

# The Value of Nature and the Nature of Value

Gretchen C. Daily\*, Tore Söderqvist, Sara Aniyar, Kenneth Arrow, Partha Dasgupta, Paul R. Ehrlich, Carl Folke, AnnMari Jansson, Bengt-Owe Jansson, Nils Kautsky, Simon Levin, Jane Lubchenco, Karl-Göran Mäler, David Simpson, David Starrett, David Tilman, Brian Walker

The world's ecosystems are capital assets. If properly managed, they yield a flow of vital services, including the production of goods (such as seafood and timber), life support processes (such as pollination and water purification), and life-fulfilling conditions (such as beauty and serenity). Moreover, ecosystems have value in terms of the conservation of options (such as genetic diversity for future use) (1). Unfortunately, relative to other forms of capital, ecosystems are poorly understood, scarcely monitored, and (in many cases) undergoing rapid degradation and depletion. Often the importance of ecosystem services is widely appreciated only upon their loss.

This is beginning to change, most notably in Australia and Costa Rica. An Australian firm called Earth Sanctuaries, Ltd. was listed on the Australian Stock Exchange in May, making it the world's first conservation company to go public. The U.S.\$25-million firm buys up land (90,000ha so far) and restores native vegetation and wildlife, earning income from tourism, consulting, and wildlife sales (2). The firm lobbied for and won a change in accounting law so as to include its rare native animals as assets. Meanwhile, the Sydney Futures Exchange is positioning itself to be a global leader in the trading of ecosystem services, from carbon sequestration (the withholding of carbon, a greenhouse gas constituent, from the atmosphere by plants and soils) to 'new environmental products,' such as credits for clean water and biodiversity. The CEO of State Forests of New South Wales is promoting a vision of foresters marketing a wide array of ecosystem services, with timber as a 'by-product' (3). The Commonwealth Scientific and Industrial Research Organization and The Myer Foundation have just launched the most advanced assessment of ecosystem assets in the world (4).

Since 1997, the government of Costa Rica has been paying landowners for sev-

eral ecosystem services: carbon sequestration and protection of watersheds, biodiversity, and scenic beauty. The payments, about U.S.\$50/ha-yr, are financed in part by a tax on fossil fuels and are resulting in significant forest conservation and restoration (5). Costa Rica has also sold carbon sequestration credits to several European nations. These and other promising government initiatives are supported by scientific expertise and growing industry participation (6).

Worldwide, ecosystems are being protected or restored to control floods, filter water, enhance soil fertility, stabilize climate, offer human enjoyment, and even to recycle orange peels (7). Such efforts are being rewarded with innovative financial mechanisms, whose scope and variety are expected to grow (see table).

Commodity	Share of farm business (%)
Wheat	40
Wool	15
Water filtration	15
Timber	10
Carbon sequestration	7.5
Salinity control	7.5
Biodiversity	5

**A hypothetical Australian farm business in 20 years (8). In this model, traditional agricultural commodities account for 55% of revenues, as opposed to 100% today. Other income derives from a mature market for ecosystem goods and services.**

These developments all involve putting a price tag on nature, an act seen by many as risky at best (9). To be sure, individuals and societies already assess the value of nature implicitly in their collective decision-making, too often treating ecosystem services as 'free.' Until recently, this was generally safe to do: relatively speaking, ecosystem capital was abundant and the impacts of economic activity were minimal. Ecosystem capital is becoming ever scarcer (10), however, so that it is now critical to understand both how to value ecosystems and the limitations of such valuations.

## Ecological Basis for Valuation

To establish sound policy, the 'production functions' describing how ecosystems generate services need to be characterized, and the interactions among these functions quantified. To begin, a cataloguing of the sources and consumers of ecosystem services is needed. For any given location, this would document service flows occurring locally (such as pest control, serenity), across regions (such as timber export and flood control), and globally (such as climate stabilization).

The production functions would also reveal critical points and interdependencies in the supply of services, and the time scales over which services are amenable to repair. Yet these are poorly known now and are likely to remain elusive. Ecosystems typically respond nonlinearly to perturbation. For example, gradual increases in salinity for decades went unnoticed by farmers in Australia, but have now reached crisis levels. Replanting native vegetation reduces soil salinity (a benefit) but also reduces river flow (a cost). Furthermore, ecosystems are idiosyncratic; what holds true in one region may not apply well elsewhere. Soil salinity appears controllable with ecosystem approaches in eastern parts of Australia, for example, but in Western Australia the threshold is higher and there is little hope for reversal without enormous investment. Putting theory into practice will therefore require locally based information.

## Principles of Valuation

There are three fundamental steps of decision-making. In this context, all require integration of ecological and economic understanding. The first step, identification of possible alternatives, is probably the most important but also the most underrated. Often the identification of alternatives is guided by narrow conventions: if a city is expanding its water treatment system, engineers may evaluate different physical treatment plants, ignoring ecosystem approaches (watershed or wetland management).

The second step requires that all impacts be identified and measured for each alternative: everything from immediate needs for labor, capital, and other inputs to long-term biophysical and social impacts. Rarely does sufficient knowledge exist to make precise estimates, but it is important to try to quantify uncertainties and the risks of proceeding.

The final step, valuation, translates the consequences of maintaining the status quo and opting for each alternative into comparable units of impact on human well-being, now and in the future. These

\*The corresponding author is in the Dept. Biological Sciences, Stanford U., Stanford, CA 94305 USA. All authors are affiliated with The Beijer Institute, The Royal Swedish Academy of Sciences, Box 50005, S-104 05 Stockholm, SWEDEN. The Beijer Institute provided the impetus and forum for this work.

1 impacts are defined in terms of the re-  
2 sources people would be willing to forego  
3 to get the goods, services, or other out-  
4 comes associated with a particular alterna-  
5 tive. The common measuring unit is typi-  
6 cally monetary (11).

7 Embedded in this process are several  
8 general principles: (i) Public policy deci-  
9 sions involve making incremental, not  
10 revolutionary, changes to the status quo.  
11 Calculating the total value of ecosystem  
12 services, by contrast, is not very helpful.  
13 (ii) In a democratic society, values used in  
14 social decision-making ought to be de-  
15 rived from those held by its individual  
16 citizens, and not be imposed by the state.  
17 (iii) We should infer peoples' values as  
18 they are revealed by actual decisions  
19 whenever possible.

### 21 Scope and Limitations of Valuation

22 In practice, valuation of ecosystem assets  
23 involves some of the oldest problems in  
24 economics: revealing and aggregating  
25 preferences, and addressing uncertainty.  
26 There are drawbacks associated with most  
27 ways of inferring value. Market prices of-  
28 ten do not reflect the full social costs of  
29 production (12); moreover, most services  
30 are not presently traded on markets. Meth-  
31 ods of indirect revealed preference (for  
32 example, valuing clean air by comparing  
33 land rents in clean vs. polluted areas) are  
34 not relevant to setting a value on the exis-  
35 tence of certain assets (such as the satis-  
36 faction derived from contemplating the  
37 existence of a tropical rainforest). Ap-  
38 proaches based on avoidance of costs (for  
39 example, valuing natural water purifica-  
40 tion at the cost of its technological alterna-  
41 tive, a filtration plant for instance) provide  
42 only partial, lower bound indications of  
43 value, especially for services without ade-  
44 quate substitute (such as global climate  
45 regulation). Contingent valuation surveys  
46 (that try to elicit how individuals value  
47 hypothetical incremental changes) are im-  
48 proving but still notoriously unreliable,  
49 especially when applied to issues with  
50 which the public is unfamiliar.

51 Reliance on individual preferences to  
52 construct social values, although defensi-  
53 ble on ethical grounds, has serious pitfalls.  
54 Preferences depend on institutional con-  
55 text – how much individuals know about  
56 the environment, for instance (13). The  
57 outcome of economic valuation is in this  
58 respect not more informed than the people  
59 whose values are being assessed.

60 Even if we were able to measure indi-  
61 vidual values accurately, we still must de-  
62 termine how to aggregate these into a so-  
63 cial value. Ultimately the weights used  
64 involve a value judgement; there is no  
65 'correct' answer. Treating all people

equally is appealing in principle but by no  
means universally accepted.

Measurement of incremental values  
works best when the increments are small  
so that a change in one service will have  
minimal feedbacks through the rest of the  
system. Values of various increments can  
then be estimated separately and simply  
added. Unfortunately, this condition is dif-  
ficult to meet for ecosystem services,  
where the underlying systems tend to be  
highly interdependent and seemingly small  
changes in one place cause large impacts  
on the overall system (14). The level of  
uncertainty in our understanding of eco-  
logical processes suggests that it would be  
prudent to avoid courses of action that  
involve possibly dramatic and irreversible  
consequences and, instead, to wait for bet-  
ter information.

Another key problem is the relative  
weight put on current versus future costs  
and benefits. The choice of 'discount rate'  
is very important where a long time frame  
is involved; sufficiently high discounting  
can be used to justify policies that exploit  
resources now at the expense of substantial  
environmental costs later. Individuals tend  
to discount their own futures, whereas  
'equal treatment' would have future gen-  
erations treated the same as current ones.  
Some social discounting is consistent with  
such equity if future generations will be  
better off than current ones, a situation that  
may not continue to prevail (15).

### The State of the Art

Valuation is a way of organizing informa-  
tion to help guide decisions, but not a solu-  
tion or end in itself. It is one tool in the  
much larger politic of decision-making.  
Wielded together with financial instru-  
ments and institutional arrangements that  
allow individuals to capture the value of  
ecosystem assets, however, the process of  
valuation can lead to profoundly favorable  
effects (16).

The rapid institutional change presently  
underway is inspiring for several reasons.  
It shows that the most important decisions  
to get right are those where benefits  
greatly outweigh costs or vice versa, and in  
such cases complete accuracy is unneces-  
sary. For example, by constructing crude  
lower bound estimates for the value of  
natural water purification services, mu-  
nicipalities worldwide are determining that  
preserving or restoring natural services is  
often preferable to constructing a water  
filtration plant (17). The new initiatives  
also account for the interdependence of  
services; in Australia and Costa Rica, for  
instance, multiple services are being bun-  
dled to achieve the desired relative in-  
creases in supply via changes in land use.

With luck, the protection of well-known  
or highly valued services (such as salinity  
control and carbon sequestration) will suf-  
fice, for now, in preserving those that are  
poorly known (such as pollination) (18).  
Finally, the initiatives are generating de-  
mand for, and spurring the development  
of, integrated ecological-economic-social  
approaches to managing ecosystem assets,  
and the potential for such approaches is  
tremendous.

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