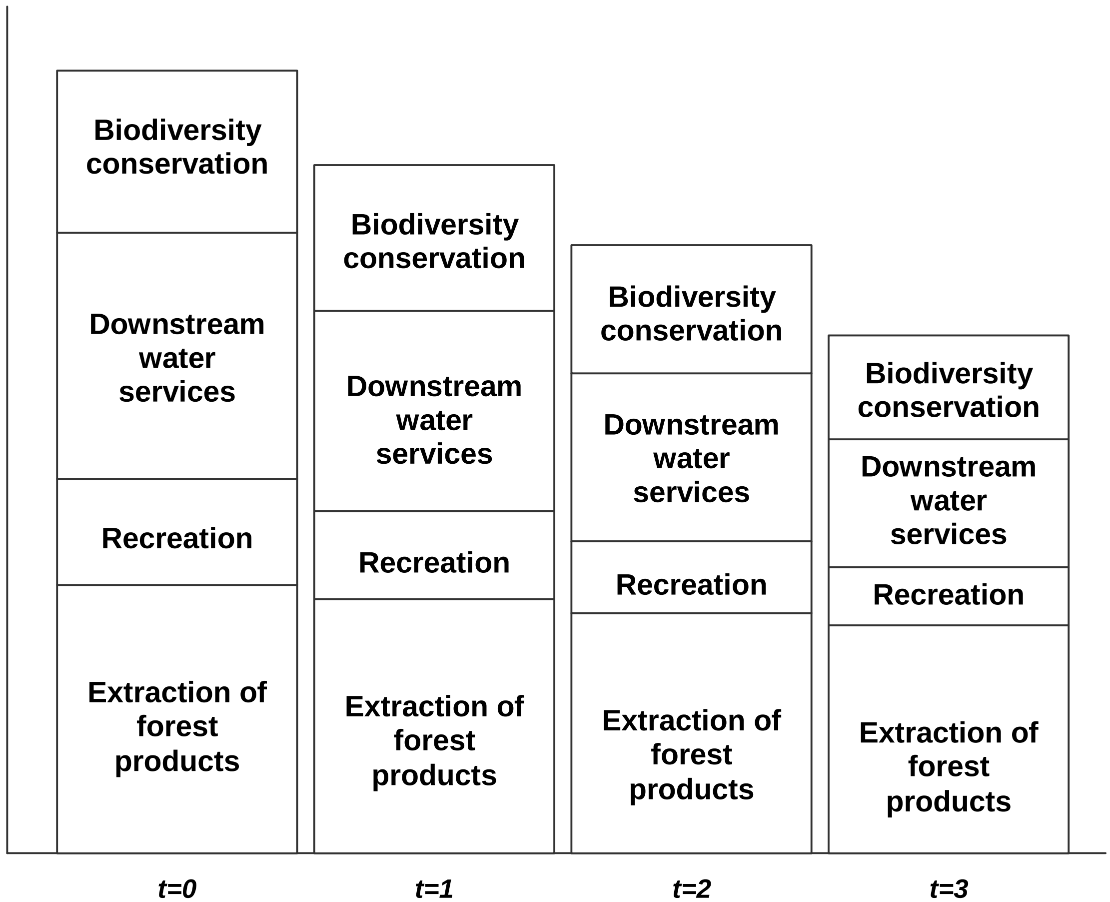
An important caveat to the use of observed prices is that they may well be distorted by policy interventions or other problems. In that case, they will not properly reflect how resources contribute to society. This will, in turn, distort the valuation of ecosystem services. For example, if irrigated agriculture is highly subsidized, the value of watershed protection services will appear higher than it be sustainable if extraction exceeds the natural rate of growth. High apparent flows of current benefits may thus come at the expense of future flows. (Conversely, if extraction is less than natural growth, the stock of the resource would grow over time; in this case the current flow of benefits would tend to understate potential future benefits.) Interpretation is also difficult when examining the value of ecosystems on a large scale, as discussed in Box 4.2.

Natural capital

Efforts to value 'natural capital' are a variation of this approach. A nation's wealth has traditionally been measured as the sum of produced capital, that is, machinery, equipment, and infrastructure (such as buildings, roads, and ports) and commercial land. But ecosystems can also be considered a form of capital. Forests represent wealth in terms of the flow of timber and non-timber products and services they provide. Fish stocks provide consumption benefits. Just as the stock of produced capital determines how much industrial production a country can undertake, so will the stock of natural capital determine how many ecosystem services it will receive. Ecosystems, considered as a form of natural capital, have the advantage that, unlike produced capital, they can regenerate themselves—if they are managed appropriately. But like produced capital, natural capital is subject to depletion which reduces future production possibilities. In the case of forests, for example, harvest rates that are greater than the rate of growth will come at the expense of the stock of the resource. This will undermine future harvests, as well as any other services that depend on the extent of forests in the ecosystem. Likewise, overharvesting fish can lead to a collapse of the fishery, as has already happened several times (Jackson and others, 2001).

Estimates of the value of ecosystems as natural capital are very closely related to the estimates of the flow of benefits they provide. Rather than looking at the flow of benefits from an ecosystem in a single year, the natural capital approach considers the present value of all current and future benefits that the ecosystem will generate. Estimating this value requires projecting how the flow of services, and their value, would evolve over time. This is illustrated in Figure 4.2, for a case in which an ecosystem is degrading and the services it provides are gradually diminishing.

Figure 4.2: Estimating the value of an ecosystem as natural capital



A major contribution of wealth accounting is that it highlights the main sources of income. Income generation in the most advanced countries heavily depends on human capital (the level of skills and education of the population). Developing countries depend more heavily on natural resources. Case Study 2 shows the results of a study of the wealth of Sub-Saharan Africa. Natural capital is an important part of this wealth, and ecosystems provide the majority of this (World Bank, 2004). Wealth accounting points at areas in which careful management of resources is required. For example, attention to land degradation in Africa appears as a very high priority, if welfare is to be sustained over time.

Beyond emphasizing the different sources of wealth and the attendant priorities for their management, wealth accounting provides important indicators of the sustainability of development. It does this first by clarifying what is truly income—depletion of minerals, reductions in fish stocks or forest resources, for example, represent asset liquidation rather than income. This distinction can be important in judging the economic performance of the most resource-dependent economies. Most important, the adjusted net saving (ANS)[3] of a country indicates whether social welfare is rising or falling. ANS measures the change in total wealth in a given period; it is calculated by adjusting the traditional measure of net national savings to account for activities which enhance wealth, such as education expenditure (an investment in human capital), as well as activities that reduce wealth, such as depletion of mineral and energy reserves, depletion of forests, and damages from pollution. A negative ANS indicates that an economy is on an unsustainable path. Case Study 3 shows how adjusting for depletion of forests can affect the estimated savings rate in Ghana.

In addition to providing an important tool for the analysis of sustainability, asset accounts can also indicate the sorts of policy interventions which may be needed in order to place development onto a more sustainable path. Boosting saving rates, for example, can certainly be achieved by the monetary and fiscal policies of ministries of Finance. But asset accounting also suggests that the fundamental rate of saving can also be boosted by better resource management policies, in particular policies which discourage excessive rates of exploitation and damage. Similarly, in over-polluted countries, policies aimed at bringing down pollution levels to the point where marginal costs and benefits are being equalized will have the effect of boosting measured genuine saving, an indication that the economy is on a more sustainable path.

Notes

1 Gross National Income (GNI), another commonly used indicator, adds net receipts of primary income from abroad. GNI was formerly known as Gross National Product (GNP).

2 The country receives additional benefits from the economic activity that the tourists stimulate through their demand for services. Tourist spending is often used as a measure of this benefit. It is not. The country needs to devote substantial amounts of resources to supply tourists with lodging, food, transport, and other resources. Tourist spending ignores these costs, thus vastly over-estimating the contributions tourists make.

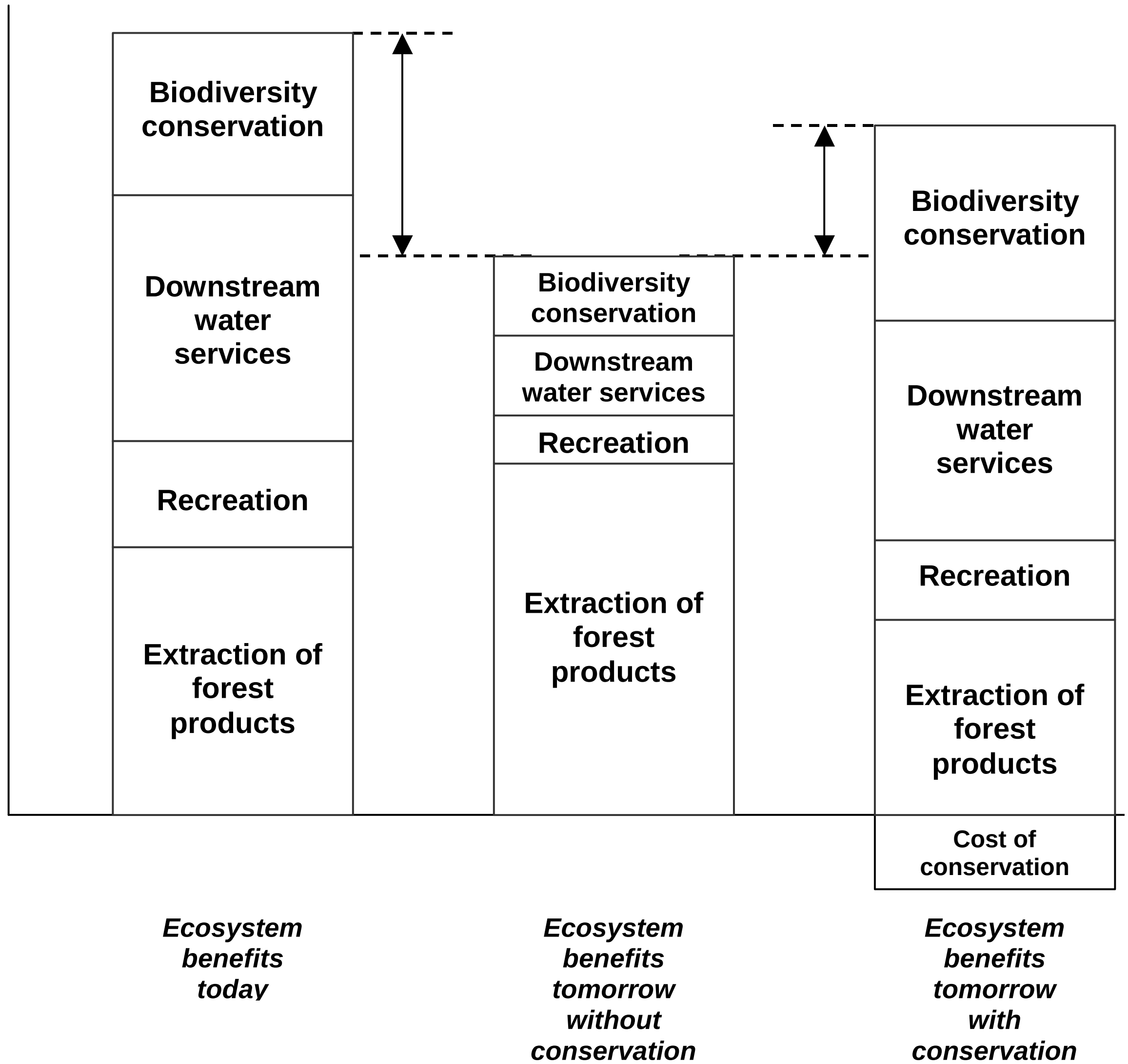
3 Sometimes known as 'genuine' savings (Hamilton and Clemens, 1999).

5 Valuing changes in flows

Estimates of the total annual flow of benefits from an ecosystem have frequently been used to justify spending to address threats or to improve its condition. But using such value estimates in this way would be a mistake. To examine the consequences of ecosystem degradation, or to assess the benefits of a conservation intervention, it is not enough to know the total flow of benefits. Rather, what is needed is information on how that flow of benefits would *change*.

The second approach to valuing ecosystem speaks directly to policy concerns: this approach attempts to estimate the *change* in the total net benefit that ecosystems would provide as a result of an intervention.[1] This approach can be applied to assess the likely results of a deliberate intervention, or to examine the consequences of on-going trends such as deforestation. The scale of the analysis is

Figure 5.1: Change in ecosystem benefits resulting from a conservation project



partly compensate for the loss of the other services.

Likewise, conservation interventions are not necessarily fully effective. Some interventions may only succeed in slowing rather than halting degradation. This does not necessarily mean that they are not worth undertaking, however; they may be, if their benefits are sufficiently high. Conversely, some interventions may not only halt degradation but actually improve conditions. And just as degradation can affect the various categories of services that an ecosystem provides differently, so can conservation. Some services may improve even as others are reduced. What is needed, then, is an assessment of the net impact of the various changes. Finally, the cost of implementing the conservation measures themselves must be taken into account

The question is whether the total economic value of the services provided by an ecosystem managed in one way (with conservation) is more or less than the total value generated by the ecosystem if it were managed in another way (without conservation), after allowing for the cost of changing management (implementing the conservation measures). It is quite likely that a change in management will increase the value of some services and decrease the value of others; what matters is the net difference between the total value of all services.

Figure 5.1 illustrates this approach. The first column on the left shows the value of the total flows of benefits that an ecosystem is providing today, as might have been estimated in the previous chapter. The pattern of use is assumed to be unsustainable: the ecosystem is being degraded, perhaps by excessive extraction of forest products, reducing its future capacity to provide services. (This problem is not, of course, visible simply by looking at the results—one of the limitations of estimates of total current flows.) The next two columns show two alternative tomorrows. The middle column illustrates what might happen under current degradation trends, if nothing is done. The overall value of services provided by the ecosystem declines. Note that the decline is not uniform across all services; indeed, the value of some services may actually increase. The case illustrated here is one in which the high level of extraction of forest products is the reason for the overall degradation. As extraction rises, recreational opportunities, watershed services, and biodiversity conservation are all diminished. Those who extract forest products may be better off, but society as a whole is worse off. The difference475 TD0.0012 tions over what they would have been otherwise, although it does this at a cost. As illustrated, the conservation measures (whose cost is shown as a negative value) severely restrict the extraction of forest products. By doing so, they preserve a good part of the recreational, watershed protection, and biodiversity conservation services the ecosystem is providing. The difference between this column and the ‘without conservation’ column can be

As already discussed, implicitly assuming that *all* benefits would be lost in the absence of conserthe specific conservation measure being considered in the analysis. Each possible conservation measure will have its own pattern of costs and benefits. Finding that one conservation measure is worth undertaking, in a specific case, does not mean that all conservation measures are worth undertaking. Nor does it mean that this same conservation measure is necessarily worth undertaking in a different situation. This is illustrated well in Case Study 4, which found that the same intervention (reforestation of burned areas) was very profitable in some areas and quite unprofitable in others.

Given that many benefits cannot be measured, estimates of benefits are often under-estimates. This is not a problem if the estimated benefits exceed the costs; measuring the other benefits would simply reinforce the conclusion that undertaking the proposed conservation intervention is desirable. This is illustrated in Case Study 5. For lack of data, many of the benefits of protecting Haiti's protected areas could not be estimated. Those benefits that could be estimated were already sufficient to justify the conservation measures, however.

When the estimated benefits of conservation are less than the estimated costs, on the other hand, a mechanical application of cost-benefit analysis would suggest rejecting the conservation option. It is possible, however, that conservation would have been accepted had all the benefits been measured. Some degree of judgment must enter at this point. By measuring at least some benefits, valuation can narrow the uncertainty over the net effect of the proposed intervention. This is also illustrated in Case Study 5: the minimum estimate, of benefits, in the more pessimistic scenario of the conservation project's effectiveness, is less than the costs. The difference is very small, however (about US$1 million, over a 50-year period), and it is quite likely that unquantified benefits would be sufficient to fill this gap, if it were possible to estimate them. Were the gap to be large, on the other hand, it would probably be wise to study the problem more carefully.

In some cases, a traditional benefit-cost analysis may not be feasible or desirable. For example, some ecosystems may be so unique that it might be felt they should be conserved at all costs. Valuation would still be useful by helping find the cheapest and most effective way of achieving the conservation objective.

Notes

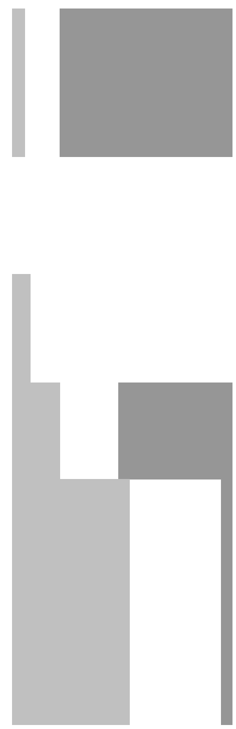
1 Barbier (1993, 1994) and others following him distinguish between 'impact analysis' which seeks to assess the damages inflicted on an ecosystem by a specific impact and 'partial valuation' which assesses project options. Here, we combine these two approaches into a single one that looks at how a change in management, whether deliberate or accidental, affects the flow of benefits provided by an ecosystem.

2 The World Bank is conducting a series of studies of the cost of degradation in the Middle East and North Africa (Sarraf and others, 2004). However, these studies have so far focused on the impacts of pollution rather than loss of ecosystem services. Future studies will attempt to include loss of ecosystem services, to the extent that data allow.

6 Identifying winners and losers

The discussion thus far has focused on aggregate benefits and costs. In many cases, however, we are concerned not only about the magnitude of benefits, but also about who receives the benefits and who bears the costs. The third approach to valuation addresses this issue by attempting to identify who benefits from ecosystems, in what way, and how much.

Figure 6.2: Effect of a conservation intervention on the distribution of ecosystem benefits



5. Indeed, the analysis described in Chapters 4 and 5 can be undertaken by estimating the benefits and costs received by different groups, and then aggregating up. As noted previously, it is important to consider not just direct costs and benefits, but also the opportunity costs that groups may face if they are prevented from undertaking certain uses of ecosystems.

As already noted in Chapter 4, when the analysis is undertaken from the perspective of individual groups, then it should include any taxes that the group pays, or subsidies that it receives. If the analysis is being undertaken in order to understand a group's incentive to conserve, for example, retaining distortions is important because they affect how the group perceives net benefits and costs. For example, if fuels are taxed, then extraction of fuelwood from natural ecosystems will be perceived as relatively valuable, and groups that use fuelwood will have a greater interest in conserving ecosystems that provide it. Conversely, if fuels are subsidized, then this direct use service will not be perceived as being very valuable, and there will be little interest in protecting the ecosystem that provides it. Likewise, if the analysis is being undertaken to understand how a group's livelihood depends on ecosystem services, retaining the distortions is appropriate because they affect how valuable those services are to that group. When the analysis is undertaken from the perspective of society as a whole, on the other hand, it is appropriate to correct for the effect of distortions (see Box 6.1).

It is often important to understand not only the absolute amount of benefit a given group may receive, but also what role that benefit plays in the

7 Identifying potential financing sources

Conservation can bring high benefits, but only if it takes place. Often, it does not, for lack of resources. Cash-strapped governments are often very reluctant to spend on conservation. The fourth approach is aimed at assessing the potential financing sources to pay for conservation.

Why are we doing this?

Effective conservation usually requires a long-term commitment of resources.

Financing conservation has two dimensions. One is to secure sufficient resources, at any given time, to cover the costs of conservation. Almost invariably, the resources available for conservation are grossly inadequate to the task. Thus, even if conservation could, in principle, generate large economic benefits, it often does not happen. Or, more commonly, it happens for some time, thanks to funding from a donor, and then collapses once the project and its funding come to an end.

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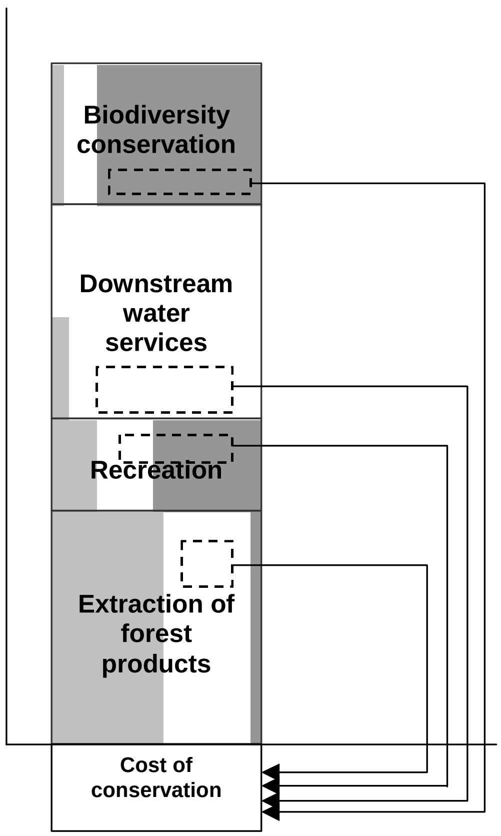
Figure 7.1: Identifying potential financing sources for conservation

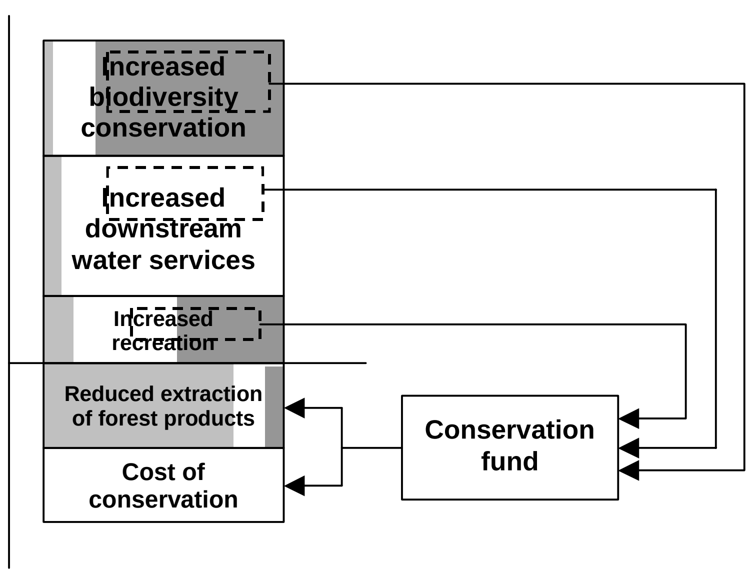


stakeholders need to be compensated for their losses, either to change their incentives to conserve or for equity reasons. Many countries, including Bolivia, Madagascar, and Costa Rica, have adopted policies of compensating affected stakeholders.

The next step, as in Chapter 6, is to identify the beneficiaries of each service an ecosystem is providing. As these groups are benefiting from the ecosystem, it is in their interest to contribute to conserving it. Different mechanisms might be used to capture some of the benefits these groups are receiving, so as to make them available for conservation. This approach is illustrated in Figure 7.1.

For some types of services, it is often politically much easier to charge service users when a change is involved. This is particularly true of indirect use values. Service users often balk at paying for services they are already receiving for free, even when they benefit handsomely from them. It is often easier to convince them to pay when changes in benefits are involved: an increase in benefits, or an avoided loss of a benefit. Likewise, some donors will only finance activities that bring incremental gains. The analysis would be similar, but be based on examining the breakdown of benefit changes from a given conservation intervention, as in Figure 6.2. This approach is illustrated in Figure 7.2.

Figure 7.2: Identifying potential financing sources for a conservation intervention



How do we use the results?

When recreational use is important, there is often a potential to use entrance fees. It is important to know to what degree recreational use is undertaken by foreign visitors as opposed to national visitors, as this may affect viable fee levels. Such mechanisms are already widely used, although fee levels are typically set far below their potential. A review of the economics valuation literature finds that foreign visitors are willing to pay considerably higher amounts than the fees currently charged for visits at developing country natural areas (Lindberg and Aylward, 1999). Some protected areas systems already generate substantial amounts of resources in this way. The South African National Park System, for example, recovers 80 percent of its budget costs from fees and tourism business it operates in parks (Eagles, 2001). This approach is only likely to work when access to conserved areas can be controlled.

Some extractive uses are also susceptible to being tapped for increased funding. It may be difficult to charge local users for collecting fuelwood and NTFPs, but relatively easy to increase royalties paid by loggers.

When indirect uses such as watershed protection provide important benefits, then payments for environmental services provide a promising approach. In a PES program, downstream water users pay fees which are used to finance payments to land users in upper watersheds who undertake appropriate land uses. Several cities and towns have implemented such programs (Box 7.1). Other PES programs focus on carbon sequestration services. Biodiversity benefits are often the hardest to capture, but even here there has been considerable experimentation with a variety of approaches. Note that it is often unrealistic to expect to capture the entire benefit from various user groups. As illustrated in Figure 7.1, typically only a portion of their benefit can be captured. (see Box 7.1 and Case Study 10).

Box 7.1: Paying for watershed protection

Recent years have seen an increasing use of mechanisms based on the principles of payments for environmental services (PES), particularly in Latin America. Costa Rica and Mexico have created

Table 8.2: Avoiding common pitfalls to valuation

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notion of assigning a monetary value to human life unacceptable.

Economic valuation also tends to handle very large-scale and long-term problems rather poorly.

Existing economic valuation techniques can provide reliable answers to questions involving relati-

9. Case studies

This section provides detailed summaries of several valuation studies, illustrating the various approaches described in this paper. They are drawn from a range of situations in a variety of countries. Some reflect sophisticated analyses undertaken with abundant data, while others had to make do with limited data of uncertain reliability.

A companion CD-ROM to this paper provides additional readings and case studies.

Table 9.1: Case studies of economic valuation of ecosystem conservation

	Type of study			
Study	*Value of total flow of benefits*	*Value of change in flow of benefits*	*Distribution of benefits*	*Financing options*
	•			
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	•			
		•		
		•		
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	•		•	
			•	
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Case study 1: The Total Economic Value of Mediterranean forests

On-going deforestation in many parts of the world has stimulated interest in estimating the benefits of forests, partly to identify the values being lost but mainly to justify conservation efforts. The figure below summarizes the estimated benefits of forests in several Mediterranean countries. The average TEV of forests in the eighteen countries studied is about US$150/ha a year. This is likely to be an underestimate, however, as many non-market benefits could not be estimated in many cases. The gap between the estimated TEV in European countries and that in North African and Middle Eastern countries is probably smaller than it appears here, as data constraints were particularly severe in the latter countries.

Direct use values contribute about 65 percent of the estimated TEV, although this share is likely over-estimated as it is easier to measure direct uses than other values. Timber and fuelwood generally account for less than a third of estimated TEV, on average. In North African countries, the importance of timber and fuelwood is dwarfed by the value of grazing. Cork drives up the contribution of NTFPs in Portugal. Recreation and hunting benefits were imperfectly measured, but in European countries these benefits rival and sometimes exceed timber values. Watershed protection is an

Case study 3: The impact of deforestation on Ghana's national savings rate

Some economists define sustainable development as a process characterized by a non-declining per capita welfare (or utility) over time. Maintaining positive changes in real wealth ('genuine' or 'adjusted net' saving) is a necessary condition to achieve sustainable development.

The World Bank's estimates of Adjusted Net Savings (ANS) measure the change in total wealth in a given period. ANS is calculated by adjusting the traditional measure of net national savings to account for activities which enhance wealth, such as education expenditure (an investment in human capital), as well as activities that reduce wealth, such as depletion of mineral and energy reserves, forest depletion, damages from carbon dioxide and health damages from particulates. The World Bank is working on extending ANS to include changes in other types of natural capital, but data availability is an important constraint.

The figure below displays these adjustments to saving in the case of Ghana in 2000. The first column is the traditional national accounts measure of gross saving, Gross National Income (GNI) minus consumption. Successive columns then add or subtract values in order to arrive at the 'bottom line' measure. The adjustments are considerable—whereas the Ghanaian Minister of Finance presumably thinks that the saving rate is over 15 percent of GNI, in fact the true rate of saving is only about 6 percent. Forest depletion accounts for about 3 percentage points of this adjustment. Note that, for lack of data, the adjustment here is only for depletion of forest (that is, the amount by which forest harvest exceeds natural regeneration). Had it been possible to estimate the degradation of other goods and services provided by natural ecosystems, the estimated ANS would likely have been even lower.

Adjusted net savings in Ghana, 2000

Case study 4: The benefits of reforestation in coastal Croatia

Croatia's coastal forests play an important role in

Case study 6: The value of mangrove forests as fish nurseries in Thailand

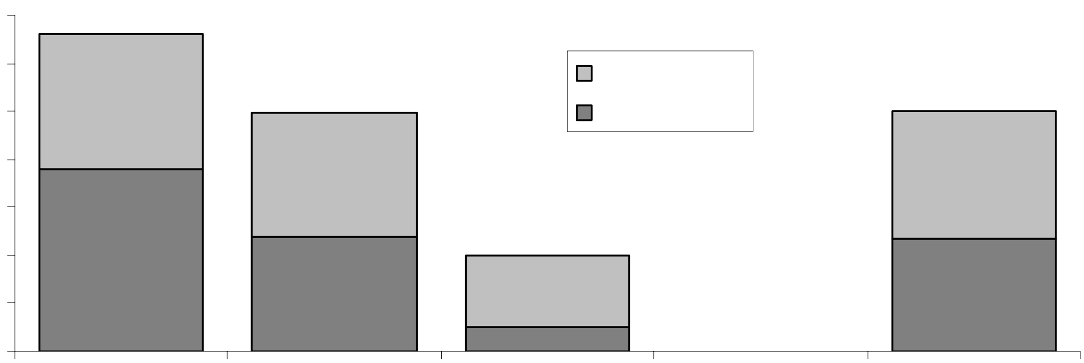
Mangrove forests can provide a number of services. These often include direct uses such as production of fuelwood and other goods, and recreation. Their most valuable services, however, are often their indirect benefits such as storm protection and their role as breeding grounds and fisheries for fish.

A large number of studies have explored the mangrove-fishery linkage. These studies generally use the production function approach: they assess the role that mangroves play as an 'input' into the 'production' of fish. This type of analysis requires two major elements. The first is an understanding of the role that mangrove forests play in the life cycle of relevant fish species. This might be arrived at either through an understanding of the biological processes at work, or by statistical analysis of the relationship between fish populations and mangrove forest condition (allowing for other factors that also contribute). The second element needed is an understanding of the markets for the products—in this case the fish. The value of mangrove forests is imputed based on how changes in their condition change the value generated in the market for the fish (holding other things constant). When there are multiple species of fish dependent on a given area of mangrove forest, and either the biology or the markets for each species are different, these analyses would have to be conducted separately for each species.

The figure below shows the estimated consequences of loss of mangrove forest in Surat Thani Province, on the Gulf of Thailand. This region lost half its mangrove forest area in the period 1975-1993, primarily to expansion of shrimp cultivation. As can be seen, the estimated losses resulting from a loss of 1,200ha of mangrove forest (the approximate annual rate of loss in the early 1990s) depends on both the species concerned and the characteristics of the market. If the fisheries are assumed to be managed, the loss of 1,200ha of mangrove forest would cause losses of about US$100,000. If the fisheries are assumed to be open access, the losses depend on how consumers respond to price changes: losses are highest when consumers are unresponsive (about US$40,000), and lower when consumers are very responsive (about US$132,000).

Note that without knowing the benefits of the land uses which replace the lost mangrove forests, we cannot conclude anything about whether society is better or worse off as a result of this deforestation.

Impact of loss of 1,200ha of mangrove forest in Surat Thani Province, Thailand



Source: Sathirathai (1997) as cited in Barbier (2000).

Case study 7: Tourism vs logging on Palawan

El Nido is a coastal town located on Bacuit Bay, in the Philippine island of Palawan. Bacuit Bay covers about 120 km^2 and includes 14 islands, each surrounded by fringing reefs. In 1986,

Case study 8: The costs and benefits of Madagascar's protected areas system

Stagnant agricultural yields and a growing population have led to substantial clearing of land for agricultural use in Madagascar, threatening the country's unique biodiversity. A protected areas system has been created in an effort to conserve biodiversity. These areas have succeeded in substantially slowing deforestation within their boundaries. With an estimated 70 percent of the population living below the poverty line in 2001, however, many have asked whether it makes sense to spend resources on protected areas and prevent the use of their land and timber resources.

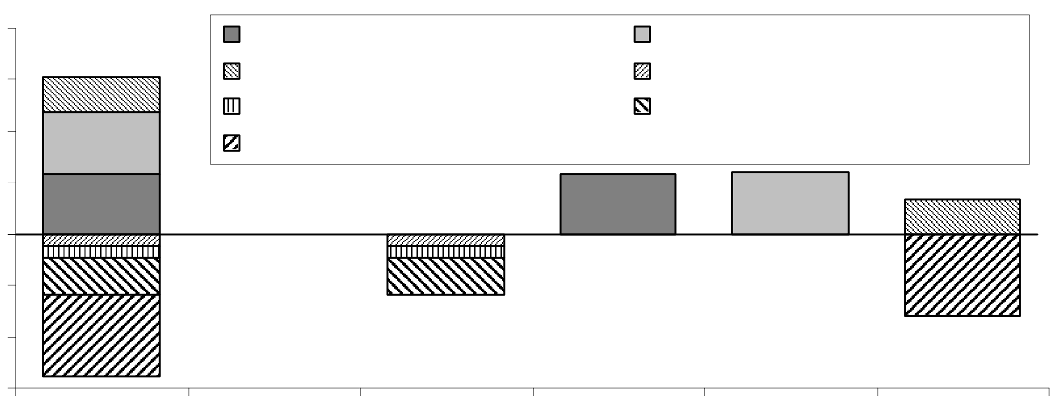
The Figure below illustrates the results of a study undertaken to estimate the costs and benefits of the protected areas system, in terms of their present value over a 10-year period. The first column shows the total flow of benefits from the protected area system. This analysis was undertaken from the country's perspective: that is, it did not include global benefits, except to the extent that the country receives payments for providing them (formally, these payments finance the costs of conservation; an avoided cost, however, is equivalent to a benefit). It also included the benefits of tourism only to the extent that they are captured by the country (although lack of data on net revenues from tourist spending limited the analysis to entrance fees paid by visitors to protected areas).

Despite the high management costs and the foregone income from use of that land, the system is estimated to provide net benefits to the country, thanks to the valuable watershed protection services these areas provide, their tourism benefits, and the payments received for biodiversity conservation.

But as the breakdown in the right side of the figure shows, these benefits are very unevenly distributed. Local communities bear the brunt of the costs, as they are barred from using protected areas either for agriculture or for the collection of fuelwood and other NTFPs. Downstream water users such as irrigated farmers benefit substantially, as do tourism operators. The protected area management agency, ANGAP, bears the management costs but receives external support (and a part of the tourism benefits).

These results confirmed that Madagascar benefits from its protected areas system, though that depends on continued support from the global community. It also indicated the need for support to protected areas to include appropriate compensation mechanisms for local communities.

Total flow of benefits from Madagascar's protected areas system and their distribution



Source: Carret and Loyer (2003).

Case study 9: The impact of conservation on local communities in Uganda

Uganda's Lake Mburo National Park (LMNP) covers 260 km^2 of open and wooded savanna and wetlands. The land and resources of the area form an important component of agro-pastoral production systems and local livelihoods. The LMNP's establishment has significantly restricted the use that local communities—more than 50,000 people, mainly *Bairu* cultivators and *Bahima* herders—can make of the area.

Recognizing that the LMNP imposes significant opportunity costs to communities living next to it, a program of local revenue-sharing was piloted and staff were employed as community conservation officers (LMNP was the first protected area in Uganda to attempt such measures). Nevertheless, chronic funding shortages have restricted the impact of these efforts.

The figure below shows estimates of the costs that local communities bear because of the LMNP and the benefits they receive. The costs are estimated at about US$700,000 a year. About half of the costs are due in damage from wildlife: more than 90 percent of households living near the park suffer regular crop destruction, livestock kills, and transmission of disease from wild animals to domestic stock. Another third of the costs are opportunity costs resulting from restrictions on product extraction in the park. The rest is due to loss of access to grazing land: the LMNP's area includes critical dry-season grazing land sufficient to sustainably support more than 10,000 cattle and small stock. On the positive side of the ledger, local communities are able to collect products worth about US$180,000 a year from within the park: small-scale fishing, fuelwood collection, and harvesting of other NTFPs are permitted. Local communities also receive about US$30,000 a year through revenue-sharing arrangements.

Under these conditions, it should not be surprising that there are intense conflicts between the park and surrounding populations. Local communities are largely unwilling—and in many cases economically unable—to bear these uncompensated

Case study 10: Paying for water services in New York State

New York City obtains its water supplies from watersheds in the Catskill Mountains, north of the City. Thanks to natural filtration, this water is of sufficient quality that it can be used unfiltered. By the end of the 1980s, however, changing agricultural practices and growing urbanization in the Catskills were threatening water quality. Non-point source pollution increased substantially, as did the threat of sewage contamination.

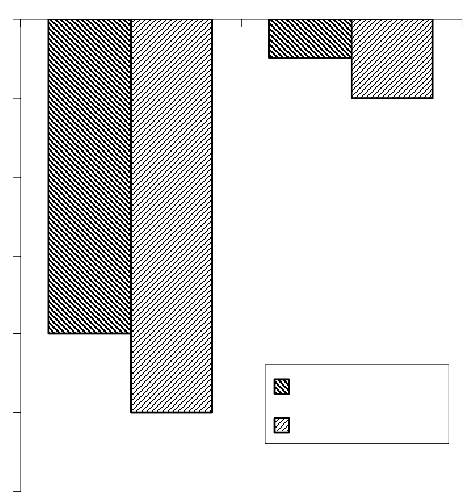
Threats to water quality forced city officials to consider filtering its water supply to ensure it continued to meet water quality standards. The estimated cost of a filtration facility with enough capacity and backup to process the 1.35 billion gallons a day of water that the watershed then provided the City (a successful water conservation program has since reduced this volume to about 1.1 billion gallons a day) was US$4 to US$6 billion dollars and the annual operating cost another US$250 million annually, for a total of about US$8-10 billion in present value terms. Clearly, replacing the services hitherto provided by the Catskills watershed would be expensive! Were these services to be lost, however, the City would have had little choice: building a filtration plant would have been mandated by the need to meet legal requirements for water quality.

To avoid incurring this cost, the City embarked on an alternative approach: instead of paying to clean up the results of degrading the water producing environment, the City invested in preserving the rural Catskill environment that was providing it with the world's best urban water. A range of measures were adopted, the most important of which were buying particularly important areas out-right and paying farmers to operate their farms in ways which minimized water pollution. Under the latter program, known as 'Whole Farm Planning', the City pays both the operating costs of the program and the capital costs of pollution control investments on each farm. Specific pollution-control investments were designed on a farm-specific basis, with measures selected not only for their pollution control benefits, but also for their integration into the farmer's business plan, thus also bringing them significant ancillary benefits (often in the form of time and labor savings). Within five years of the program's establishment, 93 percent of farmers in the watershed had chosen to participate. Whole Farm planning is considered to be one of the most successful non-point pollution control programs in the United States. It has played a major role in stabilizing and reducing watershed pollution loads and in enabling the City to avoid having to filter its water supply. The program to conserve the Catskills watershed cost the City about US$1.5 billion—a considerable saving over the US$8-10 billion that a filtration plant would have cost.

This example shows how valuation, even if only partial, can help illuminate alternative courses of action.

This example also illustrates the perils of the replacement cost technique (see Box 3.2). Clearly, the filtering wasn't the least-cost solution to the problem! Using it to value the filtration services provided by the watershed would have been a massive over-estimate.

Costs of alternative strategies to meet New York City water quality requirements



Source: NRC (2000), Heal (1999).

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