Seminar

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Valuation of Ecosystem Services

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Economic Valuation, Ecosystem Services, and Conservation Strategy

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INTRODUCTION

We live in an economic age. Financial language and arguments permeate our social and household discourse. Success and failure are judged by economic measures like GDP, profits, and income. Today's youth are more financially literate than past generations, and books on economic topics regularly make it onto bestseller lists. It is therefore not surprising that the desire to think of nature in economic terms is no longer confined to economists. Politicians, the media, conservancies, environmental advocates, and companies now routinely seek monetary analysis of, and justifications for, environmental protection. Headlines like "The world's ecosystems are worth $33 trillion," "Bats are worth at least $3 billion a year," and "The state of Georgia's forests yield $37 billion in ecological benefits each year" are all examples of a monetary depiction of nature's contributions to our well-being.[1]

Should the conservation community embrace and invest in monetary descriptions of nature's value? Will the "pricing" of ecological resources and systems advance the conservation agenda, and if so, how? To answer these questions, this article describes the ways in which ecological values are calculated, applied, and interpreted. It also discusses the philosophical and strategic implications of ecological valuation.

Dollar-based ecosystem valuations are in part a communications strategy. Dollar valuations translate nature's complicated role in our well-being into a simple bottom-line message that speaks to people in understandable monetary terms. Ecological valuation is also a scientific, methodologically sophisticated approach to environmental analysis. Akin to financial analysis, valuation studies are often designed to enlighten and influence specific decisions by businesses, governments, and non-governmental organizations (NGOs). In both cases ecosystem valuation can be controversial and subject to misinterpretation.

Skepticism regarding the accuracy, influence, and appropriateness of ecological valuation is healthy. Deeper understanding of economic valuation's meaning, strengths, and weaknesses will allow the conservation community to more effectively harness economic arguments to conservation strategy. As will be argued, ecological valuation is no panacea and is only *a* strategy, not *the* strategy, to advance the conservation agenda in coming decades.

WHY WE SHOULD MONETIZE NATURE'S BENEFITS

It is useful to review the arguments in favor of economic valuation before turning to opposing viewpoints. The positive hypothesis begins with an observation made earlier, that economic language and measures are an increasingly common and effective way to communicate across society. Economic descriptions of nature harness this language in the service of conservation and allow conservation's message to reach a wider set of audiences. While people can differ over whether or not nature should be described in economic terms, the fact is, nature produces a range of goods and services that are economically valuable. Why not discuss and measure those values so that they can be more concretely appreciated?

A motivation for ecological valuation is that nature's economic value is hidden from view. Because ecosystem goods and services tend to be shared, public goods that are not bought and sold, we do not see their value through the lens of market transactions. We are accustomed to thinking of cars and hamburgers as being valuable because we pay a price for them. We do not buy and sell ecosystem services, however, which may lead us to underappreciate their value. This is disturbing to conservationists and economists alike. After all, just because something has no price, does not mean that it is not valuable. One motivation for ecological valuation is to fill in these "missing prices," so that nature's value is seen and appreciated on an equal footing with market commodities.

Valuation is a close adjunct to the ecosystem services movement in conservation science and advocacy. Popularized over the last decade, but with much deeper roots in natural resource management and environmental economics, the ecosystem services concept holds that

[1] Results reported in the popular press based on Costanza et al. (1997), Boyles et al. (2011), and Moore et al. (2011), respectively.

natural systems produce goods and services that contribute to social and economic well-being. For example, almost any natural landscape produces cleaner air and water, supports species that provide our food and material needs, protects us against floods, and provides open space for recreation and beauty for our aesthetic and psychological well-being. All of these biophysical goods and services have an economic value. When ecologists and other natural scientists coordinate with economists, together they are able to 1) describe the production of ecosystem goods and services in biophysical terms, and 2) translate that biophysical production into estimates of economic value.

If successful, ecosystem services valuation provides environmental advocates with hard economic numbers that, in theory, can be more influential than qualitative descriptions of nature's value or non-economic conservation measures like biodiversity scores.[2] In front of planning boards, for example, land developers can easily point to the dollar value of a new shopping center or residential development. But those lands in their natural state also have a dollar value that, if calculated, may strengthen the argument against development.

Dollar values are also influential in arguments over new environmental regulations. Opponents of tighter regulatory standards routinely deploy economic arguments relating to the regulation's costs to business or property owners. The environmental benefits of regulation, translated into dollar terms, can help counter these objections.[3] Private companies, accustomed as they are to quantitative financial analysis of investments and strategy, would be better able to make decisions based on the true costs and benefits of their ecological inputs and corporate footprints.

Ecological valuations could also be influential in the calculation of our national economic accounts, such as gross domestic product (GDP). GDP is an influential yardstick used to measure the health of our economy and the success of government policies. Unfortunately, it only measures market goods and services. GDP always rises when we burn more coal, take more fish from the sea, and develop more land. By ignoring ecological costs GDP gives us a distorted view of our economy's health. If ecological costs were also measured and debited, GDP would give us a much more accurate view of our economic well-being and improve accountability for environmental losses. For example, the more energy people in the United States consume, the higher the U.S. GDP, even though energy consumption can lead to a range of ecological and human health impacts, which currently go unmeasured in the calculation of GDP. Similarly, the more fish harvested from our oceans, the higher our GDP, even though those harvests may be reducing future fish populations and future GDP. Measures that account for these kinds of ecological costs and depletions would give a more accurate depiction of our economic well-being now and in the future.

In summary, there are several motivations for ecosystem services valuation. The first relates to the perceived power of economic arguments and numbers in social discourse. Dollars are a yardstick with which people are deeply familiar. Dollars, as an economic concept, also underscore nature's connection to human, utilitarian concerns, as opposed to more ethical or biocentric concerns. Dollars also convey the message with precision and simplicity. Arguably, precision and simplicity convey a deceptive sense of certainty (given the complexity of ecological and economic systems), but simplicity has an undeniable power in most social learning and decision-making contexts.

A second motivation is rooted in economic and political theories of governance. If the goal of our political system is to maximize social welfare, our policy machinery requires knowledge of the ways in which our laws, regulations, planning, and investments affect overall social welfare. Are ecosystems' contributions to our welfare being adequately and accurately reflected in this calculus? It is possible that our failure to depict ecological benefits in monetary terms biases social decisions toward economic activities that are antagonistic to ecological health and production. If so, greater commitment to ecosystem valuation could serve both the interests of conservation and society as a whole.

Finally, valuation should not just be thought of as a black box that produces a numerical value. Viewed as a process rather than an answer, valuation can play a particularly positive educational and strategic role (specific valuation methods are described in more detail below, under "Where Do Economic Value Estimates Come From?"). For example, valuation involves identifying multiple ecological changes, each with their own consequences for human welfare (e.g., water quality, aesthetic, species, and air-quality improvements). When stakeholders are brought into the process to identify and describe these ecological and economic changes, the end result is a clearer, more tangible sense of the ecological goods and services they might otherwise take for granted. At its best, valuation promotes deliberation among experts, stakeholders, and communities — deliberations that teach us about nature's diverse contributions to human welfare.

[2] For more detailed overviews of legal and regulatory applications of ecosystem services valuation, see Ruhl et al. (2007) and Scarlett and Boyd (2011).
[3] Analyses of air-quality regulations, for example, are often able to show huge monetary benefits arising from improved human health outcomes.

ARGUMENTS AGAINST ECONOMIC VALUATION

The value of valuation as a conservation strategy should be debated rather than assumed. A skeptic can point to a range of concerns regarding valuation. Valuation studies will consume time, money, and human resources that could otherwise be devoted to conservation itself. While economic analysis and monetary valuations may be influential across a range of decision contexts (as argued above), it is not always clear whether benefit-cost analysis leads to different and better social choices, or is only used after the fact to justify decisions driven by politics, opportunism, or non-economic rationales. Analysts tend to think that analysis matters, yet it can be argued that most political decisions are driven more by emotion, stories, and ethical values than by “cold, hard numbers.”

Critics of valuation note that many of our most important social choices — including the definition of our basic liberties and rights, decisions to go to war, and definitions of fairness and justice — are not subjected to benefit-cost analysis (Vatn and Bromley 1994). Since conservation can be viewed as a fundamentally ethics-driven social issue, should it not lie outside the set of choices subjected to economic analysis? As experiments with ecological valuation proceed, their positive influence on conservation decisions should be evaluated, rather than assumed.

Philosophical critiques emphasize the difference between valuations derived from nature’s utilitarian benefits (extrinsic values) and the value of nature for its own sake (intrinsic values) (Sagoff 1996). The ecosystem services paradigm, including ecosystem valuation, with its emphasis on nature’s economic role, seeks to measure extrinsic values. Nature’s intrinsic value is reflected in the common ethical belief — and motivational message associated with many conservation advocates — that nature should be protected for its own sake, whether or not it contributes to human well-being.

Ecological systems yield both kinds of values, but the utilitarian perspective concerns some observers, who worry that utilitarian motivations are not sufficiently protective of nature (Foster 1997). For example, it is argued that the economic valuation of natural resources encourages us to think of them as property that can be bought and sold, and thereby lost or destroyed should their loss or destruction be convenient (Macauley 2006). While that concern has merit, it is worth noting that intrinsic and extrinsic values in social policy are not necessarily mutually exclusive. In other words, we can and do value nature *both* for its utilitarian contributions to our more utilitarian needs (food, shelter, recreation, industry) and as a source of intrinsic spiritual, cultural, and biological value.[4]

Conservationists might also worry about what economic valuations will reveal about nature’s value. What if valuations are “too small”? Could conservation objectives be thwarted if valuations show ecological benefits to be smaller than we imagine, expect, or hope? Here we should carefully distinguish between valuations that are small because they are incomplete (an issue we will address in detail under "Critical Interpretation of Ecological Valuations," below), and valuations that are small because people do not place great value on a given resource. It is possible that people will not place a high value on a given natural resource, even if they are fully informed. An unavoidable economic reality is that not all resources have equal value. As a rule, ecological resources in some landscape and social contexts will have relatively high values, while in other landscapes the same resources may have relatively low values.

Judging nature’s importance via public preferences can also be worrisome if we believe that the average person is uninformed or irrational. Won’t the preferences of average folks be “wrong” because they are not as enlightened as those of more educated and concerned stakeholders?[5] As a brief aside, this line of thinking deserves a critique of its own. First, it conveys an undemocratic and elitist attitude that may alienate potential conservation supporters. Second, it ignores valuation’s ability to address people’s ignorance. If people are ignorant of nature’s benefits, one reason may be that not enough attention has been given to economic assessment. Valuation studies that give greater tangibility to nature’s benefits increase the public’s ecological literacy.

All that said, however, ignorance of ecosystems’ role in our well-being is a serious issue for valuation methods. Consider how an average person values a car versus a wetland. Most of us will buy and sell several cars over our lifetime. The price of cars can be found in the newspaper, online, on TV, and at competing dealerships. Our media inundates us with advertisements that describe cars’ features and qualities. When we buy a car, we spend time thinking about and trading off in our own minds the value of certain features versus their cost. All of this information and experience educates us.

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[4] It is also important to debunk a common misconception about utilitarian values: that they refer only to profit-making or consumptive uses of nature. In fact, economists consider ecosystem benefits such as species protection, beauty, wildness, and cultural significance to be utilitarian values in need of, and consistent with the goals of, economic measurement.

[5] A related concern arises from psychological experiments that call into question people’s ability to make value judgments about complicated and unfamiliar subjects. A representative study found that subjects based their preferences on *less* information, the more complex and unfamiliar the environmental decision presented to them (Gregory et al. 1993).

We are not experts in wetland valuation. We have never bought one, sold one, seen one advertised, or been able to look up a wetland price in the classifieds. Some of us have chosen to live, hike, or boat near one. But beyond that our individual wetland valuation expertise is extremely limited. The ecologically sophisticated among us may understand that wetlands improve water quality, shelter species, and protect us from floods. But that understanding tends to be qualitative rather than quantitative — in other words, we know that wetlands are valuable because they do those things, but it is hard for us to know *how* valuable they are.

This means that if we simply ask people to "value a wetland," we should not expect economically accurate answers. Stakeholders can explain how, why, and in what ways the wetland is important to them, thereby providing useful information to help economists arrive at a more accurate answer. This also means that natural scientists must be involved in the valuation exercise. Ecologists and other natural scientists are needed to quantitatively understand the relationship between wetlands and the goods and services (cleaner water, reduced flood risks, more abundant fish and bird populations) delivered by them. The value of wetlands cannot be calculated without the knowledge of ecological production and local uses.

As a general rule, valuations will be more enlightened the closer the good or service in question is to our daily experiences and choices. The values of species we hunt, harvest, or seek out for aesthetic enjoyment are easier for us to value than species we are unaware of or rarely see. That does not mean that unseen species are not valuable — to the contrary, they are often necessary (e.g., as part of food webs) to the existence of species we do value, and therefore are valuable themselves. But the overwhelming majority of people are understandably unable to perceive or quantify that value.

PRICES VS. VALUE VS. IMPORTANCE

How do economists define the value of nature? Assigning a value to something is simply a way to depict its importance or desirability. Economic values can be thought of as rankings, weights, or priorities. Values are detected or measured by examining people's choices. Whenever we choose one thing over another, as individuals do every day, we are engaged in valuation.

One common way to measure values is via prices. Market goods and services have easily observable prices that are an important clue to their value. After all, if we pay $100 for something, that means the good must be worth at least $100. Note, though, that the actual value to us of the goods we buy is almost always higher than the price we pay. The difference between what is paid and what we would be willing to pay — given the value of the product to us — is the "benefit" of the purchase. Economists refer to this benefit as consumer surplus. The thing to keep in mind is that a thing's price is not the same thing as its economic value.

Prices are used as measures of value for a simple reason: they are easy to observe and yield a reasonable reflection of social preferences for goods. The price of cars is higher than the price of bicycles, which accurately reflects the fact that most people value cars more than bicycles.

It is also important to understand that economic valuation methods mostly help us understand the value of having a bit more or a bit less of something. In contrast, economic valuations of the aggregate importance of a resource or ecological system — the value of a lot more or a lot less — are inherently more dubious (Heal 2000). This causes a great deal of understandable confusion when economists and environmentalists discuss the value of nature. It is natural to think of the value of nature as referring to nature's larger importance — e.g., the value of the world's freshwater or forests or ecosystems. Many in the environmental community are concerned about major ecological losses (to species, water, natural lands), and want to know the value lost if there were to be a significant collapse in ecological quantity or quality. Most economists would argue that the lost value of large ecological degradations is likely to be real and large. Unfortunately, the tools and data at our disposal to measure the value of major ecological changes with precision are limited.

Supply and demand conditions determine prices, rather than the aggregate importance of the good. To see this, consider what is known as the diamonds and water paradox (attributed to Adam Smith). Water is necessary to life and is therefore much more economically and socially important than diamonds. So why is the price of diamonds so much higher? The answer is that diamonds are scarce relative to demand, whereas water is usually abundant relative to demand. Prices tell us about the value of water and diamonds "at the margin," where we get a little bit more or little bit less of them. But clearly those prices give us a misleading sense of the value we would lose if we lost *a lot* of water. The importance, or value, of the entire world's freshwater is nearly infinite, since without water all other economic and social welfare would be threatened.

In summary, economists are comfortable saying the following: 1) the total value of ecological resources and systems may be very large, if not nearly infinite, and 2) the marginal value of ecosystem goods and services — the value of having a little bit more or a little bit less of them — will rise as they become scarcer. Unfortunately, all we can observe through market prices or other choice behaviors are marginal values given current supply and demand conditions. Thus our ability to measure total (non-marginal) values, or importance, is limited.

Consequently, there is a potentially frustrating disconnect between the kind of economic valuations that many in the conservation community desire for purposes of communication and motivation and what mainstream economists are intellectually comfortable delivering. Consider the widely disseminated and influential study that placed a US $33 trillion value on the world's ecosystems (Costanza et al. 1997). The study was influential and beneficial for several reasons: it generated a huge economic number, reached a wide variety of audiences, prompted extensive academic and policy discussion, and attempted to do something almost heroic — value the world's ecosystems.

Within mainstream economics, however, such valuations are viewed as wildly inaccurate "results" derived from assumptions that violate fundamental economic principles. The Costanza et al. study in particular prompted widespread consternation within the environmental economics community (Bockstael et al. 2000). Interestingly, most of the consternation was not that the US $33 trillion estimate was too large — in fact, one economist observed that US $33 trillion was a "serious underestimate of infinity," given that society would pay everything it had to avoid the loss of the world's life support system (Toman 1998). Instead the discomfort was due to the fact that the economic value of large gains or losses in ecosystems is simply unknowable.

As noted earlier, economists can only measure the value of marginal ecosystem changes given current supply and demand conditions. Moreover, the value of massive gains or losses in ecosystems cannot be extrapolated from these existing marginal values, because marginal values change as the scale of the gain or loss changes (the point of the diamonds and water thought experiment). The US $33 trillion figure was derived by multiplying existing marginal value estimates by the total area or amount of the world's ecosystems, a practice that violates the fundamental economic axiom that marginal values change as the supply of or demand for a good changes.

Should the conservation movement worry about these academic disagreements? No, if the point of economic valuations is to capture the public's imagination and convey the notion that nature's value can be described in monetary terms. Yes, if economic valuation is to produce results that weather the scrutiny of academic economists.

WHERE DO ECONOMIC VALUE ESTIMATES COME FROM?

The economic approach to valuation relies on observation of individual, household, and community choices. Choices are a particularly reliable form of evidence when it comes to detecting preferences and values. When we make choices, we reveal our preferences for one thing over another. Paying for something is a choice. When we pay for something we are deliberately choosing it over the amount of money we paid. Assuming that people are rational, they will only pay the price if the thing they are buying is worth at least that much to them. The higher the price that is paid, the higher the valuation we can infer.

Prices are desirable not because they are the ideal measure of value, but because they are readily available. We can use market prices to value some ecosystem goods and services, but only those that are bought and sold as private goods. Examples of ecosystem goods that are bought and sold in private markets include timber, commercial fish harvests, and carbon sequestration credits (if a credit market exists). Often, however, ecosystem goods and services are public, non-market commodities for which there is no market price. Without market prices, economists must resort to so-called non-market valuation methods described below.

Non-Market Valuation Methods

HEDONIC VALUATION METHODS

Hedonic valuation methods examine the prices people pay for things that have an environmental component. For example, when people purchase a home near an aesthetically pleasing ecosystem, home prices reflect that environmental amenity.[6] The price premium of living near the ocean, having a mountain view, or being in close proximity to urban parks can be measured via statistical analysis. Similarly, farm values are related to the availability of groundwater, precipitation, and soil quality. The premium due to those features can be estimated by controlling for other factors that affect farm value.

[6] For an example, see Mahan et al. (2000).

Evidence of conservation value can also be inferred from political choices such as prohibitions on drilling, development, and other land-use changes associated with public lands, or conservation referenda that approve local or state financing of land acquisitions (Banzhaf et al. 2010).

TRAVEL COST METHODS

Travel cost methods examine the costs people are willing to bear in order to enjoy natural resources. When we spend time and money in order to enjoy nature, we are revealing something about its value. Again, if we are willing to pay the price (the cost), we must value the experience, enjoyment, or use of the resource more than the cost.[7] The travel cost method requires data and analysis linking the number of trips to a site to its quality, size, or location. Changes in these attributes can be valued if there is a perceptible change in the number, length, or cost of trips taken to the site.

Another technique is to examine costs avoided by the presence of an ecological feature or service. For example, if we lose wetlands and their water purification and flood damage reduction benefits, we may have to invest in water treatment facilities, levees, and dams. If instead we protect the wetlands, we avoid the costs associated with built infrastructure alternatives. Similarly, private firms can conduct engineering and economic analyses that calculate the costs associated with, for example, the loss of surface waters for cooling, where the cost might be associated with new refrigeration technologies.

STATED PREFERENCE METHODS

Another approach, called the stated preference method, is to present people with hypothetical scenarios that ask them to choose, in a survey format, between an ecosystem good or service and something with a clear dollar value, such as an increase in property tax. To pass academic muster, these studies are much more structured and carefully designed than simple opinion polling (Kopp et al. 1997). Stated preference methods are controversial because people's choices are undisciplined by the need to spend their own, real money, which in principle may lead them to overstate their willingness to pay. Care must also be given to clearly defining and isolating the good or service in question and framing the choice problem in a way that does not bias the responses. Nevertheless, stated methods are an improvement relative to evaluation techniques that ignore social preferences (Carson et al. 2001).

BENEFIT TRANSFER METHODS

Finally, mention should be made of benefit transfer methods, which take existing valuations derived from any of the aforementioned methods and transfer them to new landscape and resource contexts. Benefit transfer studies are desirable because they avoid the costs of conducting original valuation research. However, the transfer of valuations from one ecological and social context to another is dangerous, because ecosystem values are highly dependent on location (addressed in more detail under "Critical Interpretation of Ecological Valuations," below. Benefit transfer involves statistical methods designed to control for similarities and differences in spatial context and adjust the transferred valuation accordingly.

Researchers have assigned economic values to a wide range of ecosystem goods and services in specific spatial and social contexts. A review of existing valuation studies is beyond the scope of this paper (see Boyd and Krupnick 2009 for a review, and the Environmental Valuation Reference Inventory database of available studies). In general, the non-market valuation methods described above have a long history and are considered within economics to be a valid, if imperfect, approach to the problem of missing prices associated with public environmental goods (Freeman 1993). As a rule, the academic valuation literature finds clear evidence that ecological systems and the goods and services they produce are indeed economically valuable.

CRITICAL INTERPRETATION OF ECOLOGICAL VALUATIONS

The section titled "Arguments Against Economic Valuation" described a set of philosophical critiques of valuation as a tool to positively influence conservation outcomes. "Prices vs. Value vs. Performance" added a caution relating to the inherent difficulty of deriving credible economic values for large ecological changes or the "importance of nature." To improve the conservation community's sophistication as users and interpreters of valuation studies, several additional issues are worth noting.

[7] For an example, see McConnell (1992).

Most Valuation Results are Incomplete.

Most published valuations of ecosystem goods and services are incomplete measures of the resource's value. In general, this is obvious to the economists conducting the study, and is often explicitly acknowledged in the study. It may not always be obvious to the non-economic reader or consumer of the study, however.

Valuation studies often detect the value of ecological resources to neighboring households or businesses (via hedonic analysis) or recreators who travel to the site (via travel cost methods). But such studies usually do not and cannot measure the full ecosystem service benefits associated with the resource.

Consider a concrete example, cited earlier (Mahan et al. 2000), that used the hedonic valuation technique to measure the value of wetlands to a neighboring community in Portland, Oregon. The study found that larger wetlands increased property values, as did proximity to wetlands. Specifically, reducing the distance to the nearest wetland by 1,000 feet increased property values on average by US $436. But this result is a decidedly incomplete measure of the wetlands' value, as the authors take care to acknowledge. It is instructive to reflect on why that is true. The hedonic analysis *only* captures the wetland's benefits to neighboring property owners — their value as aesthetically appealing open space, for example. The analysis does not capture the aesthetic value enjoyed by commuters, visitors, or other transient beneficiaries.

More important, local property values do not capture the wetlands' role in larger habitat and hydrologic systems. For example, the wetlands may slow flood pulses (reducing flood damage), clean and replenish groundwater (reducing treatment costs and health risks), lead to greater surface water quality (improving recreational experiences and supporting aquatic species), and provide habitat for migratory species such as birds. Some of these benefits may accrue to local property owners, but not all. To the extent the wetland benefits systems and beneficiaries further afield, benefits based on local property price premiums will understate benefits.
As a general rule, valuation studies have only the time and resources to measure one particular benefit of a resource or ecosystem (e.g., the benefits of open space or surface water quality enhancement) enjoyed by one set of beneficiaries (e.g., neighboring households or tourists). This is true because, typically, different ecosystem benefits and beneficiaries must be analyzed with different data and econometric methods. In principle, the full range of ecosystem benefits can be measured, including "off-site" benefits that arise due to a resource's productivity across a watershed, aquifer system, habitat mosaic, or air shed. However, in practice this is rare, in part due to the cost and difficulty of economic study, and in part to the cost and difficulty of biophysical analyses that track systems of biophysical production across larger landscapes.

If an ecological valuation appears to be low, one reason may be that the valuation is capturing only a subset of the resource's benefits — a point that should be kept in mind when conservation organizations use academic valuation studies for communication and planning purposes.

Ecological Values Depend on the Resource's Location.

A second valuation issue worth noting is that the value of most ecosystem goods and services is highly dependent on their location (and sometimes the timing of their delivery). The dependence of value on location complicates the interpretation and extrapolation of one valuation study to other locations and decision contexts. Usually an ecosystem service value detected by one study in one place cannot simply be transferred to another place.

Spatial analysis — and interpretation — is fundamental to ecosystem service valuation because both the biophysical production of goods and services and the social determinants of their benefits depend upon the landscape context (Bockstael 1996; Polasky et al. 2008). From an ecological perspective, geographic context matters for several broad reasons. First, ecological production can exhibit scale and connectivity effects — for example, where a whole produces much more than the sum of unconnected parts. Second, natural systems are often characterized by movement: air circulates, water runs downhill, species migrate, seeds and pollen disperse. Moreover, the movement of one biophysical feature (e.g., water) tends to trigger the movement of other things, like birds and fish. As noted above, the consumption of ecosystem services often occurs off-site. Water purification, flood damage reduction, pollination, pest control, and aesthetic enjoyment are all services typically enjoyed in a larger area surrounding the site in question.

Spatial context matters for another reason as well, this one related to the economic value of a given ecosystem service. As economic commodities, ecosystem goods and services resemble real estate rather than cars or bottles of dish soap. The value of real estate is highly dependent on its location — the features of the surrounding neighborhood — because a given house or building cannot be easily transported to another neighborhood. In contrast, cars or soap can easily be moved around (shipped from one location to another), so their value tends to be independent of their geographic location.

The value of irrigation and drinking water quality depends on how many people depend on the water, which is a function of where they are in relation to the water. Flood damage avoidance services are more valuable the larger the value of the lives, homes, and businesses that are protected from flooding. Species important to recreation (for anglers, hunters, birders) are more valuable when more people can enjoy them.

Values Depend on the Presence of Other Goods and Services.

Placing a value on ecosystem goods and services also requires us to analyze the presence of substitutes for the good. The value of any good or service is higher the scarcer it is. How do you measure the scarcity of an ecosystem good? If recreation is the source of benefits, substitutes depend on travel times. The value of irrigation water depends on the availability (and hence location) of alternative water sources. If wetlands are plentiful in an area, then a given wetland may be less valuable as a source of flood pulse attenuation than it might be in a region in which it is the only such resource. In all of these cases, geography is necessary to evaluate the scarcity and presence of substitutes.

Finally, many ecosystem goods and services are valuable only if they are bundled with certain manmade assets. These assets are called “complements” because they complement the value of the ecosystem service. Recreational fishing and kayaking require docks or other forms of access. For example, a beautiful vista yields social value when people have access to it. Access may require infrastructure — roads, trails, parks, housing — all of which are spatially configured.

Accordingly, in order to judge the relevance of a particular valuation study to a new context, it is necessary to know how socially and biophysically comparable the original and new locations are. Environmental economics has developed a set of methods to “transfer” or adjust results as locations change — so-called benefit transfer methods (Kirchoff et al. 1997).

Valuations Will Change Over Time.

A final valuation issue is that ecological valuations are likely to change over time, perhaps substantially. The date of valuations from the published literature, some of which go back decades, should be kept in mind. Supply and demand conditions almost certainly will dramatically change in parts of the world, due to climatic and demographic factors. Less supply and more demand (e.g., for freshwater) will lead to higher valuations than are currently detected.

Also, our knowledge of ecological phenomena is undergoing rapid change.[8] With greater social knowledge will come a change in perceptions of nature’s role in social well-being and economic activity. For those of us in middle and old age, it is worth recalling the vast changes in environmental attitudes seen across our own lifetimes (people used to litter!). And as countries and households in the developing world become richer, their demand for ecological protection is likely to change. While greater wealth may place even greater stresses on ecological systems, it is also possible that rising incomes will lead to relatively greater demand for environmental protection (McConnell 1997).

Valuations derived decades ago need not reflect current social preferences, nor will current valuations necessarily predict preferences in several decades' time. Conservationists are often concerned with ecological threats and losses on a decadal timescale. It is worth repeating that contemporary valuation estimates only tell us about current preferences, based on current supply and demand conditions. We can expect that supply and demand conditions will change over time (leading to different, virtual, non-market ecological prices), and that society’s underlying preferences themselves may change as knowledge and incomes change.

COMMUNICATING AND QUANTIFYING NATURE’S ECONOMIC BENEFITS WITHOUT DOLLARS

This review has focused on studies, results, and methods designed to put a dollar value on ecosystems for the component goods and services they produce. Dollar-based valuations can be a clear and powerful way to convey the message that nature is valuable, and to influence decisions and discourse. However, monetary estimates of nature’s benefits based on sophisticated statistical techniques rooted

[8] The fact that we inadequately understand ecological systems triggers another valuation issue for economists: the value of improved ecological information. When we act in the presence of uncertainty, mistakes are made. Knowledge that helps us avoid costly mistakes has value. For a discussion of the value of improved ecological information, see Boyd (2010).

in economic theory are not necessarily the only way to quantify and communicate the connection between conservation and economic well-being.

An argument made throughout this paper is that valuation can be thought of as a process by which decision-makers and communities learn about nature's role in our lives. Academically sophisticated valuation methods can foster this learning but can also inhibit it. Monetary assessments of conservation benefits often rely on opaque statistical procedures and involve unstated or unclear assumptions. As noted earlier, they also may capture only a fraction of the ecosystem's benefits, and they communicate via a fairly abstract, oversimplified outcome measure, dollars.

There is an alternative approach to economic quantification: ecosystem benefit indicator (EBI) analysis can be applied to ecosystem conservation and management decisions. EBIs are measurable features of the physical and social landscape that relate to and describe the value of ecosystem goods and services (Boyd and Wainger 2002, 2003). Example indicators include:

- The number of farms that would benefit from an increase in summer water flows as a result of conservation that improves retention of upstream precipitation
- The number and/or value of buildings, farms, and roads in floodplains protected by wetland protection and restoration
- The number of recreators who will benefit from increased open space and species populations

Other economically relevant, and measurable, indicators include:

- The scarcity, at the scale of the neighborhood, watershed, region, wetlands, open space, habitat, or other ecological features (in general, the scarcer the feature, the more valuable)
- The presence of ecological or social features that complement the resource, such as streams or lakes that add to the experience of forest recreation or trails and docks that provide access to natural resources for recreators

All of these indicators, and others like them, are relatively easy to measure using existing social and environmental datasets, geo-referenced data in particular (such as census and land-cover data).

Arguably, EBIs can help conservationists tell the "ecosystem service story" more clearly and comprehensively than a strategy that focuses on dollar valuation alone. EBIs are quantitative, so they provide audiences with real, verifiable facts. They also permit an intuitive appreciation of economic principles (such as the importance of scarcity to value) that may otherwise be obscured by jargon or complicated statistical models.

Ecosystem Benefit Indicator Example

Consider the following entirely hypothetical comparisons of two wetlands, one based on a monetary valuation study, another on an EBI evaluation. Services provided by the two wetlands could be analyzed by economists and monetary valuations derived, leading to the result that:

- Wetland A's ecosystem services are worth US $723, 000
- Wetland B's ecosystem services are worth US $537, 000

Alternatively, an EBI analysis could compare the two wetlands in the following way.

WETLAND A:

- Is visible from 712 acres occupied or used by homeowners, businesses, commuters, and recreators
- Protects 23 drinking water wells from saltwater intrusion
- Protects US $5 million in private and public property from flood damage

WETLAND B:

- Is visible from 600 acres occupied or used by homeowners, businesses, commuters, and recreators
- Protects 67 drinking water wells from saltwater intrusion
- Protects US $3 million in private and public property from flood damage

Assume that all the facts present in the EBI result were factored into the dollar valuation. Now compare these two study results purely as forms of communication. It is possible that for some decision-makers and stakeholders, the EBI approach will be perceived as less philosophically offensive (because it avoids a description of ecological value in monetary terms), more enlightening (because it more intuitively conveys the connection between ecology and human concerns), and more useful to conflict resolution and consensus (because it clarifies rather than obscures tradeoffs).[9]

The disadvantage of the EBI approach is that is does not directly answer the question: Which wetland is more valuable? Rather, it presents information that allows stakeholders to learn, deliberate, and adjust preferences in order to arrive at their own preference ranking. In contrast, a conventional monetary valuation study would attempt to measure those preferences more directly by observing previous behavior and choices.

The comparison between monetary valuation methods and EBI evaluation is in no way meant to suggest that one is better than the other; in fact, the two methods are complementary. But sophisticated monetary valuations tend to get the lion's share of attention when we think of economic assessment of ecosystem services. This is unfortunate, not only because EBIs are potentially a valuable way to provide useful economic information and communicate ecosystem service benefits, but also because they allow more comprehensive evaluations of multiple goods and services, given limited budgets for analysis. An EBI approach to assessment of ecosystem services benefits may be well-suited to conservation strategy, particularly when a conservancy's goals include stakeholder learning, communication, and conflict resolution.

CONCLUSIONS

The economic value of ecosystem goods and services is real, often large, and relevant to a wide range of decision-makers and stakeholders. Economic arguments, language, and outcomes are already helping the conservation movement influence decisions and recruit a wider set of partners. Economic arguments are not a substitute for biophysical and ethical arguments in favor of conservation. Rather, they complement other conservation motivations by enriching the description of nature's role in our personal and community well-being. Economic valuation's role as a mode of communication and a guide to conservation policy and planning will — and should — continue to grow.

But as surely as economic arguments will be used to make the case, so too will they generate skepticism, if not outright opposition. It is incorrect to associate economic analysis with selfish, profit-driven motives or private ownership of otherwise public resources. To be sure, economic analysis can and does concern itself with nature's role in markets, profit maximization, and property ownership. But it is in no way confined to those spheres. The value of beauty, cultural significance, and stewardship of species other than our own can also be expressed and measured economically.

A more legitimate question to raise about economic valuation is the degree to which it actually works for conservation as a communications and motivational tool. It may be that ethical and emotional arguments in favor of conservation dwarf economics' more rational, utilitarian arguments. On the other hand, there is ample evidence that economic arguments for conservation are in demand — by government, community, corporate, and NGO decision-makers. It is also clear that monetary estimates of the value of ecosystem services could immediately be applied within decision frameworks that already measure outcomes in economic terms (e.g., regulatory impact analyses, national economic accounts, natural resource damage assessments, and environmental markets).[10]

By providing an overview of valuation methods — including a review of common assumptions — this article attempts to empower conservation leaders with a more sophisticated understanding of valuation's strengths and weaknesses. Valuation results usually require careful interpretation in order to clearly understand what is being valued and what is not, how current values relate to future values, and whether or not values can be transferred to other conservation contexts. Informed consumers of valuation studies will be able to use their results — and counter objections — more effectively.

Finally, ecosystem valuation should be thought of not just as a technique to generate dollar-based arguments in favor of conservation. Economics can help conservationists tell stories that convey the connections between nature conservation and social well-being. Economic analysis of ecosystem services may yield the greatest strategic benefit to conservation if it is pursued as a process designed to educate, communicate, and deliberate, rather than as a way to simply monetize nature's value.

[9] The tradeoff comes from the fact that Wetland B provides more well water protection, whereas Wetland A provides more aesthetic and flood protection services.
[10] See Scarlett and Boyd (2011) for a review of decision frameworks amenable to or already employing ecosystem service valuations.

REFERENCES

Banzhaf, H. Spencer, W. Oates, J. Sanchirico 2010. Success and design of local referenda for land conservation. *Journal of Policy Analysis and Management* 29(4):769–798.

Bockstael, N. 1996. Modeling economics and ecology: The importance of a spatial perspective. *American Journal of Agricultural Economics* 78:1168–1180.

Bockstael, N., A. M. Freeman, R. Kopp, P. Portney, and V. K. Smith. 2000. On measuring economic values for nature. *Environmental Science and Technology* 34(8):1384–1389.

Boyd, J. 2010. *Ecosystems and climate adaptation.* Issue Brief 10-16. Washington, DC: Resources for the Future.

Boyd, J., and A. Krupnick. 2009. *The definition and choice of environmental commodities for nonmarket valuation*. DP-09-35. Washington, DC: Resources for the Future.

Boyd, J., and L. Wainger 2003. *Measuring ecosystem service benefits: The use of landscape analysis to evaluate environmental trades and compensation.* DP-09-35. Washington, DC: Resources for the Future..

Boyd, J., and L. Wainger 2002. Landscape indicators of ecosystem service benefits. *American Journal of Agricultural Economics* 84(5):1371–1378.

Boyles, J., P. Cryan, G. McCracken, and T. Kunz 2011. Economic importance of bats in agriculture. *Science* 331 (6025):41–42.

Carson, R., N. Flores, and N. Meade. 2001. Contingent valuation: Controversies and evidence. *Environmental and Resource Economics* 19:173–210.

Costanza, R., R. D'Arge, R. DeGroot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. O'Neill, J. Paruelo, R. Raskin, Paul S., and M. Van Den Belt 1997. The value of the world's ecosystem services and natural capital. *Nature* 387:253–260.

Foster, J. 1997. *Valuing nature: Economics, ethics and environment*. New York: Routledge.

Freeman, A. M. 1993. *The measurement of environmental and resource values: Theory and methods*. Washington DC: Resources for the Future.

Gregory, R., S. Lichtenstein, and P. Slovic 1993. Valuing environmental resources: A constructive approach. *Journal of Risk and Uncertainty* 7:177–197.

Heal, G. 2000. Valuing ecosystem services. *Ecosystems* 3(1):24–30.

Kirchhoff, S., B. Colby, and T. LaFrance. 1997. Evaluating the performance of benefit transfer: An empirical inquiry. *Journal of Environmental Economics and Management* 35:75–93.

Kopp, R. J., W. Pommerehne, and N. Schwarz, eds. 1997. *Determining the value of non-marketed goods: Economic, psychological, and policy relevant aspects of contingent valuation methods*. Boston, MA: Kluwer Academic Publishers.

Macauley, D. 2006. Selling out on nature. *Nature* 443:27–28.

Mahan, B., S. Polasky, and R. Adams. 2000. Valuing urban wetlands: A property price approach. *Land Economics* 76(): 100–113.

McConnell, K. 1992. On-site time in the demand for recreation. *American Journal of Agricultural Economics* 74:918–925.

McConnell, K. 1997. Income and the demand for environmental quality. *Environment and Development Economics* 2:383–399.

Moore, R., T. Williams, E. Rodriguez, and J. Hepinstall-Cymmerman. 2011. *Quantifying the value of non-timber ecosystem services from Georgia's private forests.* Athens, GA: Warnell School of Forestry and Natural Resources, University of Georgia.

Polasky, S., E. Nelson, J. Camm, B. Csuti, P. Fackler, E. Lonsdorff, C. Montgomery, D. White, J. Arthur, B. Garber-Yonts, R. Haight, J. Kagan, A. Starfield, and C. Tobalske. 2008. Where to put things? Spatial land management to sustain biodiversity and economic returns. *Biological Conservation* 141:1505–1524.

Ruhl, J. B., S. Kraft, and C. Lant. 2007. *The law and policy of ecosystem services*. Washington, DC: Island Press.

Sagoff, M. 1996. On the value of endangered and other species. *Environmental Management* 20(6):897–911.

Scarlett, L., and J. Boyd. 2011. *Ecosystem services: Quantification, policy applications, and current federal capabilities*. DP-11-13. Washington, DC: Resources for the Future.

Shabman, L., and K. Stephenson 2000. Environmental valuation and its economic critics. *Journal of Water Resources Planning and Management* 126(6):382–388.

Toman, M. 1998. Why not to calculate the value of the world's ecosystem services and natural capital. *Ecological Economics* 25:57–60.

Vatn, A., and D. Bromley 1994. Choices without prices without apologies. *Journal of Environmental Economics and Management* 26:129–148.

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